EUROPEAN COMMISSION
DIRECTORATE-GENERAL FOR ENERGY

Directorate D – Nuclear energy, safety and ITER
D.3 – Radiation protection and nuclear safety

Verification under the terms of Article 35 of the Euratom Treaty

Technical Report

DENMARK

Routine and Emergency radioactivity monitoring arrangements
Monitoring of radioactivity in drinking water, food and feed samples

28-30 May 2024

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GLOSSARY OF ABBREVIATIONS

AGS	Air-borne spectrometry
CGS	Car-borne spectrometry
DAHES	Danish Agency for Higher Education and Science
DANAK	Danish Accreditation Authority
DD	Danish Decommissioning
DEMA	Danish Emergency Management Agency
DHA	Danish Health Authority
DHA/RP	Radiation Protection Department of the Danish Health Authority
DTU Sustain	Department of Environmental and Resource Engineering, Technical University of Denmark
DTU Sustain /RTS	Radioecology and Tracer Studies group in the Technical University of Denmark
DVFA	Danish Veterinary and Food Administration
EC	European Commission
EDWD	Euratom Drinking Water Directive
EURDEP	European Radiological Data Exchange Platform
GM	Geiger Müller
HELCOM	The Baltic Marine Environment Protection Commission
HPGe	High Purity Germanium (detector)
JRC	Joint Research Centre
LIMS	Laboratory Information Management System
OSPAR	The Convention for the Protection of the Marine Environment of the North-East Atlantic
PARCOM	The Convention for the Prevention of Marine Pollution from Land-Based Sources
TLD	Thermoluminescence dosimeters

1 INTRODUCTION

Under Article 35 of the Euratom Treaty, all Member States must establish the facilities necessary to carry out continuous monitoring of the levels of radioactivity in air, water and soil and to ensure compliance with the basic safety standards ([1]). Article 35 also gives the European Commission (EC) the right of access to such facilities to verify their operation and efficiency. The radiation protection and nuclear safety unit of the European Commission's Directorate-General for Energy is responsible for undertaking these verifications. The EC's Joint Research Centre (JRC) provides technical support during the verification visits and in drawing up the reports.

The main purpose of the verifications under Article 35 of the Euratom Treaty is to provide an independent assessment of the adequacy of monitoring facilities for:

- liquid and airborne discharges of radioactivity from a site into the environment;
- levels of environmental radioactivity at the site perimeter and in the marine, terrestrial and aquatic environment around the site, for all relevant exposure pathways;
- levels of environmental radioactivity on the territory of the Member State.

The Commission Communication ([2]) describing practical arrangements for Article 35 verification visits in Member States was published in the *Official Journal of the European Union* on 4 July 2006.

2 PREPARATION AND CONDUCT OF THE VERIFICATION

2.1 Preparation

The EC notified Denmark of its decision to conduct an Article 35 verification in a letter addressed to the Permanent Representation of Denmark to the European Union. The Danish Government subsequently designated the Radiation Protection Department of the Danish Health Authority (DHA/RP) to lead the preparations for this visit.

2.2 Programme of the visit

The EC and the DHA/RP agreed on a programme of verification activities in line with the Commission Communication of 4 July 2006.

The opening meeting held at the DHA/RP premises included presentations and discussions on the following:

- Commission Article 35 verification programme (Annex A)

([1]) Council Directive 2013/59/Euratom of 5 December 2013 laying down basic safety standards for protection against the dangers arising from exposure to ionising radiation; repealing Directives 89/618/Euratom, 90/641/Euratom, 96/29/Euratom, 97/43/Euratom and 2003/122/Euratom with effect from 6 February 2018 (OJ L 13 of 17.1.2014)

([2]) Commission Communication *Verification of environmental radioactivity monitoring facilities under the terms of Article 35 of the Euratom Treaty — Practical arrangements for the conduct of verification visits in Member States* (OJ C 155, 4.7.2006, pp. 2-5)

- Environmental radioactivity monitoring arrangements and responsibilities of different competent authorities and analytical laboratories in Denmark, presented by the DHA/RP
- Information about the monitoring results to the general public
- Overview of laboratory services provided by the DHA/RP
- Drinking water monitoring including the presentation of the results on the studies related to the groundwater and drinking water monitoring for decision making purposes.

The verification team pointed to the quality and comprehensiveness of all the presentations and documentation. The team carried out the verifications in accordance with the programme in Annex A. The verification team met the following representatives of the competent authorities and other organisations involved in environmental radioactivity monitoring. The list below includes the Danish representatives who also contributed to the preparatory questionnaire.

Danish Health Authority, Radiation Protection (DHA/RP):

- Kresten Breddam – Director
- Haraldur Hannesson - Head of Section
- David Garf Ulfbeck - Senior Advisor
- Rikke Harlou - Special Advisor
- Heidi Sjølin Thomsen - Special Advisor
- Asser Nyander Poulsen - Special Advisor

The Danish Environmental Protection Agency

- Annette Weeth - Chief Advisor
- Kim Lundgreen - Marine biologist

The Danish Veterinary and Food Administration

- Nikolas Kühn Hove - Head of crises management
- Charlotte Legind - Environmental Chemist, Chemistry and Food Quality Division

The Danish Emergency Management Agency, Nuclear Division (DEMA):

- Carsten Israelson, Deputy Head of Department
- Henrik Roed, Senior Advisor
- Marie Lundgaard Davidsdóttir, Special Advisor
- Naya Sophie Rye Jørgensen, Head of Section

Technical University of Denmark, Department of Environmental and Resource Engineering, DTU Sustain

- Jixin Qiao, Professor - Head of Radioecology Group
- Kasper Andersson - Senior Researcher
- Charlotte B. Corfitzen – Head of Administration

Danish Decommissioning (DD)

- Kirsten Hjerrild Nielsen - Technical Director; Nuclear Expert
- Mikkel Øberg - Head of Department
- Jens Søgaard-Hansen - Senior Health Physicist
- João Silva - Head of Department

3 LEGAL FRAMEWORK FOR RADIOLOGICAL MONITORING IN DENMARK

The following legislative provisions regulate the environmental radioactivity monitoring and define the responsibilities of involved authorities and organisations in Denmark:

3.1 Radiation Protection

- Act, No. 23 of 15 May 2018 on Ionising Radiation and Radiation Protection (The Radiation Protection Act).
  This act provides the basis for the protection of humans and the environment against the harmful effects of ionising radiation in connection with the use of man-made or natural radiation sources or in connection with exposure to radiation, whether planned or existing radiation situations or radiation caused by an emergency.
- Executive Order, No. 669 of 1 July 2019 on Ionising Radiation and Radiation Protection that gives the general framework of radiation protection in Denmark.
- Executive Order on Use of Radioactive Substances No. 670 of 1 July 2019 that gives the general framework and regulates the use of radioactive materials in Denmark.
- Act, No. 170 of 16 May 1962 on Nuclear Installations (The Nuclear Installations Act) provides the general framework that regulates the nuclear installations in Denmark (Danish Decommissioning (DD) and the Danish Technical University (DTU) Risø Campus).
- Operational Limits and Conditions for the DD and Operational Limits and Conditions for the DTU Risø Campus.
  In pursuance of the Nuclear Installations Act, DHA/RP and the DEMA have - as nuclear regulatory authorities - issued operational limits and conditions for Danish Decommissioning and DTU Risø Campus. Environmental radioactivity monitoring in the vicinity of the Risø area, as well as discharge monitoring of airborne and liquid releases from the DD, is included in the Operational Limits and Conditions for Danish Decommissioning. Clearance levels for solid materials are specified in the same document. The document is updated regularly, when needed; most recently was on the 24th of February 2022.

3.2 Food and feed

- Regulation 2020/1158 on the conditions governing imports of food and feed originating in third countries following the accidents at the Chernobyl nuclear power station;
- Regulation 2016/52 laying down maximum permitted levels of radioactive contamination of food and feed following a nuclear accident or any other case of radiological emergency;
- Executive Order No.1441 of 30 November 2023 on the import of food, feed, animal byproducts, derived products and food contact materials with special restrictions;
- Consolidation Act No. 60 of 19 January 2024 on Feed;
- Executive Order No. 1033 of 5 July 2023 on Food;
- Executive Order No. 1721 of 30 November 2020 on tasks and obligations of the Danish Veterinary and Food Administration.

3.3 Drinking water monitoring

- Consolidation Act No. 602 of 10 May 2022 on Water Supply defines the quality criteria for drinking water and regulates the radiological surveillance of drinking water according to Article 35 of the Euratom Treaty.

- Executive Order No.940 of 22 July 2024 on Drinking Water prescribes the frequency of checks for radioactivity indicators in drinking water if there is a risk of radioactivity.
- Guidance on water quality (Guidance No. 55 of February 2022, on Drinking Water)

3.4 Emergency preparedness

- Consolidated Act. No. 314 of 3 April 2017 defines the purpose and competences of fire and rescue services in Denmark and hence contains elements of relevance to fire safety and nuclear installations;
- Executive Order No. 1762 of 27 December 2016 on Security Measures for Nuclear Material and Nuclear Facilities and Drafting of Security Plan

3.5 Framework agreement

The Danish Health Authority, the Danish Veterinary and Food Administration, and the Environmental Protection Agency have signed a Framework Agreement with the Technical University of Denmark. This agreement, concluded for the period 2023-2026, focuses on research-based public sector consultancy and the provision of services to government agencies concerning the monitoring of radioactivity in the environment and food. The agreement outlines the specific services to be provided to ensure effective environmental radioactive monitoring in Denmark and designates the DTU Sustain as the responsible entity for carrying out this monitoring.

As part of the Framework Agreement:

- DTU Sustain carries out the radiological surveillance of surface and groundwater in Denmark in accordance with the requirements of the Danish Environmental Protection Agency;
- The radiological surveillance of food and feed is performed according to the Framework Agreement carried out by DTU Sustain under provisions of the Danish Veterinary and Food Administration.

3.6 International recommendations and agreements

- HELCOM Recommendation 26/3 monitoring radioactive substances in the Baltic Sea
- PARCOM Recommendation 94/8 Concerning Environmental Impact Resulting from Discharges of Radioactive Substances under the Oslo and Paris Conventions for the prevention of the marine pollution.
- OSPAR Agreement 2005-8, The Convention for the Protection of the Marine Environment of the North-East Atlantic ("OSPAR Convention") replaces the former Oslo and Paris Conventions.

