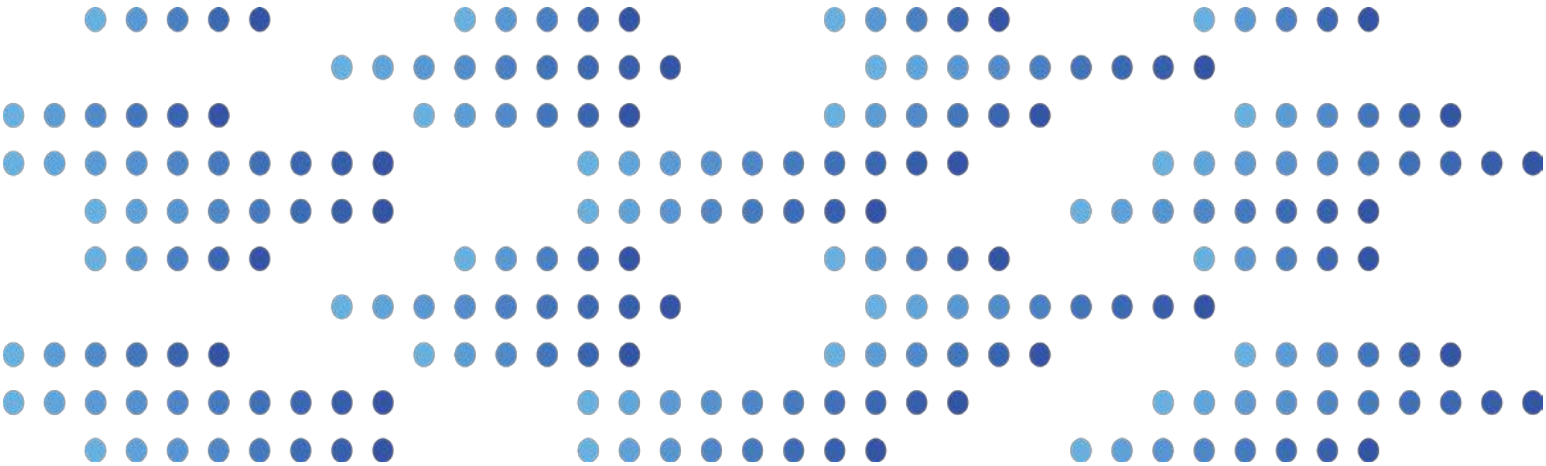
Joint convention on the safety of spent fuel management and on the safety of radioactive waste management

NATIONAL REPORT FROM THE UNITY OF THE REALM

DENMARK

GREENLAND

6TH REVIEW MEETING



2018

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

Danish Health Authority
Radiation Protection
Knapholm 7
2730 Herlev
Denmark

www.sis.dk

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Introduction

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

The Kingdom of Denmark encompasses Denmark, Greenland and 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 radioactive waste management, Greenland is thus under obligation to report independently to the Convention on the application of widely recognized principles and tools for high-quality safety management of radioactive waste.

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

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

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[1] The Greenland Self-Government Arrangement

[2] Politics in Greenland

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Contents

Section A. Introduction

The present report is the Danish National Report for the sixth Review Meeting to the Convention. The meeting takes place from 21 May to 01 June, 2018 at IAEA headquarters, Vienna. As described in the Guidelines regarding the Form and Structure of National Reports, (INFCIRC/604 rev. 3, 18 December 2014) duplication within the reporting, including repetition of former reports, should be avoided. At the same time it is stated that the report should be a stand-alone report. Consequently, Denmark has in this report decided to focus on what is considered highlights and new developments since the National Report from the Fifth Review Meeting. Readers wishing a more detailed description of the Danish practices and understanding of the development before 2015 will find the former reports as well as the questions and answers submitted via the homepage for the Joint Convention.

Main developments since the 2015 meeting fall within the following areas of work: 1) decommissioning of Danish Reactor 3 (DR 3), 2) decommissioning of the Hot Cell Facility, 3) decommissioning and clearance measurement of the Fuel Fabrication Facility and 4) the process leading to a final national management solution for LILW (Low and Intermediate Level Waste). Below, the current status is briefly summarised.

The Danish nuclear facilities are all located on the Risoe peninsula to the North of Roskilde. Decommissioning has been in progress since 2003, when responsibility for operation and decommissioning of the nuclear facilities, as well as continued waste management at the Waste Management Plant was transferred to Danish Decommissioning (DD). DR 1 (Danish Reactor 1) is fully decommissioned and released from regulatory control. As of 2008, DR 2 (Danish Reactor 2) is also fully decommissioned, but the reactor building has not been released from regulatory control, as it serves as a handling and storage hall for decommissioning work associated with the Hot Cell Facility and of DR 3. With respect to DR 3, decommissioning work is progressing. A Packing Hut and Manipulator Box unit has been installed on the top of the reactor, and the dismantling of the internal reactor parts and demolition of the reactor block are well under way. The preparatory work for the decommissioning of the Hot Cell Facility is completed, which included the rebuilding of the ventilation system, removal of the shutter houses and shutters and the development of remote handling equipment for blast and vacuum cleaning of the hot cells. The initial decontamination of the individual hot cells has commenced in August 2017. As for the Fuel Fabrication Facility, clearance measurements following the completion of the decommissioning work, showed uranium contamination of a concrete floor below a set of drainpipes in a crawlspace. The decontamination of the contaminated concrete floor awaits completion, before the final decommissioning report can be submitted to the Nuclear Regulatory Authorities.

Since the spring 2015 meeting, the plan to establish a Danish repository was supplemented with two additional lines of effort; a survey of the basis for, and implications of, establishing a long term storage solution, and an effort to explore the options for an international solution for all of the Danish radioactive waste. The three lines of work are conducted in parallel so as to ensure a minimum delay in the efforts to establish a long term solution for management of radioactive waste in Denmark. Currently, the status is that the efforts to seek an export solution for the entire Danish inventory of radioactive waste has been abandoned, while the choice between pursuing a Danish repository or a Danish long term storage solution awaits a governmental decision. Details on the possible solutions are further elaborated in Section H of this report.

The present report also throughout the text considers the challenges mentioned in the Rapporteur's Report for Denmark at the 2015 meeting:

- Taking a decision on a long term management solution for the Danish LILW (addressed in Section H):
    - Long term management policy and program
    - Comprehensive communication plan and public acceptance
    - Site selection process
- Aligning time frames (addressed in Section H):
    - The decommissioning of the nuclear facilities at the Risoe site is coming to an end versus availability of a storage or repository for the Danish radioactive waste.
- Addressing human resource and competence vulnerability (addressed in Section E and Section K)
    - Knowledge and competence compiled in a very small group of people
    - Implementation of EU-BSS directive and the IRRS process will require extensive resources.

The report is prepared by the Danish Health Authority, Radiation Protection under the Ministry of Health, which coordinated contributions from Danish Decommissioning and 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.

Section B. Policies and Practices

Please refer to the previous National Reports[1].

The policy and practice for radioactive waste management is to collect, characterize, manage and store all Danish radioactive waste under safe and secure conditions in dedicated storage facilities under responsibility of Danish Decommissioning.

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

[1]National Reports from Denmark to the Convention:

First National Report.pdf

Second National Report.pdf

Third National Report.pdf

Fourth National Report.pdf

Fifth National Report.pdf

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 as well as radioactive waste from the Danish military or defence programmes, is managed identically to the radioactive waste described in this report, as this kind of waste in Denmark is also covered by the legislative and regulatory system listed in Section E.

Section D. Inventories and Lists

Article 32, paragraph 2

D.1 Spent fuel management facilities

There is no new development regarding spent fuel. The present situation is described below.

There are no spent fuel management facilities in Denmark subject to the Convention. However, minor amounts of spent fuel are stored, under safe and secure conditions with appropriate surveillance, at the Waste Management Plant managed by Danish Decommissioning. Special precautions for heat dissipation are not necessary for these materials. An inventory of the stored spent fuel is given in Table 1.

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

Table 1: Inventory of spent fuel, listing the activities as of January 2017. The list was verified in May 2017.

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

D.2 Radioactive waste management facilities

An overview of nuclear facilities and associated buildings at Danish Decommissioning is given in Figure 1. Building numbers and their respective names are listed in Table 2.

A new evaporator, sized to handle the current amounts of waste water produced at the Risoe site, was installed in 2016 at Waste Management Plant.

Following inspection and approval by the Nuclear Regulatory Authorities ultimo 2005, the Radiological Characterization Laboratory for sampling and characterisation of materials from the nuclear facilities, buildings, and surroundings has in 2016 undergone external audit of quality assurance according to DS/EN ISO 9001: 2008. As an example all filled drums intended for storage in the Low Level Waste Storage are characterized using Ge-detectors prior to storage.

The Clearance Laboratory for decommissioning waste upholds an independent accreditation (ISO/IEC 17025:2008), granted by DANAK in 2007, and confirmed during the latest audit in 2016. The Clearance Laboratory handles clearance tasks with no restrictions on the amount or type of decommissioning waste.

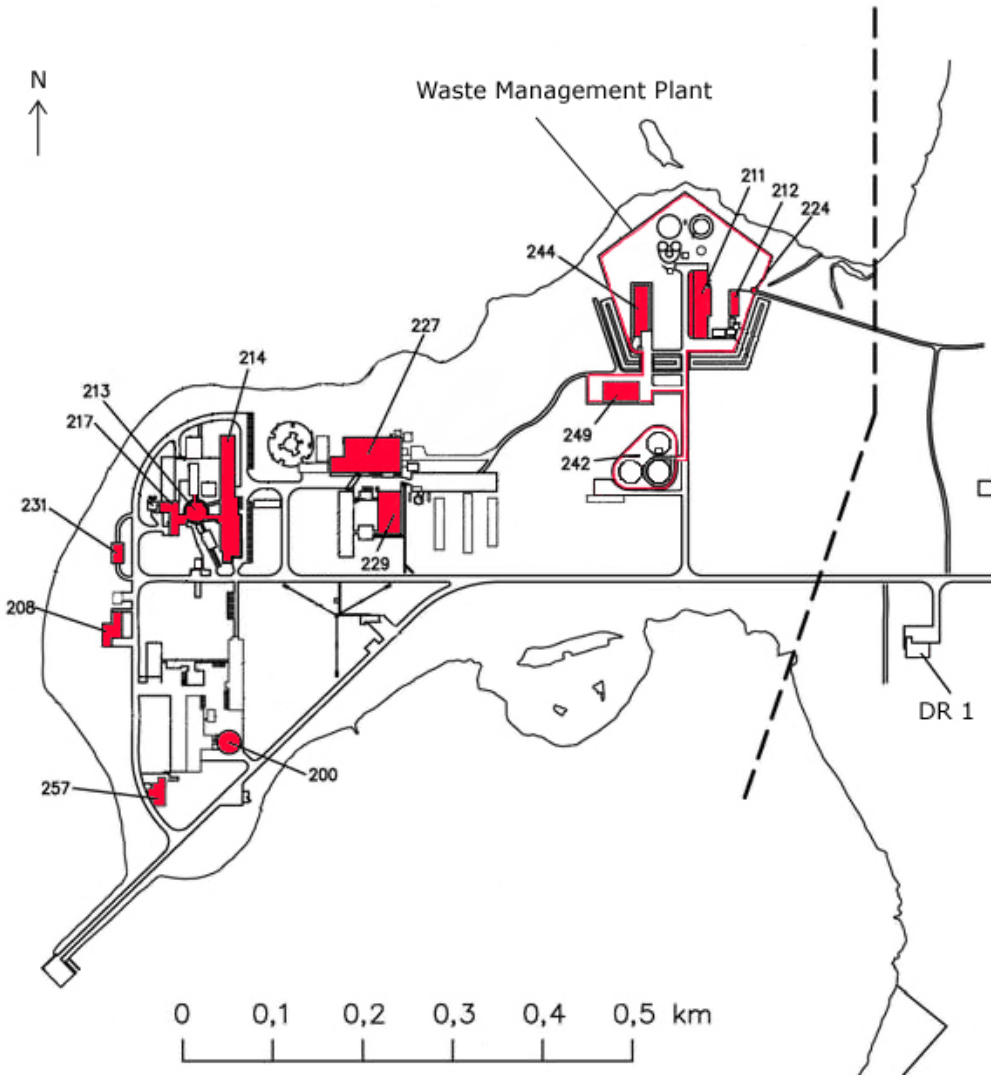


Figure 1. Nuclear facilities and associated buildings at the Risoe site managed by DD. Names of buildings in Danish as well as English are listed in Table 2. Danish names refer to nomenclature used in previous reports. The evacuation zone of Danish Decommissioning is to the West (left) of the stippled line.

Since the publication of the Fifth National Report from Denmark, a total mass of 60 tons of material has passed the clearance criteria and has been released from regulatory control.

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

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

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

Table 2: List of buildings at Danish Decommissioning

Storage facility	Volume (m^3)	Activity (TBq)
Low Level Waste Storage	~1,200	6

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

Storage facility	Mass (tons)	Activity (TBq)
Drum Storage and Centralvej Storage	~130	473
Taillings pools and ore heap	4,800	0.1
Intermediate Storage	808	112

Table 4: Inventory of unconditioned radioactive waste stored at Danish Decommissioning as of January 2017, classified as low and intermediate level waste (LLW and ILW). The list was verified in May 2017.

