SUNDHEDSSTYRELSEN
Strålebeskyttelse

2024

Questionnaire for the Euratom Article 35 verification visit to Denmark

May 2024, Week 22

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Contents

Article 35 verification visit to Denmark May 2024

This report presents the responses to the questionnaire provided by the European Commission prior to the Euratom Article 35 verification visit to Denmark in May 2024.

The report was prepared by the Danish Health Authority, Radiation Protection, and is based on contributions from the following bodies and organisations with responsibilities in relation to the monitoring of radioactivity in the environment in Denmark:

- Danish Health Authority, Radiation Protection (Point of Contact)
- Danish Environmental Protection Agency
- Danish Veterinary and Food Administration
- Danish Emergency Management Agency
- Danish Technical University (DTU Sustain)
- Danish Decommissioning

The report was submitted to the European Commission in May 2024, prior to the verification visit.

The Euratom Article 35 verification visit to Denmark was scheduled from the 28th of May through 30st of May 2024.

1. Bodies having competence in the field of environmental radioactivity monitoring in Denmark

1.1. Principal bodies

The principal bodies having competence in the field of environmental radioactivity monitoring in Denmark are described in the following. The chart in Figure 1 illustrates the hierarchy of principal bodies in Denmark.

Responsible Ministries

The responsibility for monitoring of radioactivity in the environment in Denmark is distributed over several ministerial areas, namely:

- Ministry of Defence
- Ministry of Interior and Health
- Ministry of Environment
- Ministry of Food, Agriculture and Fisheries
- Ministry of Higher Education and Science

Within each ministry, one or more authorities, agencies and research institutions have been appointed responsibilities regarding specific tasks concerning environmental monitoring. The overall division of tasks follow the principle of sectorial responsibilities, where each entity carries out tasks within its particular field of competence.

The Danish Health Authority

The Danish Health Authority (DHA) under the Ministry of the Interior and Health is the competent authority concerning radiation protection and safety. DHA is in addition one of the joint nuclear regulatory authorities according to the law on nuclear installations. The regulatory work is carried out by the Radiation Protection (RP), a division in DHA. DHA/RP is the point of contact with respect to EURATOM Art. 35.

DHA/RP is responsible for the protection of humans and the environment from the harmful effects of ionizing 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 thus to ensure that use of, or exposure to, radiation sources are always justified, optimized and within the dose limits.

DHA/RP provides regulations, requires licensing or registrations, conducts inspections and provides information/supervision to other institutions, industries and the public covering radiation protection and safety.

DHA/RP always has a duty officer on call 24/7 that can intervene in the event of a radiological emergency.

The Danish Environmental Protection Agency

The Danish Ministry of Environment and the Danish Environmental Protection Agency are responsible for Danish legislation on drinking water, including e.g. protection of the groundwater, regulation of wells and boreholes, the quality requirements for drinking water and the control of drinking water, as well as providing guidance on the regulation.

The quality criteria are defined by the Danish Environmental Protection Agency as described in the Danish Water Supply Act.

The drinking water order prescribes the frequency of checks for radioactivity indicators in drinking water if there is a risk of radioactivity.

The Danish municipalities have authority regarding water supply, and must therefore approve their local water utilities' control programmes, supervise whether the water supply meets the requirements for drinking water quality and inspect the local water utilities' technical facilities. The responsibility of the water utilities is to operate the water supply efficiently and ensure that the drinking water complies with the set quality criteria. The responsibility for checking the quality of drinking water lies with the individual water utility. A number of the municipality's decisions are subject to notification obligations to the Danish Environmental Protection Agency.

In the guidance on water quality and supervision of water supply facilities[1] there is a further description of the extent to which radioactivity indicators must be included in the quality control. At the end of 2014, it was assessed that the drinking water in Denmark has a low content of radioactive substances, which means that the drinking water generally do not need to be checked for radon, tritium and indicative dose listed in Annex I. Radon can occur in drinking water from boreholes in granite, which is why Bornholm's Regional Municipality in connection with permits for new boreholes in granite must be aware of the current quality requirement for radon and indicative dose.

The Danish Veterinary and Food Administration

The Danish Veterinary and Food Administration (DVFA) at the Ministry of Food, Agriculture and Fisheries is the competent authority concerning food safety.

[1] Guidance no. 55, February 2022, to Drinking Water

Additionally, the DVFA is responsible for selecting samples of food and feed, imported from areas with a risk of radioactivity for analysis. Currently, only import restrictions apply for certain food stuffs grown in the areas near Chernobyl.

In case of polluted feed or food, the DVFA is responsible for the follow up.

The Danish Agency for Higher Education and Science

The Danish Agency for Higher Education and Science are responsible for the activities of the Danish Technical University, in particular the activities of DTU Sustain, conducting research of environmental radioactivity.

The agency also is responsible for the state enterprise Danish Decommissioning (DD) established in 2003. DD is responsible for the operation and the decommissioning of the nuclear facilities at the Risø site. DD is subject to requirements for environmental monitoring of areas surrounding the nuclear facilities at the Risø site. In addition, DD operates an accredited clearance facility for release of materials from decommissioning from regulatory control.

The Danish Emergency Management Agency

The Danish Emergency Management Agency (DEMA) is an agency under the responsibility of the Ministry of Defence. DEMA and DHA/RP jointly constitute the nuclear regulatory authorities according to the nuclear installations act. DEMA is responsible for the general nuclear emergency plan and coordination of the sector specific planning in the field of nuclear emergency preparedness in Denmark and Greenland. DEMA operates a network of permanent gamma radiation monitoring stations in Denmark and Greenland, mobile air- and car-borne measurement systems and air filter stations.

DEMA has a nuclear emergency duty officer that can be reached 24/7. The duty officer can react to alarms from the automatic measurement systems and to alerts from international organisations (ELI, IAEA). The duty officer will, if necessary, activate the nuclear emergency plan.

1.2. Framework agreement

There is a Framework Agreement between the Danish Health Authority, the Danish Veterinary and Food Administration, Danish Environmental Protection Agency and the Danish Technical University (see Figure 1), on research-based public sector consultancy and provision of services to the government agencies regarding monitoring of radioactivity in the environment and food (Appendix 1).

Under the Framework Agreement there is a Task Agreement specifying services to be provided to ensure the environmental radioactive monitoring in Denmark (Appendix 2).

According to the agreement, the environmental radioactive monitoring is carried out by the Danish Technical University DTU Sustain[2].

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 feed and food is according to the Framework Agreement carried out by DTU Sustain following provisions of the Danish Veterinary and Food Administration.

In addition to the Framework Agreement, the nuclear regulatory authorities (DHA/RP and DEMA) require that Danish Decommissioning conduct environmental monitoring of the areas surround the nuclear facilities under decommissioning at the Risø site, North of Roskilde. Danish Decommissioning has commissioned DTU Sustain to conduct this monitoring.

1.3. List of analytical laboratories

Below is a list of analytical laboratories which provide services under the Framework Agreement, or which otherwise may carry out or participate in the monitoring of environmental radioactivity.

- DTU Sustain, Department of Environmental and Resource Engineering, Technical University of Denmark (DTU). DTU Sustain carries out sampling and analyses of radionuclides in environmental samples and foodstuffs in Denmark under the Framework Agreement and as a contractor to Danish Decommissioning regarding environmental monitoring of areas surrounding the Risø site.

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

- Danish Decommissioning (DD) 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.

[2] Department of Environmental and Resource Engineering, DTU Sustain, Technical University of Denmark (DTU) (Former DTU Nutech)

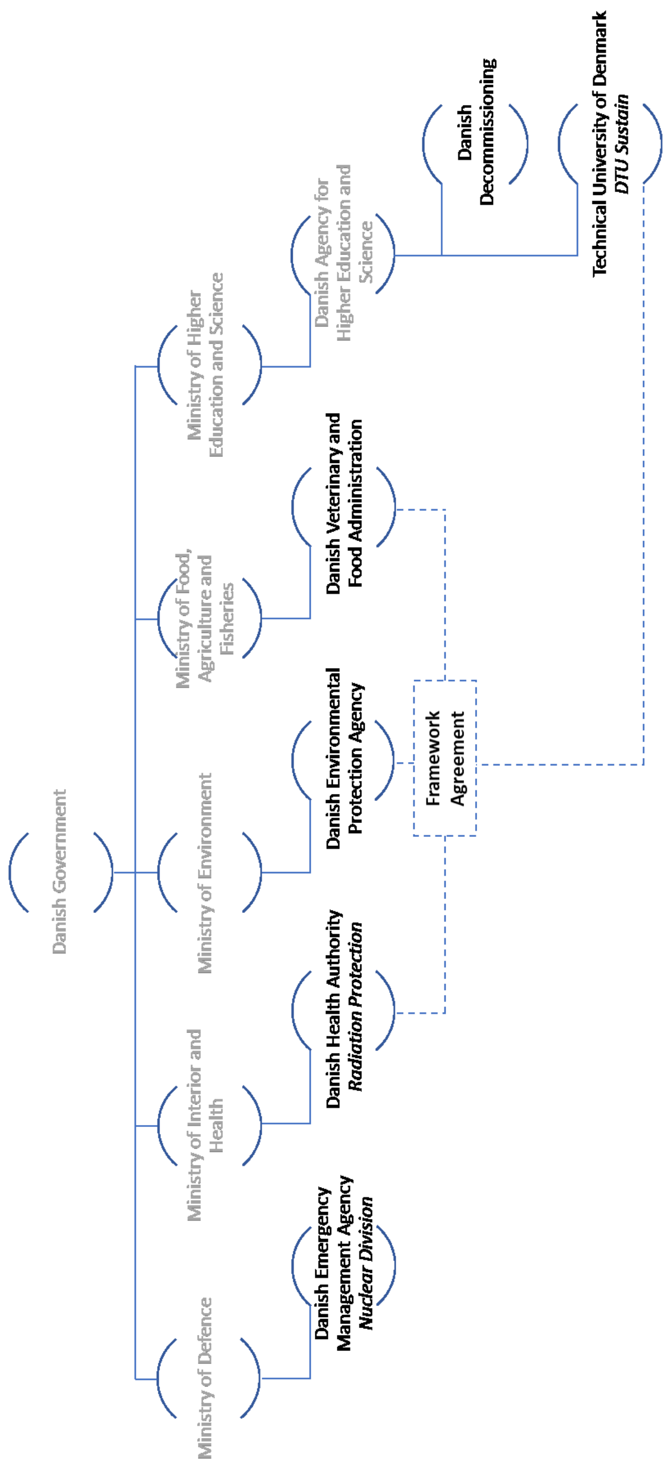

Figure 1: Principal bodies having competence in the field of environmental radioactivity monitoring in Denmark. The bodies involved in the Framework Agreement are connected dashed lines.

2. Competent authorities and other organisations involved in environmental radioactivity monitoring in Denmark

Representatives of the competent authorities and other organisations involved in environmental radioactivity monitoring who are going to meet with the verification team or who contributed to the reporting are listed below.

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

- Kresten Breddam, Director, +45 4454 3463, krb@sis.dk
- Haraldur Hannesson, Head of Section, +45 4454 3464, hah@sis.dk
- David Garf Ulfbeck, Senior Advisor, +45 4454 3462, dau@sis.dk
- Rikke Harlou, Special Advisor, +45 4454 3473, rihr@sis.dk
- Heidi Sjølin Thomsen, Special Advisor, +45 4454 3476, hsjt@sis.dk
- Asser Nyander Poulsen, Special Advisor; +45 4454 3497, apo@sis.dk

The Danish Environmental Protection Agency

- Annette Weeth, Chief Advisor, +45 2056 0353, anwee@mst.dk
- Kim Lundgreen, Marine biologist, +45 2262 9106, kilun@mst.dk

The Danish Veterinary and Food Administration

- Nikolas Kühn Hove, Head of crises management, Executive Office, +45 7227 6400, nikho@fvst.dk
- Charlotte Legind, Environmental Chemist, Chemistry and Food Quality Division, +45 +45 7227 6900, chale@fvst.dk

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

- Carsten Israelson, Deputy Head of Department, +45 2091 9989, brs-cisr@brs.dk
- Henrik Roed, Senior Advisor, +45 2937 0402, brs-hro@brs.dk
- Marie Lundgaard Davidsdóttir, Special Advisor, +45 5119 2988, brs-mld@brs.dk,
- Naya Sophie Rye Jørgensen, Head of Section, +45 30358102, brs-nsrj@brs.dk

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

- Jixin Qiao, Senior Researcher, Head of Radioecology Group, +45 21798724, jiqi@dtu.dk
- Kasper Andersson, Senior Researcher, +45 2143 7955, kgan@dtu.dk

Danish Decommissioning (DD)

- Kirsten Hjerrild Nielsen, Technical Director; Nuclear Expert, +45 46 33 63 03, khn@dekom.dk
- Mikkel Øberg, Head of Department, +45 46 33 63 44, miob@dekom.dk
- Jens Søgaard-Hansen, Senior Health Physicist, +45 46 33 63 70, jens.soegaard@dekom.dk
- João Silva, Head of Department, +45 46 33 63 12, joao.silva@dekom.dk

3. Legal provisions for environmental radioactivity monitoring in Denmark

3.1. Legislative acts regulating environmental radioactivity monitoring and acts establishing responsibilities of actors

Environmental monitoring

Consolidation Act No. 602 of 10 May 2022 on water supply (Consolidation Act No. 602/2022)

This consolidation act regulates the radiological surveillance of drinking water according to Article 35 of the Euratom Treaty.

Executive Order No. 1023 of 29 June 2023 on drinking Water (Order No. 1023/2023).

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 2020/1158)

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 (Regulation 2016/52)

Executive Order No. of 30 November 2023 on the import of food, feed, animal by-products, derived products and food contact materials with special restrictions (Order No. 1441/2023).

Consolidation Act No. 60 of 19 January 2024 on Feed (Consolidation Act No. 60/2024)

Executive Order No. 1033 of 5 July 2023 on Food (Order No. 1033/2023)

Executive Order No. 1721 of 30 November 2020 on tasks and obligations of the Danish Veterinary and Food Administration (Order No. 1721/2020)

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 ionizing 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 (Order No. 669/2019)

The executive order gives the general framework of radiation protection in Denmark.

Executive Order on Use of Radioactive Substances No. 670 of1 July 2019 (Order No. 670/2019)

The executive order gives the general framework that regulates the use of radioactive materials in Denmark.

Act, No. 170 of 16 May 1962 on Nuclear Installation (The Nuclear Installations Act)

Provides the general framework that regulates the nuclear installations in Denmark (DD and DTU Risø Campus).

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

In pursuance of the The Nuclear Installations Act DHA/RP and 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 DD, is included in the Operational Limits and Conditions for Danish Decommissioing. Clearance levels for solid materials are specified as well. The document is updated as necessary, most recently on the 24th of February 2022.

Emergency preparedness

Consolidated Act. No. 314 of 3 April 2017 (The Emergency Management Act)

Executive Order No. 1762 of 27 December 2016 on Security Measures for Nuclear Material and Nuclear Facilities and Drafting of Security Plan (Order No. 1762/2016)

The Emergency Management Act issued by the Ministry of Defence inter alia defines the purpose and competences of fire and rescue services in Denmark and hence contains elements of relevance to fire safety and nuclear installations. In addition, and pursuant to the act, DEMA has issued Executive Order No. 1762/2016 on Security Measures for Nuclear Material and Nuclear Facilities and Drafting of Security Plans which to some extent can affect operations at the nuclear facilities at Risø.

4. Environmental radioactivity monitoring programme in Denmark

4.1. General

The Danish environmental radioactivity monitoring programme is composed of

- A general monitoring programme covering external gamma dose rate, air, water, soil and foodstuff carried out by DTU Sustain.
- A specific monitoring programme in the vicinity of the nuclear installation at Risø site carried out by DTU Sustain on behalf of and as a contractor to DD.
- An automatic nationwide monitoring network for external gamma dose rate as part of the Danish nuclear emergency preparedness under the responsibility of DEMA.

In case of a nuclear emergency monitoring of foodstuffs, feeding stuffs and environmental samples can be analysed by DTU Sustain, DHA/RP and DD or other subcontractors as deemed necessary.

A continuous nationwide monitoring network for gamma dose rate and nuclide identification as part of the Danish nuclear emergency preparedness under the responsibility of DEMA.

Nuclear Facilities at Danish Decommissioning

Aggregated semi-annual release reports prepared for the purposes of this verification visit for the period 2022 to 2023 for the Risø site are given in Appendix 3a.

Aggregated semi-annual reports on environmental monitoring of areas surround the Risø site are given in Appendix 3b.

4.2. Monitoring of external gamma dose and dose rate

Maps indicating the monitoring locations with TLD and NaI detector are shown for the monitoring zones around the Risø site (Figure 2), the general monitoring in Denmark NaI detector (Figure 3) and the network of permanent monitoring stations (PMS) in Denmark and Greenland (Figure 4).

DTU Sustain is in charge of the monitoring around the Risø site and the general monitoring (Figure 2 and Figure 3).

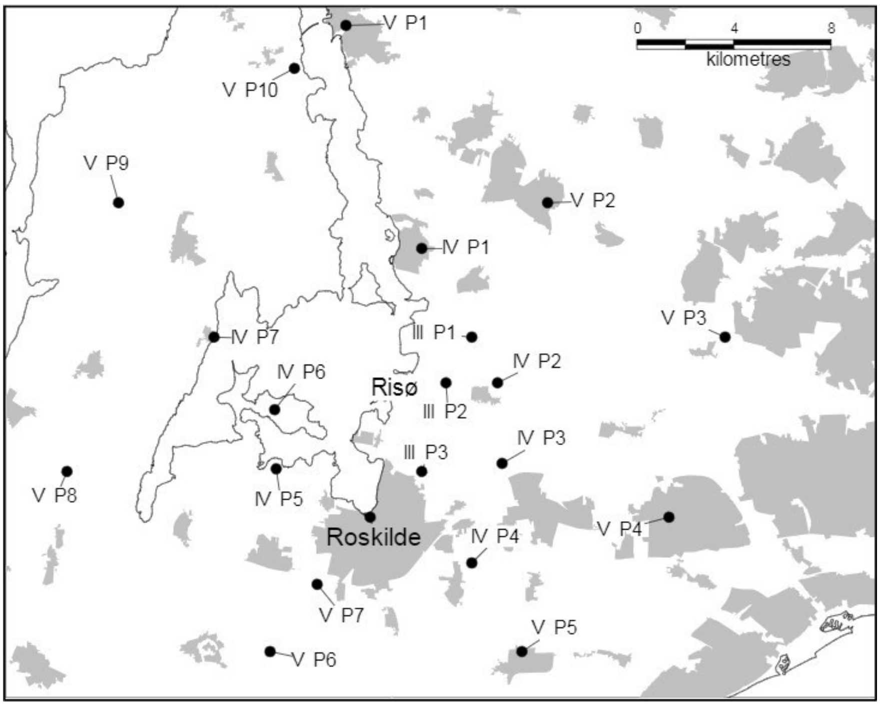

Figure 2: External background monitoring in zones at and around the Risø site carried out with TLD's and NaI detector.