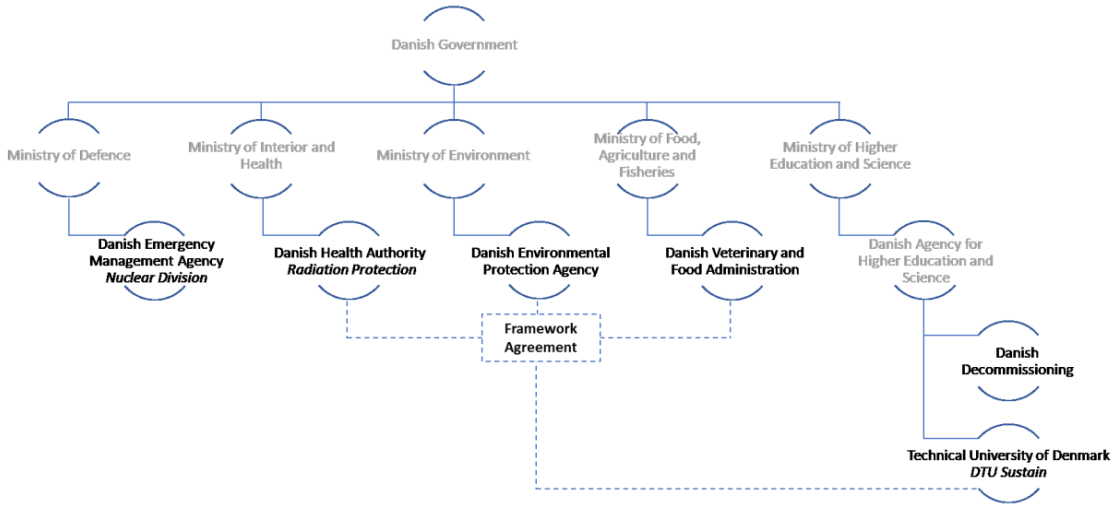
4 BODIES HAVING COMPETENCE IN THE FIELD OF ENVIRONMENTAL RADIOACTIVITY MONITORING

4.1 Introduction

The responsibility for monitoring radioactivity in the environment in Denmark is distributed across several ministries, namely: Ministry of Defence, Ministry of Interior and Health, Ministry of Environment, Ministry of Food, Agriculture and Fisheries and Ministry of Higher Education and Science. Figure 1 illustrates the hierarchy of principal bodies in Denmark.

Each ministry has assigned specific environmental monitoring tasks to different authorities, agencies, and research institutions. These tasks are divided based on sectorial responsibilities, each entity handling duties within its area of expertise.

Figure 1: Principal bodies having competence in the field of environmental radioactivity monitoring in Denmark. The bodies involved in the Framework Agreement are connected by dashed lines.



Source: Response to the Art 35 preparatory questionnaire by the Danish authorities

4.2 Danish Health Authority, Radiation Protection

The Danish Health Authority (DHA), under the Ministry of the Interior and Health, is the main authority for radiation protection and safety. Additionally, the DHA is one of the joint nuclear regulatory authorities as defined by The Nuclear Installations Act. Within the DHA, the Radiation Protection (RP) division undertakes all regulatory functions and statutory duties related to radiation protection including the matters related to Art. 35 of the Euratom Treaty.

DHA/RP is responsible for the protection of humans and the environment from the harmful effects of ionising radiation in the use of, or exposure to, human-made or natural radiation sources, whether in planned, existing or emergency radiation situations. The core function of DHA/RP is to ensure that use of, or exposure to, radiation sources are always justified, optimised and within the dose limits. DHA/RP provides regulations, requires licensing and notification, conducts inspections, and provides information/supervision to institutions, industries and to the public covering radiation protection and safety. DHA/RP has a standby duty officer on call 24/7 who can intervene in the event of a radiological emergency.

4.3 The Danish Environmental Protection Agency

The Danish Environmental Protection Agency has the overall responsibility for the implementation of legislation concerning drinking water, which takes place in collaboration with, among others, the health authorities in relation to the health aspects and assessments. This includes protecting groundwater, regulating wells and boreholes, setting quality standards for drinking water, conducting inspections, and providing regulatory guidance.

The municipalities oversee the supply of drinking water and approve the quality control programs proposed by the local water suppliers. The municipalities also supervise whether the water meets drinking water quality standards and inspect technical facilities of local drinking water suppliers. The water supply companies are responsible for supplying drinking water efficiently and for ensuring the quality of drinking water. Each water supplier is responsible for monitoring the quality of drinking water. The risk assessment of local water suppliers includes the monitoring of radioactivity parameters.

Certain municipality decisions require notification to the Environmental Protection Agency.

4.4 The Danish Veterinary and Food Administration

The Danish Veterinary and Food Administration (DVFA), under the Ministry of Food, Agriculture and Fisheries is the competent authority for food safety. The DVFA is responsible for selecting samples of food and feed for analyses that are imported from regions with a potential radioactivity risk. Currently, import restrictions are in place for specific foodstuff growing in areas near Chernobyl.

The DVFA is responsible for follow-up actions in cases involving contaminated feed or food.

4.5 The Danish Agency for Higher Education and Science

The Danish Agency for Higher Education and Science (DAHES) is responsible for the activities of the Technical University of Denmark (DTU), in particular the activities of the DTU Sustain, conducting research on environmental radioactivity. DTU Sustain ([3]) is the Environmental and Resource Engineering Department of the Technical University of Denmark.

Currently, the radiological analyses of environmental samples relevant to the national radiological monitoring programme are carried out by the Radioecology and Tracer Studies (RTS) group from the DTU Sustain.

4.6 Danish Decommissioning

The Danish Agency for Higher Education and Science is also responsible for the state-owned enterprise Danish Decommissioning (DD) established in 2003. DD is responsible for the operation and the decommissioning of the nuclear facilities at the Risø site ([4]) and for the environmental monitoring areas surrounding the nuclear facilities at the Risø site.

([3]) DTU Sustain was previously known as DTU Environment (2020-2022), DTU Nutech (2012-2019), Risø DTU (2007-2011) and as Risø National Laboratory (1956-2006).

([4]) Denmark has no nuclear power plants. Originally, there were three research reactors at the Risø site, which started operating between 1957-1960. Decommissioning activities of these reactors are on-going and expected to be finalised within the next few years.

The nuclear regulatory authorities (DHA/RP and DEMA) require that the Danish Decommissioning conduct environmental monitoring of the areas around the nuclear facilities under decommissioning at the Risø site. Danish Decommissioning has contracted DTU Sustain to conduct this monitoring.

The DD operates an accredited clearance facility for releasing materials arising from decommissioning from regulatory control.

The analyses of samples related to the site-specific environmental monitoring programme at the Risø site are carried out by the RTS group of the DTU Sustain under the responsibility of the DD.

4.7 Laboratories participating in the environmental radioactivity monitoring programme

The laboratory of DTU Sustain, Department of Environmental and Resource Engineering, Technical University of Denmark undertakes sampling and analyses of radionuclides in environmental and food samples in Denmark. The laboratory carries out also site-specific environmental monitoring at the Risø site and its surrounding areas.

Two other laboratories may carry out or participate in the monitoring of environmental radioactivity in Denmark:

- Danish Health Authority, Radiation Protection has three technical support units; the standard dosimetry laboratory, the personal dosimetry laboratory, and the environmental laboratory.

- Danish Decommissioning operates the accredited clearance laboratory as well as various laboratory facilities supporting the monitoring and control requirements for the decommissioning activities at the Risø site.

4.8 Danish Emergency Management Agency

According to The Nuclear Installations Act, Danish Emergency Management Agency (DEMA), under the Ministry of Defence and DHA/RP jointly constitute the nuclear regulatory authorities. They support the decision-making process during a nuclear emergency. DEMA is responsible for national nuclear emergency planning and coordination of specific planning in the field of nuclear emergency preparedness in Denmark and Greenland and is the first response authority in case of nuclear accidents.

DEMA operates a network of permanent gamma radiation monitoring stations in Denmark and Greenland, being equipped with mobile air- and car-borne measurement systems and air filter stations.

DEMA has a nuclear emergency duty officer who can be reached 24/7. The duty officer reacts to alarms from the automatic measurement systems and to alerts coming from other international organisations. The duty officer can, if necessary, activate the nuclear emergency plan.

5 ENVIRONMENTAL RADIOACTIVITY MONITORING PROGRAMME IN DENMARK

5.1 General

The Danish national environmental radioactivity monitoring programme is composed of

- National monitoring programme covering analyses of air, water, soil, vegetation, food and feed samples (Annex B);
- An automatic nationwide monitoring network for external gamma dose rate;
- Site-specific monitoring programme in the vicinity of the nuclear facilities at Risø site.

5.2 External gamma dose and dose rate monitoring

5.2.1 National network for dose rate monitoring

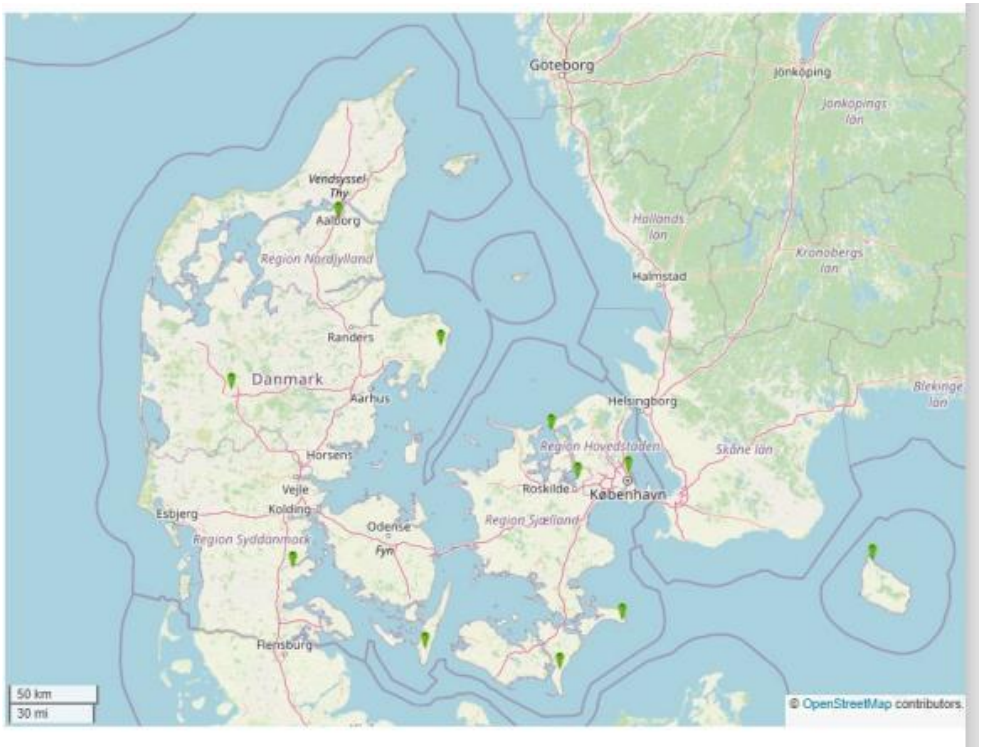
DEMA operates and maintains a network of gamma monitoring stations at 14 locations in Denmark (11) and in Greenland (3) (Figure 2 and 3). The monitoring stations provided by the company Envinet have been in operation since 2012.