The main portion of the activity in the Intermediate Storage is placed in two specially shielded containers, the top shield of the reactor tank from the former reactor DR 3 and a number of fuel element plugs. The most active component – the Top Shield Plug (TSP) was already emplaced at the Intermediate Storage, when the last report was compiled and therefore the total activity in the Intermediate Storage has decreased due to decay of short lived activity (dominated by ^{60}Co). Together the two containers contain 110 TBq activity as of January 2017.

In 2015, volume reduction through waste incineration was carried out at Studsvik Nuclear AB in Sweden. During this volume reduction campaign, 8352 kg of combustible radioactive waste was sent for incineration. The combustible radioactive waste sent for incineration consisted of: 2278 kg wood, 1574 kg plastic, 759 kg combined paper and cardboard, 382 kg metal, 310 kg rubber, and 3051 kg mixed waste. The total activity of the combustible radioactive waste was 38 MBq before the incineration. Once incinerated the resulting waste residue consisted of 1550 kg compressed air filters, 745 kg ashes and dust, in addition to 151 kg steel. The residue waste currently awaits transport from Studsvik Nuclear AB back to the Risoe site.

Internal waste handling procedures at Danish Decommissioning have been updated to ensure compliance with Studsvik Waste Acceptance Criteria for future incineration, in order to optimise the effect of volume reduction by incineration in comparison with the 2015 campaign.

Year	2014	2015	2016
Secondary waste from the Risoe site	1.5 tons	7.4 tons	6.9 tons
Secondary waste from external waste producers	4.9 tons	3.0 tons	4.2 tons

Table 5: Unconditioned waste produced/received (decommissioning waste not included).

Secondary waste generated during the decommissioning activities at the Risoe 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 received from external waste producers (i.e. hospitals, industries etc.) generally vary between 2 and 6 tons per year, and the amounts received since the last report are thus within the normal range.

D.3 Nuclear facilities under decommissioning

The decommissioning work at the Risoe site is progressing, and in the following a status is given for the completed decommissioning work and for the ongoing decommissioning work at the Risoe Site. The emphasis is on the decontamination of the Hot Cell Facility and the dismantling of the inner parts of DR 3, which were highlighted as challenges 2015 Rapporteur's Report.

An overview of the decommissioning status of each nuclear facility at the Risoe site is given in Table 6. Details on completed and ongoing decommissioning activities at the Hot Cell Facility, DR 3 and the Fuel Fabrication 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	DR 1 is 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	Reactor Containment Hall is fully decommissioned, but the building is currently being used for storage and handling of waste objects prior to final release from regulatory control.
Danish Reactor 3 (DR 3)	10 MW heavy water research reactor of the PLUTO type	2000	The final decommissioning plan was approved by the regulatory authorities at the end of 2011. Peripheral systems and primary cooling system are fully dismantled. TSP and Top Shield Ring (TSR) have been removed and remote plasma cutting of the Reactor Aluminium Tank (RAT) is ongoing.
Hot Cell Facility	Facility for post irradiation investigations of nuclear fuel	1989	In 2012 the project was put back into a planning phase. A new strategy was chosen and now remote blasting of the cells is in progress.
Fuel Fabrication Plant	Fuel Fabrication Plant for DR 2 and DR 3	2002	Decommissioning to »green field« is on-going. The work was finished early 2014, but slight contamination in the basement was discovered afterwards and is to be removed.

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

D.3.1 Danish Reactor 1 and Danish Reactor 2

The decommissioning of the DR 1 reactor and the DR 2 reactor was successfully completed in 2005 and in 2008, respectively. The building and nearby surroundings of the DR 1 reactor were released from regulatory control in 2006, while the reactor building of DR 2 still is in use as a handling and storage facility for large and/or heavy objects as well as other waste objects from the on-going decommissioning projects at the Risoe site. Details on the decommissioning of DR 1 and DR 2 reactors are given in the Third National Report.

D.3.2 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.

D.3.2.1 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

D.3.2.2 Phase 2

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

D.3.2.3 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 Aluminium Tank (RAT) - ongoing
- Graphite reflector - ongoing
- Boral plates - ongoing
- Inner and outer steel tank - ongoing
- Lead shielding – ongoing

Further 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 and at the fifth review meeting.

D.3.2.4 Phase 4

Decommissioning of the biological shield and surrounding buildings. Initial method selection studies have been carried out, in particular related to demolition methods for reactor block barite concrete and shot concrete. The scabbling of the shot concrete has following approval of application to the nuclear regulatory authority been moved forward to phase 3, as decribed below.

Progress since Fifth National Report

Since the Fifth National Report, the following dismantling operations have been completed:

- Packing Hut and Manipulator Box have been installed on top of the Movable Top Shield (MTS)
- Dry ice blasting of the Internal Storage Block (ISB) and one half of the reactor walls have been completed
- Scabbling of the shot concrete on the ISB has been undertaken
- Fuel element plugs have been packed and placed at the Intermediate Storage. The design of the inner container for Top Shield Ring (TSR) is finished and invitation to tender has been send out

Packing Hut and Manipulator Box

In order to facilitate robotic remote dismantling of the internals of the reactor, a plexiglass unit, containing a Packing Hut and Manipulator Box has been installed on top of the MTS (Figure 2). The unit is mounted with a single hydraulic unit. The whole unit is operated from a control room in the basement of the reactor hall (Figure 3).

Figure 2: The Packing Hut and the Manipulator Box installed on the MTS on the reactor top.

The Packing Hut facilitates containment vis-à-vis the reactor pit (Figure 4). This means that the low pressure in the reactor pit can be maintained during the work. The Packing Hut thus provides an enclosure around the reactor pit while the internals of the reactor are being cut and removed using the manipulator arm (Figure 5). The Packing Hut also provides a controlled area

for packing the fragmented components from the reactor pit into steel waste containers, and a safe area where the waste containers can be left until the next working day.

A second enclosure, the Manipulator Box contains the mechanical parts of a robotic manipulator arm (Figure 4 and Figure 5). When the manipulator arm is not in use, it can be retracted to the Manipulator Box.

Figure 3: The control room in the basement, from where the equipment is operated. The screens show pictures from inside the reactor tank.

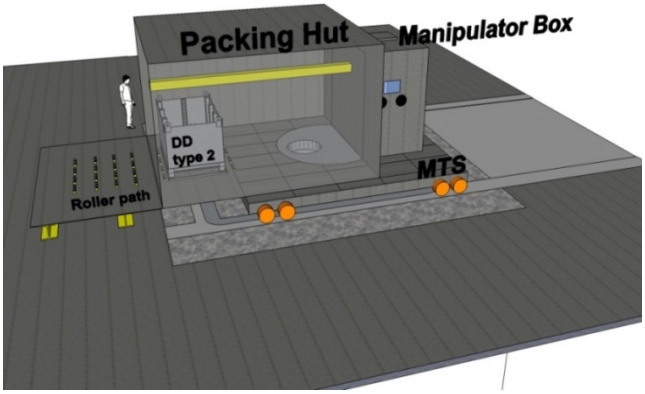


Figure 4: Principal sketch of the Packing Hut and Manipulator Box mounted on the MTS at the reactor top

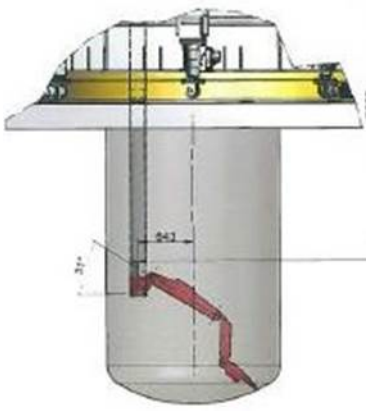


Figure 5: A sketch of the manipulator arm operating in the reactor pit

As previously carried out for the removal of the internal parts of DR 3, an option analysis for the demolishing of the concrete reactor block was made. As the reactor block contains both shot concrete and barite concrete, it proved necessary to apply two different types of tools: A wall

saw will be used to cut out blocks of the barite concrete and steel. For the shot concrete, a scabbler mounted on a Brokk machine turned out to be the most efficient tool.

Prior to the demolition it was necessary to remove paint of walls of the reactor block and ISB as the paint contains PCB, lead and mercury, and thus poses an added working environment hazard. It was chosen to use dry ice (CO_2) blasting to remove the paint on the ISB and the walls of the reactor block (Figure 6 and Figure 7). One advantage of this method for removing paint is that the process does not generate any secondary waste.

Figure 6: The CO2 ice blasting equipment

Figure 7: Removal of paint containing PCB with dry ice blasting on the ISB before scabbling

Dry ice blasting of the Internal Storage Block

Early in 2015 the removal of the ventilation ducts of the Internal Storage Block (ISB) was completed and following the fuel element plugs and rigs were removed from the ISB. Once emptied, the ISB and the reactor block were prepared for dry ice blasting and the dry ice blasting was initiated in mid-2015 to remove the paint (Figure 6 and Figure 7). Dry ice blasting of the ISB and one half of the reactor walls has been completed.

Scabbling of the shot concrete

The scabbling of the shot concrete using the Brokk took place in 2016 and shot concrete was removed as close to the reactor wall as possible (Figure 8). However, approximately 25 % of the shot concrete still remains on the back side of the ISB (Figure 9). The rest of the shot concrete from the ISB will be removed when the reactor block has been removed.

Figure 8: Removal of shot concrete from the ISB next to the D_2O plant room by use of a scabbler on a Brokk.

Figure 9: Shot concrete on the back side of the ISB.

Fuel Element Plugs packed for long term storage

The Fuel Element Plugs (FE-plugs) are made of the same materials as TSP and TSR, and therefore it was decided to store these components in the Jumbo containers containing the TSP and TSR. Eight special corner waste containers for the FE-Plugs were manufactured to fit within the Jumbo containers containing TSP and TSR (Figure 10). Once the FE-plugs were placed in the containers, the empty spaces within these containers were back-filled with shot concrete for extra shielding (Figure 11).

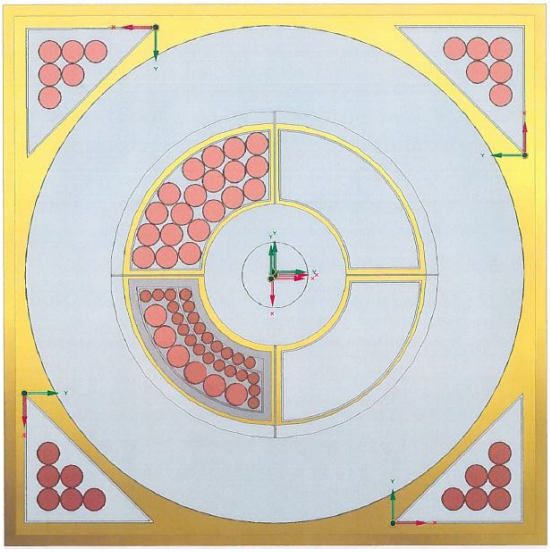


Figure 10: Sketch of the Jumbo container containing the TSR. The four triangular corner waste containers with FE-plugs are also shown. The inner container will be placed in the void of the TSR, and it is designed to be used for packing the FSA-segments in a shielded centrepiece and experimental rigs in the crescent shaped containers.

Figure 11: A corner container filled with fuel element plugs and shot concrete

In October 2016, the corner waste containers containing the FE-plugs and shot concrete were placed within the Jumbo containers (Figure 12 and Figure 13).

The Jumbo container with TSP and four corner containers with FE-plugs are now full, whereas the Jumbo container with the doughnut shaped TSR still has a void in the middle to be filled (Figure 10 and Figure 13).

Figure 12: Loading a corner container with FE-plugs into a Jumbo container.

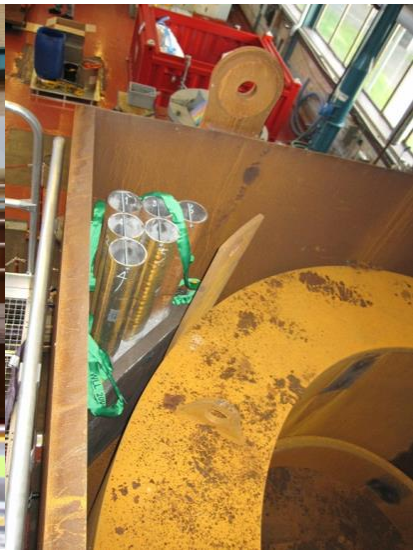


Figure 13: A corner container in the TSR Jumbo container. The space in the middle of TSR is visible in the lower right corner.

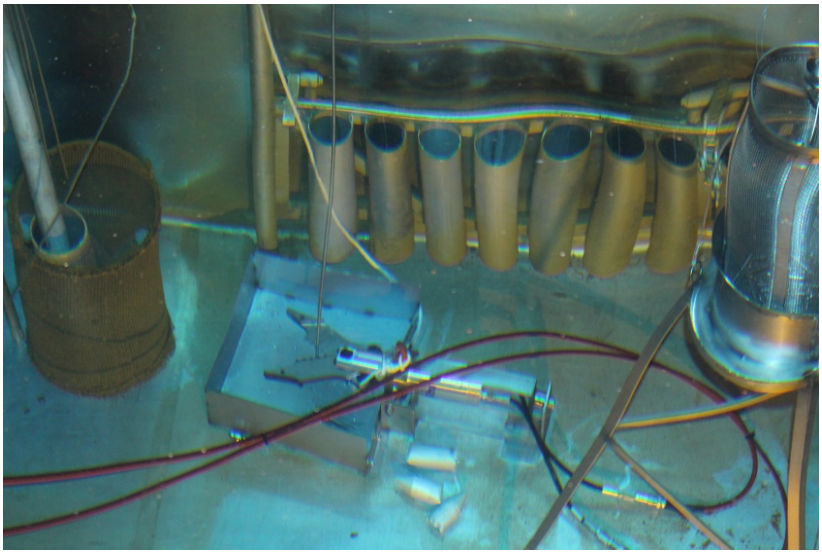


Figure 14: Cutting of FSAs in the fuel element pond. The wire basket is placed to the right of the cutting tool.