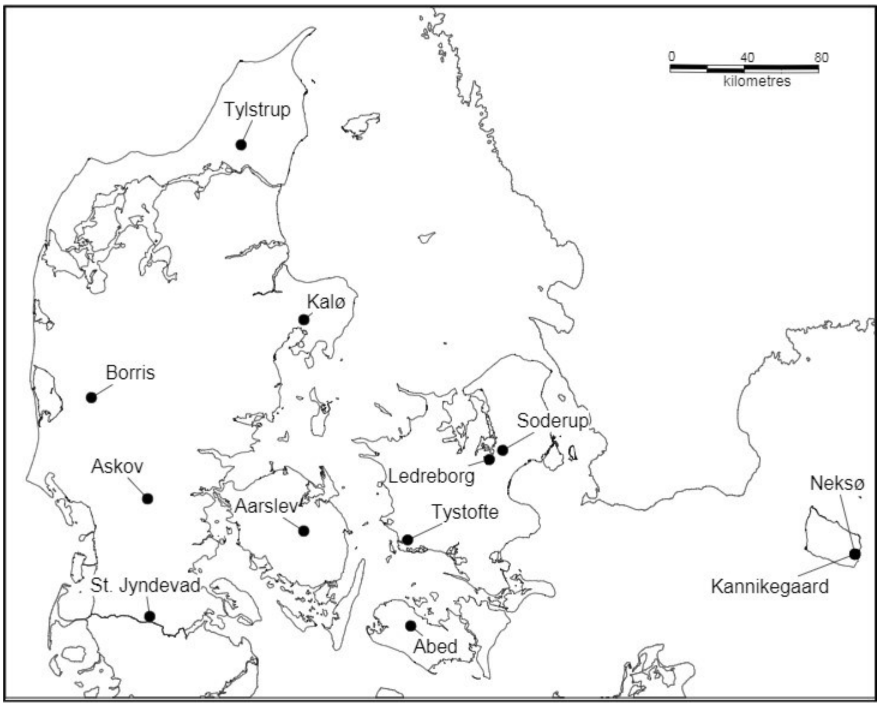

Figure 3: External background monitoring carried out with a NaI detector.

DTU Sustain uses the following monitoring devices:

- TLD, Specifications given by DHA/RP
  NaI detector: 3x3 inch, SAM 935 Surveillance and Measurement System, Berkeley Nucleonics Cooperations, USA, visual read-out

Calibration of TLD, specified by DHA/RP.

The NaI detector is calibrated periodically vs. a Reuter Stokes ionisation chamber.

DEMA operates and maintains a monitoring network with stations at 14 locations in Denmark (11) and in Greenland (3) (Figure 4). The present monitoring stations at each location have been in operation since 2012 and is provided by Envinet.

The stations have an automatic alert system that goes directly to the nuclear emergency duty officer at DEMA.

Each monitoring station contains:

- A spectral station with a 2 by 2 inch NaI (TI) detector for nuclide identification. The stations in Greenland are equipped with a heating element.
- A gamma dose rate station with two GM-tubes.

The setup with two independent systems at each station ensures data coverage at all times.

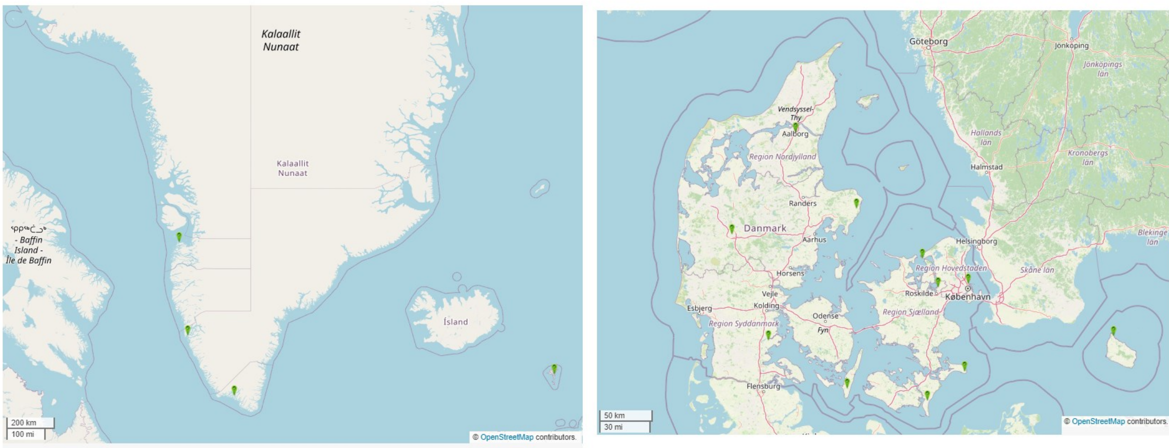

Figure 4: Maps of monitoring network for gamma dose rate and nuclide identification. Provider: Envinet

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. Measurement data from the monitoring stations are reported in real time to the European Radiological Data exchange Platform, EURDEP (Figure 5).

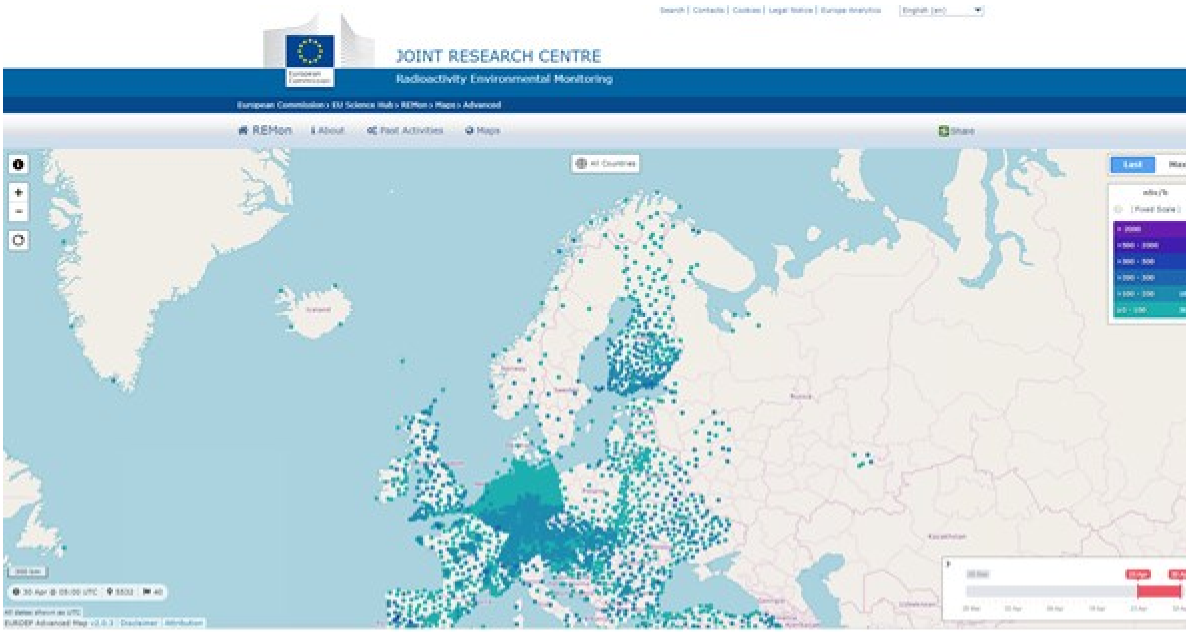

Figure 5: European Radiological Data exchange Platform, EURDEP

4.3. Monitoring of radioactivity in air

Air samplers (low/medium/high-volume) collecting particulate matter and/or iodine

A map indicating the monitoring locations of the three high-volume air samplers in Denmark is shown in Figure 6.

DTU Sustain is in charge of the air sampler at the Risø site. DEMA is in charge of the air samplers at Allinge and Haderslev, which are placed close to the PMS.

The sampler at Risø is manufactured by DTU Sustain. Air is drawn through a polypropylene filter at a rate of about 2000 m^3/h. The filter is normally changed every week. 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 intermittently.

DTU Sustain analyses filters from the 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. DTU Sustain analyses the air filters from the Risø site for ^{137}Cs, ^{7}Be, and ^{210}Pb on a weekly basis; ^{90}Sr is determined on a semi-annual basis on bulked samples.

DTU Sustain also analyses the air filters from Allinge and Haderslev by gamma spectrometry on monthly bulked samples. In addition to being analysed by DTU Sustain, the filters are being monitored on-line by a NaI detector mounted on top of the filters. Measurement data from these NaI detectors are sent to the DEMA-server alongside the other PMS data.

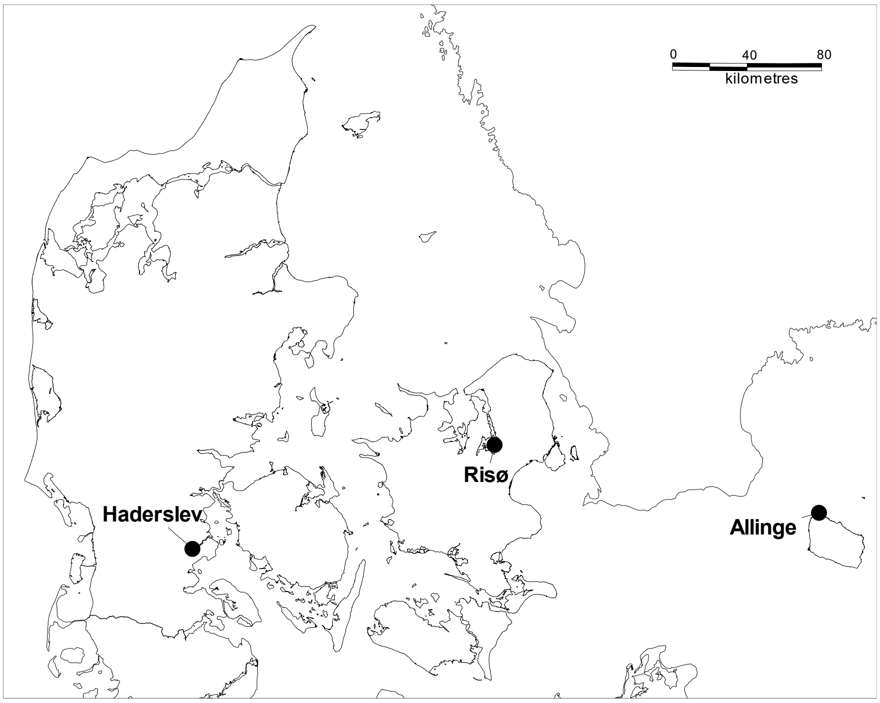

Figure 6: There are three locations in Denmark with high-volume air samplers.

Dry/wet deposition collectors

The eleven monitoring locations with rain collectors are shown in Figure 7.

Each site has three unheated rain collectors with a total area of 0.42 m^2. Each collector has a funnel situated above a 25-L plastic container. The Risø site, furthermore, operates a large rain collector of 10 m^2 (not shown on Figure 7). The collector is heated and water is passed through an ion exchange column to a large tank.

Plastic containers with precipitation are sent to Risø on a monthly basis where samples are bulked for each location to provide annual samples which are analysed for ^{90}Sr and ^{137}Cs.

The 10 m^2 collector provides monthly samples of rainwater analysed for tritium and ion exchange resin which is analysed by gamma spectrometry (^{7}Be, ^{137}Cs, and ^{210}Pb). The resin is bulked for 4 consecutive months and analysed for ^{90}Sr.

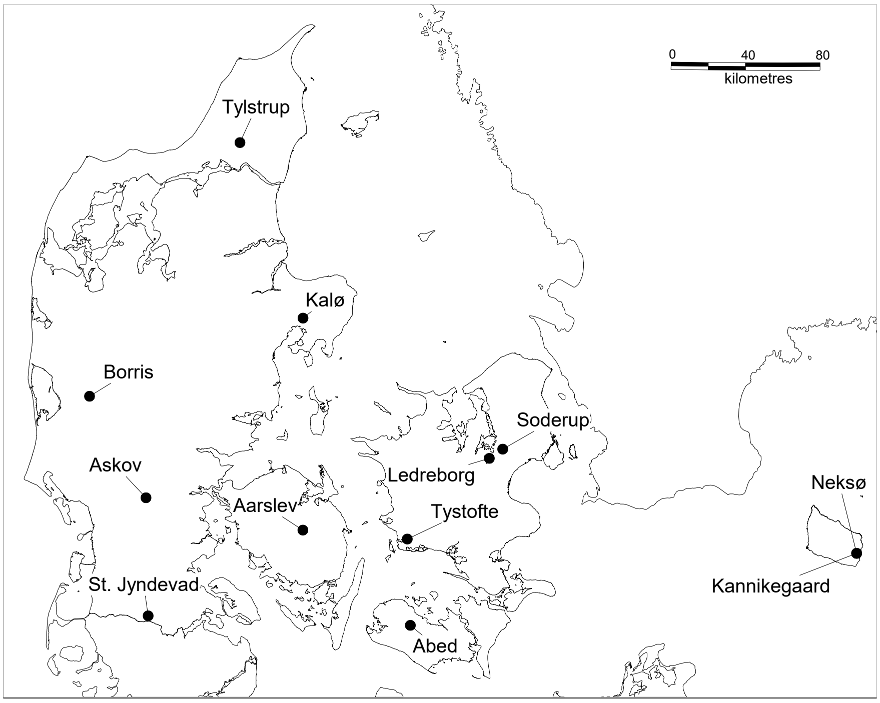

Figure 7: There are eleven locations with rain collectors.

4.4. Monitoring of radioactivity in water and marine sediments

Surface waters

Maps indicating the locations for sampling of surface waters are shown in Figure 8 and Figure 9 (the sample location Svenskehavn on Bornholm is not shown in the figures).

There is no information on water flows.

The Danish marine monitoring programme is carried out in accordance with HELCOM Recommendation 26/3 and PARCOM Recommendation 94/8 in parallel with OSPAR Agreement 2005-8. The obtained data is reported to HELCOM and OSPAR annually.

Samples of seawater (50-100 L) from 12 locations (surface and bottom) are collected annually 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 Risø for analysis (Figure 8). In addition, samples of water from Roskilde Fjord (not shown in the figure) are collected quarterly and surface seawater annually from Svenskehavn on Bornholm.

Freshwater samples from 8 streams and 8 lakes are collected every second year. Samples at 100-600 L for ^{137}Cs are passed through impregnated filters in the field and the filters taken to the lab for analysis (Figure 9).

Seawater samples are analysed for ^{90}Sr, ^{137}Cs, ^{99}Tc, $^{239, 240}$Pu, ^{237}Np. Samples from Roskilde Fjord are analysed for tritium, annually for ^{137}Cs.

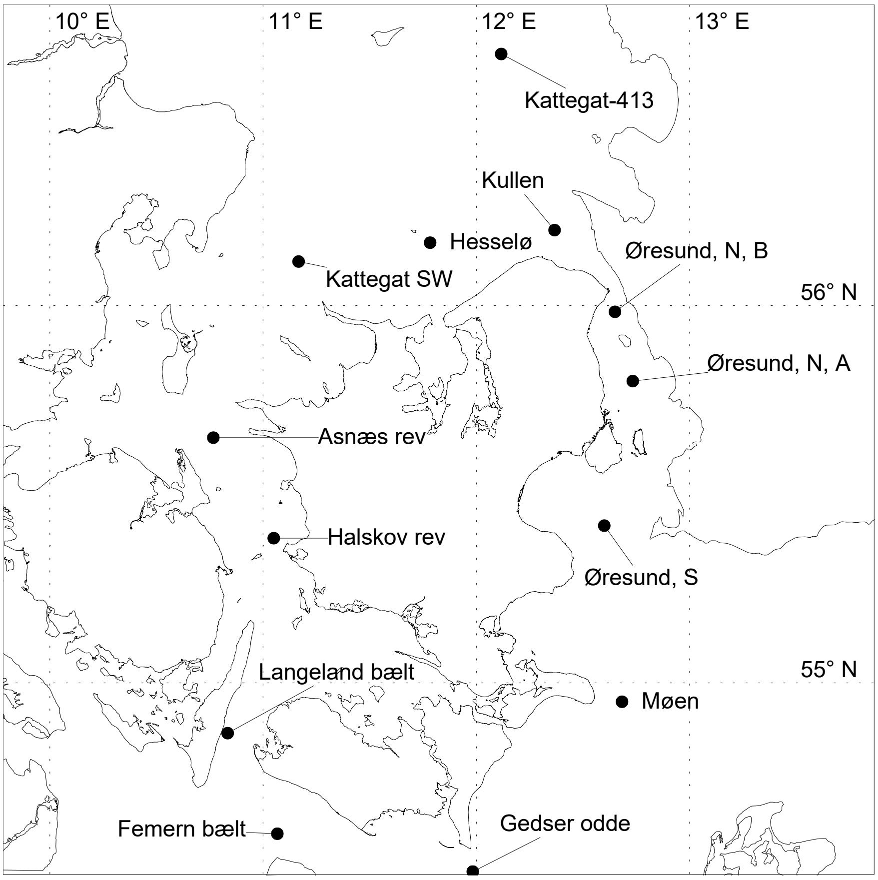

Figure 8: Locations for sampling of seawater.

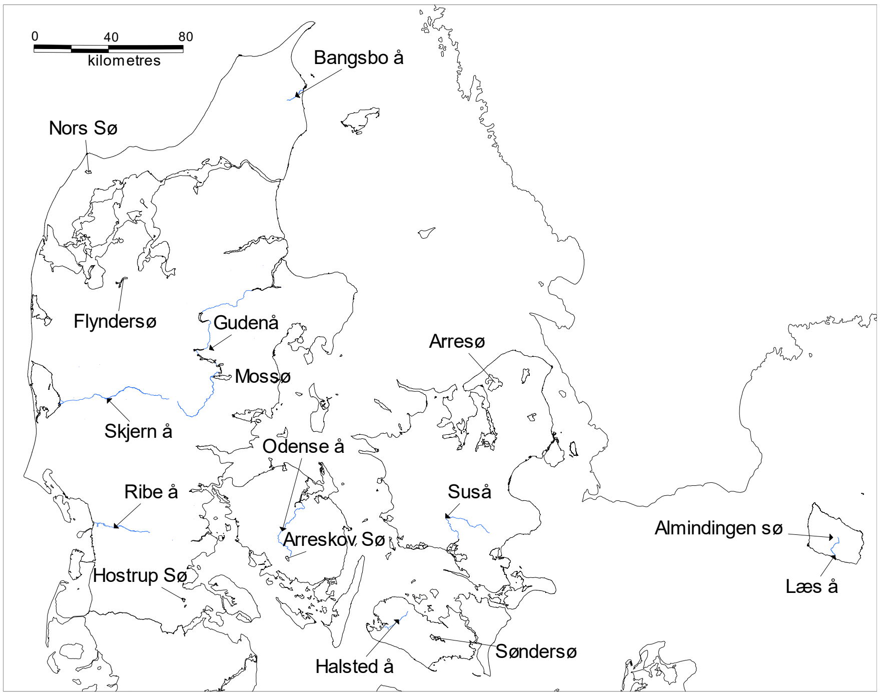

Figure 9: Locations for sampling of fresh water from streams and lakes.

Ground water and drinking water

A map indicating the locations for sampling of groundwater is shown in Figure 10.

Groundwater samples (200 L) from the 11 locations are collected every 3 years (Figure 10).

Samples are analysed for ^{90}Sr. Samples from the Feldbak location are furthermore collected by filtration in the field for analysis of ^{137}Cs.

4.5. Monitoring of radioactivity in soil

Soil and sediments

A map indicating the 11 monitoring locations for soil is shown in Figure 11.

Samples are collected approx. every 5 years from 11 locations. A coring device is used to collect 13 sub-cores 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. Samples are dried, ashed and sieved.

Samples are analysed for ^{90}Sr and ^{137}Cs (and natural gamma emitters), occasionally for Pu.