Each Envinet monitoring station contains:

- A spectroscopic monitoring station with a 2x2 inch NaI (TI) detector for nuclide identification. The stations in Greenland are equipped with a heating element.
- A gamma dose rate monitoring station with two Geiger-Müller probes.

The setup with two independent systems at each station ensures data coverage at all times. Specific monitoring software is used for remote control and administration of the stations for handling, storage, analysis, presentation, and publication of collected data. The stations have an automatic alert system that goes directly to the nuclear emergency duty officer at DEMA. Measurement data from the monitoring stations are sent in real time to the European Radiological Data Exchange Platform (EURDEP).

Figure 2: Locations of 11 gamma dose rate monitoring stations in Denmark



Source: Response to the Art 35 preparatory questionnaire by the Danish authorities

Figure 3: Locations of 3 gamma dose rate monitoring stations in Greenland

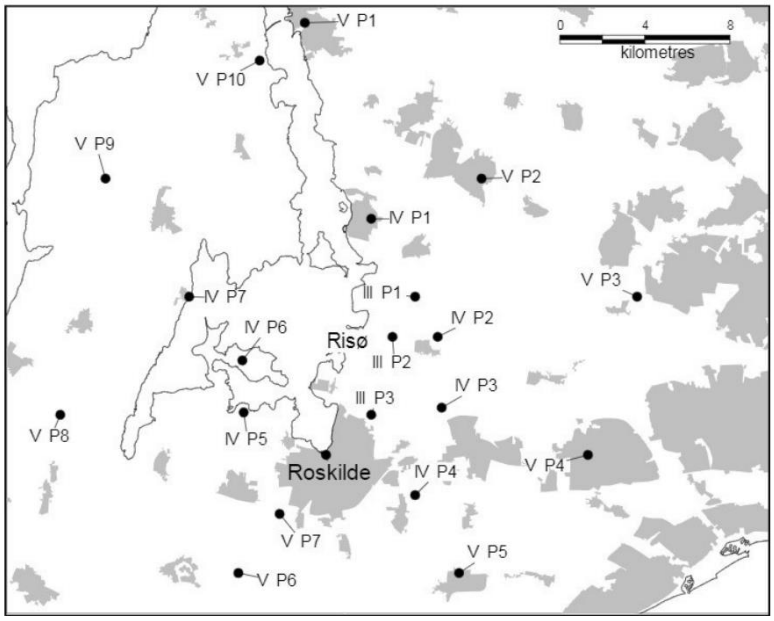
Source: Response to the Art 35 preparatory questionnaire by the Danish authorities

5.2.2 Site specific monitoring programme around the Risø site.

Monitoring at and around the Risø site is carried out by the DTU Sustain/RTS Group using the thermoluminescence dosimeters (TLD) and NaI detectors. Figure 4 shows the location zones around the Risø site where the TLDs are installed and where the monitoring with a portable Nal detector is carried out.

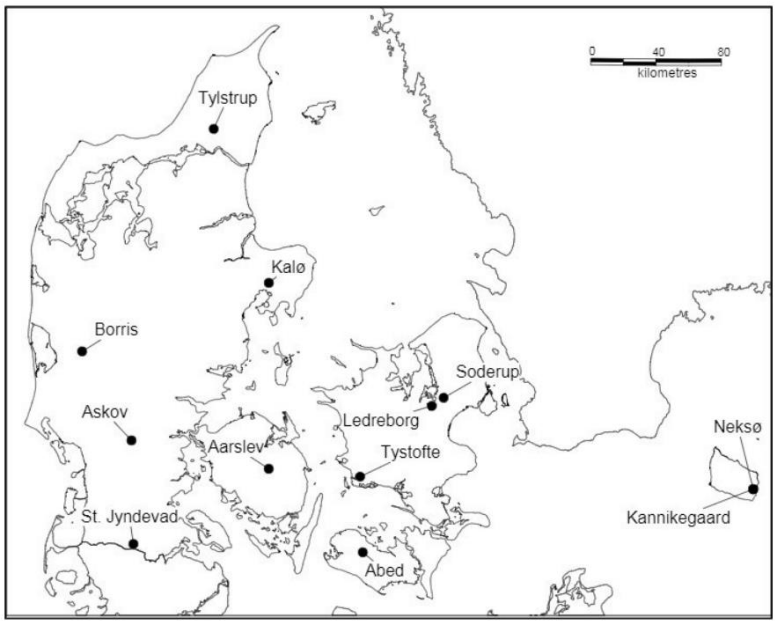
Figure 5 presents other locations in Denmark (different from those shown in Figure 2), where the dose rate is measured annually by a portable NaI detector. Monitoring at these locations has been carried out since 1960 before the network operated by DEMA was initiated.

Figure 4: External dose rate monitoring zones at and around the Risø site carried out with TLDs and Nal detectors.



Source: Response to the Art 35 preparatory questionnaire by the Danish authorities

Figure 5: External background monitoring carried out with a NaI detector.



Source: Response to the Art 35 preparatory questionnaire by the Danish authorities

5.3 Environmental sampling

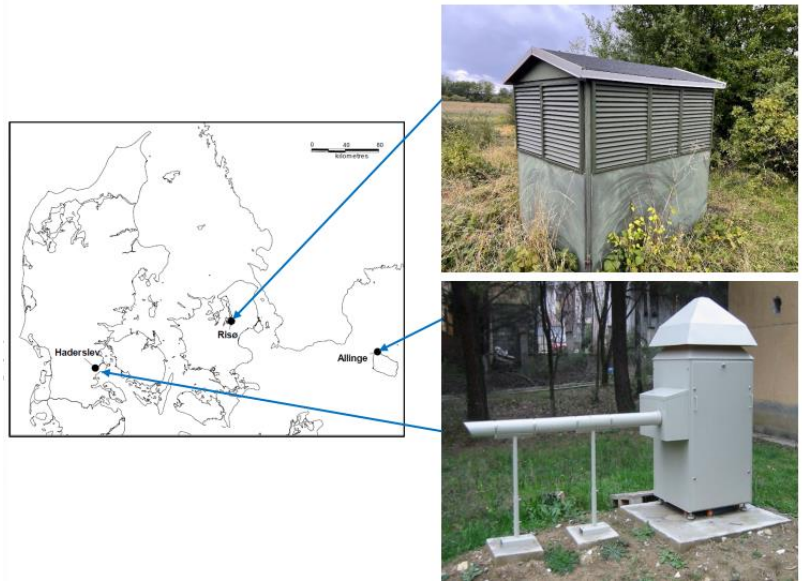
5.3.1 Airborne radioactivity

In Denmark, three high volume air samplers are used to determine airborne radioactivity concentrations (Figure 6):

- One aerosol sampler located in Risø - equipment with an air flow of 2000 m^3/h, sampling particulates only;
- Two aerosol samplers located in Allinge and Haderslev: type JL-400 Watchman (SENYA, Finland) having an air flow of 400 m^3/h. Each of these samplers are equipped with a calibrated activated carbon line to enable sampling from gaseous substances.

DTU Sustain/RTS Group is in charge of the air sampler at the Risø site and DEMA is in charge of the air samplers at Allinge and Haderslev. The SENYA air samplers are placed close to the permanent monitoring stations for gamma dose rate.

Figure 6: Locations of three high-volume air samplers in Denmark



Source: Presentation of DTU Sustain

The air filters of the high-volume air sampler at Risø site are exchanged by RTS staff every week.

The air filters from the other two air samplers in Allinge and Haderslev are exchanged by DEMA staff weekly and sent to the DTU Sustain/RTS by mail.

DTU Sustain analyses filters from all three high-volume air samplers by gamma spectrometry shortly after filter change to check for the presence of short-lived man-made radionuclides. The air filters are subsequently stored for a minimum of one week to allow for decay of short-lived naturally occurring radionuclides before further analysis. The filters from the Risø site are analysed on a weekly basis for caesium (Cs-137), beryllium (Be-7), and lead (Pb-210). Twice a year the bulked samples are analysed for strontium (Sr-90).

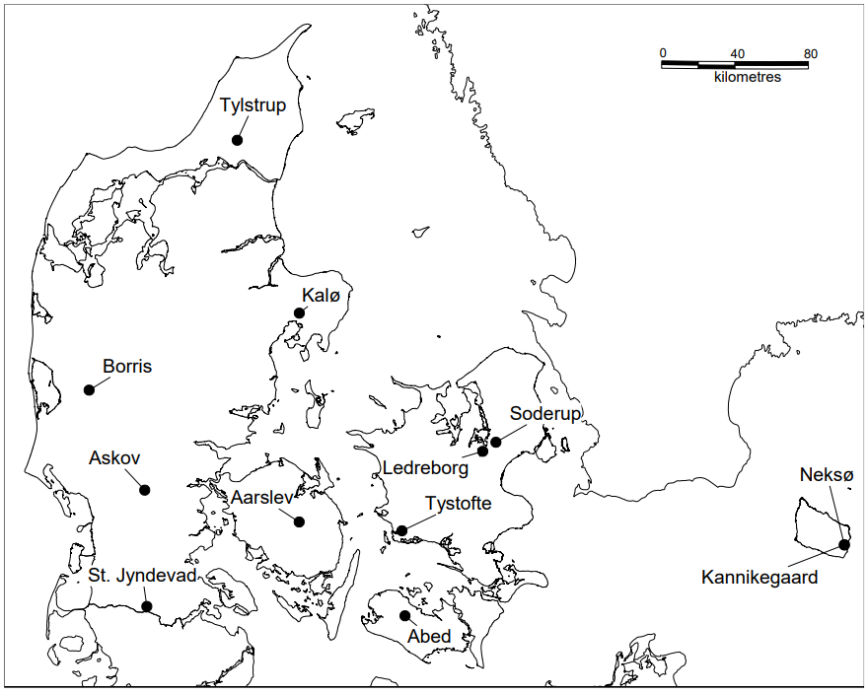
The monthly bulked filters from Allinge and Haderslev are analysed by gamma spectrometry.