The inner waste container, which is to be placed in void within the TSR, is designed and will be produced later in 2017. It consists of a shielded piece in the centre for Flux Scan Absorbers (FSA) and four crescent shaped containers for experimental rigs (Figure 10).

The FSAs were cut into 10 cm long segments before being placed in the inner container. This work was done in the fuel element pond (Figure 14), and each segment of the FSAs was placed in a wire basket, awaiting the production of the inner container.

Current decommissioning status for DR 3

Currently the decommissioning work is focused on the removal of the internal parts (Phase 3):

- Plasma cutting of the Reactor Aluminium Tank (RAT) is on-going
- The custom-made saw for cutting up experimental rigs have been tested

Reactor Aluminium Tank

Removal of the RAT was closely linked to the removal of the TSR in the preceding step of dismantling. As the support ring of the RAT was placed on top of the TSR, it was necessary to remove the upper part of the RAT, by cutting, before the TSR could be removed.

The MTS, creating a seal on the opening of the reactor tank after removal of the TSP and TSR, was moved to the side by using the overhead crane. A circular saw was lowered into the reactor tank opening, and the upper part RAT was cut (Figure 15). The cut was placed at a depth of 62 cm and caused no stress on the tank.

The saw was removed after the cutting of the RAT, and a special 150 mm shielding steel plate was bolted to the top of the RAT. The steel plate was used for lifting the cut off section of the RAT (Figure 16).

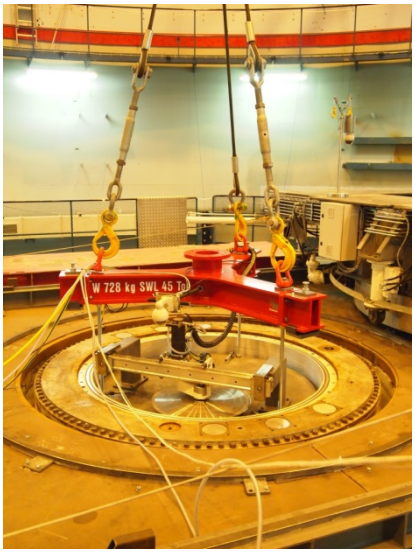


Figure 15: Cutting of the upper part of RAT

Figure 16: The cut off upper part of the RAT with a steel plate mounted

Remote cutting of the Reactor Aluminium Tank

Prior to cutting of the RAT, experiments were made with different gases, which showed plasma cutting with helium to be the most efficient when cutting in aluminium. Consequently, a remotely operated plasma cutter was mounted on the manipulator arm, and the cutting of the RAT commenced in January 2017. Once the RAT has been removed, the next task will be to remove the graphite reflector.

Figure 17: Horizontal saw (to be shielded with concrete blocks) on which the flask is going to be placed.

Figure 18: Flask for handling experimental rigs placed on a viewing box.

Preparations for cutting up experimental rigs

The External Storage Block (ESB) is still in the process of being emptied, and approximately 25% of the tubes are still filled with experimental rigs. Each experimental rig needs to be cut into two or three segments in order to fit in the crescent shaped inner waste containers. The cutting of the experimental rigs is done using a specially designed horizontal saw (Figure 17). A

large lead shielded flask for handling the experimental rigs (shown in Figure 18) and fitted with the saw inside are placed on top of the table (Figure 17). Through an opening in this table the rigs are lowered into a hole in the floor, cut, and then transferred using the lead shielded flask to the four crescent-shaped waste containers for storage.

D.3.3 Hot Cell Facility

The Hot Cells Facility was in active use in the years from 1964 to 1989. The facility consists of 6 interconnected concrete 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 pins irradiated in the DR 3 reactor, the Halden reactor in Norway, and other European reactors. Examination of power reactor fuel pins, including plutonium enriched pins, from several foreign reactors have been carried out at the Hot Cell Facility. Also, various kinds of non-destructive and destructive physical and chemical examinations have been performed at the facility. In addition, various radiotherapy sources – mainly Co-60 sources - were produced.

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

The originally chosen method for decontamination of the cell-interiors by sandblasting underwent re-evaluation and by 2012, an updated approach requiring rebuilding of the ventilation system in the cells was chosen. Progress since last reporting is detailed in the following subsections.

Rebuilding of the ventilation system

In 2014 it was decided to rebuild the ventilation system in accordance to ISO 17873: "*Criteria for the design and operation of ventilation systems for nuclear installations other than nuclear reactors*". In order to comply with the ISO Standard 17873, the filters on the roof of the Hot Cell Facility needed to be moved inside. This operation required more space, and therefore it was necessary to vacate the office facilities being used by DTU Risø Campus (Figure 19). Offices were cleared mid-2015 and the rebuilding of the ventilation system commenced in August 2015. Afterwards, airlocks were built to support the ventilation: Three permanent (Sco, Scde and Sd) and one for cell entrance (Se) as shown at the drawing (Figure 20).
The rebuilding of the ventilation system was completed in the spring of 2016. All filters from the roof are now placed inside the facility (Figure 21) in the area, which was acquired for this purpose in 2015.

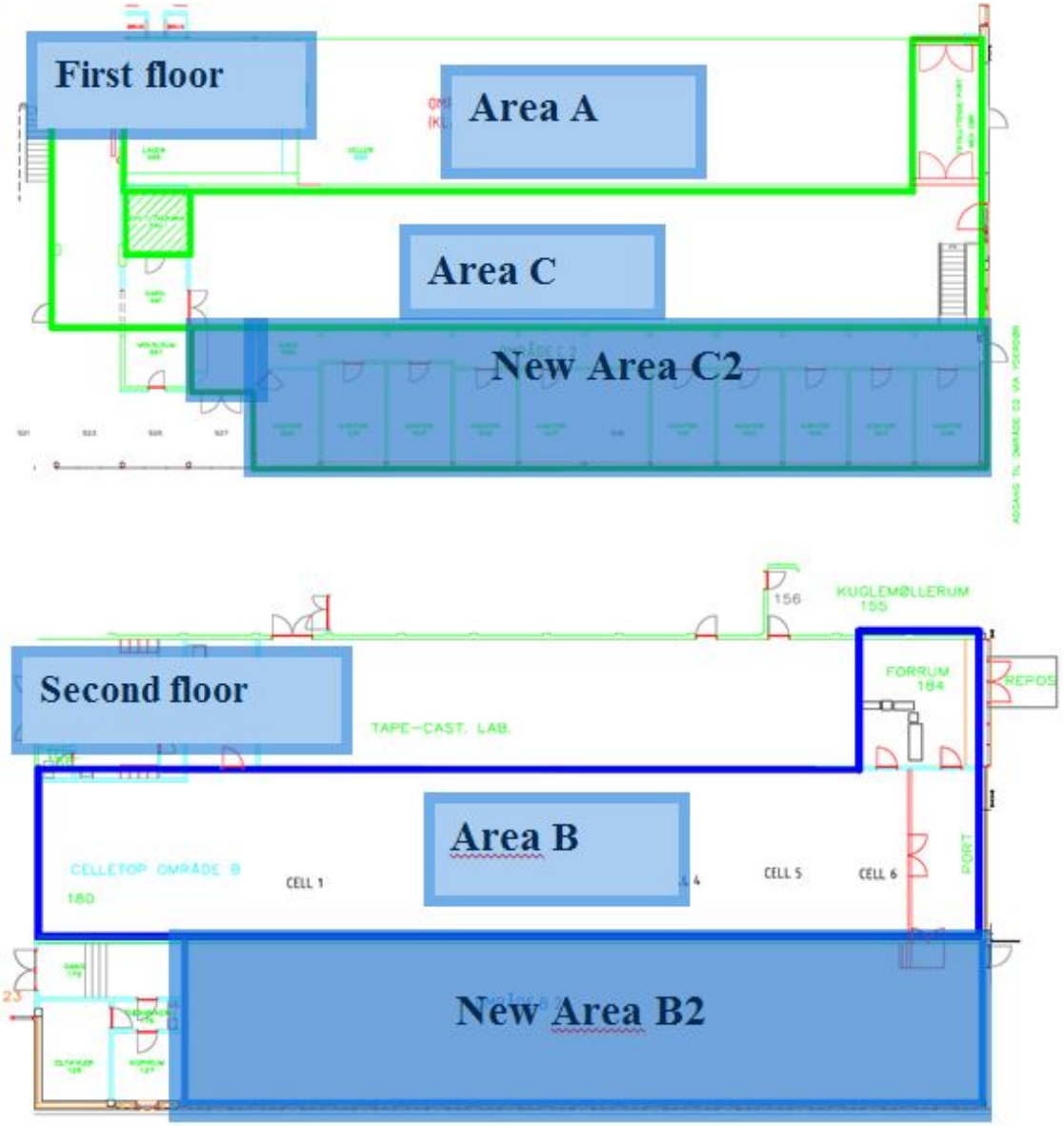


Figure 19: The additional space – the office facilities marked in blue (New Area B2 and C2) that were vacated by DTU Risø Campus in mid-2015.

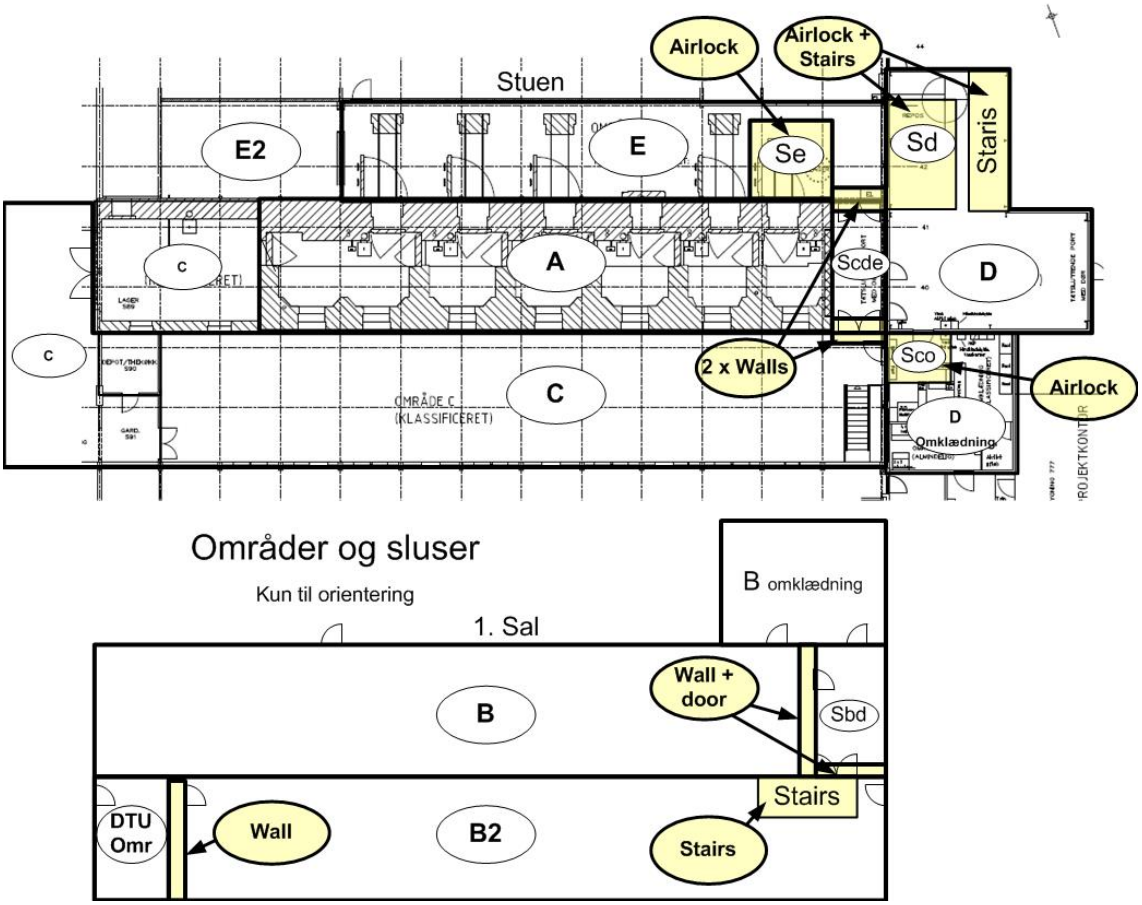


Figure 20: Airlocks

Figure 21 : Filters from the roof are now placed inside the facility

Removal of shutters and shutter houses

Prior to blast cleaning the hot cells, the shutters and the shutter houses (used to separate the six hot cells) were removed, due to the risk of damage on the movable parts of the shutter winches system during the blast cleaning.