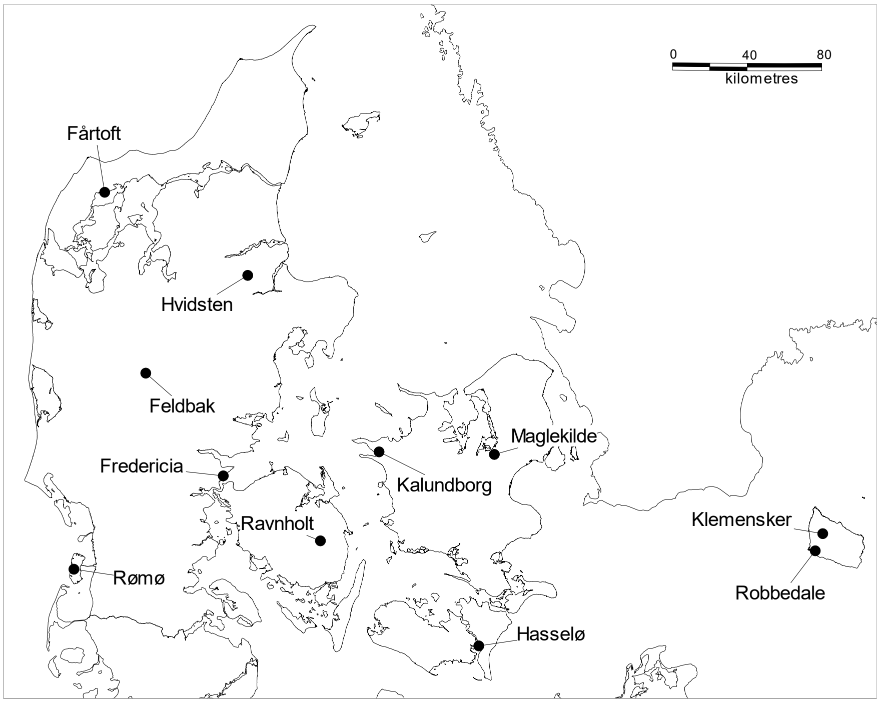

Figure 10: Locations for sampling of groundwater.

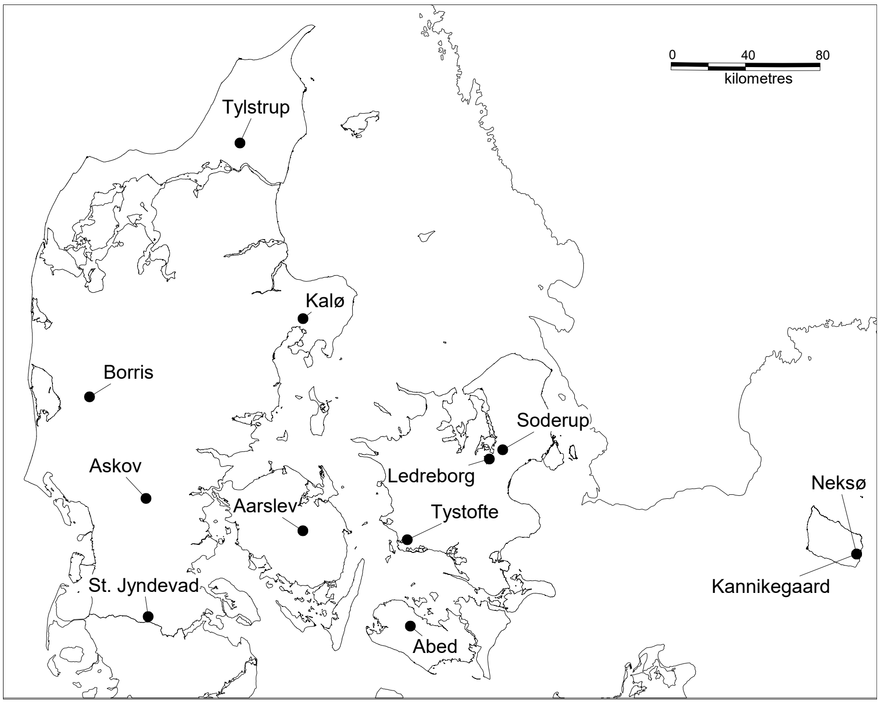

Figure 11: Locations for sampling of soil.

Terrestrial and aquatic biota (including mushrooms)

Grass samples are collected every second week at the Risø site and gamma analysed. Samples are bulked to monthly samples which are analysed for ^{137}Cs and bulked further to quarterly samples which are analysed for ^{90}Sr.

Seaweed samples are collected annually from Roskilde Fjord at Risø and analysed for ^{137}Cs (Figure 12).

Seaweed samples are collected quarterly from two locations in Jutland and one on location Zealand and one location on Bornholm annually (Figure 12) and analysed for ^{137}Cs and ^{99}Tc.

Marine fish samples (cod, herring and plaice) are collected annually from harbours in West Jutland, Zealand and Bornholm and analysed for ^{137}Cs and ^{210}Po. Lobster is collected from Kattegat annually and analysed for ^{99}Tc.

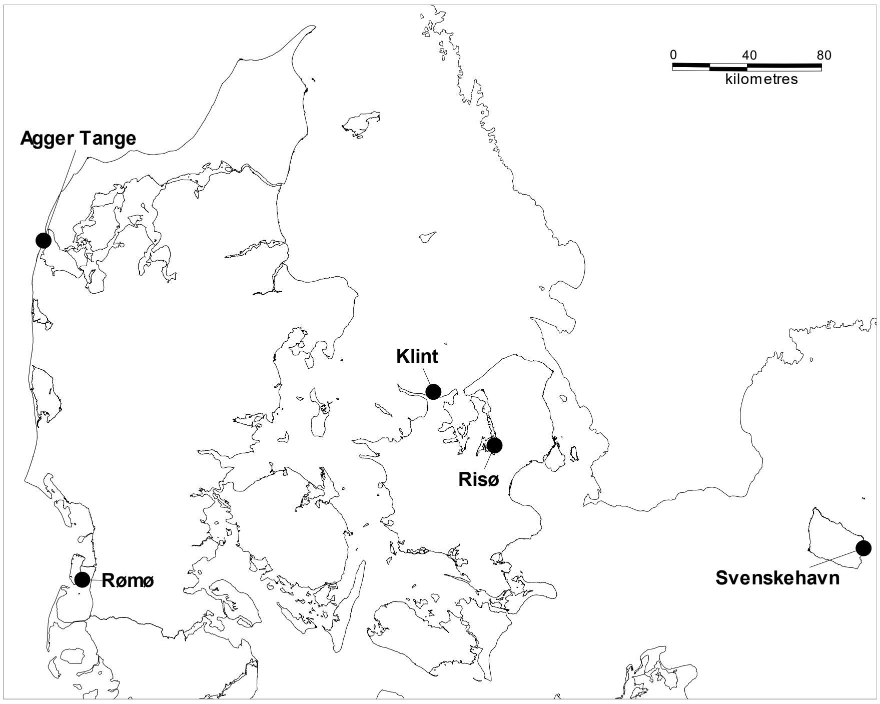

Figure 12: Locations for sampling of seaweed.

4.6. Monitoring of radioactivity in food and feed

Milk

A map showing zones in Denmark in which milk samples are collected is shown in Figure 13.

Milk samples are collected every second month from 8 zones in Denmark and analysed for ^{137}Cs and ^{90}Sr.

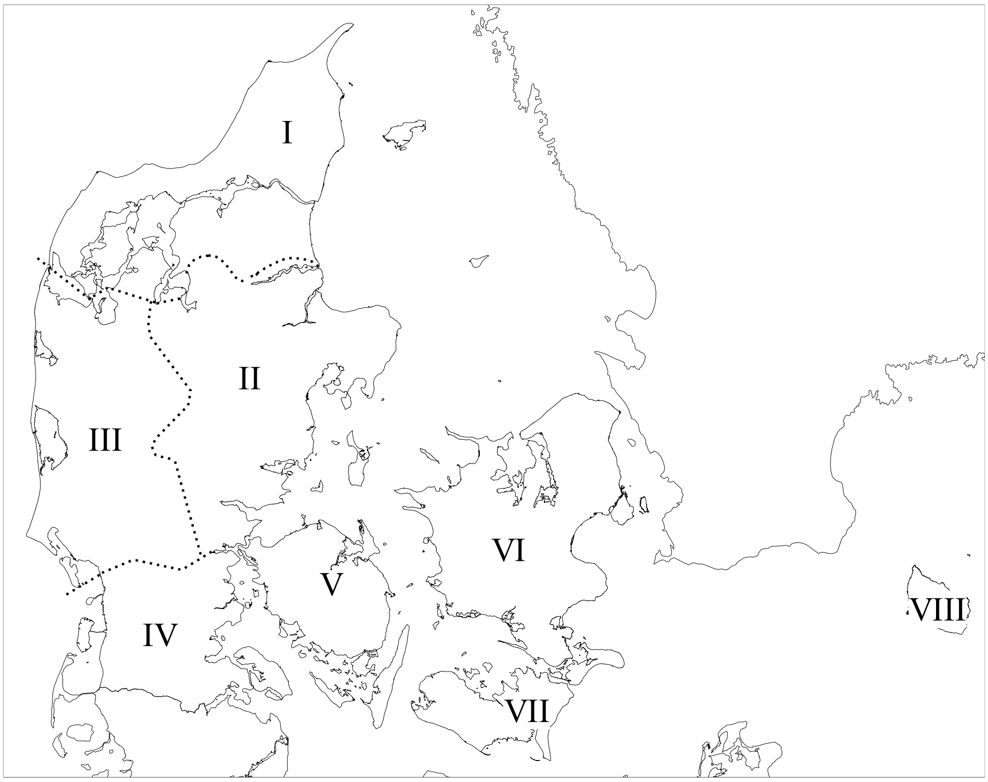

Figure 13: Zones in which milk samples are collected.

Mixed diet

Food ingredients are collected from shops in 9 cities including Copenhagen annually and mixed to composite samples of an average daily intake corresponding to 4 daily meals (12 kg fw[3]). Samples are bulked by region to cover Jutland, the islands[4] and Copenhagen[5] and are analysed for ^{137}Cs and ^{90}Sr.

Food

Cereals (oats, wheat, barley and rye) are collected at the 10 locations annually, bulked by species. 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. Samples are analysed for ^{137}Cs and ^{90}Sr

[3] Fresh weight
[4] Zealand, Fyn, Lolland-Falster and Bornholm
[5] The capital area

Feed

Feed is only indirectly measured - not on feed mixtures or specialized feed. We measure contents of ^{131}I and ^{134}Cs and ^{137}Cs annually in grain (wheat, rye, barley, oat) and potatoes, which may enter the feed-chain. Also, grass is measured, on a bi-weekly basis.

4.7. Information for the general public

Monitoring data have been informed to the general public online via DTU Nutech website, but currently are not available due to organizational changes in DTU and associated department (DTU Sustain) website reconstruction.

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

5. Laboratories participating in the environmental radioactivity monitoring programme

5.1. DTU Sustain

Department of Environmental and Resource Engineering, DTU Sustain
Technical University of Denmark
Frederiksborgvej 399, Building 204
4000 Roskilde
Denmark

DTU Sustain carries out sampling and analysis of radionuclides in environmental samples and foodstuffs at premises of DTU Risø Campus (the Risø site).

Sample reception and preparation
Sample ID numbers are entered in logbooks. Methodologies used to prepare samples before measurement include drying, freeze drying, ashing, sorting and sieving. Selected samples are archived.

Sample measurements
- Gamma spectrometry using Ge detectors for assessing gamma emitting radionuclides,
- Alpha spectrometry using Si detectors for assessing alpha emitting radionuclides,
- Low-level Geiger-Müller counters used for assessing ^{90}Sr and ^{99}Tc,
- Liquid scintillation counter used for analysis of tritium.

Measurement devices
10 Ge detectors for gamma spectrometry. Calibration of detectors based on mixed-nuclide standards used occasionally. Monthly checks of detector efficiency and energy resolution. Background measurements of gamma systems a few times per year. Gamma spectrum analysis by software developed at DTU and based on Mirion Genie 2000.

17 Si detectors for alpha spectrometry. Calibration of Si detectors using sources produced from standard solutions. Results of alpha analyses by software developed at DTU.

Analytical results and data handling and reporting tools
Analytical results are stored in a database on intranet. Results below detection limits recorded as such.

Spreadsheets or dedicated software are used for calculating results from raw data. Data base is used for storage of analytical results.

Statutory accounting and reporting

DTU is reporting environmental results to the European Commission and HELCOM.

DTU is reporting environmental results for the monitoring at the Risø site to DD who is reporting these results to DHA/RP and DEMA.

Quality assurance, laboratory accreditation and intercomparison exercises

All analytical results are checked by experienced staff and discussed with senior scientists if questions arise.

DTU is accredited to testing for radioactivity by the Danish accreditation body DANAK according to the international standard ISO 17025. The accreditation covers testing for certain non-gamma emitting radionuclides and not radionuclides occurring in the environment and food in general.

DTU participates in international intercomparisons (Appendix 4).

5.2. Danish Health Authority, Radiation Protection

Danish Health Authority, Radiation Protection
Knapholm 7
2730 Herlev
Denmark

Laboratory facilities at DHA/RP

The Danish Health Authority, Radiation Protection possesses as part of its organisation, a strategic laboratory function that primarily supports the work of the authority. Currently, the laboratory has no contractual involvement in environmental monitoring programs, but may perform measurements for investigative and verification purposes. It works independently from authority interests according to international quality standards (ISO17025). The laboratory services include analysis of samples for radionuclide content, dosimetry and instrument calibration or verification, partly performed under accreditation (by DANAK). For environmental monitoring, the laboratory can handle a variety sample types including materials, objects and liquids. The services are presented on the institution website (www.sis.dk) and are offered to external customers as well.

Available services

Radionuclide identification and quantification:

- Gamma spectrometry, various sample types (high-resolution Ge) (accredited)
- In situ gamma spectrometry, field analysis (high-resolution Ge) (accredited)

- ^{3}H-3, ^{14}C and ^{125}I, liquid samples (LSC beta, low-resolution NaI)
- Surface contamination, wipes/swabs (LSC gross alpha/beta)

Calibration or verification of:

- Electronic dose-rate meters
- Surface contamination monitors (accredited)
- Passive or electronic personal dosimeters (accredited)
- Thyroid I-131 monitoring equipment

Dosimetry services:

- Passive dosimeters (TLD) for personal use (external dose) (accredited)
- Passive dosimeters (TLD) for area monitoring
- Urine analysis (internal dose)

Sample reception and preparation

Sampling procedure is performed by the laboratory customers including authority inspectors. The laboratory may provide sampling materials (containers, swabs). Received samples are controlled for radiation dose-rate and potential contamination risk, and are individually registered with a unique identification. The laboratory can handle potentially contaminated samples in a dedicated controlled area (isotope laboratory). Samples can be analysed either in their original form, dispensed or subdivided as needed. No chemical separations are performed.

Sample measurements

Samples for gamma spectrometry and ^{125}I are analysed individually. With typical counting times of 3-24 hours per sample. For each sample a geometry description and modelling are performed.

^{3}H, ^{14}C and surface contamination swabs, are loaded unto equipment (LSC) in groups up to 40 or 96 samples, with counting times of 2-3 hours per sample

Measurement devices

One (+1 standby) Stationary high-resolution characterized Ge detector (Canberra/Mirion XtrHPG). Low background. LabSOCS calibration (45-2000 keV).

Two Mobile high-resolution characterized Ge detector (Canberra/Mirion Falcon5000). LabSOCS calibration (45-2000 keV).

One Liquid scintillation counter (Hidex 300SL). ^{3}H, ^{14}C calibrations. 40 (20 ml) or 96 (7ml) sample racks.

One (+1 standby) NaI well detector calibrated for ^{125}I measurements (Canberra/Mirion).

Measurement results

Results are reported as radionuclide activity concentration (Bq/g) or total activity (Bq) (ISO11929 best estimate) with standard (k=1) or expanded (k=2) absolute or relative uncertainty (u, U, ur, Ur), along with radionuclide decision level or detection limit (ISO11929 y* or y#). Activity significance is evaluated against the decision level or detection limit and only activities above these are reported

Analytical results and data handling and reporting tools

All measurements are reported in electronic form (.pdf). QC procedures are performed which controls critical settings and parameters before approval or the report.

Data are stored in a laboratory information system and can be presented in a database-accessible format (delimited text) upon request.

Data handling and reporting are performed in accordance with the international standard ISO17025. Uncertainty and detection limits are calculated according to ISO11929.

Statutory accounting and reporting

No formal requirements specified.

Quality assurance, laboratory accreditation and intercomparison exercises

The laboratory works in compliance with international standard for testing and calibration (ISO17025), requiring extensive quality assurance management, competence allocation and participation in proficiency tests/interlaboratory comparisons. Parts of the activities are performed under accreditation (DANAK).

5.3. Danish Decommissioning

Danish Decommissioning
Frederiksborgvej 399,
4000 Roskilde
Denmark

Danish Decommissioning is an institution under the Ministry of Higher Education and Science.

Mass-specific clearance measurements in the Clearance Laboratory and surface-specific clearance measurements started in May 2007 after the accreditation by DANAK. The total amount of material cleared from 2015 up until the end of 2023 is 155 tonnes by either mass-specific measurements or surface-specific measurements.

6. Mobile measurement systems

DEMA has a capacity for car-borne gamma spectrometry (CGS) and air-borne gamma spectrometry (AGS) (Figure 14 and Figure 15). Trained personnel at DEMA, officers of the reserve and qualified volunteers can operate the CGS and AGS systems. The systems are subject to systematic calibration and exercises scheduled regularly where operators train deployment of equipment in-air and on the ground.

Car-borne Gamma Spectrometry (CGS)

The CGS systems consist of two repurposed VW Multivans containing 1 Radiation Solution RS-701 console, 1 Radiation Solution RSX-1 4 litre NaI(TI) crystal, 1 Radiation Solutions RS-725/21, 0.39 litre (3 by 3 inch) NaI(TI) crystal and a laptop running RadAssist software with mapping and nuclide identification features (Figure 14). The two detector setup provides better coverage even in highly contaminated areas where the smaller RS-725 may sample 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.

Furthermore, DEMA has recently received 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.

Figure 14: The car-borne gamma spectrometry system (CGS).

Airborne Gamma Spectrometry (AGS)

DEMA has two AGS systems each containing 1 Radiation Solution RS-701 console, 2 Radiation Solution RSX-1 4 litre NaI(Tl) crystal, UPS for continuous power supply, and a Panasonic Toughbook running RadAssist software with mapping and nuclide identification features (Figure 15). 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 15: The air-borne gamma spectrometry system (AGS).

7. Other Information

Denmark hosted an IAEA integrated regulatory review service (IRRS) mission in 2021. The mission did not identify any recommendations or suggestions to Denmark specifically regarding the provisions for environmental monitoring of radioactivity in Denmark. The mission report is available through the following link: IRRS mission Denmark 2021.

As part of the preparatory activities for this verification visit, the parties of the Framework Agreement; the Danish Health Authority, the Danish Veterinary and Food Administration, Danish Environmental Protection Agency and the Danish Technical University (DTU Sustain), have agreed that the overall scope, range of services, and reporting requirements and mechanisms, including provision of information to the general public, should be reviewed and updated as deemed necessary. For this purpose, an initiating meeting in the autumn of 2024 has been agreed upon.

Appendix

Appendix 1.

The Framework Agreement on research-based public sector consultancy

Appendix 2.

The Task Agreement

Appendix 3. a

Aggregated semi-annual release reports prepared for the EU verification visit for the period 2022 to 2023 for the nuclear facilities and the Waste Management Plant, at the Risø site.

Appendix 3.b

Aggregated semi-annual on environmental monitoring of areas surround the Risø site prepared for the EU verification visit covering the period 2. quarter of 2021 to 1. quarter of 2023.

Appendix 4.

DTU participation in international intercomparison exercises on analyses of radioactivity since 2016

Appendix 1:

The Framework agreement concluded between Danish Health Authority, Danish Veterinary and Food Administration and Environmental Protection Agency and Technical University of Denmark on research-based public service 2023-2026

English translation of front page and contents of the Framework Agreement

Framework Agreement
on research-based public sector consultancy

Framework agreement concluded between

Danish Health Authority, Danish Veterinary and Food Administration and Environmental Protection Agency

and

Technical University of Denmark

on research-based public service

2023-2026

Table of contents:

Rammeaftale om forskningsbaseret myndighedsbetjening

Rammeaftale indgået mellem

Sundhedsstyrelsen, Fødevarestyrelsen, Miljøstyrelsen

og

Danmarks Tekniske Universitet

om forskningsbaseret myndighedsbetjening

2023-2026

Indhold

1. Indledning

Rammeaftalen er indgået mellem Sundhedsstyrelsen (SST), Fødevarestyrelsen (FVST), Miljøstyrelsen (MST) og Danmarks Tekniske Universitet (DTU) for perioden 2023 -2026. Rammeaftalen underskrives af SST's direktør med ansvar for strålingsområdet, FVST's fødevaredirektør, MST's vicedirektør med ansvar for havmiljøområdet og rektor for DTU. Rammeaftalen vedrører forskningsbaseret rådgivning, udviklingsopgaver og overvågning inden for de anførte indsatsområder.