5.3.2 Atmospheric deposition

Wet deposition ([5]) samples are collected by DTU Sustain/RTS at eleven locations as shown in Figure 7. Each site has three unheated rain collectors with a total area of 0.42 m^2 (Figure 8). Each collector has a funnel situated above a 25 L plastic container. Three identical collectors are used at each location to ensure sufficient amount of precipitation collected for detection of radionuclides with the low activity levels. The collection period for deposition samples is one month. Plastic containers with precipitation are sent on a monthly basis to DTU Sustain/RTS at Risø where samples are bulked for each location to provide annual samples which are analysed for strontium (Sr-90) and caesium (Cs-137).

([5]) Deposition refers to radioactive substances that have fallen to the ground or water from air. Wet deposition may come with rain.

Figure 7: Wet deposition collectors (rain collectors) at eleven locations



Source: Response to the Art 35 preparatory questionnaire by the Danish authorities

Figure 8: Deposition collectors

Source: DTU Sustain presentation

Further to this the DTU Sustain operates at the Risø site a large rain collector of 10 m^2. The collector is heated and water is passed through an ion exchange column to a large tank (Figure 9). Monthly samples of rainwater are analysed for tritium and the resin is analysed monthly by gamma spectrometry for beryllium (Be-7), caesium (Cs-137), and lead (Pb-210). The resin is bulked for 4 consecutive months and analysed for strontium (Sr-90).

Figure 9: Rain tank with the ion exchange resin

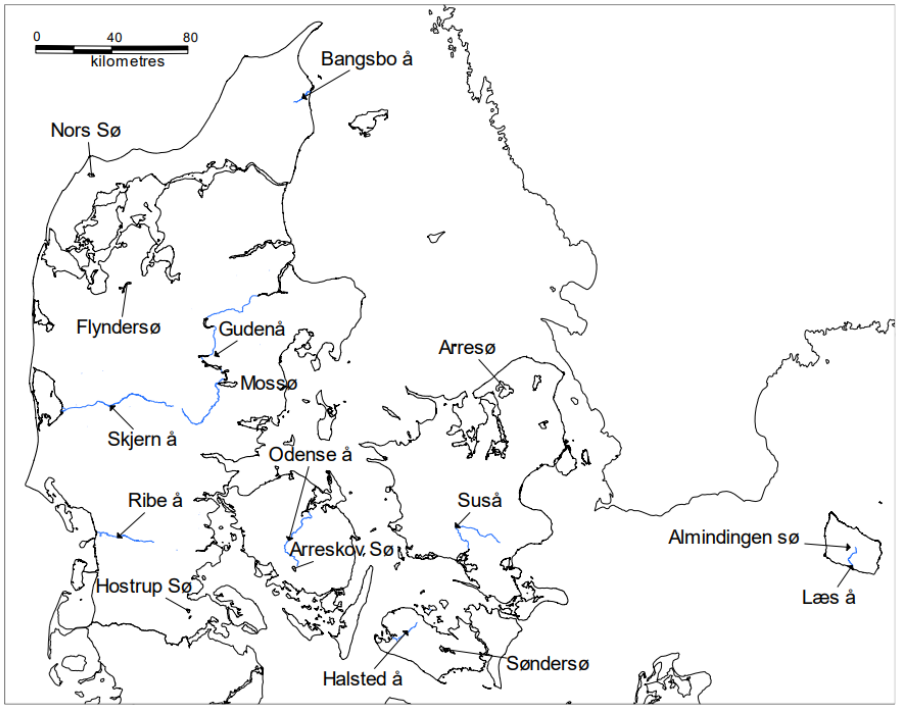
Source: Photo taken by the verification team

5.4 Monitoring of radioactivity in water

5.4.1 Surface waters

Freshwater samples from 8 streams and 8 lakes are collected every second year. 100-600 L samples are passed through impregnated filters in the field and the filters are taken to the DTU Sustain/RTS laboratory for caesium (Cs-137) analysis. A map indicating the locations for sampling of surface waters (streams, lakes) are shown in Figure 10 (the sample location Svenskehavn on Bornholm is not shown on this map).

Figure 10: Locations for sampling of fresh water from streams and lakes.



Source: Response to the Art 35 preparatory questionnaire by the Danish authorities

5.4.2 Seawater and marine sediments

Seawater samples of 50-100 L are collected annually from 12 locations (Figure 11) by the Danish Navy. Furthermore, samples of sediment are collected from four locations in the Baltic Sea by the Danish Environmental Protection Agency. All samples are transported to DTU Sustain/RTS for analysis.

The Danish marine monitoring programme for the Baltic Sea is carried out in accordance with HELCOM ([6]) Recommendation 26/3.

Marine monitoring of the North-East Atlantic Ocean is carried out in accordance with PARCOM Recommendation 94/8 in parallel with OSPAR([7]) Agreement 2005-8**.** The samples are collected by DTU in connection with separate projects only, not part of the Danish national monitoring programme.

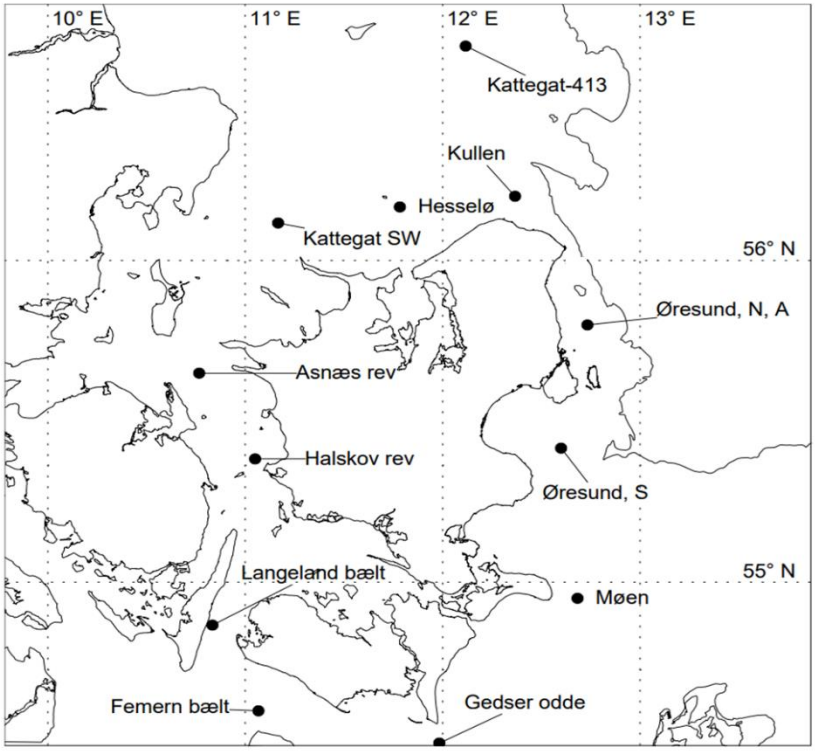
In addition, samples of water from Roskilde Fjord (not shown in the Figure 11) are collected quarterly and surface seawater annually from Svenskehavn on Bornholm.

Seawater samples are analysed annually for strontium (Sr-90) and caesium (Cs-137), and occasionally for technetium (Tc-99), plutonium (Pu-239, Pu-240) and neptunium (Np-237). Samples from Roskilde Fjord are analysed quarterly for tritium (H-3) and annually for caesium (Cs-137).

([6]) The Baltic Marine Environment Protection Commission – also known as the Helsinki Commission (HELCOM) – is an intergovernmental organisation and a regional sea convention in the Baltic Sea area. A regional platform for environmental policy making, HELCOM was established in 1974 to protect the marine environment of the Baltic Sea from all sources of pollution.

([7]) OSPAR is the mechanism by which 15 Governments & the EU cooperate to protect the marine environment of the North-East Atlantic.

Figure 11: Seawater sampling locations.



Source: Response to the Art 35 preparatory questionnaire by the Danish authorities

5.4.3 Groundwater and drinking water

In Denmark, drinking water is produced entirely from groundwater. Pursuant to the Executive Order No. 940 of 22 July 2024, the Danish water suppliers supplying less than 100m^3 per day are not obliged to monitor the drinking water on radioactivity parameters. This is permitted under the Council Directive 2013/51/Euratom (Euratom Drinking Water Directive-EDW) ([8]), specifically referenced in Annex II ([9]). At the end of 2014, the Danish authorities have established, on the basis of previous measurements of radioactive substances in drinking and groundwater, that the drinking water contains low levels of radioactive substances. As a result of this, it has been decided not to include in Danish law regular monitoring of radioactivity parameters (radon, tritium and the Indicative Dose) in drinking water, for water suppliers producing **less** than 100 m^3 per day.

The Danish water suppliers producing **more** than 100 m^3 per day must comply with the requirements of the Executive Order No. 940 of 22 July 2024, which defines the minimum sampling and analysis frequencies for monitoring of drinking water. In the Guidance on Water

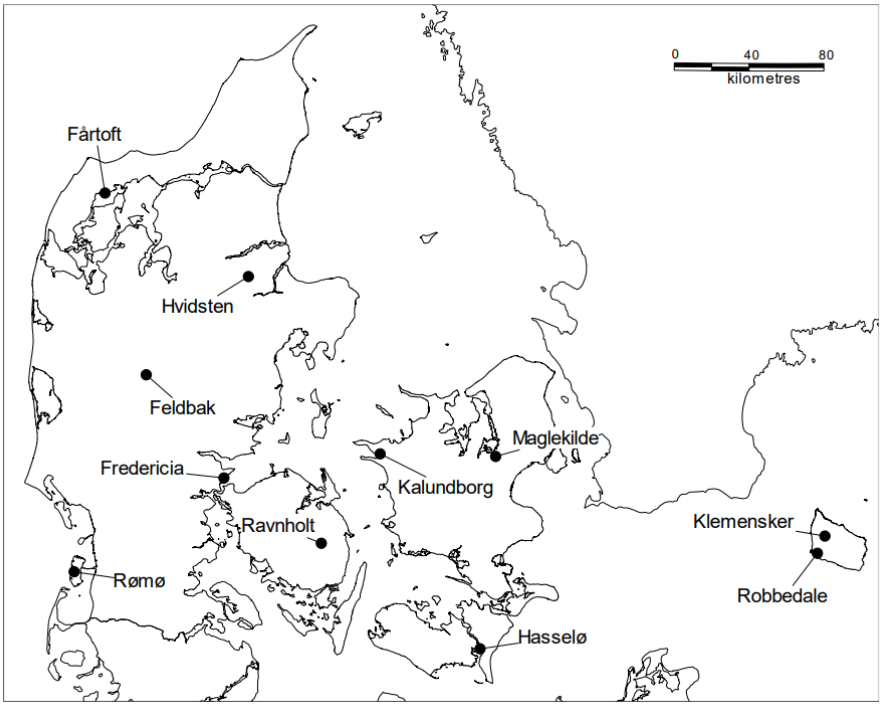
([8]) Council Directive 2013/51/Euratom of 22 October 2013 laying down requirements for the protection of the health of the general public with regard to radioactive substances in water intended for human consumption (OJ L 296, 7.11.2013, p. 12–21)

([9]) Annex II (1)….no monitoring of a specific parameter shall be required where a competent authority can establish that, for a period of time to be determined by them, that parameter is not likely to be present in a given supply of water intended for human consumption in concentrations which could exceed the corresponding parametric value.