In May 2016 the shutter houses, with the shutters inside, was separated from each hot cell using a circular saw (Figure 22). Following, the shutter housings were removed, and the original shutters were replaced with “dummy” shutters made of sheet metal, and the openings in the cell roofs were sealed with sheet metal lids (Figure 23).

The shutter houses with shutters were transported from the Hot Cell Facility to the basement of the DR 2 Reactor Containment Hall by the Dutch company “Mammoet” (Figure 24). The shutter houses are now awaiting decontamination.

Figure 22: Circular saw for cutting the shutters.

Figure 23: The room above the cells after the removal of all the shutter houses. Dummy shutters are installed.

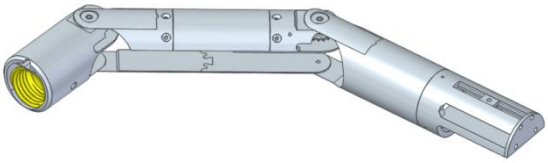
Figure 24: The last shutter house with shutter inside is being removed.

Developing mechanical arms for blast and vacuum cleaning of cell interiors

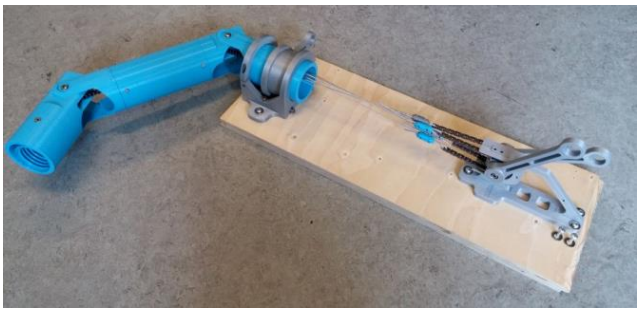
The development of mechanical arms for blast and vacuum cleaning were done in house at Danish Decommissioning (Figure 25). The development of the mechanical arms took place in four steps:

- Step 1: Construction of 3D computer drawings of the mechanical arms
- Step 2: 3D printing in plastic of the modelled parts of the mechanical arms
- Step 3: Upon acceptance of the design each part were manufactured in steel
- Step 4: Construction of the prototypes in steel for testing

Using 3D printing to produce the initial design of the mechanical arms, instead of producing the initial design in a metal shop proved to be a much faster method to reach production stages of the prototypes.



Step 1: 3D computer drawing



Step 2: 3D printing in plastic

Step 3: First construction in steel

Step 4: Prototype for testing

Figure 25: The developing process of the mechanical arms

The production of the mechanical arms for blast and vacuum cleaning commenced in 2016, and since the mechanical arms have been tested in mock ups (Figure 26 and Figure 27).

At the end of 2016, the final parts of project descriptions of the blast cleaning processes for the Hot Cell Facility was approved by the Nuclear Regulatory Authorities. The actual blast cleaning of the Hot Cell Facility was initiated in the summer of 2017.

Figure 26: Test in mock up

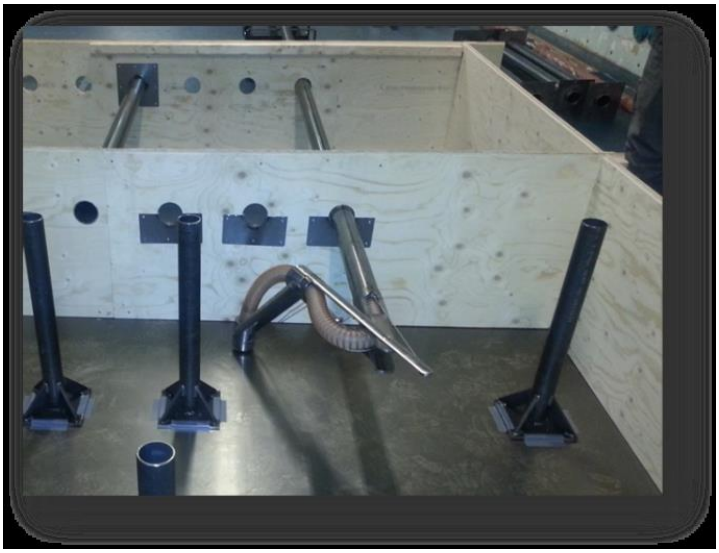


Figure 27: Vacuum extraction – mock up test

D.3.4 Fuel Fabrication Plant

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

Based on a historical study of the operations carried out at the Fuel Fabrication Plant and radiological measurements, each area (laboratory or room) within the building was in general found to hold the predicted level of contamination as mapped out in Figure 28 and Figure 29.

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

Figure 29: Classification by colours of the first floor level before the start of decommissioning

The degreasing workshop

The degreasing workshop (denoted “renseværksted S16” and marked in yellow in Figure 28) was used for degreasing fuel plates in large vats. After the removal of the degreasing vats and the remaining equipment, the wall paint was removed. This room was following cleared during the spring of 2014 for unrestricted use.

The vacuum oven

The vacuum oven placed in the oven room on the ground floor (indicated by the red in Figure 28) will be handled as radioactive waste, as uranium has been imbedded in the metal inside of the oven, but not on the surface.

The powder room

The powder room (designated “pulverrum” on the ground floor in Figure 28) was used for handling the uranium powder. As uranium fuel production was terminated in 2003, the walls of the powder room were painted to seal in potential uranium contamination of the walls, instead of removing the contamination. In the decommissioning process the surface of the walls in the room was removed along with the linoleum on the floor.

The paint on the walls and the ceiling was removed using a wall shaver tool (Figure 30).

Clearance measurements carried out after the paint removal showed the presence of uranium spots on the floor beneath the linoleum. In order to remove the uranium spots, parts of the floor were removed using a dry concrete saw (Figure 31). The dry sawing method was chosen to minimize the risk for cross contamination. The following clearance measurements and the final measurements showed that the room may be released for unrestricted use.

The drain system

Uranium contamination was detected in a drainpipe, which initiated thorough examination of the drain system for possible uranium contaminations. Eventually, the entire pipework was dismantled.

Figure 30: Wall shaver during shaving the ceiling in the powder room

Figure 31: Sawing of the floor in the powder room.

Ventilation above the powder room

Three ventilation systems have been removed above the powder room. However, as uranium was detected on the clean side of the filter in the ventilation system servicing the table for handling uranium powder, the complete duct was been removed. The surface beneath the outlet was examined without finding further contamination.

Crawlspace with uranium contamination in the floor

By the end of February 2015, the decommissioning plan for the Fuel Fabrication Plant was completed and the final decommissioning report was being compiled. Unexpectedly, conformational clearance measurements of the gutters below the drainpipes in a crawlspace below floor level revealed the presence of uranium contamination on the concrete floor.
The uranium contamination appears as dark spots on the concrete floor of the crawlspace, where leakage has occurred due to corrosion of the gutter (Figure 32). 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 32), a study was carried out to find a possible method for removing the upper 6 cm of the concrete floor. The method chosen was milling. A purpose built milling tool was developed (Figure 33 and Figure 34) by rebuilding a tool previously used for other tasks at the Fuel Fabrication Plant and at DR 3. Once installed in the crawlspace, the milling tool can be operated by remote control and will not require an operator to be present in the crawl space during milling operations.

Figure 32: Crawlspace with uranium contamination in the floor

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

Figure 34: The milling tool in action

D.4 International expertise and decommissioning

Representatives from Radiation Protection (Danish Health Authority) have participated in or contribute to:

- Facility Decommissioning training course provide by Argonne National Laboratory
- Workshop on Current and Emerging Methods for Optimising Safety and Efficiency in Nuclear Decommissioning organised by IFE on behalf of the OECD Halden Reactor Project and in collaboration with the IAEA and the NEA.
- International Conference on the Safety of Radioactive Waste Management organized by IAEA
- International Project on Decommissioning Risk management (DRiMa) organized by IAEA
- The Waste Safety Standards Committee (WASSC) organized by IAEA
- The Safety Standards Committees for Radiation Safety (RASSC) organized by IAEA
- Challenges to the Regulators in siting and licensing the construction and operation of radioactive waste repositories – a meeting organized by The OECD-NEA RWMC Regulators' Forum (RWMC-RF)
- Working Group 2 on Waste Management and Decommissioning (WGRWMD) organized by ENSREG
- The 7th International Conference on Clays in Natural and engineered Barrieres for Radioactive Waste Confinement organised by Nagra in cooperation with ANDRA, COVRA, KORAD, NUMO, NWMO, ONDRAF/NIRAS, POSIVA, PURAM, RWM, SKB, SURAO, and Swisstopo.

Representatives from Danish Decommissioning have participated in or contribute to:

- Facility Decommissioning training course provided by Argonne National Laboratory
- MARSSIM training course provide by Argonne National Laboratory
- Workshop on Current and Emerging Methods for Optimising Safety and Efficiency in Nuclear Decommissioning organised by IFE on behalf of the OECD Halden Reactor Project and in collaboration with the IAEA and the NEA.
- Technical Advisory Group (TAG) which is a part of a joint project between NEA and OECD
- The International Co-operative Programme for the Exchange of Scientific and Technical Information Concerning Nuclear Installation Decommissioning Projects (CPD)
- ERDO working group a project managed by the national waste agency of the Netherlands, COVRA and the Arius Association.

Section E. Legislative and Regulatory System

Article 18. Implementing measures

Article 19. Legislative and regulatory framework

The Danish legislation for radioactive waste and spent fuel management is unchanged. A list of relevant Acts, Orders etc. in force by 01 October 2017 is given in Section L.

On 09 July 2013, Denmark notified the European Commission about the implementation of Directive 2011/170/Euratom into Danish legislation through the above mentioned Acts, Orders etc., and supplemented by the following documents:

- Order No. 1510 of 15 December 2010 on environmental impact assessment of certain public and private facilities (EIA).
- Circular letter of 21 December 2011 from the Minister for Health to the Nuclear Regulatory Authorities.
- Motion B 48 of 13 March 2003 on the decommissioning of the nuclear facilities at Risø National Laboratory.
- Minister for Health Statement R4 of 15 January 2009 to the Parliament on the basis for decision for a Danish repository for low and intermediate level waste.
- Information from the Minister for Health of 22 January 2013 about the further process for the location of radioactive waste currently stored at Risø.

Danish legislation is currently under revision in order to comply with Council Directive 2013/59/EUROATOM of 5 December 2013. The revised legislation will enter into force on 06 February 2018.

Article 20. Regulatory body

Please refer to the previous National Reports.

After undergoing staff reductions and loss of staff in 2012, the Danish Health Authority, Radiation Protection has filled vacancies and formed new positions such that staffing is equivalent to pre-2012 levels.

Section F. Other General Safety Provisions

F.1 Responsibility of the licence holder

Article 21. Responsibility of the licence holder

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

The prime responsibility for the safety of a nuclear installation resides with the licence holder. The Nuclear Regulatory Authorities have issued Operational Limits and Conditions for Danish Decommissioning, detailing how the nuclear installations at Risoe may be safely operated and decommissioned. As the decommissioning of the nuclear facilities at the Risoe peninsula is ongoing, the Operational Limits and Conditions are progressively updated. Latest version of the Operational Limits and Conditions is from 2017. In analogy to the Operational Limits and Conditions for Danish Decommissioning, similar conditions have been issued for DTU Risø Campus, addressing the role and obligations of the institution hosting the nuclear facilities at the Risoe peninsula.

Public versions of the Operational Limits and Conditions are available on the websites of the Nuclear Regulatory Authorities[2].

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 Risoe 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 full accordance with the safety provisions prescribed by the Nuclear Regulatory Authorities. As Danish Decommissioning is subject to minor, but continuous staff adjustments and replacements, training courses, seminars, and more extensive classes are therefore undertaken in order to ensure both an adequate level of qualification as well as transfer of relevant experience from skilled members of the staff.

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

[2] https://www.sst.dk/da/straalebeskyttelse/radioaktivitet/nukleare-anlaeg/afvikling

Article 23. Quality assurance

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

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

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

Article 24. Operational radiation protection

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

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

With respect to personnel at the contractor level, it is the responsibility of 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.

F.2 Discharge

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

Since the reactors were taken out of operation, the release of tritium to Roskilde Fjord has been reduced by one to two orders of magnitude and now displays a declining trend

below 100 GBq per year, as shown in Figure 35. As facilities containing tritium have been progressively decommissioned, the remaining tritium inventory is low and discharges are similarly expected to remain so.

The annual release of activity into Roskilde fjord determined as dissolved gross β/γ-activity has remained low since the reactors were taken out of operation. The annual releases, which originate from distillation waste water and overflow from the tailing ponds, are shown in Figure 36.