Rammeaftalens formål er at sikre tilvejebringelsen af forskningsbaseret myndighedsbetjening[1] til SST, FVST og MST fra DTU. Rammeaftalen etablerer rammerne for et samarbejde mellem parterne for at sikre, at DTU gennemfører forskning, som kan understøtte styrelsernes forvaltningsmæssige opgaver, samt sikre at DTU har den viden og de kompetencer, der kræves for at levere forskningsmæssig understøttelse inden for de fagområder, der er omfattet af rammeaftalen.

Rammeaftalen beskriver de overordnede rammer og vilkår for samarbejdet mellem SST, FVST, MST og DTU og vedlægges en ydelsesaftale, som beskriver DTU's forskningsbaserede myndighedsbetjening af SST, FVST og MST. Rammeaftalen med tilhørende ydelsesaftale (herefter aftalen) er 4-årig med forbehold for vedtagelse af de enkelte års finanslove og rulles årligt for en ny 4-årig periode.

Aftalen omfatter aktuelt en ydelsesaftale, som beskriver den forskningsbaserede myndighedsbetjening inden for følgende indsatsområder:

- Overvågning af radioaktive stoffer i miljø og fødevarer (artikel 35/36 i Euratom-traktaten)
- Overvågning af radioaktive stoffer i havmiljø i Nordøst-atlanten (OSPAR Konventionen)
- Overvågning af radioaktive stoffer i havmiljø i Østersøen (Helsinki Konventionen, HELCOM/MORS EG)

Den forskningsbaserede myndighedsbetjening i henhold til ovenstående ydelsesaftale varetages af DTU Sustain.

Ved rulning af aftalen kan der indgås nye ydelsesaftaler med mulighed for at inddrage andre institutter på DTU. Ligeledes kan ydelsesaftalen opsiges, jf. retningslinjer for konkurrenceudsættelse i *Notat om aftaler mellem universiteter og ministerier for forskningsbaseret myndighedsbetjening* med tilknyttet bilag[2]. Indgåelse af nye ydelsesaftaler eller opsigelse af nuværende ydelsesaftaler påvirker som udgangspunkt ikke rammeaftalens generelle vilkår, jf. afsnit 6.1.

1.1 Strategiske perspektiver

DTU udfører forskning af høj kvalitet inden for ydelsesaftalernes faglige områder med henblik på, at myndighedsbetjeningen er forskningsbaseret og sker på basis af den nyeste viden.

Den forskningsbaserede myndighedsbetjening skal være fremsynet og effektiv i forhold til at løse på centrale samfunds- og erhvervsmæssige udfordringer inden for det nukleare område.

Parternes strategiske perspektiver for aftalen er beskrevet i ydelsesaftalen med udgangspunkt i styrelsernes strategi og relevante dele af DTU's forskningsstrategi. Ydelsesaftalen udmønter de strategiske perspektiver gennem

[1] Forskningsbaseret myndighedsbetjening er defineret i bemærkningerne til universitetslovens § 2, stk. 4, og dækker de i lov nr. 326 af 5/5 2014 § 2 anførte opgavetyper, som med universitetsreformen blev overført fra de tidligere sektorforskningsinstitutter til universiteterne.

[2] Se http://ufm.dk/forskning-og-innovation/samspil-mellem-viden-og-innovation/forskningsbaseret-myndighedsbetjening/retningslinjer/retningslinier-for-forskningsbaseret-myndighedsbetjening, hvor den til enhver tid gældende version vil være at finde

konkrete forskningsindsatser og større strategiske opgaver. DTU vil i videst muligt omfang søge gearing af bevillingen gennem relevante forskningsprojekter, som ligger inden for aftalens strategiske perspektiver og økonomiske ramme.

DTU udnytter synergimulighederne mellem den forskningsbaserede myndighedsbetjening og DTU's øvrige formål, herunder innovation. DTU forpligter sig til at sikre robuste forskningsmiljøer inden for aftalens økonomiske og faglige rammer, som kan levere kvalificeret rådgivning til styrelserne.

2. Ydelsesaftalens opbygning og anvendelse

Ydelsesaftalen beskriver den faglige ramme for den forskningsbaserede myndighedsbetjening, som DTU udfører i henhold til denne aftale. Ydelsesaftalen omfatter en række indsatsområder, inden for hvilke parterne opbygger og udvikler et strategisk samarbejde. Tabel 1 er en oversigt over den aktuelle ydelsesaftale og indsatsområder under denne rammeaftale.

Tabel 1. Oversigt over ydelsesaftalens indsatsområder

Ydelsesaftale	Indsatsområde
Radioaktive stoffer i miljø og fødevarer	Overvågning af radioaktive stoffer i miljø og fødevarer
	Overvågning af radioaktive stoffer i havmiljø i Nordøst-Atlanten
	Overvågning af radioaktive stoffer i havmiljø i Østersøen

Ydelsesaftalen beskriver de ydelser, som DTU forventes at levere inden for hvert indsatsområde. Den forskningsbaserede myndighedsbetjening til styrelserne omfatter følgende ydelseskategorier:

- Forskningsbaseret rådgivning
- Forskningsbaseret overvågning og monitorering
- Forskning og generel kompetenceopbygning

Det overordnede princip for arbejdsdeling mellem styrelserne og DTU er at styrelserne er ansvarlige for risikohåndtering, mens DTU varetager miljøovervågning og -vurdering af radioaktive stoffer i miljø og fødevarer og i havmiljø.

Uddybende specifikationer om arbejdsfordeling i akutte situationer fremgår af ydelsesaftalen mellem parterne. DTU kan kun påtage sig myndighedsopgaver rettet mod borgere og virksomheder, hvis der er særskilt hjemmel hertil.

2.1 Forskningsbaseret rådgivning

Planlagte og faste løbende opgaver samt ad hoc bestillinger i det enkelte år, fx akutte bestillinger til lovforberedende arbejde, udredninger og evalueringer mv.

2.2 Forskningsbaseret overvågning og monitorering

Gennemførelse af forskningsbaseret overvågning og monitorering herunder specifikke monitoreringsopgaver, nationale og internationale datarapporteringsopgaver samt drifts-, vedligeholdelses- og dataudviklingsopgaver.

2.3 Forskning og generel kompetenceopbygning

Forskning og kompetenceopbygning inden for de aftalte indsatsområder for den forskningsbaserede myndighedsbetjening, herunder tiltrækning af ekstern finansiering på strategisk vigtige områder til gearing af parternes bevilling.

3. Økonomi

3.1 Økonomiske rammer for aftalen

Med forbehold for at bevillingerne tilvejebringes på de årlige bevillingslove, forpligter DTU sig til i perioden 2023-2026 at anvende 8,0 mio. kr. årligt af DTU's basisbevilling (FL§19.22.37) til ydelser inden for ovennævnte indsatsområder.

Tabel 2 viser indsatsområdernes forventede andel af den samlede kapacitetsramme.

Tabel 2. Økonomisk ramme, 2023-2026 (mio. kr.)

Ydelsesaftale	2023	2024	2025	2026
Radioaktive stoffer i miljø og fødevarer	8,0	8,0	8,0	8,0

3.2 Finansiering af forskning, forskningsbaseret rådgivning og indirekte omkostninger

Myndighedsbetjeningen er kendetegnet ved et højt grundlæggende forskningsomfang. Aftalens bevilling budgetteres derfor anvendt til forskning og generel kompetenceopbygning samt indirekte omkostninger knyttet hertil. Forskningsandelen medregnes ved opgørelsen af de samlede udgifter til offentlig forskning, udvikling og innovation, jf. 1-procentmålsætningen.

Parterne tilstræber, at DTU i gennemsnit i aftaleperioden anvender ca. 50 % af rammeaftalens bevilling til forskning og generel kompetenceopbygning samt indirekte omkostninger knyttet hertil. Parterne er enige om at udvise fleksibilitet i forhold til den forventede anvendelse af den økonomiske ramme, jf. tabel 2, i tilfælde af pludseligt opståede eller andre uventede begivenheder.

Parterne vil løbende sikre fuld balance mellem omkostninger, som følger af de opgaver, der påhviler DTU i medfør af nærværende aftale. Konkrete omprioriteringer af opgaver og opgavebortfald vil efter aftale med parterne kunne indgå i balanceringen.

DTU arbejder samtidig løbende på at effektivisere opgavevaretagelsen via faglige og administrative synergigevinster, så som bedre kapacitetsudnyttelse, administrative forenklinger, procesoptimeringer m.v. DTU vil i videst muligt omfang søge gearing af basisbevillingen gennem relevante forskningsprojekter, som ligger inden for aftalens strategiske perspektiver og økonomiske ramme.

I situationer, hvor der er akut behov for en indsats, der overskrider aftalens økonomiske ramme, fakturerer DTU Sustain SST/FVST/MST for de ekstraordinære omkostninger, som forventes dækket via en særlig bevilling.

I det omfang DTU Sustain's ramme- og opgavevilkår er genstand for ændringer ud over de årlige pris- og lønreguleringer, drøfter parterne behovet for at justere omfanget af ydelserne, herunder den tidsmæssige ikrafttrædelse heraf.

Tabel 3 viser parternes forventede anvendelse af den samlede bevilling fordelt på ydelsesaftalernes indsatsområder.

Tabel 3. Forventet anvendelse af den økonomiske ramme på indsatsområder (mio. kr)

Ydelsesaftale	Indsatsområde	Mio.kr. [3]
Radioaktive stoffer i miljø og fødevarer	Overvågning af radioaktive stoffer i miljø og fødevarer	5,0
	Overvågning af radioaktive stoffer i havmiljø i Nordøst-Atlanten	0,4
	Overvågning af radioaktive stoffer i havmiljø i Østersøen	2,6
	I alt	8,0

3.3 Opfølgning og rapportering

For ydelsesaftalen nedsættes en chefgruppe (se afsnit 4) som er ansvarlig for den løbende opfølgning på den forskningsbaserede myndighedsbetjening, herunder om leverancerne lever op til det aftalte, herunder kvaliteten af bestillinger og leverancer.

Chefgruppen behandler en årsrapportering med frist den 1. maj det efterfølgende år. Til brug herfor er DTU forpligtet til at rapportere bevillingsanvendelsen for ydelsesaftalen fordelt på indsatsområder.

[3] Angivne beløb dækker både direkte og indirekte omkostninger.

4. Samarbejdsorganisation

Samarbejdet mellem SST, FVST, MST og DTU forankres i to samarbejdsfora på ledelsesniveau:

1. Ledelsesgruppe for den samlede aftale, som er øverste besluttende forum og overordnet ansvarlig for rulning af og opfølgning på rammeaftalen med tilhørende ydelsesaftale, jf. afsnit 4.1.
2. Chefgruppe for ydelsesaftalen, som er ansvarlig for rulning af og opfølgning på den enkelte ydelsesaftale, jf. afsnit 4.2.

SST, FVST, MST og DTU indgår i tillæg til ovenstående samarbejdsfora i en teknisk faglig dialog om konkrete opgaver inden for aftalen under iagttagelse af principper for armslængde, transparens og universitetets metodefrihed.

Ledelses- og chefgrupperne kan – i det omfang der er behov herfor – nedsætte faglige arbejdsgrupper, udvalg mv. Det faglige samarbejde skal inddrage relevante fagkompetencer på tværs af styrelserne og DTU.

4.1 Ledelsesgruppen

Ledelsesgruppen sammensættes af SST's direktør med ansvar for strålingsområdet, enhedschefen fra SST/SIS, direktør fra afdeling for Forskning, Rådgivning og Innovation på DTU og institutdirektøren for DTU Sustain. FVST og MST kan på eget initiativ vælge at lade sig repræsentere som observatører i ledelsesgruppen. Mødeindkaldelser, mødereferater og korrespondancer vedr. rulning af aftalen forelægges FVST og MST til orientering.

Ledelsesgruppen har det overordnede ansvar for rulning af aftalen og opfølgning på den leverede myndighedsbetjening på ydelsesaftalen. Tabel 4 viser bemandingen af ledelsesgruppen. Ledelsesgruppen sekretariatsbetjenes af et aftalesekretariat bestående af repræsentanter fra ministeriet og universitetet. Ledelsesgruppens sammensætning kan ændres ved beslutning i ledelsesgruppen.

Tabel 4. Bemanding af ledelsesgruppen

Institution	Deltagere	Navn
SST	Direktør	Søren Brostrøm (el. dennes repræsentant)
	Enhedschef fra SST/SIS	Mette Øhlenschlæger
DTU	Direktør	Jakob Fritz Hansen (el. dennes repræsentant)
	Institutdirektør DTU Sustain	Claus Hélix-Nielsen

Ledelsesgruppens rolle og ansvar

Ledelsesgruppen er øverste myndighed for den faglige tilrettelæggelse af samarbejdet, herunder den årlige rulning af ydelsesaftalen og opfølgning på den leverede myndighedsbetjening. Ledelsesgruppen sekretariatsbetjenes af SST/SIS med input fra og i tæt samarbejde med DTU's Afdeling for Innovation og Sektorudvikling. Derudover har ledelsesgruppen følgende ansvarsområder:

- Gensidig vidensdeling om forskning og projekter af relevans for aftalen.
- Strategisk dialog i forhold til politiske og faglige tendenser med relevans for myndighedsbetjeningen.
- Styrke det langsigtede samarbejde mellem parterne med henblik på fortsat kompetenceopbygning, herunder vedligeholdelse af de aktiviteter og metoder m.v., der kræves for at levere og udnytte kvalificeret og relevant myndighedsbetjening.
- Vurdere om der er behov for nye indsatser eller justering af eksisterende indsatser, herunder vurdere om der er behov for ændringer i ressourcetilførslen til ydelsesaftalen.

- Drøfte faglige og administrative synergier.
- Drøfte større og langsigtede ændringer i forskningsinfrastrukturen og evt. investeringsbehov.
- Rulle den samlede aftale samt sikre udmøntning af de strategiske perspektiver.
- Godkende og indstille samlet aftale for det kommende år til underskrift.
- Godkende årsrapportering for samlet aftale, herunder drøfte evt. indstillinger fra chefgruppen.

4.2 Chefgruppen

Chefgruppen for ydelsesaftalen sammensættes af repræsentanter fra SST/SIS fagenheder og DTU Sustain på chefniveau. Chefgruppen er inden for sit faglige område ansvarlig for den faglige tilrettelæggelse af samarbejdet, herunder den årlige rulning af ydelsesaftalen og opfølgning på denne.

Chefgruppens rolle og ansvar

- Gensidig vidensdeling om forskning og projekter af relevans for aftalen.
- Strategisk dialog i forhold til politiske og faglige tendenser med relevans for myndighedsbetjeningen.
- Tilrettelægge det faglige samarbejde, så både aktuelle og langsigtede strategiske behov tilgodeses.
- Vurdere opgavemængden og eventuelt prioritere udførelsen af opgaver, så ressourcerne afsat til indsatsområderne er i overensstemmelse med ydelsesaftalen.
- Vurdere om leverancerne lever op til det aftalte, herunder kvaliteten af bestillinger og leverancer.
- Rulning af ydelsesaftale på baggrund af faglige input, herunder vurdere eventuelle behov for ændret ressourcefordeling og evt. indstille forslag om omprioriteringer til ledelsesgruppen.
- Udarbejde årsrapportering for ydelsesaftalen, herunder drøfte indstillinger fra opgaveansvarlige samt evt. indstille til ledelsesgruppen.
- Efter behov nedsættes faglige arbejdsgrupper mv. som sikrer teknisk faglig dialog mellem parternes fagenheder og DTU's forskningsmiljøer.

4.3 Mødeplan

Ledelsesgruppen mødes efter behov. Alternativt gennemføres processerne skriftligt. , dog mindst en gang om året typisk i 4. kvartal, hvor rulning af rammeaftalen drøftes. Der indkaldes til mødet med minimum to måneders varsel. Ledelsesgruppen kan i enighed vælge at lade det ordinære møde erstatte af en skriftlig proces om rulning af aftalen. Ledelsesgruppen kan i enighed vælge at supplere sig ved møderne med personer fra partnernes ledelser og bestyrelser i øvrigt.

4.4 Skriftlighed i universitetets rådgivning

Universitetets rådgivning af styrelserne sker altid skriftligt i form af blandt andet rapporter, notater mv. Skriftligheden understøttes desuden af de almindelige procedurer omkring rådgivningsleverancen. I tilfælde af telefonisk rådgivning, hvor styrelserne vil citere eller henvise til DTU, eller hvor en sag afgøres på grundlag af rådgivningen fra DTU, udarbejder styrelserne efter en fast skabelon et telefonnotat, som sendes til godkendelse af universitetet.

I de tilfælde, hvor der nedsættes styre- eller følgegrupper i tilknytning til rådgivningsopgaver, formuleres et kommissorium, som skal skabe klarhed omkring roller, kompetencer og eventuel rammesætning for løsningsrum. Universitetet kan alene deltage som faglig rådgiver, og universitetets faglige anbefalinger og rådgivning skal fremgå skriftligt af afrapportering.

Styrelserne og universitetet er underlagt de almindelige offentligretlige regler om notatpligt mv. Aftalens bestemmelser ændrer ikke herpå.

4.5 DTU's interessentinddragelse og informationsforpligtelse

DTU kan frit planlægge sin interessentinddragelse i universitetets aktiviteter vedr. forskningsbaseret myndighedsbetjening. DTU har rådgivende advisory boards på institutniveau. I tillæg hertil formidler DTU relevante resultater inden for ydelsesaftalernes indsatsområder til styrelserne, erhverv og andre interessenter samt til offentligheden, jf. generelle forpligtelser i universitetsloven. Øvrige formidlingsaktiviteter aftales mellem styrelserne og DTU i ydelsesaftalen.

DTU vil på eget initiativ informere styrelserne om forskningsstrategier, resultater af forskningsaktiviteter, rapporter, nyheder, konferencer, internationalt samarbejde, og lignende inden for ydelsesaftalens område af relevans for styrelsernes arbejde. Dette sker. gennem gensidig orientering på chefgruppe- og ledelsesgruppemøder, hvor styrelserne tilsvarende giver DTU indblik i den politiske og forvaltningsmæssige dagsorden med henblik på, at DTU kan holde styrelserne orienteret om forskning og andre aktiviteter med relevans herfor, jf. afsnit 4.6.

Nærværende rammeaftale med tilhørende ydelsesaftale og bilag offentliggøres på DTU's hjemmeside.

4.6 Styrelsernes interessentinddragelse og informationsforpligtelse

Styrelserne kan frit planlægge sin interessentinddragelse i styrelsernes aktiviteter vedr. den forskningsbaserede myndighedsbetjening.

Styrelserne forpligter sig til løbende og på eget initiativ at informere DTU om politiske og forvaltningsmæssige strategier, handlingsplaner samt andre initiativer og forhold af betydning for DTU's forskning og forskningsbaserede myndighedsbetjening. Dette sker gennem gensidig orientering på chefgruppe- og ledelsesgruppemøder, hvor styrelserne giver DTU indblik i den politiske og forvaltningsmæssige dagsorden og med henblik på, at DTU kan holde styrelserne orienteret om forskning og andre aktiviteter med relevans herfor, jf. afsnit 4.5.

Nærværende rammeaftale med tilhørende ydelsesaftale og bilag offentliggøres på styrelsernes hjemmeside.