Quality ([10]) and Supervision of Water Supply Facilities, there is a further description of the extent to which radioactivity indicators must be included in the quality control.

Groundwater is sampled at 11 locations every third year by DTU Sustain/RTS (Figure 12) and all samples are analysed for strontium (Sr-90). Samples from the Feldbak location are collected by filtration in the field for analysis of caesium (Cs-137).

Figure 12: Locations for sampling of groundwater.



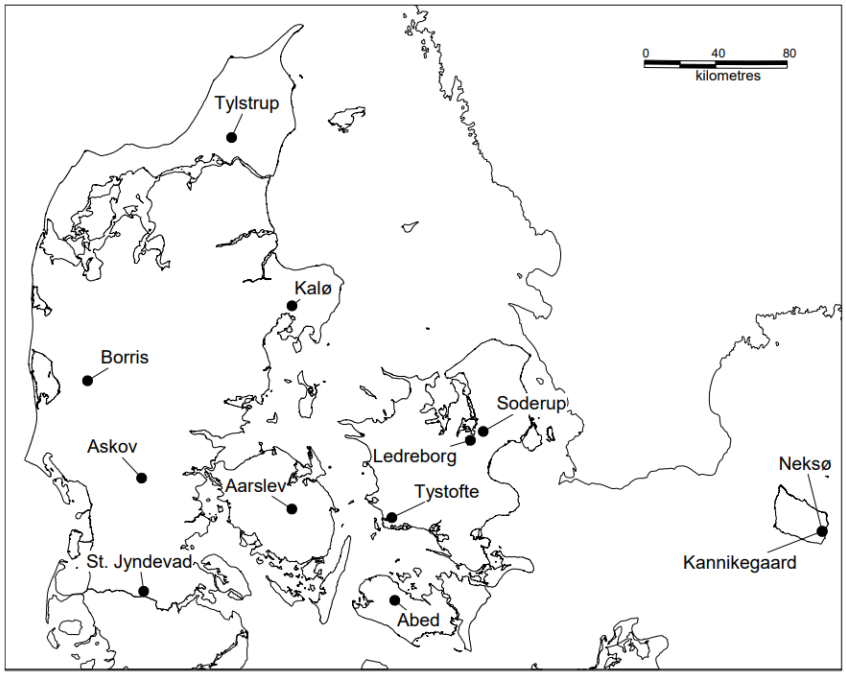
Source: Response to the Art 35 preparatory questionnaire by the Danish authorities

5.5 Monitoring of radioactivity in soil

Soil samples are collected every 5 years from 11 locations as shown in Figure 13. A coring device is used to collect 13 sub-cores at each location which are separated in depth segments of 0-5 cm, 5-10 cm, 10-20 cm, 20-30 cm, and 30-50 cm and combined by depth. Sample preparation includes sieving, drying, and ashing. Samples are analysed for strontium (Sr-90) and caesium (Cs-137), and natural gamma emitters, occasionally for plutonium.

([10]) Guidance no. 55, February 2022, Drinking Water

Figure 13: Soil sampling locations



Source: Response to the Art 35 preparatory questionnaire by the Danish authorities

5.6 Terrestrial and aquatic biota

5.6.1 Grass

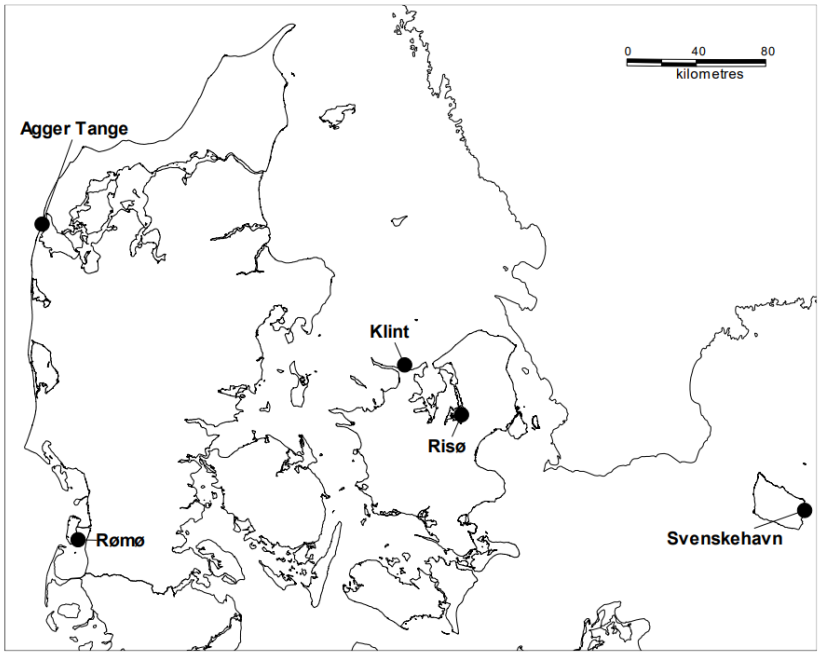
Grass samples are collected every second week at the Risø site and analysed for gamma emitting radionuclides. Samples are bulked to monthly samples which are analysed for caesium (Cs-137) and bulked further to quarterly samples which are analysed for (Sr-90).

5.6.2 Seaweed

Seaweed samples are collected from different locations (Figure 14):

- annually from Roskilde Fjord at Risø and analysed for caesium (Cs-137);
- quarterly from two locations in Jutland and one on location Zealand and analysed for caesium (Cs-137) and technetium (Tc-99);
- annually from Bornholm and analysed for caesium (Cs-137) and technetium (Tc-99).

Figure 14: Seaweed sampling locations.



Source: Response to the Art 35 preparatory questionnaire by the Danish authorities

5.6.3 Aquatic biota

Marine fish samples (cod, herring, and plaice) are collected annually from harbours in West Jutland, Zealand and Bornholm and analysed for caesium (Cs-137) and polonium (Po-210). Lobster is collected from Kattegat annually and analysed for technetium (Tc-99) (Figure 15).

Figure 15: Marine fish and lobster sampling, DK-Denmark, FO-Faroe Island, GL-Greenland

	DK	FO	GL
Sampling Method	Fish dealers / local people	Fish dealers / local people	Fish dealers / local people
Location	North Sea, Kattegat, Sound, Great Belt, Bornholm	North Atlantic	West Greenland
Frequency	Annually	Annually	Annually
Nuclides	^{90}Sr, ^{137}Cs, ^{210}Po	^{90}Sr, ^{137}Cs, ^{210}Po	^{90}Sr, ^{137}Cs, ^{210}Po
Pooling	By species and locations	By species and locations	By species and locations
Species	Cod, plaice, herring	Cod, haddock	Cod, halibut, salmon, trout

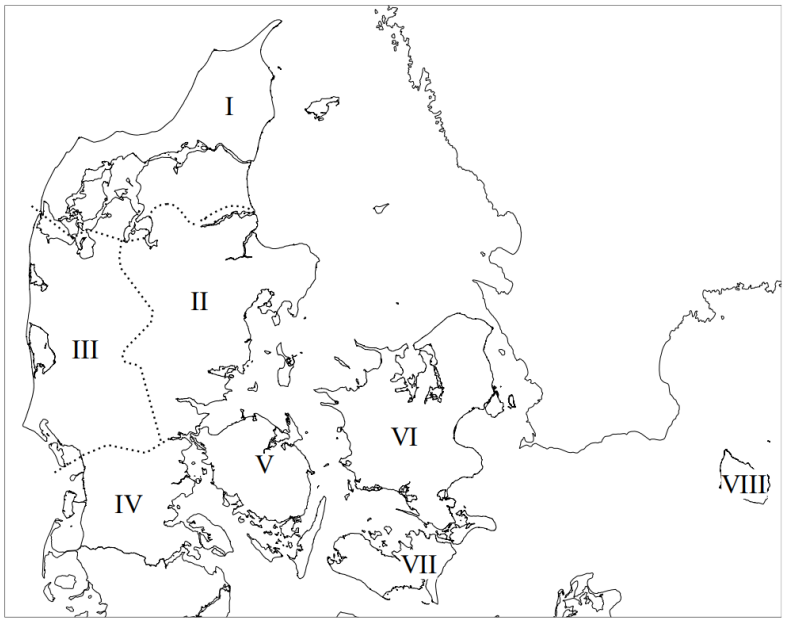
Source: RTS Group/DTU Sustain presentation

5.7 Monitoring of radioactivity in food and feed

5.7.1 Milk

Milk samples are collected from eight zones in Denmark (Figure 16), every second month. Bulked samples are analysed three times a year for caesium (Cs-137) and strontium (Sr-90).

Figure 16: Milk samples collection points.



Source: Response to the Art 35 preparatory questionnaire by the Danish authorities

5.7.2 Mixed diet

Food ingredients for mixed diet are collected annually from shops in nine cities including Copenhagen. The samples are bulked by region to cover Jutland, the Islands ([11]) and the capital area of Copenhagen. Samples are mixed to composite samples of an average daily intake corresponding to 4 daily meals (fresh weight of 12 kg) and analysed for caesium (Cs-137) and strontium (Sr-90).

5.7.3 Food

Samples of cereals (oats, wheat, barley and rye) are collected annually from 10 locations and bulked by species. Samples of vegetables, fruit, potatoes, beef and pork are collected at the market in Roskilde annually. Imported food (bananas, oranges, rice, oatmeal, coffee, tea, nuts) are sampled every 3 years from Copenhagen.
All samples are analysed for caesium (Cs-137) and strontium (Sr-90).

5.7.4 Feed

Animal feed is not included in the regular radioactivity monitoring programme in Denmark. Feed is indirectly measured, not on feed mixtures or specialised feed, but annually in grain (wheat, rye, barley, oat) and potatoes, which may enter to the feed-chain. Samples are collected from 10 locations and analysed for iodine (I-131) and caesium (Cs-134 and Cs-137) annually. Grass is measured, on a bi-weekly basis for caesium (Cs-137).