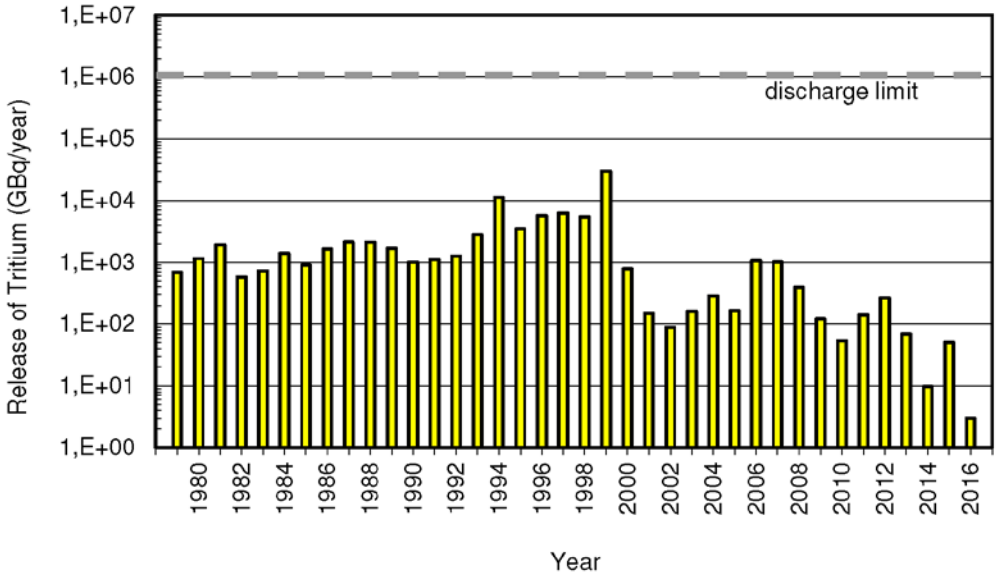


Figure 35: Annual release of tritium into Roskilde Fjord from the Waste Management Plant.

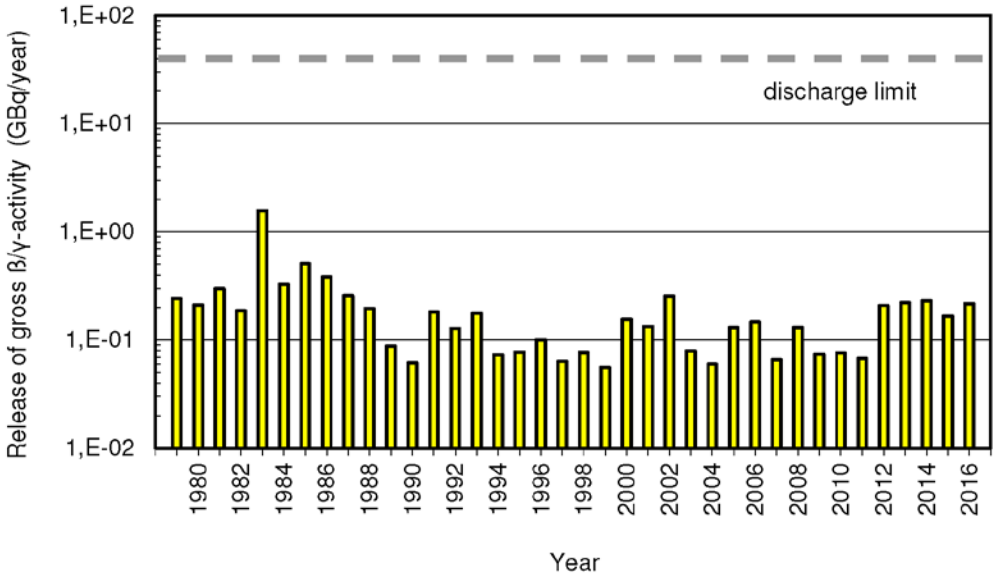


Figure 36: Annual release of gross ß/γ-activity into Roskilde Fjord from the Waste Management Plant.

Article 25. Emergency preparedness

Sector based responsibility is fundamental for the Danish emergency preparedness and, wherever possible, the Danish nuclear emergency preparedness system is based on organisations and preparedness arrangements already in force for other purposes with the adequate amendments regarding special matters within the nuclear area. A revised nationwide nuclear emergency preparedness plan entered into force in 2014.

F.3 Decommissioning

Article 26. Decommissioning

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

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

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

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

Workers at 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 2014-2016 was less than 7.5 person-mSv, with a maximum individual dose of 1.1 mSv.

Section G. Safety of Spent Fuel Management

Article 4. General safety requirements

Article 5. Existing facilities

Article 6. Siting of proposed facilities

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

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

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

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

Section H. Safety of Radioactive Waste Management

Article 11. General safety requirements

Article 12. Existing facilities and past practices

Article 13. Siting of proposed facilities

Article 14. Design and construction of facilities

Article 15. Assessment of safety of facilities

Article 16. Operation of facilities

Article 17. Institutional measures after closure

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

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

H.1.1 Radiation protection - policy

In accordance with the overall objectives in the Council Directive 2011/70/Euratom of 19 July 2011 establishing a Community framework for the responsible and safe management of spent fuel and radioactive waste and with the policy to follow the principles outlined in IAEA Fundamental Safety Principles, ICRP and other relevant international organisations, Denmark has established 4 principles for all work related to long term management of radioactive waste:

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

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

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

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

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

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

H.2 Developments since the Fifth National Report

The Danish Parliament agreed unanimously in March 2003 to initiate the preparation of a 'Basis for Decision' for the establishment of a Danish disposal facility for LILW. For developments in this respect until 2013, kindly refer to the Fifth National Report and references therein, where detailed accounts of legal aspects, waste inventory, safety principles and the findings of the preliminary studies and the site selection process were presented.

In January 2013, the Ministry of Health, chairing a cross-ministerial Working Group presented a revised scheme for defining a long term management solution for the Danish radioactive waste. According to this scheme, the initial efforts for establishing a Danish repository as outlined in previous reports, were to be continued. In addition, the basis for, and implications of, establishing a long term storage solution (intermediate storage) for all of the Danish radioactive waste was to be explored. Lastly, the options for an international solution for all of the Danish radioactive waste were to be investigated.

Progress of these three lines of effort since the last National Report is presented in following.

H.2.1 Disposal of all of the Danish radioactive waste

Following the scoping of the environmental impact assessment, a revised plan and environmental impact assessment was subjected to public hearing in October 2014. The hearing process included a renewed consultation of neighbouring countries in alignment with the Espoo Protocol.

In total, the hearing drew 41 domestic responses and 150 responses from neighbouring countries. Responses to a number of high level topics, mainly of a technical nature but also including ministerial handling of the process and socio-economic consequences of the localisation of a repository, were reported. In addition, a number of responses were received regarding site-specific issues of the six potential repository sites. On the basis of all contributions received by the deadline of the hearing on 5 December 2014, a summary report was presented in February 2015.

The summary report only serves to inform on strategic planning and decision-making. It does not substitute the environmental impact assessment for a specific facility. In order to initiate the construction of a repository, a proposal for a project planning permit (*projekteringslov*) containing a plan and a budget will be need to be drawn up and presented to the Danish Parliament for approval. The project planning permit will be based on the material produced

earlier, including the strategic environment assessment given in the summary report[3] of February 2015.

The project planning permit will reserve the sites and underpin project design, thorough investigations (including a project-specific environmental impact assessment), a public consultation phase, etc. Following from the process of the project planning permit, the next stage in the project will be to design the repository in detail and to build the safety case.

H.2.2 Intermediate storage of all of the Danish radioactive waste

The cross-ministerial working group presented its report to the Minister for Health in February 2015. The report concluded that it would be feasible to design and construct a safe long-term storage solution for an operational period of 100 years, following which the radioactive waste would be transferred to a repository facility. An outline of a long-term storage facility and the accompanying organisation was presented, including an outline of the necessary procedural steps to be taken. The general safety criteria were laid out in order to facilitate preparation of the safety case of a long-term storage, should it be decided to carry out this option. The report was included in renewed political discussions in March 2015 (see Section H.3).

H.2.3 International solution for all of the Danish radioactive waste

The cross-ministerial working group decided to explore the feasibility of an international solution for all Danish radioactive waste fractions and required the assistance of the Ministry of Foreign Affairs in this effort in order to assess the possibility of exporting the entire Danish radioactive waste inventory.

In early 2015, the Ministry of Foreign Affairs reported that it did not consider the undertaking of export of the total Danish radioactive waste inventory realistic. It was found that technical issues, national legislation and/or political considerations in the countries explored presented major obstacles for the proposed export solution.

In parallel with exploration of the export track, Danish Decommissioning is participating as a member of the European Repository Development Organisation Working Group[4] (ERDO WG) to study the feasibility of setting up an organisation that would implement one or more shared geological repositories in Europe.

H.3 Renewed political discussions in 2015 and further developments 2015-2017

In March 2015, renewed political discussions took place in order to take stock of the situation following the finalisation of the parallel tracks of 1) the strategic environmental assessment of the repository solution, 2) the exploration of a long-term storage solution, and 3) the exploration of the feasibility of an international solution.

[3] Plan and environmental impact assessment for the establishment of a permanent repository for Danish low and intermediate level waste - Summary Report

[4] ERDO working group

It was decided that a halt of the process to establish a repository should be effected immediately in order to allow for supplementary studies of the long-term storage solution prior to the final policy decision. As a consequence, the process of preparing a project planning permit for the repository solution was put on hold.

The supplementary studies of the long-term storage solution were to be aimed at further documenting details of the safety, economy, operation and localisation of a long-term storage.

Finally, it was decided to abandon the efforts to seek an international solution for the entire Danish radioactive waste inventory. However, it was decided to continue to explore the feasibility of an international solution for the spent fuel from the research reactor DR 1 and the 233 kg of experimentally produced and irradiated spent fuel.

Following a government decision on 28 June 2015, the responsibility for all matters relating to the radioactive waste management, was transferred from the Ministry of Health to the Ministry of Higher Education and Science. The transfer has resulted in a clear separation of the responsibility for facilitating and realizing the political decision for a long-term solution from the responsibility of regulatory oversight of radioactive waste management in general.

H.3.1 Re-organisation of the policy-making process and interaction with stakeholders

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

In the spring of 2016, the Ministry of Higher Education and Science reactivated the cross-ministerial working group in order to secure competent monitoring and reporting of the supplementary long-term storage studies and the exploration of export opportunities for the special waste fraction. The Ministry of Finance was added to the group of participating ministries.

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

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

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

panel replies to questions raised by the public. Questions are invited every month, with replies to be submitted by the panel in the following month. Questions and answers are posted on the website of the Ministry of Higher Education and Science.

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

H.3.2 Reports from the supplementary long-term storage studies

Throughout 2016, preliminary reporting of the long-term storage studies was received by the Ministry of Higher Education and Science. A total of five reports have been submitted, covering the following themes:

1. Safety, economy and operation for a Danish long-term storage facility for radioactive waste (translated into English, see: http://www.dekom.dk/media/169966/langtidsmellemlager_rapport_eng.pdf)
2. Recommendations for the analysis of socio-economic effects of a long-term storage for radioactive waste (in Danish only)
3. Criteria and process design of the localisation of a storage for radioactive waste (in Danish only)
4. Desk study of Danish geology in approx. 500 meters below ground, based on existing information (in Danish only)
5. Supplementary long-term storage studies – summary (translated into English, see: http://ufm.dk/en/newsroom/issues/radio-active-waste/english-material/supplerende-mellemlagerstudier-sammenfatning-engelsk-version.pdf). The summary includes the comments of the International Experts' Group to Danish Decommissioning mentioned above.

In January 2017, the Ministry of Foreign Affairs reported that renewed consultations with relevant authorities in 23 OECD-countries had not produced realistic possibilities for exporting the spent fuel from the research reactor DR 1 and the 233 kg of experimentally produced and irradiated spent fuel. If was found that an import ban on radioactive waste was in place in most countries. Furthermore, issues of capacity/technical capability and/or local political opinion added to the conclusion that export of these special waste fractions was not a feasible undertaking for the time being.

H.3.3 Summary report of the cross-ministerial working group regarding long-term storage

In early 2017, the cross-ministerial working group convened to prepare a summary report on the basis of the collected body of information deriving from the supplementary long-term storage studies. In April 2017, the working group presented its summary report to the Minister for Higher Education and Science.

The summary report concluded that a long-term storage could be constructed and operated in accordance with basic principles of radiation protection, environmental protection and security

of physical constructions. It was emphasized that a long-term storage solution would only make it possible for Denmark to fulfil its international obligations regarding radioactive waste management if a decision to construct and operate a long-term storage facility was clearly linked with a decision to begin planning and constructing a repository facility.

With regard to the repository type, the summary report noted that it could be relevant to consider a deep geological repository as an alternative to near surface or medium deep repository types which had earlier been laid out in the prefeasibility studies of 2011. The near surface and medium deep repository designs were subjected to criticism by various stakeholders for being too shallow to ensure sufficient protection. The report noted that further research will be needed to establish the feasibility of a deep geological repository in Denmark.

As for the process of localisation of a long-term storage facility, the summary report outlined a process based on voluntary participation by local communities which had been identified initially as possible hosts on the basis of a hierarchy of criteria. Further feasibility studies would be conducted in collaboration with local authorities and involving local citizens. The summary report noted that it could be considered to introduce an element of compensation to the host community in recognition of the derived costs of hosting a long-term storage.

In the event that no voluntary participation can be achieved, the process of localisation will revert to a traditional process governed by the ministry in charge. This process will include hearings of the public but with the final decision on localisation resting exclusively with the Danish Parliament.

H.3.4 Political process after the summary report of the cross-ministerial working group

The political decision-making process towards a long-term solution for radioactive waste management in Denmark will be prepared by the Danish Government upon having received the recommendations of the Minister for Higher Education and Science in the spring of 2017. Political talks are expected to commence later in 2017, possibly continuing into 2018.