4.7 Kvalitetssikring

DTU er ansvarlig for den faglige kvalitetssikring af den forskningsbaserede myndighedsbetjening. Den sektorrelaterede forskning er underlagt samme kvalitetssikring som universiteternes øvrige forskning. DTU har egne retningslinjer for kvalitetssikring af myndighedsbetjeningen.

4.8 Samarbejde med andre forskningsmiljøer

Rammeaftalen og ydelsesaftalerne skal bidrage til at sikre langsigtede og stabile rammer for den forskning og kompetenceopbygning, der er forudsætningen for forskningsbaseret myndighedsbetjening af høj kvalitet.

DTU kan på konkrete områder, efter aftale med styrelserne, etablere forpligtende afgrænsede samarbejder af kortere varighed på tværs af relevante forskningsmiljøer i forbindelse med en konkret tidsafgrænset rådgivningsopgave. Ligeledes kan DTU ved længerevarende eller tilbagevendende opgaver eller ved etablering af større forskningsområder etablere forpligtende længerevarende samarbejder med andre forskningsinstitutioner.

5. Bestemmelser om regulering af samarbejdet

De gensidige forpligtelser i henhold til denne aftale reguleres ved de fælles retningslinjer i *Notat om aftaler mellem universiteter og ministerier for forskningsbaseret myndighedsbetjening* med tilknyttet bilag[4].

5.1 Aftaleperiode og rulning

Aftalen er 4-årig og gælder for perioden 2023-2026. Aftalen rulles årligt for en ny 4-årig periode. Den årlige rulning angår primært opgaveporteføljen samt justering i henhold til udviklingen i den økonomiske ramme.

Rulning

Ud over den årlige rulning af aftalen kan hver part anmode om øjeblikkelig ændring af aftalen, såfremt der indtræder væsentlige ændringer i partens forudsætninger for opfyldelse af grundlæggende dele af aftalen, herunder bevillingsmæssige ændringer på finansloven.

Såfremt en part ønsker ændring af aftalen som følge af væsentlige ændringer, skal parten meddele dette skriftligt til den andre parter. Meddelelsen skal indeholde en redegørelse for de forhold, som parten mener, udgør væsentlige ændringer i forudsætningerne for opfyldelse af grundlæggende dele af aftalen. Der er en gensidig forpligtelse til orientering om væsentlige ændringer hurtigst muligt.

5.2 Tavshedspligt

Parterne er underlagt forvaltningsretlige regler om tavshedspligt. Aftalen indebærer ikke en udvidelse af reglerne om tavshedspligt.

DTU afgør selv i overensstemmelse med egne procedurer og i henhold til gældende ret, om der foreligger tavshedspligt i forbindelse med en rådgivningsleverance eller oplysninger i denne og i givet fald dens udstrækning, herunder om der er grundlag for at udsætte offentliggørelse af rådgivningsleverancen eller oplysninger heri, indtil begrundelsen ikke længere er til stede. Styrelserne kan gøre DTU opmærksom på, at en rådgivningsleverance efter styrelsernes vurdering helt eller delvist kan være omfattet af tavshedspligt. Dette skal altid ske skriftligt og være begrundet. Parterne skal rådføre sig med hinanden ved evt. tvivlsspørgsmål om, hvorvidt en oplysning er omfattet af reglerne om tavshedspligt. På denne måde sikres et fuldt oplyst beslutningsgrundlag.

5.3 Forskningsfrihed, offentliggørelse og aktindsigt

DTU har efter universitetslovens § 2 forskningsfrihed og pligt til at værne om DTU og de enkelte forskeres forskningsfrihed samt udveksle viden og kompetencer med det omgivende samfund og tilskynde medarbejderne til at deltage i den offentlige debat.

DTU har ret og pligt til at offentliggøre eller på anden vis gennem innovation eller undervisning at nyttiggøre samtlige relevante resultater af leverancer i henhold til denne aftale. DTU kan offentliggøre resultater i henhold til almindelige retningslinjer for god videnskabelig praksis. Udgangspunktet er altid, at leverancer frit kan offentliggøres af parterne efter aflevering.

DTU's og forskeres adgang til at udbrede kendskab om deres konkrete arbejde med rådgivningsleverancerne er alene begrænset i det omfang, oplysninger er omfattet af reglerne om tavshedspligt, jf. pkt. 5.2. Adgangen til at

[4] Se http://ufm.dk/forskning-og-innovation/samspil-mellem-viden-og-innovation/forskningsbaseret-myndighedsbetjening/retningslinjer/retningslinier-for-forskningsbaseret-myndighedsbetjening, hvor den til enhver tid gældende version vil være at finde.

oplyse om informationer, der allerede er kendte, og som indgår i grundlaget for rådgivningsleverancer, herunder f.eks. officiel statistik, allerede publicerede artikler mv., kan ikke begrænses.

DTU har, uanset at offentliggørelsestidspunktet udskydes, ret til at indsende patentansøgninger om intellektuelle rettigheder og videnskabelige artikler til bedømmelse.

Parterne kan aftale at udsætte offentliggørelsen af en rådgivningsleverance i op til 7 arbejdsdage efter leverancens aflevering til SST, FVST og MST. Aftalen indgås som udgangspunkt i forbindelse med bestilling af opgaven, men kan også indgås eller ændres senere i takt med rådgivningsleverancens udarbejdelse, så der f.eks. kan tages højde for evt. forsinkelser.

DTU kan frit offentliggøre forskningsresultater, der er udarbejdet i henhold til denne aftale. For offentliggørelsen af større forskningsrapporter og artikler med væsentlige nye forskningsresultater, der er udarbejdet i henhold til denne aftale, gælder dog følgende:

- Hvis DTU vurderer, at materialet kan have væsentlig betydning for styrelsernes opgavevaretagelse skal DTU senest 7 arbejdsdage inden offentliggørelsen orientere styrelserne herom og sende kopi af materialet, der ønskes offentliggjort. Parterne kan konkret aftale en kortere frist.

Parterne er underlagt miljøoplysningsloven og offentlighedsloven, der fastlægger reglerne for offentlighedens adgang til aktindsigt i oplysninger, der indgår i parternes samarbejde i henhold til denne aftale. Parterne skal ved evt. tvivlsspørgsmål rådføre sig med hinanden om, hvorvidt den anden part ønsker at afgive en udtalelse om en modtaget aktindsigtsanmodning. Der fastsættes en tidsfrist, så kravene til sagsbehandlingstiden i miljøoplysningsloven og offentlighedsloven kan overholdes. Anmodninger om udtalelser besvares hurtigst muligt. Udtalelsen er ikke bindende for den anden part. Hver part træffer afgørelse ud fra en selvstændig vurdering.

5.4 Rettigheder efter ophavsretsloven

Ejerskab til leverancerne (herunder ophavsrettigheder) følger hidtidig praksis og tilfalder universitetet. SST, FVST og MST får brugsrettigheder til leverancerne som beskrevet nedenfor.

5.4.1 Generelt om rådgivnings- og forskningsleverancer

I det omfang rådgivnings- og forskningsleverancer er beskyttet efter ophavsretsloven, tilhører disse rettigheder den part, der har frembragt rådgivnings- og forskningsleverancerne. Andre immaterielrettigheder, herunder patentrettigheder, er ikke omfattet af dette afsnit 5.5.

Styrelserne og tredjemand erhverver en royalty-fri, ikke-eksklusiv og uigenkaldelig brugsret til rådgivnings- og forskningsleverancer. Brugsretten er ubegrænset mht. tid, sted og antal og omfatter eksemplarfremstilling og tilgængeliggørelse for og af

i. de ansatte i styrelserne med underliggende institutioner,
ii. fysiske og juridiske personer, der arbejder for eller samarbejder med styrelserne, eller som styrelserne har forpligtelser overfor, herunder leverandører, nationale institutioner, EU's institutioner samt andre internationale institutioner.
iii. fysiske og juridiske personer, der ikke er omfattet af pkt. i og ii ovenfor, fx borgere og virksomheder i Danmark, i EU eller internationalt, herunder i forbindelse med videregivelse af rådgivnings- og forskningsleverancer ved evt. konkurrenceudsættelse eller opgavevaretagelse m.v.

Ved eksemplarfremstilling i pkt. i-iii ovenfor forstås fx – men ikke udtømmende – kopiering i papirformat samt uploading til og downloading fra internettet.

Ved tilgængeliggørelse i pkt. i-iii ovenfor forstås fx – men ikke udtømmende – spredning af fysiske kopier, præsentation for fysisk tilstedeværende modtagere, udsendelse i radio og tv samt tilrådighedsstillelse på internettet.

Styrelserne og tredjemand, jf. i-iii, har. i forbindelse med eksemplarfremstilling og tilgængeliggørelse i forhold til skriftlige leverancer (rapporter o.l.) ret til at formidle disse og i den forbindelse forkorte, opdele og oversætte af rådgivnings- og forskningsleverancerne. Ændringer skal ske med respekt for den oprindelige leverance og foretages i styrelsernes navn. DTU er ikke ansvarlig for nogen form for ændring foretaget af styrelserne eller tredjemand.

Styrelsernes anvendelse af rådgivnings- og forskningsleverancer skal altid ske med behørig kildehenvisning.

I tilfælde hvor styrelserne stiller eget eller tredjemands materiale til rådighed for DTU, garanterer styrelserne, at materialet er tilstrækkeligt klareret.

Såfremt styrelserne eller tredjemand på vegne af styrelserne stiller materiale, herunder data, koder, beskrivelser og dokumentation, til rådighed for DTU, kan dette materiale udelukkende anvendes i forbindelse med DTU's opfyldelse af rammeaftalen. Materialet skal ved rammeaftalens ophør skal tilbageleveres til styrelserne af DTU.

DTU kan beholde en referencekopi af rådgivnings- og forskningsleverancerne og det inkorporerede materiale til brug for videre forskning og opbevare kopier af alt modtaget og bearbejdet materiale. Persondata slettes i det omfang, det er påkrævet i henhold til dansk ret.

5.5 Konfliktløsning ved tvister samt misligholdelse

Enhver tvist, som måtte opstå i forbindelse med denne aftale, herunder enhver tvist vedrørende aftalens, fortolkning, gyldighed, opsigelse eller ophævelse, er underlagt dansk ret.

Tvister om aftalen, fx om misligholdelse, søges løst ved forhandling mellem aftalens parter i det rette samarbejdsforum, jf. afsnit 4. Der er krav om skriftlighed for at sikre transparens om processen.

Ved uenighed kan ledelsesgruppen forelægge sagen for DTU's rektor og styrelsescheferne med henblik på forhandling/mægling. Uddannelses- og Forskningsministeriet kan evt. inddrages.

6. Underskrift

For Sundhedsstyrelsen

København, d. 10. februar 2023

Dato	Søren Brostrøm Direktør

For Fødevarestyrelsen

Dato	Annelise Fenger Fødevaredirektør

For Miljøstyrelsen

Dato	Mads Leth-Petersen Vicedirektør

For Danmarks Tekniske Universitet

Dato	Anders O. Bjarklev Rektor

Appendix 2:

The Task Agreement between Danish Health Authority, Danish Veterinary and food Administration and Environmental Protection Agency and DTU Sustain under the Framework Agreement between Danish Health Authority, Danish Veterinary and food Administration and Environmental Protection Agency 2023-2026

Excerpt covering tasks related to Articles 35 and 36 of the Euratom Treaty

Task Agreement
between

Danish Health Authority, Danish Veterinary and food Administration and Environmental Protection Agency

and

DTU Sustain

under the Framework Agreement between

Danish Health Authority, Danish Veterinary and food Administration and Environmental Protection Agency

On research-based public sector consultancy of above-mentioned government agencies including underlying units within the area Radioactivity in the Environment and Food

2023-2026

Table of Contents:

Purpose of the Task Agreement

This Task Agreement is an appendix to the Framework Agreement for 2023-2026 between the parties on research-based public sector consultancy. The Task Agreement describes the type and extent of services that Danish Technical University (DTU) Sustain performs for Danish Health Authority, Radiation Protection (DHA/RP), Danish Veterinary and Food Administration and Environmental Protection Agency in 2023-2026, according to the Framework Agreement.

The Task Agreement does not include tasks that the Government Agencies as well as other external Parties request from DTU Sustain against payment according to separate contracts.

Work areas

DTU Nutech's serices to DHA/RP belong to the following main work areas

- Monitoring of radioactivity in the environment and food (Articles 35 and 36 in the Euratom treaty)
- Monitoring of radioactivity in the marine environment in the North-East Atlantic (OSPAR)
- Monitoring of radioactivity in the marine environment in the Baltic Sea (HELCOM/MORS EG)

Services within each of the three work areas include maintenance and expansion of the radioecological monitoring, tasks relating to consultancy and research. DTU Sustain maintains and upgrades equipment, methods and skills for use in research as well as monitoring, among other things, by participating in relevant national and international research projects. This ensures that DTU Sustain can provide relevant research-based advice of high quality. Tasks and services which are reviewed subsequently can be cross-cutting. The areas of focus are described in more detail below.

Monitoring of radioactivity in the environment and food

DTU Sustain manages the monitoring program for radioactivity in the Danish environment covered by Articles 35 and 36 of the Euratom Treaty. Monitoring includes external gamma radiation as well as radioactive substances in air, water, soil, plants and food. The program is carried out in accordance with recommendations from the European Commission (document 2000/473/Euratom). The program includes annual collection of samples from throughout the country, analyzes of the samples' content of radioactive substances and reporting of results to the commission as well as information about it on DTU's website.

DTU Sustain carries out sample collection and analysis work with employees, equipment and other infrastructure at DTU Sustain. The quality of the analysis work is occasionally tested by the commission by comparative laboratory analyses, in which DTU Sustain participates together with laboratories from other member countries. DTU Sustain also participates in EU meetings relevant to the task.

Ydelsesaftale mellem

Sundhedsstyrelsen, Fødevarestyrelsen og Miljøstyrelsen
og
DTU Sustain

i henhold til rammeaftale mellem

Sundhedsstyrelsen, Fødevarestyrelsen, Miljøstyrelsen
og
Danmarks Tekniske Universitet

om forskningsbaseret myndighedsbetjening af ovennævnte styrelser med underliggende enheder inden for området radioaktive stoffer i miljø og fødevarer

2023-2026

Indholdsfortegnelse:

Ydelsesaftalens formål

Denne ydelsesaftale indgår som bilag til rammeaftale for 2023-2026 mellem parterne om forskningsbaseret myndighedsbetjening. Ydelsesaftalen beskriver art og omfang af de ydelser, som DTU i henhold til rammeaftalen udfører for Sundhedsstyrelsen/Strålebeskyttelse (SST/SIS), Fødevarestyrelsen (FVST) og Miljøstyrelsen (MST) i 2023-2026.

Ydelsesaftalen omfatter ikke opgaver, som styrelserne i lighed med andre eksterne parter rekvirerer hos DTU mod betaling i henhold til separate kontrakter.

Indsatsområder

DTU Sustains ydelser til SST/SIS, FVST og MST falder inden for hovedindsatsområder:

- Overvågning af radioaktive stoffer i miljø og fødevarer (artikel 35/36 i Euratom-aftalen)
- Overvågning af radioaktive stoffer i havmiljø i Nordøstatlanten (OSPAR)
- Overvågning af radioaktive stoffer i havmiljø i Østersøen (HELCOM/MORS EG)

Ydelser inden for hvert af de tre indsatsområder omfatter opretholdelse og udbygning af den radioøkologiske overvågning, opgaver vedrørende rådgivning, og forskning.

DTU Sustain opretholder og opkvalificerer udstyr, metoder og kompetencer til brug for såvel forskning som overvågning blandt andet ved at deltage i relevante nationale og internationale forskningsprojekter. Herved sikres det, at DTU Sustain kan yde relevant forskningsbaseret rådgivning af høj kvalitet. Opgaver og ydelser, som gennemgås efterfølgende, kan være tværgående. Indsatsområderne er nærmere beskrevet nedenfor.

Overvågning af radioaktive stoffer i miljø og fødevarer

DTU Sustain varetager overvågningsprogrammet for radioaktivitet i det danske miljø omfattet af Euratom-traktatens artikel 35 og 36. Overvågning omfatter ekstern gammastråling samt radioaktive stoffer i luft, vand, jord, planter og fødevarer. Programmet udføres i henhold til anbefalinger fra EU-kommissionen (dokument 2000/473/Euratom). Programmet omfatter årlig indsamling af prøver fra hele landet, analyser af prøvernes indhold af radioaktive stoffer samt rapportering af resultater til kommissionen samt information herom på DTU's hjemmeside.

DTU Sustain gennemfører prøveindsamling og analysearbejde med medarbejdere, udstyr og øvrig infrastruktur på DTU Sustain. Kvaliteten af analysearbejdet testes lejlighedsvis af kommissionen ved sammenlignende laboratorieanalyser, hvor DTU Sustain deltager sammen med laboratorier fra andre medlemslande. DTU Sustain deltager desuden i EU-møder af relevans for opgaven.

Overvågning af radioaktive stoffer i havmiljø i Nordøstatlanten

DTU Sustain bidrager til at overvåge radioaktivitet i den danske del af Nordøstatlanten omfattet af OSPAR-konventionen (Oslo-Paris Havmiljøkonvention for Nordøstatlanten inklusive Nordsøen). Overvågning omfatter radioaktive stoffer i vand og biota i danske dele af Nordøstatlanten, herunder omkring Færøerne, Grønland og Danmark. Overvågning udføres i henhold til PARCOM Recommendation 94/8 samt OSPAR Agreement 2005-08 og omfatter prøver fra ovennævnte farvande, analyser af prøvernes indhold af radioaktive stoffer samt rapportering af resultater til OSPAR.

Overvågning er baseret på prøver, som DTU Sustain indsamler i forbindelse med andre forsknings- og samarbejdsprojekter. Der foreligger ikke et dansk program for indsamling af prøver til denne overvågning. DTU Sustain foretager analysearbejde med medarbejdere, udstyr og øvrig infrastruktur på DTU Sustain.

Overvågning af radioaktive stoffer i havmiljø i Østersøen

DTU Sustain varetager overvågningsprogrammet for radioaktivitet i den danske del af Østersøen omfattet af Helsinki-konventionen (Baltic Marine Environment Protection Commission, HELCOM). Overvågning omfatter radioaktive stoffer i vand, sediment og biota i Østersøens havmiljø. Programmet udføres i henhold til retningslinjer i HELCOM Recommendation 26/3. Programmet omfatter årlig indsamling af prøver fra danske farvande, analyser af prøvernes indhold af radioaktive stoffer samt rapportering af resultater til HELCOM samt information herom på DTU's hjemmeside.

Indsamling af prøver af havvand og sedimenter udføres af henholdsvis Søværnet og Miljøstyrelsen. DTU Sustain foretager indsamling af biota og analysearbejde med medarbejdere, udstyr og øvrig infrastruktur på DTU Sustain. Kvaliteten af analysearbejdet testes rutinemæssigt af HELCOM ved sammenlignende laboratorieanalyser, hvor DTU Sustain deltager sammen med laboratorier fra andre lande omkring Østersøen. DTU Sustain deltager desuden i HELCOM-møder af relevans for opgaven.

Beredskabssituationer

I tilfælde af akutte og/eller alvorlige hændelser af samfundsmæssig relevans (f.eks. trusler mod folkesundheden) kan DTU Sustain om nødvendigt omstille de aktiviteter, der er omfattet af ydelsesaftalen til at indgå i beredskabssituationer.

Beredskabsaktiviteterne er ikke reguleret af nærværende aftale, men reguleres i henhold til en særskilt bistands- og samarbejdsaftale mellem Beredskabsstyrelsen og DTU Sustain.