([11]) Zealand, Fyn, Lolland-Falster and Bornholm

6 EMERGENCY MONITORING

In an emergency, the main responsible authorities in Denmark are DEMA, DHARP, the National Police, the Danish Veterinary and Food Administration, the Fisheries Agency, the Environmental Protection Agency, the Danish Meteorological Institute.

The Nuclear Department of DEMA is responsible for 24/7 monitoring of radiation levels in Denmark and Greenland. It provides dispersion forecasts, decision support, and communicates nuclear incident information to the public and press. Specialised teams are deployed for accurate measurements, verifications, and dissemination of radioactive fallout.

In an emergency, the food, feed, and environmental samples can be analysed by the DTU Sustain, by the DHA/RP and by the DD or other subcontractors.

Capabilities and instrumentation of DEMA

DEMA has 40 teams equipped with handheld instruments (100 units) having basic training in dose rate measurements and surface contamination monitoring. Apart from these, 12 specialized teams are furthermore trained in nuclide identification technics. These 12 teams can map fallout and identify radioactive hot spots and are equipped with handheld nuclide identification instruments (14 units).

DEMA operates the continuous nationwide monitoring network for gamma dose rate and nuclide identification in Denmark as part of nuclear emergency preparedness.

DEMA uses the ARGOS decision support system that provides daily dispersion forecast for nearest nuclear power plants. The system can forecast radioactive releases also for the nuclear-powered vessels passing through Danish or Greenlandic waters.

DEMA has a car-borne gamma spectrometry ([12]) (CGS) and an air-borne gamma spectrometry (AGS) that can be used in emergency (Figure 17). Trained personnel at DEMA, officers of the reserve and qualified volunteers can operate the CGS and the AGS system. The systems are subject to systematic calibration and exercises scheduled regularly where operators train deployment of equipment in-air and on the ground.

The CGS systems consist of two repurposed VW Multivans containing:

- 1 Radiation Solution RS-701 console
- 1 Radiation Solution RSX-1 4 litre NaI(Tl) crystal
- 1 Radiation Solutions RS-725/21, 0.39 litre (3 by 3 inch) NaI(TI) crystal
- laptop running RadAssist software with mapping and nuclide identification features.

The two-detector setup provides better coverage even in highly contaminated areas where the smaller RS-725 may measure if the lager RSX-1 saturates. For mobile measurements outside the Multivan, the console and the small RS-725 detector can be removed and installed in any vehicle or aircraft where a 12V power supply is available.

DEMA has recently acquired 6 additional Envinet MONA EPR (3 by 3 inch) NaI(TI) mobile measurement systems that can be mounted on any vehicle. The MONA EPR systems are undergoing final stages of testing and preparation before their full integration in the mobile measurement capacities at DEMA.

DEMA has two AGS systems each containing:

- 1 Radiation Solution RS-701 console

([12]) Car-borne gamma ray spectrometry is used for the search for lost or orphan radioactive sources or confirming the absence of such sources, geological survey, and radionuclide fallout mapping

- 2 Radiation Solution RSX-1 4 litre NaI(TI) crystal
- UPS for continuous power supply
- Panasonic Toughbook running RadAssist software with mapping and nuclide identification features.

The systems are installed in a DART helipod which can be mounted on an AS-550 Fennec helicopter operated by the Danish Air Force. An agreement with the Danish Air Force assures that the airborne systems can be mounted and put into operations within 48 hours after notification.

Figure 17: Car-borne and air-borne gamma spectrometry systems

Source: Response to the Art 35 preparatory questionnaire by the Danish authorities

7 INFORMATION FOR THE PUBLIC

Currently, in Denmark, information on radioactivity monitoring is not made available to the public. In the past, monitoring data has been provided to the general public online via DTU Nutech website. Due to organizational changes in DTU and reconstruction of the DTU Sustain website the data is not available anymore.

Radiation monitoring data from the gamma stations network operated by DEMA (in Denmark and Greenland) can be accessed by the general public at the European Radiological Data exchange Platform, EURDEP.

8 VERIFICATIONS

8.1 Introduction

Verifications were carried out in accordance with the agreed programme (Annex A). This chapter summarises the verifications carried out by the verification team. The team has assessed the monitoring arrangements based on their own expertise and comparison with similar arrangements in other Member States.

The outcome of the verification is expressed as follows:

- A '*Recommendation*' is made when there is a clear need for improvement in implementing Art. 35. These are included in the main conclusions of the verification. The Commission requests a report on the implementation of the recommendations – lacking implementation of a recommendation can lead to a reverification.
- A '*Suggestion*' is made when the verification team identifies an action, which would further improve the quality of the monitoring.

In addition, the team may '*commend'* particularly good arrangements, which could serve as a best practice indicator for the other EU Member States.

8.2 Monitoring Programme

The verification team verified the structure of the national environmental radioactivity monitoring programme in Denmark including both automatic and laboratory-based monitoring.

8.2.1 Monitoring frequencies

The verification team notes that the current radioactivity monitoring programme in Denmark covers the relevant environmental medias, but there is room for improvement in terms of sampling frequencies.

> *The verification team suggest increasing the frequency of groundwater monitoring as it is the main source for drinking water production.*
>
> *The verification team suggests increasing the monitoring frequency of mixed diet to at least quarterly in line with Recommendation 2000/473/Euratom ([13]).*
>
> *Verification team suggest increasing the monitoring frequency of milk at least once a month at few monitoring zones.*
>
> *The verification team suggest including analyses of I-131 in milk samples. In an emergency the ingestion of milk contaminated with I-131 is the major radiation exposure pathway.*

8.2.2 Drinking water

As regards the analyses of drinking water, Denmark does not analyse the radioactive parametric values in drinking water, for the water volumes produced less than 100 m^3per day. This is allowed

([13]) Commission recommendation of 8 June 2000 on the application of Article 36 of the Euratom Treaty concerning the monitoring of the levels of radioactivity in the environment for the purpose of assessing the exposure of the population as a whole, (OJ L 191, 27.7.2000, p. 37–46)

conditionally by the Euratom Drinking Water Directive 2013/51 (EDWD). During the transposition checks of the EDWD, the European Commission has reviewed the results of different studies provided by the Danish authorities. The analyses carried out back in early 2000s showed that generally the radioactivity levels in drinking water were low in Denmark. The radon monitoring studies date back to the early 80s. The sampling methods and detection sensitivities might have changed over the time.

The verification team suggest carrying out new studies on the monitoring of radioactivity in drinking water and/or groundwater, including radon measurements.

8.3 Information to the public

In Denmark the information on monitoring of radioactivity is not available to the public on regular base. The verification team was informed that the monitoring results were previously published on the DTU Sustain website. However, since this website is currently under reconstruction, the results of national radioactivity monitoring programme are not accessible to the public.

The verification team recommends making the environmental monitoring results available for the public.

8.4 Laboratories of Danish Health Authority, Radiation Protection

The verification team visited the laboratories of the Radiation Protection ([14]) Division of the Danish Health Authority. These laboratories support the activities of the DHA/RP.

8.4.1 Radionuclide identification and quantification laboratory

The laboratory is not involved in analysing samples relevant for the national environmental radioactivity monitoring programme as it has limited capabilities to carry out chemical sample preparations. The verification team verified the availability of the following equipment (Figure 18):

- two characterised HPGe-detectors (type XtrHPG, Mirion), LabSOCS calibration for the energy range between 45-2000 keV;
- two portable characterised HPGe-detectors (type Falcon5000, Mirion). LabSOCS calibration for the energy range between 45-2000 keV;
- one liquid scintillation counter (Hidex 300SL). Tritium (H-3), carbon (C-14) calibrations with 40 (20 ml) or 96 (7ml) sample racks;
- one NaI well detector calibrated for I-125 measurements (Mirion).

The laboratory analyses about 100 samples a year. They have an excellent know-how and state-of-the-art radiation counting equipment available to carry out radionuclide identification on various samples with different geometries (e.g consumer products, ventilation filters etc.).When necessary, the laboratory can also analyse environmental samples, which do not require chemical sample preparation.

([14]) Danish Health Authority, Radiation Protection, Knapholm 7 2730 Herlev

Figure 18: Counting equipment at the DHA/RP radionuclide identification and quantification laboratory (Mirion HPGe-detector, NaI-detector, portable Mirion HPGe-detector and Liquid scintillation counter-Hidex 300SL)

Source: Photos taken by the verification team

The laboratory follows the international standard ISO17025, and part of its activities are accredited by the Danish Accreditation Authority (DANAK). In particular, the verification team verified the quality control procedures for gamma spectrometry method and can confirm that extensive quality control is put in place. For the infield measurements, two in situ gamma spectrometers are available that can be used also in an emergency situation.

The laboratory is operated only by a single person, who is highly competent to carry out the radiation measurements. However, the verification team questions the continuity of this service as well as maintaining the accreditation, which relies only on the competence of one person.

> *The verification team suggest involving new staff member(s) that will be trained to carry out the analytical work at the radionuclide identification and quantification laboratory of DHA/RP.*

8.4.2 Dosimetry laboratory

The dosimetry laboratory is the only laboratory in Denmark that provides personal dosimetry service for exposed workers. The laboratory analyses also the TLDs that are used to register the ambient dose around the Risø campus. The dosimetry laboratory is accredited and has the necessary equipment to analyse about 5000 TLDs a month.

> *No remarks.*

8.4.3 Calibration and verification laboratory

The laboratory is accredited to calibrate and check the performance of surface contamination monitors as well as passive and electronic personal dosimeters. The laboratory provides also calibration and verification services of electronic dose rate meters and thyroid I-131 monitoring equipment.

> *No remarks.*

8.5 Laboratories of DTU Sustain/RTS

The verification team verified the laboratories facilities of the DTU Sustain located at the Risø campus ([15]).

The facilities of the DTU Sustain/RTS group comprise several radiochemical laboratories dedicated to processing environmental samples for the measurement of a wide range of radionuclides (Annex D). The facilities have six radiochemistry laboratories and several radioanalytical counting rooms, located in the separate buildings at the Risø campus.

The radioanalytical laboratories have 11 staff members in the Risø laboratory and 3 staff members in the Waste, Climate & Monitoring (WCC) section, fully or partially working on the routine monitoring program. The laboratories analyse in total ca. 2000 samples a year. The majority of samples are related to the national monitoring programme covering the entire Denmark. Part of samples are from the Risø site-specific monitoring programme.

No remarks.