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. 1175 of 25 December 2008 replacing Order no. 969 of 13 December 1993 on international transfer of radioactive waste. 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 26 applications according to Council Directive 2006/117/Euratom concerning the supervision and control of shipments of radioactive waste and spent fuel.

Section J. Disused Sealed Sources

Article 28

The possession, use and disposal of disused sealed sources is regulated through the Order No. 985 of 11 July 2007 on sealed radioactive sources. This order states that once a sealed source is taken out of use it must be returned to the producer or alternatively turned over to a company that is licenced to handle, store or dispose of radioactive waste.

Disused sealed sources are occasionally, but rarely found in metal scrap. To date, the radioactive sources have been detected by means of portal monitoring systems typically installed at major scrap yards rather than in surveys or by handheld monitors. Monitoring systems are thus recommended in advisory material distributed to the scrap dealers. A strategy for management of disused sealed sources in the scrap industry is under development, and specific guidelines on how to handle disused sealed sources and radioactive substances found in metal scrap will follow.

At the administrative level, a national data integration interface enables combination of data for relevant individuals in Denmark with the Danish Central Business Register (CVR) to facilitate a proactive and timely intervention by the authorities in case of bankruptcy, or discontinuation for other reasons, of companies possessing radioactive sources. This also provides the authorities with a tool to track the owners of a disused sealed sources if such occur as orphan sources, for instance in scrap metal.

An increased number of household ionizing smoke detectors containing Am-241 are collected at the local scrap yards as they are being replaced by photoelectric smoke detectors. The 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 one of three 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.

At the Waste Management Facility, Am-241 sources are taken out of the smoke detectors and stored in dedicated waste containers, ready for further management.

Section K. General Efforts to Improve Safety

K.1 International co-operation

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

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

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

K.2 International peer review

The Danish government has invited the International Atomic Energy Agency to conduct a combined Integrated Regulatory Review Service (IRRS) and ARTEMIS mission in Denmark. The combined mission is anticipated to take place in 2020.

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

The Danish obligations through Article 14.3 in Council Directive 20011/70/Euratom, are further satisfied through the conduct of an ARTEMIS review of the Danish national framework, competent regulatory authority and/or national programme in the area of safe management of spent fuel and radioactive waste.

Section L. Annexes

L.1 Danish Legislation – Spent Fuel and Radioactive Waste

The Danish legislation[5] listed below is in force per October 2017. The legislation is available in Danish at the web site of the Danish Health Authority, Radiation Protection.

Acts:

- Act No. 94 of 31 March 1953 on use etc. of radioactive materials.
- Act No. 170 of 16 May 1962 on nuclear installations.

Ministerial Orders:

- Order No. 278 of 27 June 1963 on protective measures against accidents in nuclear installations (atomic installations) etc. with amendments in Order No. 502 of 1 October 1974.
- Order No. 574 of 20 November 1975 on precautionary measures for the use etc. radioactive substances.
- Order No. 192 of 2 April 2002 on exemptions from Act on the use of radioactive substances.
- Order No. 154 of 6 March 1990 on smoke detectors and consumer products containing radioactive materials with amendments in Orders No. 547 of 23 July 1993 and No. 793 of 19 October 1999.
- Order No. 546 of 23 June 1993 on transfer of radioactive materials.
- Order No. 663 of 12 July 1994 on outside workers, who are exposed to ionizing radiation in a CE-country with amendments in Order no. 824 of 31 October 1997.
- Order No. 823 of 31 October 1997 on dose limits for ionizing radiation.
- Order No. 954 of 23 October 2000 on the use of unsealed radioactive sources in hospitals, laboratories etc.
- Order No. 993 of 5 December 2001 on transport of radioactive materials.
- Order No. 985 of 11 July 2007 on sealed radioactive sources.
- Order No. 1175 of 5 December 2008 on international transfer of radioactive waste and spent nuclear fuel.
- Order No. 1762 of 27 December 2016 on security measures for nuclear material and nuclear facilities and drafting of security plans.

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

[5] Danish Legislation

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

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

L.2 Denmark – Overview matrix

Type of Liability	Long-term management policy	Funding of liabilities	Current practice/facilities	Planned facilities
Spent fuel	An international solution remains an option for the Danish inventory of spent fuel. The long term management policy will include a management solution for all Danish radioactive wastes.	The Danish state carries the financial liability of an ultimate management solution.	Spent fuel from DR 1 and the experimentally produced and irradiated spent fuel is stored under safe and secure conditions by the operator Danish Decommissioning (DD)	The Danish management solution may include both a long-term storage facility followed by a repository facility. Long term management will include provisions for managing the inventory of spent fuel, if an international solution proves unsuccessful.
Nuclear fuel cycle wastes	Not applicable	Not applicable	Not applicable	Not applicable
Application Wastes	Intermediate storage or disposal is under consideration.	Waste producers pay a management fee upon delivery of waste to DD. The Danish State carries the financial liability of an ultimate management solution.	DD receives, handles and stores application wastes produced by hospitals, industry and research intuitions in Denmark.	Pending a decision on long term management policy
Decommissioning	Following parliamentary decision in March 2003, 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 is responsible for the decommissioning of the nuclear facilities at Risoe.	Decommissioning works are in progress and should according to the parliamentary decision of 2003 be completed no later than 2023
Disused sealed sources	Return to the manufacturer or management by DD	Return to the manufacturer is at the cost of the licensee DD carries other costs.	DD stores disused sealed sources, which cannot be returned to the manufacturer.	Pending a decision on long term management policy

Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management

National Report from Greenland

Sixth Review Meeting, 21 May – 1 June 2018

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 Managementand on the Safety of Radioactive Waste Management.

Waste that contains only NORM is not radioactive waste for the purpose of the Convention. However 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. For transparency purposes a description regarding the management related to NORM has therefore been added to this report as a sub section to each chapter.

The present report is the first Greenlandic Report prepared for the Sixth Review Meeting to the Convention, which takes place 21 May – 1 June 2018 at IAEA in Vienna. 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.

The report is prepared by the Danish Center for Environment and Energy, Department of Bioscience, Aarhus University (DCE) for the Greenland Environmental Agency for Mineral Resource Activities (EAMRA). The report has been reviewed by the Ministry of Health, the Ministry of Mineral Resources including the Mineral Licence and Safety Authority (MLSA),

the Ministry of Industry, Labour, Trade and Energy and the Ministry of Nature and Environment.

Section B. Policies and Practices

Article 32 (Reporting), (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, animals and the environment are not unnecessarily subjected to the risks of radiation exposure.

The Radiation Protection Act sets the framework from which executive orders will be issued. Executive orders issued under the Act will resemble corresponding Danish legislation and will align with international IAEA standards and EU-directives for best practices.

The Act authorizes the Greenland Self-Government to issue executive orders on the use of sources of radiation, both from radioactive materials and X-ray, dose limits, constraints and measuring services, reporting of emergencies involving radiation, and the supervision and oversight of these areas.

According to the Act, any use of and exposure to radiation is to be justified and optimized so that the likelihood of exposure is kept as low as reasonably possible.

The Ministry of Health is the competent authority to decide whether the use of radiation is justified.

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 Ministry of Health.

NORM waste

Waste that may be generated in the future from mining and milling industry contains only NORM. At present, no NORM waste is generated from the mining and milling industry.

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

For future possible exploitation of NORM, Greenland is responsible for developing waste management policy and regulating and overseeing radioactive waste producers and owners in order to ensure that they meet their operational and funding responsibilities in accordance with approved waste management plans.

NORM waste is regulated according to Greenland Parliament Act no. 7 of 7 December 2009 on mineral resources and mineral resource activities with later amendments (Mineral Resources Act). Waste owners are responsible for funding, managing and operating waste management facilities including disposal and decommissioning in accordance with the "polluter pays" principle of the Mineral Resources Act.

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

The Greenlandic policy and practice for waste management of NORM based on the principles of the Mineral Resources Act, is to require waste owners to:

- Minimize the waste generation to the extent practicable by the implementation of design measures, operating procedures and decommissioning practices
- Reuse, recycle, collect, characterize, segregate, manage and dispose of all radioactive wastes under safe and secure conditions in storage facilities
- Manage radioactive waste commensurate with its radiological, chemical and biological hazard to the health and safety of persons and to the environment
- Ensure that impacts from the management of radioactive waste facilities on the health and safety of persons and the environment are mitigated
- Ensure that the measures needed to mitigate risks to the present and future generations and the environment from radioactive waste are implemented as soon as reasonably practicable

Specific guidelines for safe management of generated radioactive NORM waste in Greenland are currently under development.

Classification of radioactive waste in Greenland

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

Waste from the medical sector

The regulation of radioactive waste generated from the medical sector is under the responsibility of the Ministry of Health.

The Greenland Health Care System does not use nuclear medicine in the examination and treatment of patients. This means that no radioactive waste is generated from the medical sector in Greenland.

Waste from the industry sector

Radioactive waste generated in the industry sector outside of the radioactive waste generated pursuant to the Mineral Ressources Act are regulated by the Ministry of Health in accordance with the Radiation Protection Act.

A system for the disposal of radioactive waste generated in the industry sector will be implemented according to the Act.

The protection of employees working with radiation is regulated by the Danish Working Environment Authority (WEA) in accordance with The Working Environment Act.

Waste from the educational sector

Disposal of radioactive waste generated in the educational sector is regulated by the Ministry of Health in accordance with the Radiation Protection Act.

A system for the disposal of radioactive waste generated in the educational sector will be implemented according to the Act.

Furthermore, The Working Environment Act applies to employees working with science education facilities and laboratories and contains provisions on storage facilities for radioactive waste generated in the educational sector.

Waste from NORM

Unconditionated waste generated in the future if mining and milling of NORM is approved will be classified as low level waste - long lived (LLW-LL) according to IAEA GSG-1 (2009).

Mineralized and clean waste rock and mill tailings may be generated in the future from the mining and milling of ore material in Greenland. The mineralized waste rock and mill tailings contain long lived radionuclides above clearance levels, namely thorium, radium and a portion of original uranium which are not fully recovered in the hydrometallurgical employed processes.

Section C. Scope of Application

Article 3 (Scope of application)

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 waste consisting of purely naturally occurring radioactive materials as radioactive waste for the purpose of this Convention, pursuant to Article 3(2);
(c) 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.

Waste that contains only NORM is not radioactive waste for the purpose of the Convention.

Section D. Inventories and Lists

Article 32 (Reporting), (paragraph 2)

This section addresses article 32 (Reporting) (paragraph 2) of the Joint Convention.

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)
- 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 will be drafting executive orders aligned with international IAEA standards and EU-directives for best practices.

The executive orders will live up to ILO Radiation Protection Convention (No. 115) concerning the Protection of Workers against Ionising Radiations.

The Greenland Working Environment Act regulates the health and safety of employees including use of 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. As the regulatory field of working environment has not been taken over by the Greenland Self-Government and the responsibility hereof rests with the Danish Ministry of Employment and the underlying authority, the Danish Work Environment Authority, which is the regulatory authority. The physical protection of nuclear materials and nuclear facilities is regulated in accordance with two Danish Acts. Act for Greenland on the Control of Peaceful Uses of Nuclear Material (No 621 of 8 June 2016), which is the resonsibility of the Danish Ministry of Foreign Affairs. Furthermore, 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 catastrophies in relation to mineral resource activities involving nuclear materials. The Danish Emergency Management Authority is the supervisory authority. The IAEA Convention on the Physical Protection of Nuclear Material and Nuclear Facilities is in force in Greenland.

Regulatory system and licensing of radioactive waste management

According to the Radiation Protection Act, any possession, production, packaging, import, storage or disposal of radioactive materials is subject to registration or authorization according to a licence issued by the Ministry of Health, except when exempted by the regulations. The Ministry of Health may issue detailed requirements regarding production,

importation, use, storage, transport, disposal etc. of such materials and inspect all holders of authorizations and locations, where radioactive materials are or could be present.

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

The possession, production, packaging, importation, storage or disposal of radioactive waste without an issued licence or a registration from 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, which since 2013 includes exploitation of NORM. The Mineral Resources Act generally regulates safety, health, the environment, resource exploitation and social sustainability in relation to mineral resource activities. Under the Mineral Resources Act, the management of waste produced from mining and milling of radioactive minerals is regulated throughout the entire life cycle – from site preparation, construction and operation to decommissioning and site abandonment. Each phase of the lifecycle requires specific approvals.

Applicants for an exploitation licence are required to submit an environmental impact assessment (EIA), a social impact assessment (SIA) and feasibility studies including documentation that the company is able to provide sufficient financial guarantees. The EIA and SIA are generally required if any proposed activity is likely to have a significant environmental or social impact. The EIA and all supporting study reports shall include comprehensive information on the applicant's policies and programs, the design of proposed waste facilities, the manner in which the facility is expected to operate and potential impacts on the site and surrounding environment. All submissions are reviewed by the authorities and independent scientific advisors. International third party consultants are used as appropriate. Following EIA and SIA approval a detailed environmental monitoring plan (EMP), a radiation management plan (RMP), a radioactive waste management plan (RWMP) and closure plan (decommissioning and rehabilitation) plan have to be prepared.

The review work is performed in accordance with existing legislation and experience available in Greenland, Denmark and globally to ensure that regulatory requirements are met and that the company applies best available techniques (BAT) and best environmental practices (BEP).