Laboratorieanalyser af importerede foder og fødevarer

I henhold til gældende EU-lovgivning er der fastsat regler for analyser af foder og fødevarer, der indføres til EU fra områder med strålingsfarer efter ulykker på kernekraftværker med mere. Aktuelt gælder importrestriktionerne for landbrugsprodukter udsat for strålingsfare efter ulykken i 1986 på kernekraftværket i Tjernobyl og ulykken i 2011 på atomkraftværket i Fukushima.[1]

Prøverne analyseres efter rekvisition fra Fødevarestyrelsen på DTU Sustain og finansieres særskilt uden for rammen i nærværende aftale. DTU Sustain forpligter sig til at opretholde den nødvendige viden, langsigtet kompetenceudvikling og vedligeholdelse af aktiver, jf. rammeaftalens punkt 3.3 til at kunne udføre prøverne og myndighedsbetjene Fødevarestyrelsen på dette område.

Samarbejde og opgavevaretagelse

Ledelsesgruppe og chefstyregruppe

Ledelsesgruppen og chefstyregruppen er nærmere beskrevet i rammeaftalens afsnit 4.

Faglige tværgående medarbejdergrupper

I nødvendigt omfang oprettes der tværgående medarbejdergrupper, som kan sikre den gensidige informationsdeling og den løbende drøftelse af de faglige områder, som er hidrørende under aftalen.

DTU Sustain og SST/SIS, FVST og MST informerer gensidigt hinanden før udsendelsen af pressemeddelelser om sager, der er relevante for alle parter. SST/SIS, FVST og MST videreformidler til de andre styrelser i sager af bredere relevans.

1 Jf. Rådets forordning (EF) nr. 733/2008 af 15. juli 2008 om betingelser for indførsel af landbrugsprodukter med oprindelse i tredjelande som følge af ulykken på kernekraftværket i Tjernobyl samt Kommissionens gennemførelsesforordning nr 322/2014 af 28.marts 2014 om særlige importbetingelser for foder og fødevarer, der har oprindelse i eller er afsendt fra Japan efter ulykken på atomkraftværket i Fukushima

Sagsbehandlingstider

Rådgivning og faglig bistand til styrelserne vil blive behandlet inden for rammerne af ydelsesaftalen. Der gælder specifikke leveringstider, der aftales for de enkelte leveringer.

I andre sager, hvor der indhentes bidrag fra DTU Sustain, aftales leveringstiden fra sag til sag. I alle tilfælde gælder, at DTU Sustain ved modtagelsen af sagen foretager en vurdering af den forventede sagsbehandlingstid. Hvis denne skønnes at være af længere varighed end normalt, aftaler parterne de nærmere tidsfrister for besvarelserne under hensyntagen til styrelsernes behov og sagens nærmere karakter.

DTU Sustain skal på et så tidligt tidspunkt som muligt orientere styrelserne, hvis der i en sag er problemer med at levere inden for den aftalte tidsfrist.

Der foretages ikke en generel registrering af sagsbehandlingstider, men i tilfælde hvor sagsbehandlingen ikke afsluttes inden for en rimelig tid, tages problemet op til drøftelse på ledelsesgruppeniveau.

Forsinkelser, fejl og mangler

Konstaterer DTU Sustain en forsinkelse i en leverance, skal den relevante part i styrelserne informeres. Med 'forsinkelser' forstås leverancer fra DTU Sustain, der overskrider den tidsfrist, som parterne er enige om. Gensidigt aftalte omprioriteringer udgør ikke en forsinkelse.

Er parterne bekendte med en forsinkelse, skal parterne uden ophold enes om en ny tidsplan for arbejdet og evt. andre nødvendige tiltag.

I de tilfælde, hvor DTU Sustain ikke kan overholde den aftalte tidsfrist inden for de enkelte leveringer, skal DTU Sustain oplyse den relevante part i styrelserne om, hvornår DTU Sustain forventes at fremsende svar.

Konstaterer parterne fejl eller mangler i resultater af laboratorieanalyser, videnskabelige publikationer eller rapporter eller lign., der ikke kan henføres til det eksisterende vidgrundlag på det givne tidspunkt, skal DTU Sustain, hvis det er teknisk muligt, omgøre de fejlagtige laboratorieanalyser, og i fornødent omfang omarbejde de fejlagtige publikationer eller rapporter hurtigst muligt. Ekstraomkostninger i den forbindelse påhviler DTU Sustain, dog undtaget de i pkt. 11.5 nævnte tilfælde.

DTU Sustain bærer ikke ansvaret for forsinkelser, fejl og mangler, der kan henføres til opgaver udført af andre myndigheder, herunder indsamling af prøver af havvand og sedimenter der udføres af hhv. Søværnet og Styrelsen for Vand- og Naturforvaltning.

I tilfælde af fejl og mangler er DTU Sustain forpligtet til at bistå styrelserne med at kommunikere dette til nationale og internationale firmaer, organisationer m.v., der har brug for denne viden.

Ressourceanvendelse i 2023-2026

DTU Sustain løser de beskrevne opgaver i den udstrækning, det er fagligt muligt inden for de givne økonomiske rammer, jf. rammeaftalens afsnit 3. DTU Sustain foretager løbende en registrering af de anvendte ressourcer, og udarbejder på det grundlag en årlig statusopgørelse over ressourceforbruget. Indsatsområdernes forventede årlige andel af den samlede kapacitetsramme fremgår af tabel 1.

Tabel 1: Parternes forventede årlige anvendelse af den økonomiske ramme (2015 niveau), herunder de forventede omkostninger til forskning og udvikling

Ydelsesaftale	Indsatsområde	Rådgivning	Forskning	Sum
Radioaktive stoffer i miljø og fødevarer	Overvågning af radioaktive stoffer i miljø og fødevarer	2,5	2,5	5,0
	Overvågning af radioaktive stoffer i havmiljø i Nordøst-Atlanten	0,2	0,2	0,4
	Overvågning af radioaktive stoffer i havmiljø i Østersøen	1,3	1,3	2,6
Total		4,0	4,0	8,0

Misligholdelse og tvist

Tilfælde af tvistighed mellem DTU og styrelserne om indholdet i denne ydelsesaftale, søges i første instans bilagt ved mægling mellem Enhedschefen fra SST/SIS og Institutdirektøren fra DTU Sustain, hvis relevant inddrages repræsentanter fra MST og FVST i mæglingen. Derefter anvendes principperne i rammeaftalens afsnit 5.

Underskrift

For Sundhedsstyrelsen

Dato Direktør Søren Brostrøm

For Fødevarestyrelsen

Dato Fødevaredirektør Annelise Fenger

For Miljøstyrelsen

Dato Vicedirektør Mads Leth-Petersen

For DTU Sustain

Dato	Institutdirektør Claus Hélix-Nielsen

Appendix 3a:

Aggregated semi-annual release reports prepared for the EU verification visit for the period 2022 to 2023 for the nuclear facilities and the Waste Management Plant, at the Risø site.

Rapporteringsperioden er 1. januar til 30. juni 2022

Udledning til luft

Der monitoreres for gross-α og β aktivitet i udledning gennem ventilationen på de nukleare anlæg: DR3, HotCell og Behandlingsstationen. I den anvendte metode ledes en delstrøm fra skorstenen gennem en luftmonitor med et opsamlingsfilter. Filtret monitoreres kontinuerligt for aktivitet og udskiftes ugentligt. Den udledte aktivitet bestemmes ved at måle α- og β-aktiviteten på filtret. Filtret måles med en proportional-tæller der er kalibreret efter ^{239}Pu for α og ^{60}Co for β, og aktiviteter skal derfor forstås som ækvivalenter af disse isotoper. Usikkerheden på filtermålinger er for α-aktivitet vurderet til under 50 % og for β-aktivitet til under 15 %. Skorstensflowet på de enkelte anlæg kontrolleres hvert andet år af ekstern tekniker. Usikkerheden for flowet forventes at være under 20 %.

For DR3 specifikt monitoreres også for tritium.

DR3

Den udledte luftbårne aktivitet fra DR3's reaktorhal.

Måned	α-aktivitet kBq	β-aktivitet kBq
Januar	0,4	15,5
Februar	0,3	14,6
Marts	0,1	17,4
April	0,1	21,1
Maj	0,2	19,3
Juni	0,2	17,7
Total	1,3	105,6

Tabel 1. Partikelbåren aktivitet udledt fra DR3 facilitet i 1. halvår 2022.

Tritium monitoreres ved frysefælde, og den fundne udledning kan ses i tabel 2.

Måned	Tritium GBq
Januar	22,6
Februar	20,4
Marts	20,5
April	21,9
Maj	23,0
Juni	19,2

Tabel 2. Tritiumudledning fra DR3 i 1. halvår 2022. Tritium kommer fra betonen. Hvordan den er fordelt i betonen er ikke kendt. Det forventes, at der er mere tritium i den nederste del af betonen. Hver gang der saves og tages en ny betonklods ud, åbnes der op for nye overflader, hvorfra der kan fordampet tritiurn. Tilsvarende kan savningen forårsage nye revnedannelser, der kan lede tritium op nedefra. Endelig er der sat bure op, hvorfra der suges luft. Dette sug vil også hjælpe tritium ud af betonen. Set fra et strålingsbeskyttelsessynspunkt er det acceptabelt, at tritium-udledningen er stigende, da det mindsker sandsynligheden for, at der opstår problemer med trtium i hal- luften.

HotCell

På HotCells er luftstrømmene delt på en sådan måde at ventilationsluften fra cellerne, ventilationsluften fra de i øvrige områder og cyklonafkastet, analyseres separat.

Lokalitet	α-aktivitet kBq	β-aktivitet kBq
Cellerække	1,1	2,8
Cyklon	0,5	0,9
Øvrige områder	17,3	36,5
Totalt	18,9	36,5

Tabel 3. Partikelbåren aktivitet udledt fra HotCells facilitet i 1. halvår 2022.

Der er kun afkast til atmosfæren fra cyklonen når denne er i drift, hvilket ikke er konstant, men begrænset til dagtimerne i hverdage. Der antages i beregningerne at afkastet er med konstant maksimalt flow døgnet rundt. Dette er et stærkt konservativt estimat.

Funktionen Behandlingsstationen

Den samlede udledte aktivitet kan findes i tabel 4. Der er ikke tørret tromler i tromletørreren i perioden.

Lokalitet	α-aktivitet kBq	β-aktivitet kBq
Destillation	36,4	86,6
Tromletørrer	-	-

Tabel 4. Partikelbåren aktivitet udledt fra Behandlingsstationens faciliteter i 1. halvår 2022

Udledning til fjord

Der er fastlagt et MDA (minimum Detectable Activity concentration) på 0.01 Bq/ml på det anvendte instrument til måling af beta-aktivitet. I perioden var 40 % af målingerne fra tailing og destillat, under MDA. Da en stor del af målingerne er under MDA, skal den opgjorte aktivitet ses som et konservativt estimat over den faktisk udledte aktivitet. Usikkerheden er estimeret til at være <5 %. Der henvises til DD's notater om Påvisnings- og detektionsgrænser for multitælleren på Dansk Dekommissionering af d. 20. oktober 2015 og Kontrolmålinger for udløb af d. 25. april 2016 for yderligere beskrivelse.

Kontrolleret udledning ved tanktømning

Til det konventionelle rensningsanlæg er der tilført 195 m^3 destillat fra den aktive spildevandsbehandling og 480 m^3 vand fra tailingbassinerne.

Måned	Udledning ved destillat MBq	Udledning ved tailingsoverløb MBq
Januar	0,34	0,73
Februar	1,13	0,64
Marts	8,01	0,69
April	6,01	1,01
Maj	9,11	0,55
Juni	2,22	0,47
Totalt for perioden	26,82	4,09

Tabel 5. Gross-β aktivitet udledt til renseanlægget fra destillattanke og overløb fra tailingsbassiner i *1. halvår 2022.*

Tritiumaktivitet i destillatet

	Tritium GBq
1. Kvt.	3,5
2. Kvt.	4,9
Total for perioden	8,4

Tabel 6. Tritiumaktivitet i *destillatet for de første kvartaler af 2022. I perioden er DD begyndt at tømme vandet fra skærebassinet* ·i *Ah-Hallen og indholdet af tritium har påvirket tritiumaktivitet* i *destillatet.*

Kontrolmålinger

I perioden har renseanlægget renset og udledt 22682 m^3 vand til Roskildefjord.
Den daglige kontrol af aktiviteten i vandet ved udløbet har vist en gennemsnitlig aktivitet i det, rensede spildevand på 0,013 Bq/ml gross-β. Den højeste målte aktivitetskoncentration var 0,040 Bq/ml. 34 % af målingerne var under den fastsatte MDA.

Konklusion

For 1. halvår 2022 er der ikke konstateret udledninger, der overskrider udledningsgrænserne i BfDA kap. 6.1

Rapporteringsperioden er 1. juli til 31. december 2022

Udledning til luft

Der monitoreres for gross-α og β aktivitet i udledning gennem ventilationen på de nukleare anlæg: DR3, HotCell og Behandlingsstationen. I den anvendte metode ledes en delstrøm fra skorstenen gennem en luftmonitor med et opsamlingsfilter. Filtret monitoreres kontinuerligt for aktivitet og udskiftes ugentligt. Den udledte aktivitet bestemmes ved at måle α- og β-aktiviteten på filtret. Filtret måles med en proportional-tæller der er kalibreret efter ^{239}Pu for α og ^{60}Co for β, og aktiviteter skal derfor forstås som ækvivalenter af disse isotoper. Usikkerheden på filtermålinger er for α-aktivitet vurderet til under 50 % og for β-aktivitet til under 15 %. Skorstensflowet på de enkelte anlæg kontrolleres hvert andet år af ekstern tekniker. Usikkerheden for flowet forventes at være under 20 %.

For DR3 specifikt monitoreres også for tritium.

DR3

Den udledte luftbårne aktivitet fra DR3's reaktorhal.

Måned	α-aktivitet kBq	β-aktivitet kBq
Januar	0,12	14,6
Februar	0,16	17,5
Marts	0,15	10,1
April	0,16	15,6
Maj	0,16	14,1
Juni	0,16	16,1
Total	0,91	88,0

Tabel 1. Partikelbåren aktivitet udledt fra DR3 facililet i 2 . halvår 2022.

Tritium monitoreres ved frysefælde, og den fundne udledning kan ses i tabel 2.

Måned	Tritium GBq
Januar	24,0
Februar	26,0
Marts	22,5
April	21,4
Maj	20,2
Juni	15,8

Tabel 2. Tritiumudledning fra DR3 i 2. halvår 2022. Tritium kommer fra betonen. Hvordan den er fordelt i betonen er ikke kendt. Det forventes, at der er mere tritium i den nederste del af betonen. Hver gang der saves og tages en ny betonklods ud, åbnes der op for nye overflader, hvorfra der kan fordampe tritium. Tilsvarende kan savningen forårsage nye revnedannelser, der kan lede tritium op nedefra. Endelig er der sat bure op, hvorfra der suges luft. Denne sug vil også hjælpe tritium ud af betonen. Set fra et strålingsbeskyttelsessynspunkt er det acceptabel, at tritium-udledningen er stigende, da det mindsker sandsynligheden for, at opstå problemer med tritium i halluften.

HotCell

På HotCells er luftstrømmene delt på en sådan måde at ventilationsluften fra cellerne, ventilationsluften fra de i øvrige områder og cyklonafkastet, analyseres separat.

Lokalitet	α-aktivitet kBq	β-aktivitet kBq
Cellerække	1,0	3,1
Cyklon	0,1	0,6
Øvrige områder	5,1	20,7
Totalt	6,2	24,4

Tabel 3. Partikelbåren aktivitet udledt fra HotCells facilitet i 2. halvår 2022.

Der er kun afkast til atmosfæren fra cyklonen når denne er i drift, hvilket ikke er konstant, men begrænset til dagtimerne i hverdage. Der antages i beregningerne at afkastet er med konstant maksimalt flow døgnet rundt. Dette er et stærkt konservativt estimat.

Funktionen Behandlingsstationen

Den samlede udledte aktivitet kan findes i tabel 4. Der er ikke tørret tromler i tromletørreren i perioden.

Lokalitet	α-aktivitet kBq	β-aktivitet kBq
Destillation	39,5	102,0
Tromletørrer	-	-

Tabel 4. Partikelbåren aktivitet udledt fra Behandlingsstationens faciliteter i 2. halvår 2022

Udledning til fjord

Der er fastlagt et MDA (minimum Detectable Activity concentration) på 0.01 Bq/ml på det anvendte instrument til måling af beta-aktivitet. I perioden var 40 % af målingerne fra tailing og destillat, under MDA. Da en stor del af målingerne er under MDA, skal den opgjorte aktivitet ses som et konservativt estimat over den faktisk udledte aktivitet. Usikkerheden er estimeret til at være <5 %. Der henvises til DD's notater om Påvisnings- og detektionsgrænser for multitælleren på Dansk Dekommissionering af d. 20. oktober 2015 og Kontrolmålinger for udløb af d. 25. april 2016 for yderligere beskrivelse.

Kontrolleret udledning ved tanktømning

Til det konventionelle rensningsanlæg er der tilført 77,7 m^3 destillat fra den aktive spildevandsbehandling og 254 m^3 vand fra tailingbassinerne.

Måned	Udledning ved destillat MBq	Udledning ved tailingsoverløb MBq
Januar	1,7	0,07
Februar	3,0	0,08
Marts	13,1	0,11
April	5,8	0,11
Maj	3,3	0,17
Juni	1,7	0,08
Totalt for perioden	28,6	1,25

Tabel 5. Gross-β aktivitet udledt til renseanlægget fra destillattanke og overløb fra tailingsbassiner i 2. *halvår 2022.*

Tritiumaktivitet i destillatet

	Tritium GBq
3. Kvt.	0,91
4. Kvt.	0,46
Total for perioden	1,37

Tabel 6. Tritiumaktivitet i destillatet for 3. og 4. kvartal af 2022. Niveauer for tritium i destillat for 3. og 4 kvartal skyldes formentlig stadig resultatet af tømning af i alt 82 m^3vand fra skærebassinet i Ah-Hallen i løbet af foråret 2022

Kontrolmålinger

I perioden har renseanlægget renset og udledt 12132 m^3 vand til Roskilde fjord. Den daglige kontrol af aktiviteten i vandet ved udløbet har vist en gennemsnitlig aktivitet i det, rensede spildevand på 0,017 Bq/ml gross-β. Den højeste målte aktivitetskoncentration var 0,127 Bq/ml. 44,4 % af målingerne var under den fastsatte MDA.

Konklusion

For 2. halvår 2022 er der ikke konstateret udledninger, der overskrider udlednings- grænserne i BfDA kap. 6.1

Rapporteringsperioden fra 1. januar til 30. juni 2023

Udledning til luft

Der monitoreres for gross-α og β aktivitet i udledning gennem ventilationen på de nukleare anlæg: DR3, HotCell og Behandlingsstationen. I den anvendte metode ledes en delstrøm fra skorstenen gennem en luftmonitor med et opsamlingsfilter. Filtret monitoreres kontinuerligt for aktivitet og udskiftes ugentligt. Den udledte aktivitet bestemmes ved at måle α- og β-aktiviteten på filtret. Filtret måles med en proportional-tæller der er kalibreret efter ^{239}Pu for α og ^{60}Co for β, og aktiviteter skal derfor forstås som ækvivalenter af disse isotoper. Usikkerheden på filtermålinger er for α-aktivitet vurderet til under 50 % og for β-aktivitet til under 15 %. Skorstensflowet på de enkelte anlæg kontrolleres hvert andet år af ekstern tekniker. Usikkerheden for flowet forventes at være under 20 %.

For DR3 specifikt monitoreres også for tritium.

DR3

Den udledte luftbårne aktivitet fra DR3's reaktorhal.

Måned	α-aktivitet kBq	β-aktivitet kBq
Januar	0,3	12,2
Februar	0,3	12,0
Marts	0,5	19,7
April	0,4	12,7
Maj	0,2	12,1
Juni	0,2	14,4
Total	1,9	83,1

Tabel 1. Partikelbåren aktivitet udledt fra DR3 facilitet i 1 . halvår 2023.

Tritium monitoreres ved frysefælde, og den fundne udledning kan ses i tabel 2.