8.5.1 Sampling

DTU Sustain/RTS staff collects the environmental samples as well as airborne and food and feed samples at the premises of DTU Risø Campus. Other authorities might be involved in collecting samples at other location in Denmark.

No remarks.

8.5.2 Sample reception

Prior the analyses the samples are stored in a dedicated storage area. The verification team noticed that there was a large number of containers with water sample waiting for analyses, some of these collected in 2021. Each container has a specific identification number (sampling date and location) handwritten. Sample data and analytical results are registered into the internally developed laboratory management system, based on an SQL server and a set of software which interacts with the database.

The verification team was informed that there is no formalised plan for managing increased number of incoming (contaminated) samples.

The verification team suggests that the laboratory of DTU Sustain/RTS puts in place a documented procedure for the management of increased number of incoming (contaminated) environmental, food and feed samples in the event of an emergency.

8.5.3 Sample preparation

Methodologies used to prepare samples prior to measurement include sorting, sieving drying, freeze, ashing. Water samples are prepared at the seawater laboratory, which is equipped with two fume hoods and three working stations (in total 22 fume hoods are available in the whole lab complex). The standard analytical method for strontium (Sr-90) determination in water is used to remove the coexisting radionuclides. Consequently, it takes more than 2−3 weeks after sampling to report the results.

([15]) Frederiksborgvej 399, Building 204, 4000 Roskilde Denmark

Solid samples are received and prepared in another building, which has separate rooms equipped with two fume hoods, eight ovens for ashing and three drying cabinets.

Samples received from the Danish Decommissioning site, that might be slightly contaminated, are prepared in a semi-hot laboratory.

No remarks.

8.5.4 Measurement equipment

The laboratory is very well equipped (Figure 19) with the following:

- 18 liquid nitrogen cooled HPGe-detectors (10 dedicated to routine measurements, 1 for analysing samples from decommissioning activities, 7 not in use).
- 32 alpha spectroscopy systems,
- 35 low-level gas flow beta counters,
- two liquid scintillation counters (Quantulus, Tricap),
- one ICP-MS (Agilent 8800 ICP-QQQ), one ICP-OES (Agilent 5800).

As regards the gamma spectrometry systems, the laboratory is in the process of replacing the old electronic units by digitizers. For the low-level gross alpha-beta measurements the laboratory has a newly purchased detector, but this detector is not yet put into operation.

Figure 19: low level beta counter, gamma-spectrometers, alpha spectrometer at the DTU Sustain/RTS

Source: Photos taken by the Verification Team

No remarks.

8.5.5 Quality control

DTU Sustain/RTS is accredited for certain analyses by the Danish national accreditation (DS/EN ISO/IEC 17025:2017) since 2012. While the radioactivity measurements for environmental samples are not accredited, the laboratory follows closely the requirements of the international standard ISO 17025:2017 The laboratory checks its performance by regular participation in the interlaboratory comparison exercises that covered identification and quantification of various radionuclides in different sample types (Annex C). Measurement results are reviewed by experienced staff members and if necessary, discussed with senior scientists. Quality controlled data are recorded electronically and in the instrument logbooks.

The gamma detectors are calibrated when necessary for energy and efficiency using a multigamma reference solution. For full energy-peak efficiency calibration, routine containers are filled with the solution at different heights. The coincidence summing corrections are calculated for each measurement using GenTran software. Relevant parameters (i.e. energy, efficiency, resolution) are checked once a month, the background measurements of gamma systems a few times a year. Gamma spectrum is analysed by the inhouse software that is based on *Mirion Genie 2000*.

The alpha spectrometers are calibrated with the sources prepared from standard solutions. Results of alpha spectrometry is analysed by software developed at DTU.

The stability of the low-level beta counters is monitored on a monthly basis using internal reference sources. Calibration of the counters is performed approximately every five years for strontium (Sr-90) and technetium (Tc-99).

No Remarks.

8.5.6 Measurement results and reporting

The laboratory has developed worksheets and software for calculating results from raw data. Measurement results relevant for the national monitoring programme can be made available to the relevant authorities upon request. The monitoring results are not published elsewhere for the public.

DTU Sustain/RTS directly reports the results of relevant environmental radioactivity monitoring to the European Commission and HELCOM. The results that concern the environmental monitoring at the Risø site is sent to the Danish Decommissioning who is reporting these results to DHA/RP and DEMA.

The DTU Sustain have excellent analytical capabilities carrying out radioactivity measurements in environmental samples as well as in food and feed samples in the routine situation.

No Remarks.

8.6 Fixed monitoring stations at the DTU Sustain/RTS

The verification team verified the aerosol sampling stations and the wet precipitation sampler at the DTU Sustain/RTS. The stations are located in a fenced area at the Risø site close to the entrance gate.

8.6.1 Air sampler

The high-volume air sampler (Figure 20) is manufactured and maintained by the DTU Sustain/RST. Air flows through six individual filters, which are changed once a week. Air is drawn through a polypropylene filter at a rate of about 2000 m3/h. The flow rate is monitored by a gas meter connected to a shunt. The gas meter reading is compared to that of a reference gas meter in irregular intervals. Filters are changed weekly and first compressed into a cylindrical geometry for gamma spectrometry counting and after one week ashed and counted again for gamma emitting radionuclides.

Figure 20: High volume air sampler at the DTU Risø Campus

Source: Photos taken by the verification team

The verification team was informed that there is a possibility to install an activated charcoal filter for gaseous radioactive iodine monitoring in the two air samplers at Allinge and Haderslev. DTU Sustain has experience with analysing the gaseous radioactive iodine using active charcoal cartridges, however these analyses are not carried out at a regular basis.

> *The verification team suggest reestablishing the procedures for analysing the gaseous radioactive iodine in the event of an emergency to ensure that laboratory staff is adequately trained in this method.*

8.6.2 Wet deposition collector

The wet deposition (rainwater) collector has a very large heated collection plate of 10 m^2 (Figure 21). Water is rinsed through an ion exchange column to a large tank. A monthly sample is analysed for gamma-emitting radionuclides and strontium (Sr-90).

Figure 21: Rainwater collector. Shown on the top and inside of the housing where the water is collected into the large container

Source: Photos taken by the verification team

No Remarks.

8.7 Danish Emergency Management Authority

8.7.1 Automatic dose rate equipment

The verification team verified the equipment located at the premises of a former military base on the outskirts of Copenhagen city ([16]). Two gamma stations are installed next to each other at more than one meter height: a GM dose rate station and a spectroscopic monitoring station SARA ENVINET (Figure 22).

The SARA station from company Envinet has a NaI (Tl) detector, which in addition of measuring the ambient dose rate offers also radionuclide identification. The station has rain detection capabilities included. The gamma dose rate readings are recorded in ten-minutes intervals and sent to DEMA.
The communication with the station is made via the internet cable.
The second station having two Geiger-Müller tubes sends the dose rate data twice a day via telephone connection to the DEMA server. In case of an alarm, the detector is switched to emergency mode. DEMA officer on duty is immediately informed of any elevated readings as well as technical alarms. Double detector system provides a redundant system for continuous dose rate monitoring.

The Network monitoring software (NMC-RAD) is used for remote control and administration of the stations and for handling, storage, analysis, presentation, and publication of the collected data.

The dose rate monitoring stations verified by the verification team are identical to the 13 other stations installed across Denmark, the Faroe Islands and Greenland. The three stations in Greenland

([16]) Svanemøllens Kaserne, Ryvangs Alle 1, 2100 København

have heating elements. Maintenance of detectors is carried out by DEMA's facility management service. The verification team was informed that due to the ageing of detectors (installed in 2011), renewal of the network is planned.

Figure 22: Automatic monitoring stations (Envinet SARA and GM)

Source: photos taken by the verification team

Data from these stations is sent to the EURDEP platform by DEMA, but data is not published elsewhere in Denmark.

> *The measurement performance of NaI(Tl) detectors is sensitive to the environmental conditions, its efficiency may decline in time, hence the verification team commands the efforts made to renew the aging equipment of the national dose rate monitoring network.*
>
> *The verification team recommends making the on-line dose rate monitoring data available for the public. Currently the public can access these data only on the EURDEP platform through a link provided on the DEMA website.*

8.7.2 Mobile radiation monitoring equipment

The verification team verified the following mobile radiation monitoring equipment at the premises of DEMA ([17]) (Figure 23):

- A car-borne gamma ray spectrometry system installed in a Volkswagen multivan for mapping the radionuclide fallout. This system consist of two NaI (Tl) detectors (4 and 0.39 litres). The generated spectra are analysed with the RadAssist software. The vehicle is also equipped with

([17]) Datavej 16, 3460 Birkerød

protective equipment, mobile kit with dose rate counters, Identifinder and contamination detection equipment.

- Portable Envinet MIRA autonomous dose rate monitoring stations with Geiger-Müller probe are currently being tested and set-up for final use. The integrated GPS allows for automatic determination of detector's position. Monitoring data are sent to the specific software via cellular networks.
- Portable Envinet MONA stations are being tested and calibrated for final use by DEMA. The systems has a NaI (Tl) detector for radionuclide identification and a GM probe for dose rate recording.

The radiation monitoring equipment is distributed across the six emergency centres in Denmark. Each centre has staff who can operate the radiation measurement devices. DEMA staff participates regularly in the national and international exercises related to the response and preparedness for a nuclear emergency.

Figure 23: Car-borne gamma ray spectrometry system installed in a Volkswagen multivan, MIRA mobile autonomous dose rate monitoring station, MONA mobile spectroscopic detection and dose rate survey system

Source: Photos taken by the verification team

9 CONCLUSIONS

All planned verification activities were completed successfully. The information supplied in advance of the visit, as well as the additional documentation received during and after the verification activities, proved very useful.

The information provided and the verification findings lead to the following observations:

(1) The verification activities that were performed demonstrated that the facilities necessary to carry out continues monitoring of levels of radioactivity in the environment, food and feed in Denmark are adequate. The Commission could verify the operation and efficiency of a representative part of these facilities.

(2) The verification activities that were performed demonstrated that the facilities necessary to carry out monitoring of levels of radioactivity in the environment, food and feed in the event of a radiological emergency in Denmark are adequate. The Commission could verify the availability of a representative part of these facilities.

(3) Few recommendations and suggestions are formulated. Notwithstanding these remarks, the verified parts of the monitoring system for environmental radioactivity in place in Denmark are in conformity with the provisions laid down under the Article 35 of the Euratom Treaty.

(4) The verification summary is presented in the 'Main Conclusions' document that is addressed to the Danish competent authority through the Permanent Representative of Denmark to the European Union.