The assessments and decisions by the Mineral Resource authority regarding environmental issues are based on considerations from one or more scientific and independent environmental institutions. The Greenland Environmental Agency for Mineral Resource Activities (EAMRA) obtains counsel from the Danish Centre for Environment and Energy, Department of Bioscience, Aarhus University (DCE) and the Greenland Institute of Natural Resources (GINR).

This is set out in accordance with article 9 of the Act on Greenland Self-Government of 2009 and the cooperation agreement of august 2014 between the Minister of Nature and Environment and the Danish Minister of Education and Research covering years 2015-2019. The role of DCE and GINR is set out in an agreement of august 2014 regarding the joint environmental advice of DCE and GINR to EAMRA 2015-2019. Independent third party consultants may be included on a case-by-case basis.

There are public pre-consultations of 35 days and consultations of 8 weeks including public meetings throughout EIA/SIA development.

The Mineral Resources Act stipulates that a positive decision shall be made on an EIA and SIA for all projects with a significant impact on the environment or society, in order for the Greenland Self-Government to proceed with a licensing decision.

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

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

According to the Mineral Resources Act exploitation of NORM may be performed only under a licence granted by the Greenland Self-Government. Standards for clearance of radioactive materials from the regulatory system are under development. Clearance of radioactive materials will be subject to prior authorization from the relevant authorities. For NORM the guidelines for Radiation Protection for Mineral Exploration in Greenland are under development.

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 issue executive orders detailing responsibilities for registrants and licence holders. The provisions will align with corresponding Danish legislation, as well as international standards for best practices.

NORM responsibility of the licence holder

Greenland applies the “polluter pays” principle, by which the Greenland Self-Governmenthas clearly indicated that waste owners are financially responsible for the management of their radioactive waste, and has set in place mechanisms to ensure that this financial responsibility does not fall to the Greenlandic public.

In Greenland the licence holders of uranium mines and mills waste facilities are responsible for providing qualified staff and financial resources to enable appropriate controls, decommissioning and monitoring of those waste facilities to effect compliance with the provision of the Mineral Resources Act and specific guidelines.

According to the Mineral Resources Act it is the responsibility of the licence holder to collect, treat and store all radioactive waste produced under the licence in a safe manner. The

licence holder responsibility includes providing adequate financial resources to support the safe management of the radioactive waste and the waste management facility while the mine is in operation and for the long term stewardship. The licence holder has the responsibility to apply for a licence for closure of mine and its facilities. The closure includes decommissioning and rehabilitation. After rehabilitation of the waste facilities the licence holder must perform environmental monitoring for a period as long as it is necessary. Monitoring terms are part of the exploitation licence terms and specified in the more detailed approvals of exploitation and abandonment plans as well as the final activity approvals.

The Greenland Self-Government requires a bank guarantee, cash deposit, insurance or other measures deemed satisfactory before mining and milling operations can commence.

Currently, the only mine and mill facility preparing to submit an application for an exploitation licence that will produce uranium as by-product in South Greenland is privately owned. Any liability will be carried by the owner.

NORM Compliance enforcement

Environmental liability is set out in section 14 of the Mineral Resources Act. Furthermore liability terms are set in the exploitation licence pursuant to the Mineral Resources Act article 16, 63-72, 84, 86, 92 and 96-97. In case of non-compliance with regards to health, safety, security or environmental matters orders can be issued until the situation is corrected and compliance achieved. Activities under the licence can be restricted or terminated for a period until the corrective measures requested are taken. Ultimately the punishment for violations of this Act and/or provisions can be penalties, termination of the licence as well as other sanctions according to the criminal acts of Greenland (cf. MRA Section 96).

According to the Mineral Resources Act the licence holders are subjugated inspections by the authorities. Injunctions can be issued due to safety concerns or other non-compliance with the Mineral Resources Act and other applicable legislation in Greenland such as the Radiation Protection Act.

NORM Regulatory reporting

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

Article 22. Human and financial resources

Industry, medical and educational sectors

The Ministry of Health is responsible for the Radiation Protection Act.

To make sure that the Ministry of Health is supported by relevant professional expertise in the field of radiation protection, it is the intention of the Ministry of Health to pursue the possibility of making an agreement with the Danish Health Authority, Radiation Protection (SIS) in which cooperation between the authorities are laid out.

The cooperation agreement will preferably contain agreements on the extent to which SIS can be the consulting authority on the drafting of executive orders and the implementation of the provisions of the Radiation Protection Act.

According to The Greenland Working Environment Act a number of guidelines and safety instructions for the handling of radioactive materials during work, for example in instruments, laboratories and equipment are issued by the Danish WEA and apply in Greenland.

Currently the Danish Working Environment Authority is in the process of drafting a new executive order regarding ionizing radiation and working environment in Greenland. This is prepared in collaboration with the Greenland Self-Government. The overall principles and practices expected to be established with the order, are the following. The scope of the order will include occupational health and safety issues associated with exposure to ionizing radiation. Requirements of the order, which may have direct effect on health and safety (such as adherence to dose limits) will be applicable to both employees and self-employed alike. On a more general note, the provisions will stipulate requirements, such as avoidance of unnecessary exposure to radiation, the drafting of a workplace assessment and prohibition of employment of persons under 18 years of age in work with ionizing radiation. Dose limits will be set in the order and to ensure health and safety of persons, exceeding this limit will be prohibited. Method of evaluation and calculation of radiation exposure is also established in the order on the basis of international approved standards and on the basis of the system applied in Denmark. Lastly, working with ionizing radiation must only be done by persons which are capable and whose health does not suffer by this type of work. To ensure minimum risk of exposure, health exams must be executed on a regular basis. Measured doses of radiation will be required, which may be done with a chip that is placed on the garment of the worker. This chip is sent to a laboratory for reading every three months.

NORM Regulatory agencies

The Ministry of Mineral Resources is responsible for the Mineral Resources Act. The MLSA and the EAMRA are administrative authorities pursuant to the Mineral Resources Act. The Ministry of Industry is responsible for certain issues related to social sustainability.

The staff of the Mineral Resource Authorities which include the EAMRA, the MLSA, the Ministry of Mineral Resources, and the Ministry of Industry, Labor and Trade regularly undergo various training programs specifically targeted at Mineral Resource Administration. This includes courses and training on topics such as geology, mining management, HSE management, HSE risk analysis, Strategic Decision Making, courses on best practices for public administration in general, as well as specific legal courses on administration of the mineral resource area. The staff is furthermore trained according to the Anti-Corruption Policy of the Ministry of Mineral Resources and its subordinate institutions of March 2015 (the Policy document may be downloaded here).

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

Training courses, seminars, conferences, IAEA related meetings, workshops, international collaborations with researcher, independent regulatory bodies and consultants especially from Arctic region and visits to uranium mine sites both under operation but also closed facilities are therefore undertaken by the DCE and GINR staff in order to ensure both an

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

NORM Licence holders

Under the Mineral Resources Act and the Radiation Protection Act, the licence holders for mining and milling of radioactive minerals must ensure that all workers, employees, contractors and sub-contractors are trained and competent to perform the work they are employed for.

Since the exploration activities started at Kvanefjeld in 2007, the licensee prepared and submitted an RMP, performed occupational and environmental monitoring (air, water, land and geochemical characterization of waste rock, tailings and rock) of radionuclides, non-radionuclides and other physical parameters.

Article 23. Quality assurance

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

NORM quality assurance

According to the Mineral Resources Act and Guidelines for Preparing an Environmental Impact Assessment (EIA 2015), the licence holders must prepare and implement a management system: quality assurance (QA) programs for mine, mill and waste facilities. The environmental management shall comply with the requirements set out in ISO 14001 or equivalent standards. The licence holders shall consider having the environmental management certified (e.g. ISO 9001 and ISO 14001).

The licence holders must submit their overall management system programs to the MLSA and EAMRA accordingly before they start their planned activity. After a licence is granted, the involved mine and mill operator must demonstrate the effectiveness of the QA programs, e.g. its ability to consistently define roles and responsibilities for the facility, implement the QA program, demonstrate control of changes, internal audits and take corrective action(s). The specific waste management activities are performed under accepted QA programs.

After the QA program is accepted, the Greenland Self-Government monitors compliance of the licence holder through regular site visits and monitoring programs.

Article 24. Operational radiation protection

The Ministry of Health will issue executive orders that regulate dose constraints and limits for the exposure to radioactivity for the medical, educational and industry sectors and for the general public. Constraints and limits will resemble corresponding Danish legislation and international standards and practices.

NORM Keeping radiation exposures and doses ALARA

Operational Limits and Conditions will be formulated in accordance with the Radiation Protection Act and internationally accepted standards such as those of the ICRP.

During the operational lifetime of facilities at Kvanefjeld the discharge limits are expressed with reference to a dose constraint of 0.3 mSv/y.

Operations at Kvanefjeld mining and mill waste management facilities must be carried out in a manner ensuring that radiation exposures and doses to workers, the public and the environment are below the established regulatory dose limits and kept as low as reasonably achievable (ALARA).

NORM Authorized discharge limits

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

NORM Preventing unplanned releases

Several measures to prevent the risk of unplanned releases of radioactive materials from mill waste facilities and waste rock dumps into the surrounding environment shall be developed prior to start-up of mining projects and implemented by the licensee in accordance with licence terms.

Article 25. Emergency preparedness

Industry, medical and educational sectors

The Ministry of Health is to be informed of any accidents or incidents that may result in unintentional radiation, theft of or any other loss of radioactive materials.
The Ministry 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 in the vicinity of Greenland territory, the Danish Emergency Management Authority may accord assistance. The Danish Emergency Management Authority has a revised nationwide nuclear emergency preparedness plan, which entered into force in 2014. The overall emergency response is under private sector liability, which entails that each sector/licensee is responsible for preventing accidents and likewise establishing a sound emergency management plan for accidents and other incidents.

NORM Emergency preparedness

In Greenland, onsite and offsite emergency preparedness and response including radiological and nuclear emergencies for mineral resource activities is a responsibility carried by the licensee with administrative oversight by the Ministry of Mineral Resources, the MLSA and EAMRA.

Offsite radiological emergency response refers to actions and measures taken outside and beyond the licence area. The offsite radiological emergency events may originate from, or be associated with a licensed waste facility or activity within mineral resources. Events of this type require the involvement of relevant authorities and also require the support of the licensee associated with each specific event. Onsite radiological emergency response refers to all actions and measures taken within the boundary of the licence area. The response activities in these two areas involve and require different stakeholders, and therefore coordination must occur among all levels of government and the licensee to assure an effective and efficient response to a radiological emergency.

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

Article 26. Decommissioning

Industry, medical and educational sectors

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

In the early phase of an exploitation project, the operator/licensee has to prepare an initial decommissioning and rehabilitation plan and submit it to the appropriate authorities for review and approval.

The initial decommissioning and rehabilitation plan should be progressively updated throughout the life of the facility, and each separate application for authorization (construction, operation and decommissioning) should include a decommissioning plan. The closure (decommissioning and rehabilitation) plan should be periodically updated by the operator.

The licensee has to prepare and submit a final closure plan and supporting documents for review and approval by the regulatory body, in accordance with national regulations, in order to obtain an authorization to conduct closure activities. To provide the necessary confidence that the resources will be available to maintain radiation and environmental protection during the decommissioning, to secure the funds needed for decommissioning including premature decommissioning, long term monitoring and to protect against the contingency of a private company ceasing to exist, the Greenland Self-Government require appropriate financial guarantees such as bank guarantees, cash deposits or other means deemed appropriate before mining and milling operations can commence.

Section G. Safety of Spent Fuel Management

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

NORM facilities

This subsection provides a list of waste facilities proposed for mining and milling involving radioactive minerals in Greenland (Table D 1). An application for an exploitation licence for a project which contains uranium and thorium as bi-products is currently being processed. The project is named “Kvanefjeld” for the purpose of this report. The Kvanefjeld project underwent public pre-consultation in 2014. Consultation material is available online at the Greenland Self-Government website here.

Table D 1. Proposed waste facilities

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

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

The Greenland Self-Government have not licensed the design, construction and the operation of a nuclear reactor and at the present there are no considerations or plans for taking any kind of nuclear reactors into operation in Greenland. As a consequence of this 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 only radioactive waste in Greenland is generated from industry and the educational sector.

Industry, medical and educational sectors

The Greenland Self-Government establishes the policy framework for the management of radioactive wastes. A system for the disposal of radioactive waste generated will be implemented according to the Radiation Protection Act.

NORM

Exploitation of radioactive minerals in Greenland is governed by the Mineral Resources Act and specific guidelines for radiation and environmental protection and radioactive waste management which currently are under development.

The main objective in the regulation of radioactive waste management facility in Greenland is to ensure that such facilities and their activities do not pose unreasonable risks to the health, safety, security and the environment. The design, construction and operation of uranium mine and mill tailings facilities must ensure the safety of human health and the environment. Safety requirements for the management of radioactive uranium mill tailings must provide for the protection of the environment and the health and safety of workers and the public. During operations, uranium mill tailings management facilities must be operated in a safe manner.

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

As stated in Section F protective methods providing for effective protection of individuals, society and the environment are under development as part of the Greenlandic framework legislation and with due regard to internationally endorsed criteria and standards.