Måned	Tritium GBq
Januar	15,8
Februar	14,4
Marts	17,5
April	17,8
Maj	14,4
Juni	16,4

Tabel 2. Tritiumudledning fra DR3 i 1. halvår 2023 Tritium kommer fra betonen. Hvordan den er fordelt i betonen er ikke kendt. Det forventes, at der er mere tritium i den nederste del af betonen. Hver gang der saves og tages en ny betonklods ud, åbnes der op for nye overflader, hvo1jra der kan fordampet tritium. Tilsvarende kan savningen forårsage nye revnedannelser, der kan lede tritium op nedefra. Endelig er der sat bure op, hvorfra der suges luft. Dette sug vil også hjælpe tritium ud af betonen. Set fra et strålingsbeskyttelsessynspunkt er det acceptabel, at tritium-udledningen er stigende, da det mindsker sandsynligheden for, at opstå problemer med tritium i halluften.

HotCell

På HotCells er luftstrømmene delt på en sådan måde at ventilationsluften fra cellerne, ventilationsluften fra de i øvrige områder og cyklonafkastet, analyseres separat.

Lokalitet	α-aktivitet kBq	β-aktivitet kBq
Cellerække	1,3	3,2
Cyklon	0,3	1,1
Øvrige områder	13,7	30,9
Totalt	15,3	35,2

Tabel 3. Partikelbåren aktivitet udledt fra HotCells facilitet i 1. halvår 2023.

Der er kun afkast. til atmosfæren fra. cyklonen når denne er i drift, hvilket ikke er konstant, men begrænset til dagtimerne i hverdage. Der antages i beregningerne at afkastet er med konstant maksimalt flow døgnet rundt. Dette er et stærkt konservativt estimat.

Funktionen Behandlingsstationen

Den samlede udledte aktivitet kan findes i tabel 4. Der er ikke tørret tromler i tromletørreren i perioden.

Lokalitet	α-aktivitet kBq	β-aktivitet kBq
Destillation	35,8	87,6
Tromletørrer	-	-

Tabel 4. Partikelbåren aktivitet udledt fra Behandlingsstationens faciliteter i 1. halvår 2023

Udledning til fjord

Der er fastlagt et MDA (minimum Detectable Activity concentration) på 0.01 Bq/ml på det anvendte instrument til måling af beta-aktivitet. I perioden var 54,5 % af målingerne fra tailing og destillat, under MDA. Da en stor del af målingerne er under MDA, skal den opgjorte aktivitet ses som et konservativt estimat over den faktisk udledte aktivitet. Usikkerheden er estimeret til at være <5 %. Der henvises til DD's notater om Påvisnings- og detektionsgrænser for multitælleren på Dansk Dekommissionering af d. 20. oktober 2015 og Kontrolmålinger for udløb af d. 25. april 2016 for yderligere beskrivelse.

Kontrolleret udledning ved tanktømning

Til det konventionelle rensningsanlæg er der tilført 88 m^3 destillat fra den aktive spildevandsbehandling og 0,95 m^3 vand fra tailingbassinerne.

Måned	Udledning ved destillat MBq	Udledning ved tailingsoverløb MBq
Januar	0,24	0,02
Februar	0,44	0,11
Marts	0,32	0,16
April	0,18	0,13
Maj	0,26	0,08
Juni	0,93	0,08
Totalt for perioden	2,38	0,57

Tabel 5. Gross-β aktivitet udledt til renseanlægget fra destillattanke og overløb fra tailingsbassiner i *1. halvår 2023.*

Tritiumaktivitet i destillatet

	Tritium GBq
1. Kvt.	0,83
2. Kvt.	0,55
Total for perioden	1,38

Tabel 6. Tritiumaktivitet i *destillatet for 1. og 2. kvartal af 2023.*

Kontrolmålinger

I perioden har renseanlægget renset og udledt 24665 m^3 vand til Roskildefjord. Den daglige kontrol af aktiviteten i vandet ved udløbet har vist en gennemsnitlig aktivitet i det, rensede spildevand på 0,012 Bq/ml gross-β. Den højeste målte aktivitetskoncentration var 0,034 Bq/ml. 51 % af målingerne var under den fastsatte MDA.

Konklusion

For 1. halvår 2023 er der ikke konstateret udledninger, der overskrider udledningsgrænserne i BfDA kap. 6.1

Rapporteringsperioden fra 1. juli til 31. december 2023

Udledning til luft

Der monitoreres for gross-α og β aktivitet i udledning gennem ventilationen på de nukleare anlæg: DR3, HotCell og Behandlingsstationen. I den anvendte metode ledes en delstrøm fra skorstenen gennem en luftmonitor med et opsamlingsfilter. Filtret monitoreres kontinuerligt for aktivitet og udskiftes ugentligt. Den udledte aktivitet bestemmes ved at måle α- og β-aktiviteten på filtret. Filtret måles med en proportional-tæller der er kalibreret efter ^{239}Pu for α og ^{60}Co for β, og aktiviteter skal derfor forstås som ækvivalenter af disse isotoper. Usikkerheden på filtermålinger er for α-aktivitet vurderet til under 50 % og for β-aktivitet til under 15 %. Skorstensflowet på de enkelte anlæg kontrolleres hvert andet år af ekstern tekniker. Usikkerheden for flowet forventes at være under 20 %.

For DR3 specifikt monitoreres også for tritium.

DR3

Den udledte luftbårne aktivitet fra DR3's reaktorhal.

Måned	α-aktivitet kBq	β-aktivitet kBq
Januar	0,2	17,1
Februar	0,5	22,3
Marts	0,4	20,4
April	0,1	8,7
Maj	0,2	14,2
Juni	0,1	9,6
Total	1,5	92,3

Tabel 1. Partikelbåren aktivitet udledt fra DR3 facililet i 2. halvår 2023.

Tritium monitoreres ved frysefælde, og den fundne udledning kan ses i tabel 2.

Måned	Tritium GBq
Januar	17,6
Februar	17,8
Marts	17,2
April	16,2
Maj	15,4
Juni	15,8

Tabel 2. Tritiumudledning fra DR3 i 2. halvår 2023 Tritium kommer fra betonen. Hvordan den er fordelt i betonen er ikke kendt. Det forventes, at der er mere tritium i den nederste del af betonen. Hver gang der saves og tages en ny betonklods ud, åbnes der op for nye overflader, hvorfra der kan fordampet tritiurn. Tlsvarende kan savningen forårsage nye revnedannelser, der kan lede tritium op nedefra. Endelig er der sat bure op, hvorfra der suges luft. Dette sug vil også hjælpe tritium ud af betonen. Set fra et strålingsbeskyttelsessynspunkt er det acceptabel, at tritium-udledningen er stigende, da det mindsker sandsynligheden for, at opstå problemer med tritium i halluften.

HotCell

På HotCells er luftstrømmene delt på en sådan måde at ventilationsluften fra cellerne, ventilationsluften fra de i øvrige områder og cyklonafkastet, analyseres separat.

Lokalitet	α-aktivitet kBq	β-aktivitet kBq
Cellerække	0,9	2,9
Cyklon	0,2	0,7
Øvrige områder	8,6	29,5
Totalt	9,7	33,1

Tabel 3. Partikelbåren aktivitet udledt fra HotCells facilitet i 2 . halvår 2023.

Der er kun afkast til atmosfæren fra cyklonen når denne er i drift, hvilket ikke er konstant, men begrænset til dagtimerne i hverdage. Der antages i beregningerne at afkastet er med konstant maksimalt flow døgnet rundt. Dette er et stærkt konservativt estimat.

Funktionen Behandlingsstationen

Den samlede udledte aktivitet kan findes i tabel 4. Der er ikke tørret tromler i tromletørreren i perioden.

Lokalitet	α-aktivitet kBq	β-aktivitet kBq
Destillation	68,6	147,1
Tromletørrer	-	-

Tabel 4. Partikelbåren aktivitet udledt fra Behandlingsstationens faciliteter i 2. halvår 2023

Udledning til fjord

Der er fastlagt et MDA (minimum Detectable Activity concentration) på 0.01 Bq/ml på det anvendte instrument til måling af beta-aktivitet. I perioden var 57,6 % af målingerne fra tailing og destillat, under MDA. Da en stor del af målingerne er under MDA, skal den opgjorte aktivitet ses som et konservativt estimat over den faktisk udledte aktivitet. Usikkerheden er estimeret til at være <5 %. Der henvises til DD's notater om Påvisnings- og detektionsgrænser for multitælleren på Dansk Dekommissionering af d. 20. oktober 2015 og Kontrolmålinger for udløb af d. 25. april 2016 for yderligere beskrivelse.

Kontrolleret udledning ved tanktømning

Til det konventionelle rensningsanlæg er der tilført 88 m3 destillat fra den aktive spildevandsbehandling og 0,95 m3 vand fra tailingbassinerne.

Måned	Udledning ved destillat MBq
Juli	0,72
August	0,50
September	0,08
Oktober	0,33
November	0,47
December	0,18
Total	2,28

Tabel 5. Gross-β aktivitet udledt til renseanlægget fra destillattanke og overløb fra tailingsbassiner i *1. halvår 2023.*

Tritiumaktivitet i destillatet

	Tritium GBq
3. Kvt.	0,47
4. Kvt.	0,02
Total for perioden	0,49

Tabel 6. Tritiumaktivitet i destillatet for 3. og 4. kvartal 2023.

Kontrolmålinger

I perioden har renseanlægget renset og udledt 18255 m^3 vand til Roskildefjord. Den daglige kontrol af aktiviteten i vandet ved udløbet har vist en gennemsnitlig aktivitet i det, rensede spildevand på 0,011 Bq/ml gross-β. Den højeste målte aktivitetskoncentration var 0,076 Bq/ml. 57,6 % af målingerne var under den fastsatte MDA.

Konklusion

For 2. halvår 2023 er der ikke konstateret udledninger, der overskrider udledningsgrænserne i BfDA kap. 6.1

Appendix 3b:

Aggregated semi-annual on environmental monitoring of areas surround the Risø site prepared for the EU verification visit covering the period 2. quarter of 2021 to 1. quarter of 2023.

DTU SUSTAIN

Radioactivity in the Risø District January-June 2023

Radioactivity in the Risø District January-June 2023

Report DTU-ENV-RAS-0008
2023

By
Jixin Qiao and Kasper G. Andersson

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Preface

A specific monitoring programme in the vicinity of the nuclear installations at the Risø site is carried out by DTU Environment on behalf of and as a contractor to Danish Decommissioning (DD). This report presents the analytical results of the monitoring and sampling carried out in the period January - June 2023. The materials and methods used in connection with the monitoring programme are described in pages 27-28.

Risø, December 2023

Contents

Summary

The environmental surveillance of the Risø environment was continued in January-June 2023. The mean concentrations in air were: 0.20±0.14 μBq m^{-3} of ^{137}Cs, 3.04±1.54 mBq m^{-3} of ^{7}Be and 0.19±0.13 mBq m^{-3} of ^{210}Pb (±1 standard uncertainty). The depositions by precipitation at Risø in the first half of 2023 were: 0.021±0.003 Bq m^{-2} of ^{137}Cs, 305±21 Bq m^{-2} of ^{7}Be, 15.9±1.8 Bq m^{-2} of ^{210}Pb and <0.5 kBq m^{-2} of ^{3}H. The average background dose rate (TLD) at Risø (Zone I) was measured as 0.09 µSv h^{-1} compared with 0.10 µSv h^{-1} in the four zones around Risø.

*Table 1. Radionuclides in ground level air collected at Risø (cf. Figs. 1, 1.1 and 1.2), January-June 2023 (Unit: μBq m^{-3})**

Date			^{7}Be	^{137}Cs	^{210}Pb
28-dec-22	–	06-jan-23	1482(11%)	0.070(12%)	68(11%)
06-jan-23	–	13-jan-23	1646(11%)	0.091(12%)	88(11%)
13-jan-23	–	20-jan-23	1562(11%)	0.111(12%)	57(11%)
20-jan-23	–	27-jan-23	1909(11%)	0.237(12%)	216(11%)
27-jan-23	–	03-feb-23	1075(11%)	0.142(12%)	51(11%)
03-feb-23	–	10-feb-23	1819(11%)	0.293(11%)	206(11%)
10-feb-23	–	17-feb-23	3341(11%)	0.193(11%)	271(11%)
17-feb-23	–	24-feb-23	1337(11%)	0.078(12%)	53(11%)
24-feb-23	–	03-mar-23	1039(11%)	0.332(11%)	131(11%)
03-mar-23	–	10-mar-23	1989(11%)	0.226(11%)	78(11%)
10-mar-23	–	17-mar-23	2102(11%)	0.068(12%)	52(11%)
17-mar-23	–	24-mar-23	3072(11%)	0.169(12%)	171(11%)
24-mar-23	–	31-mar-23	2315(11%)	0.061(12%)	111(11%)
31-mar-23	–	11-apr-23	2847(11%)	0.216(12%)	200(11%)
11-apr-23	–	14-apr-23	2140(11%)	0.108(12%)	107(11%)
14-apr-23	–	21-apr-23	4882(11%)	0.307(12%)	328(11%)
21-apr-23	–	28-apr-23	3103(11%)	0.123(11%)	169(11%)
28-apr-23	–	04-may-23	3304(11%)	0.126(12%)	147(11%)
04-may-23	–	12-may-23	4594(11%)	0.561(11%)	170(11%)
12-may-23	–	17-may-23	6138(11%)	0.648(12%)	281(11%)
17-may-23	–	26-may-23	4754(11%)	0.225(12%)	279(11%)
26-may-23	–	02-jun-23	3487(11%)	0.096(13%)	174(11%)
02-jun-23	–	09-jun-23	4177(11%)	0.144(12%)	298(11%)
09-jun-23	–	16-jun-23	5222(11%)	0.271(12%)	358(11%)
16-jun-23	–	23-jun-23	6414(11%)	0.213(12%)	617(11%)
23-jun-23	–	30-jun-23	3198(11%)	0.140(12%)	190(11%)
Mean			3037	0.202	187
SD			1544	0.142	126

*Figures in brackets are relative standard uncertainties.

Table 2.1. Radionuclides in precipitation in the 10 m^2 rain collector at Risø (cf. Fig. 8.1), January-June 2023. (Unit: Bq m^{-3})

Month	^{7}Be	^{137}Cs	^{210}Pb
January	794(11%)*	0.019(20%)	56(11%)
February	1044(11%)	0.045(15%)	117(11%)
March	1546(11%)	0.042(16%)	100(11%)
April	1829(11%)	0.089(14%)	217(11%)
May	3779(11%)	0.979(12%)	452(11%)
June	3867(11%)	0.355(12%)	197(11%)

* Figures in brackets are relative standard uncertainties

Table 2.2. Radionuclides in precipitation in the 10 m^2 rain collector at Risø (cf. Fig. 8.1), January-June 2023. (Unit: Bq m^{-2})

Month	Precipitation (m)	^{7}Be	^{137}Cs	^{210}Pb
January	0.076(10%)*	60(12%)	0.0014(22%)	4.2(12%)
February	0.035(10%)	37(12%)	0.0016(18%)	4.2(12%)
March	0.045(10%)	69(12%)	0.0019(19%)	4.5(12%)
April	0.029(10%)	53(12%)	0.0026(17%)	6.2(12%)
May	0.010(10%)	36(12%)	0.0093(16%)	4.3(12%)
June	0.013(10%)	50(12%)	0.0046(16%)	2.5(12%)
Sum	0.208(5%)	305(7%)	0.0214(14%)	15.9(9%)

* Figures in brackets are relative standard uncertainties

Table 2.3. Tritium in precipitation collected at Risø (cf. Figs. 2.3.1 and 2.3.2). January – June 2023. (Unit: kBq m^{-3})

Month	10 m^2 rain collector*
January	1.6(32%)[a]
February	<1.3
March	2.1(21%)
April	2.0(24%)
May	4.4(21%)
June	2.8(22%)
Double determinations*.	

[a] Figures in brackets are relative standard uncertainties. '<' means detection limit.

Table 2.4. Tritium in precipitation collected at Risø. January – June 2023 (Unit: kBq m^{-2})

Month	Precipitation (m)	10 m^2 rain collector
January	0.076(10%)[a]	0.122(34%)[a]
February	0.035(10%)	<0.046
March	0.045(10%)	0.095(23%)
April	0.029(10%)	0.058(26%)
May	0.010(10%)	0.044(23%)
June	0.013(10%)	0.036(24%)
Sum	0.208(5%)	< 0.401

[a] Figures in brackets are relative standard uncertainties. '<' means detection limit.

Table 3.1. Radionuclides in sediment samples collected at Bolund in Roskilde Fjord.(cf. Fig. 3.1) January - June 2023. (Unit: Bq kg^{-1} dry)

Date	^{137}Cs	K*
14 June	<0.17	14.2(11%)[a]
*Unit: g kg^{-1} dry		

[a] Figures in brackets are relative standard uncertainties. ‘<’ means detection limit.

Table 4.1. Radionuclides in seawater collected in Roskilde Fjord (cf. Fig. 4.1) January - June 2023. (Unit: Bq m^{-3})

Date	^{137}Cs
2 June	6.3(12%)[a]

[a] Figures in brackets are relative standard uncertainties

Table 4.2. Tritium in seawater collected in Roskilde Fjord (Risø pier) (cf. Fig. 4.2) January – June 2023 [a].*

Month	kBq m^{-3}
March	1.3(28%)
June	1.7(32%)
* Double determinations	

[a] Figures in brackets are relative standard uncertainties

*Table 5.1. Radionuclides in grass collected at Risø near the Waste Treatment Station, location I P3, Fig. 1, January – June 2023. (**Measured on bulked ash samples)*

Week no. or month	Date	K ($g\ kg^{-1}$ fresh)	^{137}Cs ($Bq\ kg^{-1}$ fresh)	^{137}Cs ($Bq\ m^{-2}$)
2	13 January	4.2(12%) [a]	<0.4	
4	27 January	3.2(12%)	<0.2	
6	10 February	5.8(11%)	<0.3	
8	24 February	3.5(11%)	<0.3	
10	10 March	4.9(12%)	<0.5	
12	24 March	2.0(12%)	<0.3	
14	11 April	4.0(11%)	<0.3	
16	21 April	7.1(11%)	<0.4	
18	04 May	6.0(12%)	<0.6	
20	17 May	6.6(11%)	<0.4	
22	02 June	6.5(11%)	<0.3	
24	16 June	6.5(11%)	<0.5	
26	30 June	4.6(11%)	<0.3	
**January		4.0(11%)	0.091(13%)	0.023(13%)
**February		3.6(11%)	0.043(14%)	0.015(14%)
**March		2.9(11%)	<0.055	<0.021
**April		5.0(11%)	0.034(13%)	0.013(13%)
**May		7.0(11%)	<0.032	<0.010
**June		6.4(11%)	<0.044	<0.014

[a] Figures in brackets are relative standard uncertainties. ‘<’ means detection limit.

Table 5.2. Radionuclides in Fucus vesiculosus collected at Bolund in Roskilde Fjord. January – June 2023. (Unit: Bq kg^{-1} dry)

Date	^{137}Cs	K*	% dry matter
08 June	2.3(12%)[a]	36(11%)	17(10%)
*Unit: g kg^{-1} dry			

[a] Figures in brackets are relative standard uncertainties

Table 7.1. Waste water collected at Risø (cf. Fig. 1), January – June 2023.