(5) The Commission services kindly request the Danish authorities to submit, by 28 February 2026, a progress report on how the team's recommendations have been implemented, and on any significant changes in the set-up of the monitoring arrangements. Based on this report the Commission will consider the need for a follow-up verification.

(6) The verification team acknowledges the excellent cooperation it received from all persons involved in the activities undertaken during its visit.

Annex A Euratom Article 35 Verification Programme in Denmark

Tuesday, 28 May 2024

Opening meeting on the premises of the Danish Health Authority

(Address: Knapholm 7, 2nd floor, 2730 Herlev)

- European Commission Art. 35 verification programme introduction
- Discussion on past verifications in Denmark by the Commission
- Overview of radioactivity monitoring arrangements in Denmark and discussion on:
  - Air monitoring
  - Soil monitoring
  - Water monitoring including the presentation of the results on the studies related to the groundwater and drinking water monitoring for decision making purposes.
  - Dose and dose rate monitoring
  - Mobile monitoring systems
  - Emergency monitoring systems
  - Public information arrangements
- Verification planning
- Radioanalytical laboratory of the Danish Health Authority, if any
  - Introduction to the analytical programme of laboratory
  - Visit to these laboratory facilities
- **Verification of a gamma monitoring station located closest to Copenhagen**,

(Address: Svanemøllens Kaserne, Ryvangs Alle 1, 2100 København)

Wednesday, 29 May 2024

Verifications at the DTU Risø-campus: Department of Environmental and Resource Engineering, DTU Sustain, Technical University of Denmark (DTU)

(Address: DTU Risø Campus, Frederiksborgvej 399, Bygning 201 4000 Roskilde)

- Introduction to the analytical programme of environmental monitoring laboratory
- Visit to these laboratory facilities
- Environmental monitoring facilities/equipment: gamma monitoring station, on-site high volume air sampler, precipitation collector, TLD, any other equipment part of environmental monitoring

Verification at the Danish Emergency Management Agency DEMA

(Address: Datavej 16, 3460 Birkerød)

• Automatic monitoring data centre

• Emergency monitoring equipment (mobile equipment)

Thursday, 30 May 2024

09:00 – 11:00 Closing meeting at the Danish Health Authority

Annex B National environmental radioactivity monitoring programme in Denmark

Media monitored	Number of sampling location	Sampling Frequency	Radionuclides/dose rates	Equipment/method
Air filter	3	Weekly	Cs-137, Be-7, Pb-210, Sr-90	γ-spectrometry, radiochemistry and GM counter
Precipitation (Rain)	11	Monthly	Cs-137, Sr-90, Be-7, Pb-210	γ-spectrometry, radiochemistry and GM counter
Soil	11	Every 5 years	Cs-137, Sr-90, Pu/Np	GM counter, γ-spectrometry, radiochemistry, ICPMS
Grass	1	Once every two weeks	Cs-137	γ-spectrometry
Groundwater	11	Every 3 years	Sr-90, Cs-137	LSC, GM counter, γ-spectrometry, radiochemistry
Surface waters (stream/lake)	16	Every 2 year	Cs-137	γ-spectrometry, radiochemistry
Seawater	14	Annually	Sr-90, Cs-137, Tc-99, Pu/Np, H-3	LSC, GM counter, γ-spectrometry, α-spectrometry, radiochemistry, ICPMS
Marine sediments	4	Annually	Cs-137, natural elements	γ-spectrometry
Marine biota (seaweed)	5	Quarterly	Cs-137, Tc-99	γ-spectrometry, radiochemistry and GM counter
Cereals (barley, wheat, oats and rye)	10	Annually	Cs-137, Sr-90	γ-spectrometry, radiochemistry and GM counter
Vegetables fruit, potatoes, beef, pork	1	Annually	Cs-137,Sr-90	γ-spectrometry, radiochemistry and GM counter
Imported foods (bananas, oranges, rise, oatmeal, coffee, tea, nuts)	1	Every 3 years	Cs-137, Sr-90	γ-spectrometry, radiochemistry and GM counter
Milk	8	Every second month	Cs-137, Sr-90	γ-spectrometry, radiochemistry and GM counter
Fish (cod, herring, plaice, lobster)	3	Annually	Cs-137, Tc-99, Po-210	γ-spectrometry, α-spectrometry, radiochemistry and GM counter
Mixed diet	9	Annually	Sr-90, Cs-137	γ-spectrometry, radiochemistry and GM counter
External gamma dose rate	14	Continuous	γ dose rate	NaI detector and GM probe

Source: Response to the Art 35 preparatory questionnaire by the Danish authorities and the presentation by the DTU Sustain /RTS Group

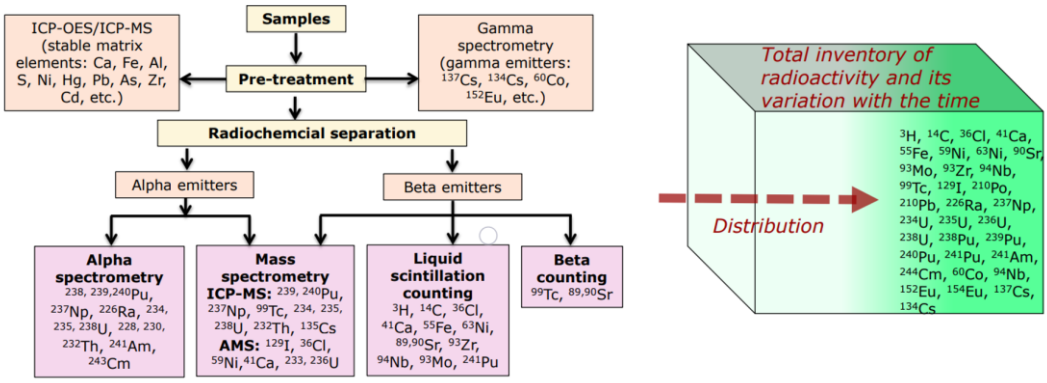
Annex C Interlaboratory comparisons- DTU Sustain/RTS Group

Year	Title	Organiser	Sample type	Radionuclides
2016	EC MetroERM2016	European Commission	Air filter	^{131}I, ^{134}Cs, ^{137}Cs
2016	IAEA ALMERA	IAEA	Seawater	^{89}Sr, ^{90}Sr
2016	IAEA-465	IAEA	Sediment	Gamma emitters, U, Th, Pu
2016	IAEA-RML-2016-01	IAEA	Seawater	^{3}H, ^{90}Sr, ^{134}Cs, ^{137}Cs
2016	IAEA-TEL-2016-04 ALMERA	IAEA	Water, Spruce needles, Sediment	Gamma emitters, ^{89}Sr, ^{90}Sr, ^{226}Ra, ^{234}U, ^{238}U
2016	MRI-ILC	Max Rubner Institut	Raw milk	^{40}K, ^{131}I, ^{134}Cs, ^{137}Cs
2016	NPL ER PTE 2016	National Physical Laboratory	Water	^{3}H, ^{14}C, ^{36}Cl
2017	Proficiency Test	European Commission	Maize powder	^{131}I, ^{134}Cs, ^{137}Cs
2017	IAEA-RML-2017-01	IAEA	Seawater	^{3}H, ^{60}Co, ^{90}Sr, ^{134}Cs, ^{137}Cs
2017	IAEA-TEL-2017-04 ALMERA	IAEA	Water, milk powder, CaCO3	Gamma emitters, ^{3}H
2017	NKS Exercise	NKS	Water, sediment	Gamma emitters, ^{222}Rn, U-isotopes
2017	ZERMC/DTU exercise	Risø DTU	Soil, seaweed, sludge	Gamma emitters, ^{90}Sr
2018	JRC-Geel Trial	European Commission	Animal feeding stuff	^{131}I, ^{134}Cs, ^{137}Cs
2018	MRI-ILC	Max Rubner Institut	Raw milk	^{40}K, ^{131}I, ^{133}Ba, ^{134}Cs, ^{137}Cs
2018	NPL ENV PTE 2017	National Physical Laboratory	Water	^{3}H, ^{90}Sr, ^{63}Ni, ^{134}Cs, ^{210}Pb, ^{238}Pu, ^{241}Am
2019	NPL ENV PTE 2019	National Physical Laboratory	Water	Gamma emitters
2019	ZERMC/DTU exercise	Risø DTU	Fish	^{40}K, ^{90}Sr, ^{137}Cs
2021	IAEA-TEL-2021-03	IAEA	Water	^{3}H, ^{133}Ba, ^{137}Cs, ^{152}Eu, ^{241}Am
2021	NKS-B GammaRay X Seminar Exercise	FOI, Sweden	Filter	Gamma emitters
2022	NKS DTM-Decom III	VTT, Finland	Spent ion exchange resin	^{55}Fe, ^{55}Ni, ^{90}Sr, ^{99}Tc, gamma emitters
2022	NPL PTE 2021	National Physical Laboratory	Water	^{3}H, ^{14}C, ^{99}Tc
Nearly annually	HELCOM MORS Intercomparison	HELCOM MORS Group	Seawater	^{90}Sr, ^{137}Cs
2024	NPL PTE 2024	National Physical Laboratory	Water	^{3}H, ^{14}C, ^{226}Ra

Source: Response to the Art 35 preparatory questionnaire by the Danish authorities

Annex D Radioanalytical capabilities of DTU Sustain/RTS

Scheme for radioactivity measurements



Source: Presentation of DTU Sustain/RTS Group

Radioanalytical methods

Radionuclides	Chemical Analyses	LSC	Total Beta Counting	Gamma Spec	Alpha Spec	ICPMS	AMS
Gamma emitters				X			
^{3}H	X	X					
^{14}C	X	X					
^{36}Cl	X	X					
^{41}Ca	X	X					
^{59}Fe	X	X					
^{63}Ni	X	X					
^{79}Se	X					X	
^{90}Sr	X	X	X				
^{93}Mo	X	X					
^{93}Zr	X					X	
^{94}Nb	X			X			
^{99}Tc	X		X			X	
^{126}Sn	X					X	
^{129}I	X						X
^{135}Cs	X			X		X	
^{137}Cs	X			X			
^{210}Pb				X			
^{210}Po	X				X		
^{226}Ra	X	X		X			
^{230}Th	X				X		
^{232}Th	X				X	X	
^{234}U, ^{235}U, ^{238}U	X				X	X	
^{233}U, ^{236}U	X						X
^{237}Np	X					X	
^{239}Pu, ^{240}Pu	X					X	
$^{239+240}$Pu	X	X			X		
^{241}Am	X			X	X		

Source: Presentation of DTU Sustain/RTS Group