Article 12. Existing facilities and past practices

Past activities and existing exposure situations:

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

The Kingdom of Denmark is the contracting party to the Convention. Nevertheless, within the Kingdom of Denmark, the legislative and administrative powers relating to radiation protection in Greenland has been taken over by the Greenland Self-Government. However,

the events in the 60´s took place prior to the transfer of such powers. In light hereof, the Danish government has since been involved in the relevant clean-up operations, surveying projects, as well as monitoring related to the accident at Thule and the licensed activities at Camp Century.

Although both the accident at Thule Air Base and operations at Camp Century were part of military undertakings, and as such would be 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 in the vicinity of the Thule Air Base in Northwestern Greenland. As a result of the accident, radioactive material (primarily 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 and 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, and 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. This comprehensive health study of the population of Avanersuaq (the Thule area) was carried out by the National Institute of Public Health and the Ministry of Health in Nuuk 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 Danish Technical University. 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/yr was selected. The final assessment of exposure to representative persons in the Thule area concluded that the total radiation dose was orders of magnitude lower than the reference level, even considering extreme exposure scenarios. Thus, given the foreseen use of land, no recommendations for remedial actions were given. The complete report on this survey and references to earlier studies are available through the following link: https://www.sst.dk/en/publications/2011/~/media/B06E1CBEED9C48028DE403B7B47AD8D6.ashx.

Camp Century 1960-1963:

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

Operational limits and conditions included health physical monitoring as well as environmental monitoring of the subsurface camp areas and sampling of the ice surface and atmosphere above the camp. All solid operational radioactive waste was transported to the USA. Liquid radioactive waste was discharged directly into a dedicated well established within the ice by steam melting, presumably extending to a depth of about 40 m below the camp floor level. The liquid radioactive waste was estimated to consist of fission products such as I-131 and Cs-137 and activated shortlived corrosion products in subequal 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 pr. year.

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.

As a consequence, the Danish government has agreed with the Greenland Self-Government to undertake further investigations of the rate of effects of climate change at Camp Century. In addition, various initiatives regarding further characterization of the remaining types and amounts of waste present at Camp Century is underway, both through review of archived documentation as well as through sampling and monitoring programs.

Based on the results of these investigations, assessments concerning the need for special control or protection measures will be evaluated using a reference level of 1mSv/year in the same manner as was the case for the Thule Accident described above.

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

The only radioactive waste in Greenland is generated from the educational sector and industry. Future possible mining and milling of radioactive minerals will produce wastes containing NORM.

The waste from industry and the educational sectors

A system for the disposal of radioactive waste generated in the educational sector and from industry will be implemented according to the Radiation Protection Act.

NORM

According to the Mineral Resources Act and specific guidelines, prior to siting, construction and commissioning of mill tailings facilities, the applicant shall prepare and submit a draft Environmental Impact Assessment (EIA) together with additional study reports on tailings facilities risk assessment, alternatives for tailings disposal, management practices for the tailings resulted from the project and decommissioning of tailings facilities. Those reports are assessed by engineers, independent consultants and scientists from the Ministry of Mineral Resources, the MLSA, Ministry of Health, EAMRA, GINR, DCE and independent international third party reviewers.

Public consultation

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

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

Article 16. Operation of facilities

Industry, medical and educational sectors

There are no operating facilities in Greenland.

NORM Operation of facilities

The third step in the licensing process is the operating licence. Requirements to operate a uranium mill tailings facility and other radioactive waste resulted from the mining of radioactive minerals include the preparation and implementation of an EMP, RWMP and RMP. The EMP is approved prior to commencement of construction and operation of tailings facilities. The RWMP and RMP must be prepared and approved prior to disposal operations. A preliminary closure plan of the tailings facilities must be submitted prior to commissioning and must be reviewed and up-dated when there is a change in the project.

The approved RWMP must ensure the use of Best Available Technology (BAT) and Best Environmental Practice (BEP).

The RMP must be in accordance with the ICRP fundamental principles for managing radiation exposures, BAT, BEP and take into account the potential dose delivery pathways. It is important that BAT and BEP are incorporated into the design of facilities at a mining and processing site.

NORM Operational limits and conditions

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 such as environmental parameters, exposure pathways scenarios particular to the project and the annual effective dose to the members of the public from the proposed activities.

It is standard procedure for mining projects that the authorities perform inspections and monitoring during construction, operation, closure and after closure. The authorities would perform a routine monitoring program of dose rates, radioactive and non-radioactive contaminants at the mine site and into the environment in order to ensure compliance with the regulatory requirements. It is standard procedure for mining projects that the licensee is requested to report incidents relevant to waste management significant to safety.

Article 17. Institutional measures after closure

NORM institutional measures after closure

The authorities conduct inspections and review of closure actions to ensure that they are being carried out in accordance with the authorization for closure and the specific requirements (e.g. safety requirements) of licences and approvals. In order to demonstrate e.g. the radiological-physical-chemical stability of a closed facility, it is standard procedure for mining projects that the licensee performs environmental monitoring for a number of years after completion of decommissioning and rehabilitation of the site.Terms for such monitoring are established in the licensing process.

Section I. Transboundary Movement

Article 27. Transboundary movement

Import, export and transport of radioactive materials in Greenland and within Greenlandic waters are regulated under the Radiation Protection Act.

Any import, export, and transport of radioactive materials are to be subjected to a licence or a registration from the Ministry of Health.

The Ministry of Health will be issuing executive orders 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.

Thus so far an application of transboundary movement of radioactive waste has not been received and consequently no licence has been issued for a transboundary movement of radioactive waste for the purpose of this Convention.

Chapter 37 a in the Danish Emergency Management Act (No. 314 of 3 April 2017) is named '*Safety of nuclear materials and nuclear facilities'*. In the supporting material to the Act transport is defined as a transfer of nuclear material from one facility to another facility. Provided that the facility is located in another state the transport is classified as an international transport (transboundary movement). The Chapter 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 transportion 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 1980 an experimental extraxtion of 10,000 tons of radioactive minerals was completed, of which 4.200 tons were sent to Risø in Roskilde, Denmark for further research. Tailings produced in the process are stored in Denmark and are regulated under the Danish Ministry of Health.

In 2007 an exploration licence was granted at Kvanefjeld. NORM waste (tailings) generated from exploration activities in 2012 were transported to Perth (Australia) for temporary 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 and it was proposed by the company to be transported to Perth (Australia) for temporary storage. It is the plan of the company to transport these tailings back to the project site for final disposal if commercial operations commence. In 2017 an export permit has been granted for 536.5 kg of rock samples with an ore body grade of 0.03

uranium and 0.05 thorium. This transfer is for one single shipment to China. Export permits were issued by the Ministry of Industry, Labour, Trade and Energy for the above activities.

Section J. Disused Sealed Sources

Industry, medical and educational sectors

Sealed sources used in industry, medical and educational sectors are regulated in the Radiation Protection Act.
The Greenland Health Care System does not use sealed sources in the treatment and examination of patients.

A system for the safe disposal of radioactive waste will be implemented according to the Radiation Protection Act, see above Section B.

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 exploitation of radioactive minerals in Arctic region was started in 2014 and continued through 2015, 2016 and 2017. A compliance laboratory unit, development of a compliance regulatory project specific for Kvanefjeld, workshops specific for exploitations of radioactive minerals in Arctic regions, uranium mine sites visits, training courses, international collaborations both with independent consultants but regulatory bodies e.g. CNSC, Northern Territory Department of Mines and Energy, Southern Australian Environmental Protection Agency, US Environmental Protection Agency have been undertaken. A report was published in English with a summary in Danish and Greenlandic in 2016: http://dce2.au.dk/pub/SR200.pdf.

Regulatory framework initiatives

Radiation standards and requirements for radiation safety matters for exploration and exploitation of radioactive materials in Greenland will be developed. In the meantime, IAEA safety fundamentals, general safety requirements, general safety guides and specific requirements and specific safety guides related to uranium mining and milling are

considered while developing the Greenlandic above mentioned standards and requirements for radiation safety.

L. Annexes

Annex A – Inventory of Radioactive wastes

The ministry of Health will be working on a system for the registration of radioactive waste within Greenland.

Inventory of unsealed radioactive waste

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

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

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

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

Acts:

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

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

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

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

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

Danish 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 the 23rd of 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.

Executive orders based on the Ionizing Radiation and Radiation Protection Act are currently being drafted

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_Impact_Assessment_EIA_report_for_mineral_exploitation_in.pdf

Guidelines under development:

Guidelines for Radiation Protection for Mineral Exploration in Greenland

Guidelines for preparation of Radioactive Waste Management Plan for Mineral Exploitation in Greenland

Guidelines for preparation of a Radiation Protection Plan for Mineral Exploitation in Greenland

http://www.dma.dk/Documents/Safety%20at%20sea/klasse%207-radioaktive%20materialer-uk.pdf

The IAEA safety fundamentals, general safety requirements, general safety guides and specific requirements and specific safety guides related to uranium mining and milling that are considered in Greenland for standards development:

Table 3.3. IAEA publications on exposure to radiation from natural sources.

Exposure to Radiation from Natural Sources	
Safety Standards series	Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards - INTERIM EDITION - GSR Part 3
	Application of the Concepts of Exclusion, Exemption and Clearance Safety Guide, Safety Standards Series No. RS-G-1.7, 2004
	Occupational Radiation Protection in the Mining and Processing of Raw Materials Safety Guide, Safety Standards Series No. RS-G-1.6, 2004
	Management of Radioactive Waste from the Mining and Milling of Ores Safety Guide, Safety Standards Series No. WS-G-1.2, 2002
	Occupational Radiation Protection Safety Guide, Safety Standards Series number RS-G-1.1, 1999
Safety Reports series	Radiation Protection and NORM Residue Management in the Production of Rare Earths from Thorium containing Minerals, Safety Report Series No. 68, 2011
	Assessing the Need for Radiation Protection Measures in Work Involving Minerals and Raw Materials, Safety Reports Series No. 49, 2006
	Monitoring and Surveillance of Residues from the Mining and Milling of Uranium and Thorium, Safety Reports Series No. 27, 2002
Technical Reports series	Measurement and Calculation of Radon Releases from NORM Residues, Technical Report Series No. 474, 2013
	Extent of Environmental Contamination by Naturally Occurring Radioactive Material (NORM) and Technological Options for Mitigation, Technical Reports Series No. 419, 2003
	Current Practices for the Management and Confinement of Uranium Mill Tailings, Technical Reports Series No. 335, 1992
	Measurement and Calculation of Radon Releases from Uranium Mill Tailings, Technical Reports Series No. 333, 1992
TECDOC series	Regulatory Control for the Safe Transport of Naturally Occurring Radioactive Material (NORM), IAEA-TECDOC 1728, 2014
	Management of NORM Residues, IAEA-TECDOC 1712, 2013

	Regulatory and Management Approaches for the Control of Environmental Residues Containing Naturally Occurring Radioactive Material (NORM) – Proceedings of a Technical Meeting held in Vienna, 6-10 December 2004, IAEA-TECDOC-1484, 2006
	Naturally occurring radioactive materials (NORM IV): Proceedings of an international conference held in Szczyrk, Poland, 17-21 May 2004, IAEA-TECDOC-1472, 2005
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	Impact of New Environmental and Safety Regulations on Uranium Exploration, Mining, Milling and Management of its Waste, IAEA TECDOC Series No. 1244, 2001
	Guidebook on Good Practice in the Management of Uranium Mining and Mill Operations and the Preparation for their Closure, IAEA TECDOC Series No. 1059, 1998
	Planning for Environmental Restoration of Uranium Mining and Milling Sites in Central and Eastern Europe, IAEA TECDOC Series No. 982, 1998
	Environmental Impact Assessment for Uranium Mine, Mill and In Situ Leach Projects, IAEA TECDOC Series No. 979, 1997
	Planning and Management of Uranium Mine and Mill Closures, IAEA TECDOC Series No. 824, 1995

http://www-ns.iaea.org/publications/norm-publications.asp

Other relevant IAEA publications regarding uranium production for the nuclear fuel cycle include but are not limited to:

- Best Practice in Environmental Management of Uranium Mining, IAEA Nuclear Energy Series No. NF-T-1.2, Published 2010
- Establishment of Uranium Mining and Processing Operations in the Context of Sustainable Development, IAEA Nuclear Energy Series NF-T-1.1, Published 2009
- Generic models for use in assessing the impact of discharges of radioactive substances to the environment, Safety Reports Series No. 19, Published 2001
- Monitoring and surveillance of residues from the mining and milling of uranium and thorium, Safety Reports Series No. 27, Published 2002
- Assessing the Need for Radiation Protection Measures in Work Involving Minerals and Raw Materials, Safety Reports Series No. 49, Published 2006
- Programmes and systems for source and environmental radiation monitoring, Safety Reports Series No. 64, Published 2010
- Monitoring for Compliance with Exemption and Clearance Levels, Safety Reports Series No. 67, Published 2012
- Monitoring for Compliance with Remediation Criteria for Sites, Safety Reports Series No. 72, Published 2012
- Code of Conduct on the Safety and Security of Radioactive Sources (2003)

Greenland – Overview matrix

Sixth 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	No current practices	A system for disposal of radioactive waste will be implemented according to the Radiation Protection Act
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 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 current practices	A system for disposal of radioactive waste will be implemented according to the Radiation Protection Act