Week Number	Total beta (eqv. mg KCl l^{-1})	^{137}Cs ($Bq\ m^{-3}$)	^{131}I ($Bq\ m^{-3}$)	^{226}Ra ($Bq\ m^{-3}$)
1	75(11%)[a]	<73	<82	<152
2	70(11%)	<81	<96	<163
3	46(16%)	<56	<50	<121
4	67(11%)	<78	<92	<151
5	75(10%)	<49	<60	<110
6	59(12%)	<53	<70	<110
7	72(12%)	<56	<65	<114
8	129(16%)	<71	<80	<155
9	67(13%)	<158	<203	<312
10	63(12%)	<125	<144	<255
11	79(10%)	<140	<169	<307
12	74(13%)	<161	<175	<343
13	79(13%)	<150	<140	<329
14	59(11%)	<145	<160	<315
15	69(14%)	<118	<105	<201
16	65(15%)	<149	<129	<300
17	88(11%)	<100	<118	<214
18	69(16%)	<120	<103	<244
19	78(12%)	<111	<138	<232
20	82(13%)	<139	<211	<280
21	76(14%)	<151	<180	<309
22	103(12%)	<174	<109	<367
23	104(12%)	<152	<169	<307
24	121(10%)	<152	<173	<309
25	135(11%)	<103	<127	<218
26	137(11%)	<112	<163	<223
Mean	82.3	<115	<128	<237
SD	24.3			

[a] Figures in brackets are relative standard uncertainties. '<' means detection limit.

Table 8.1. Background dose rates around the border of Risø (cf. Fig. 8.1) measured with thermoluminescence dosimeters (TLD) in the period October 2022 – May 2023. (Results are normalized to μSv h^{-1}).

Location	μSv h^{-1}
1	0.09[a]
2	0.09
3	0.09
4	0.09
5	0.09
6	0.09
Mean	0.09

[a] In relation to the uncertainty on dose rate values reported in Tables 8.1 and 8.2 the Danish Health Authority, Radiation Protection that carries out the dose determination state that for a dose of 0.1 mSv the uncertainty will for a measurement period of 1 month or 3 months be respectively ca. 50 % and 100 % (95 % confidence). At doses higher than 1 mSv the uncertainty is a bit less than 25 % (95 % confidence) regardless of the length of the measurement period. The values in these tables are a bit in the high end compared with those typically reported in previous years when the dose determination was made at DTU, and with the NaI(Tl) detector measurements in Table 8.3, but considered to agree reasonably taking the clearly high uncertainty into account. Anyway all dose rates reported are very low and close to the TLD detection limit.

Table 8.2. Background dose rates around Risø (cf. Fig. 8.2 and Fig. 1) measured with thermoluminescence dosimeters (TLD) in the period October 2022 – May 2023. (Results are normalized to µSv h^{-1}). See text on p. 16 marked 'a' on uncertainties for Tables 8.1 and 8.2.

Risø zone	Location	µSv h^{-1}
I	1	0.09
I	2	0.09
I	3	0.11
I	4	0.09
I	5	0.09
Mean		0.09
II	P1	0.09
II	P2	0.09
II	P3	0.09
II	P4	0.09
Mean		0.09
III	P1	0.11
III	P2	0.09
III	P3	0.09
Mean		0.10
IV	P1	0.09
IV	P2	0.09
IV	P3	0.09
IV	P4	0.09
IV	P5	0.11
IV	P6	0.09
IV	P7	0.09
Mean		0.10
V	P1	0.09
V	P2	0.09
V	P3	0.09
V	P4	0.11
V	P5	0.09
V	P6	0.09
V	P7	0.11
V	P8	0.11
V	P9	0.11
V	P10	0.09
Mean		0.10

Table 8.3. Terrestrial dose rates at the Risø zones (cf. Fig. 8.2 and Fig. 1) October 2022 – May 2023. Measured with a NaI(Tl) detector. (Unit: µSv h^{-1})[a]

Risø zone	Location	May
I	P1	0.039(10%)
I	P2	0.053(10%)
I	P3	0.253(10%)
I	P4	0.042(10%)
I	P5	0.044(10%)
Mean		0.086(5%)
II	P1	0.042(10%)
II	P2	0.043(10%)
II	P3	0.039(10%)
II	P4	0.041(10%)
Mean		0.041(4%)
III	P1	0.047(10%)
III	P2	0.046(10%)
III	P3	0.045(10%)
Mean		0.046(6%)
IV	P1	0.040(10%)
IV	P2	0.046(10%)
IV	P3	0.044(10%)
IV	P4	0.045(10%)
IV	P5	0.040(10%)
IV	P6	0.039(10%)
IV	P7	0.045(10%)
Mean		0.043(4%)
V	P1	0.042(10%)
V	P2	0.048(10%)
V	P3	0.055(10%)
V	P4	0.044(10%)
V	P5	0.048(10%)
V	P6	0.048(10%)
V	P7	0.044(10%)
V	P7a	0.039(10%)
V	P8	0.045(10%)
V	P9	0.038(10%)
V	P10	0.038(10%)
Mean		0.045(4%)

[a] Figures in brackets are relative standard uncertainties

Fig. 1. Locations for measurements of gamma-background radiation Zone I and II (cf. Tables 8.2 and 8.3)

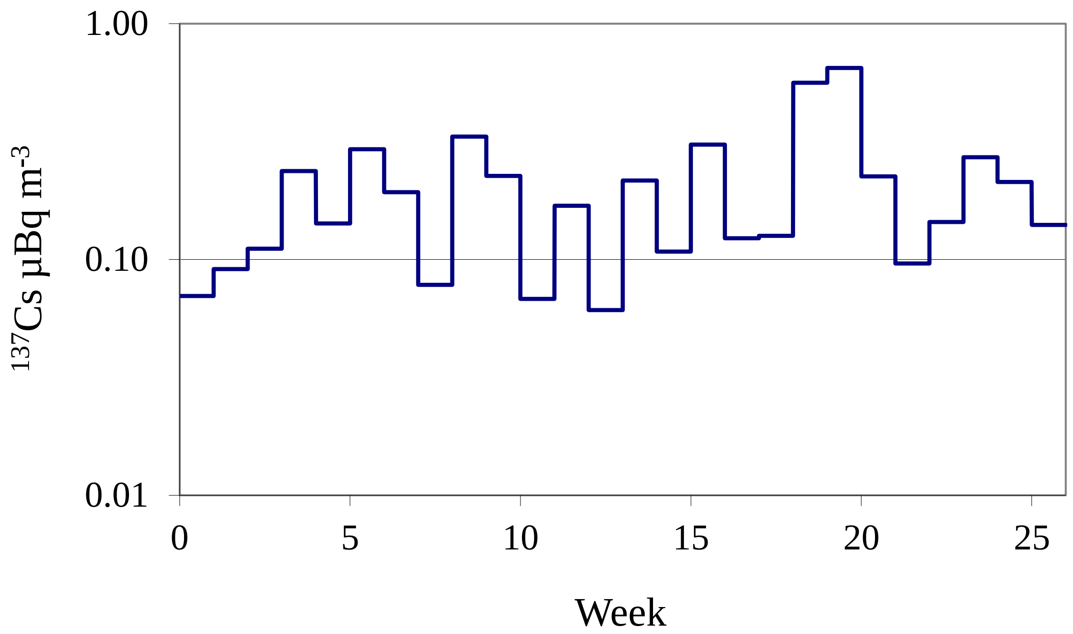

Fig. 1.1. Caesium-137 in ground level air collected at Risø in January-June 2023. (Unit: µBq m⁻³)

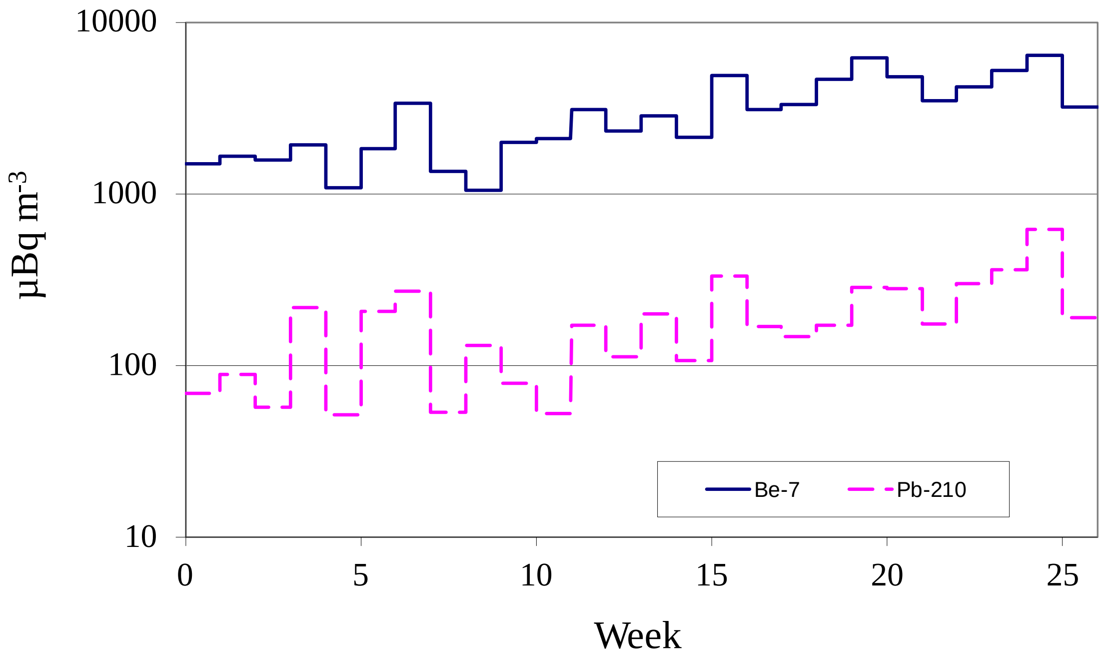

Fig. 1.2. Beryllium-7 and Lead-210 in ground level air collected at Risø in January-June 2023. (Unit: µBq m⁻³)

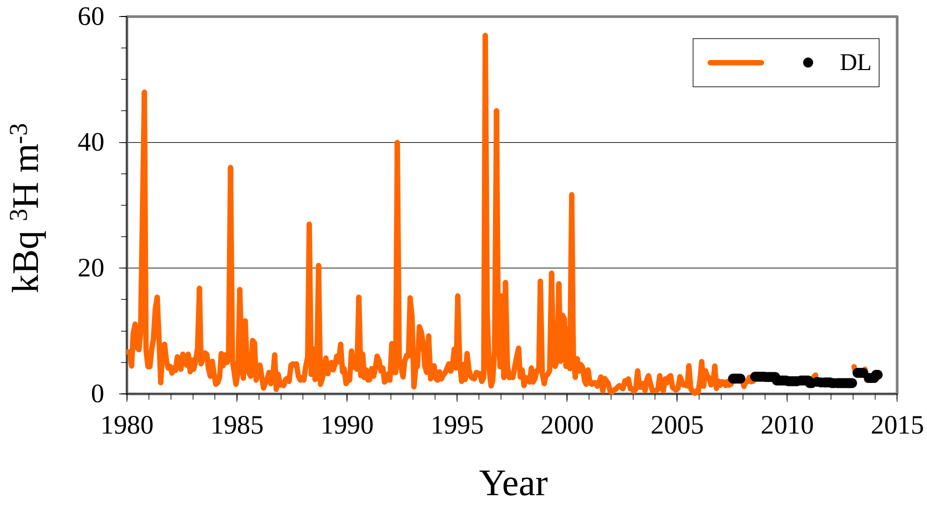

Fig. 2.3.1. Tritium in precipitation collected at Risø (1 m² rain collector) 1980 - 2013. (Unit: kBq m⁻³; DL = detection limit). This rain collector was taken out of operation in 2013.

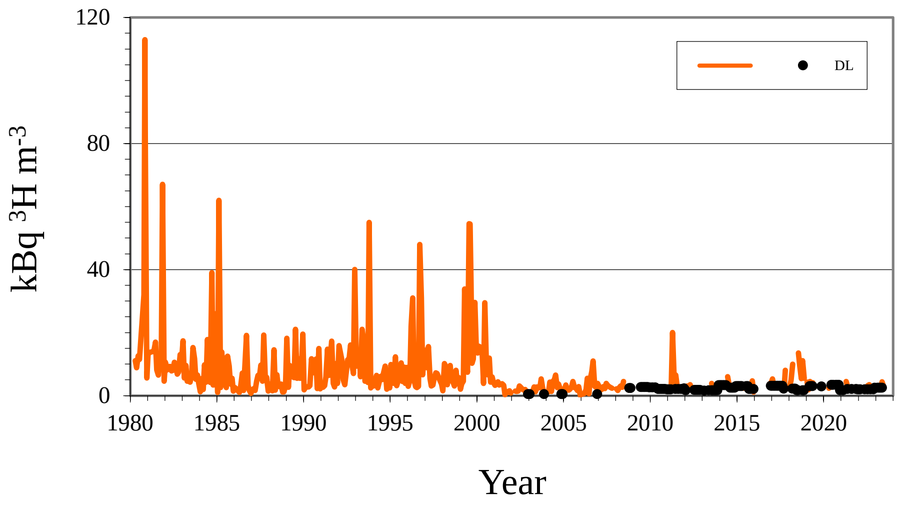

Fig. 2.3.2. Tritium in precipitation collected at Risø (10 m² rain collector) 1980 - 2023. (Unit: kBq m⁻³; DL = detection limit)

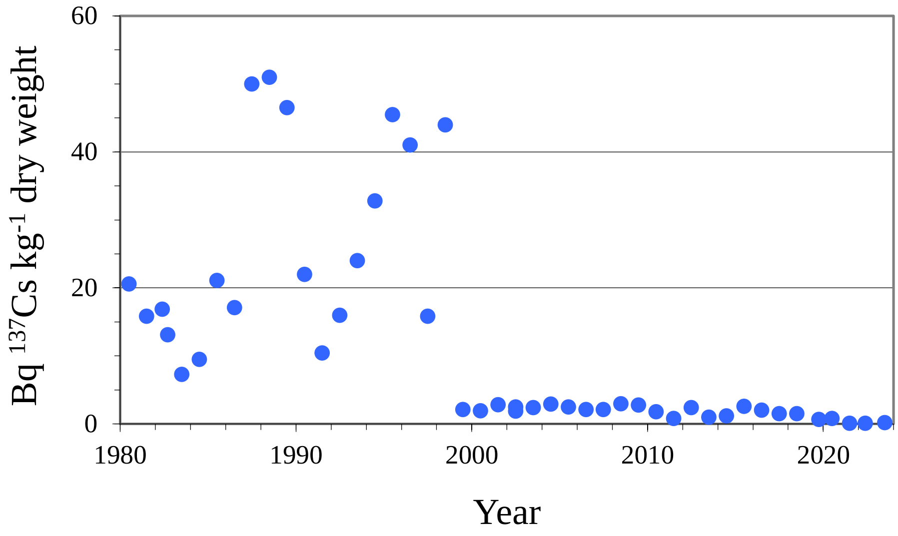

Fig. 3.1. Caesium–137 in sediment samples collected at Bolund in Roskilde Fjord. 1980 – 2023. (Unit: Bq kg^{-1} dry matter)

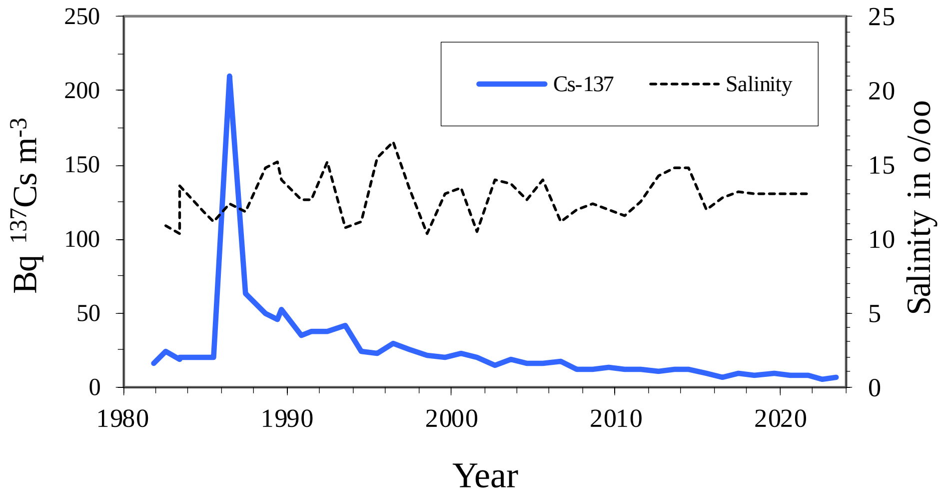

Fig. 4.1. Caesium–137 in seawater collected in Roskilde Fjord 1980 – 2023. (Unit: Bq m^{-3})

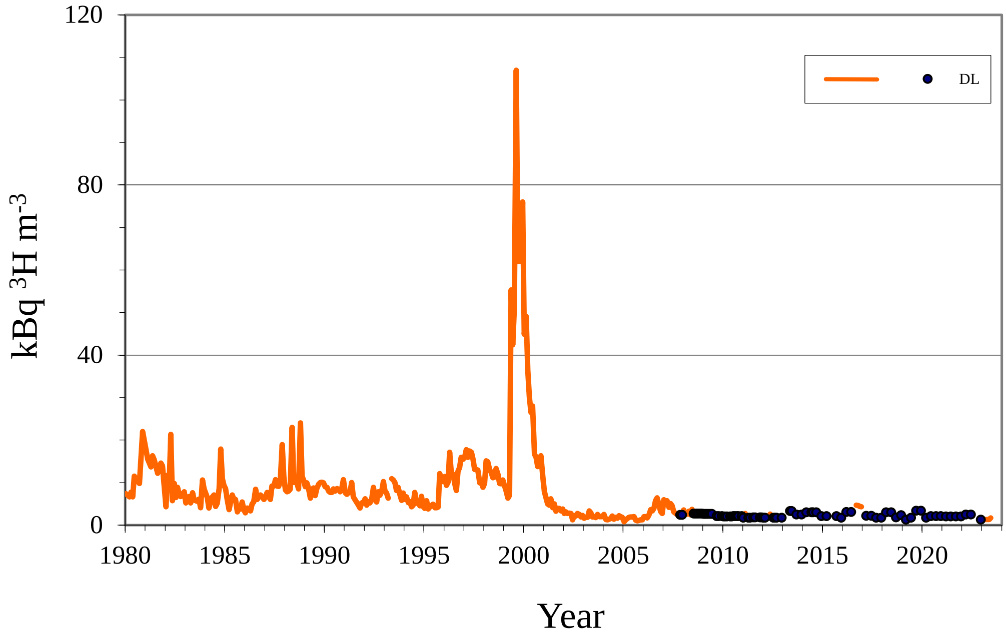

Fig. 4.2. Tritium in seawater collected in Roskilde Fjord 1980 - 2023. (Unit: kBq m^{-3}; DL = detection limit)

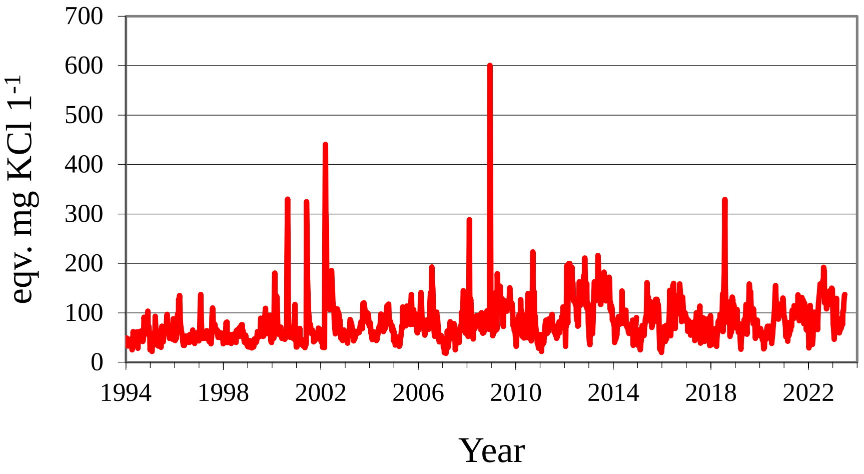

Fig. 7.1. Total-beta radioactivity in waste water collected at Risø 1994 - 2023. (Unit: eqv. mg KCl l^{-1})

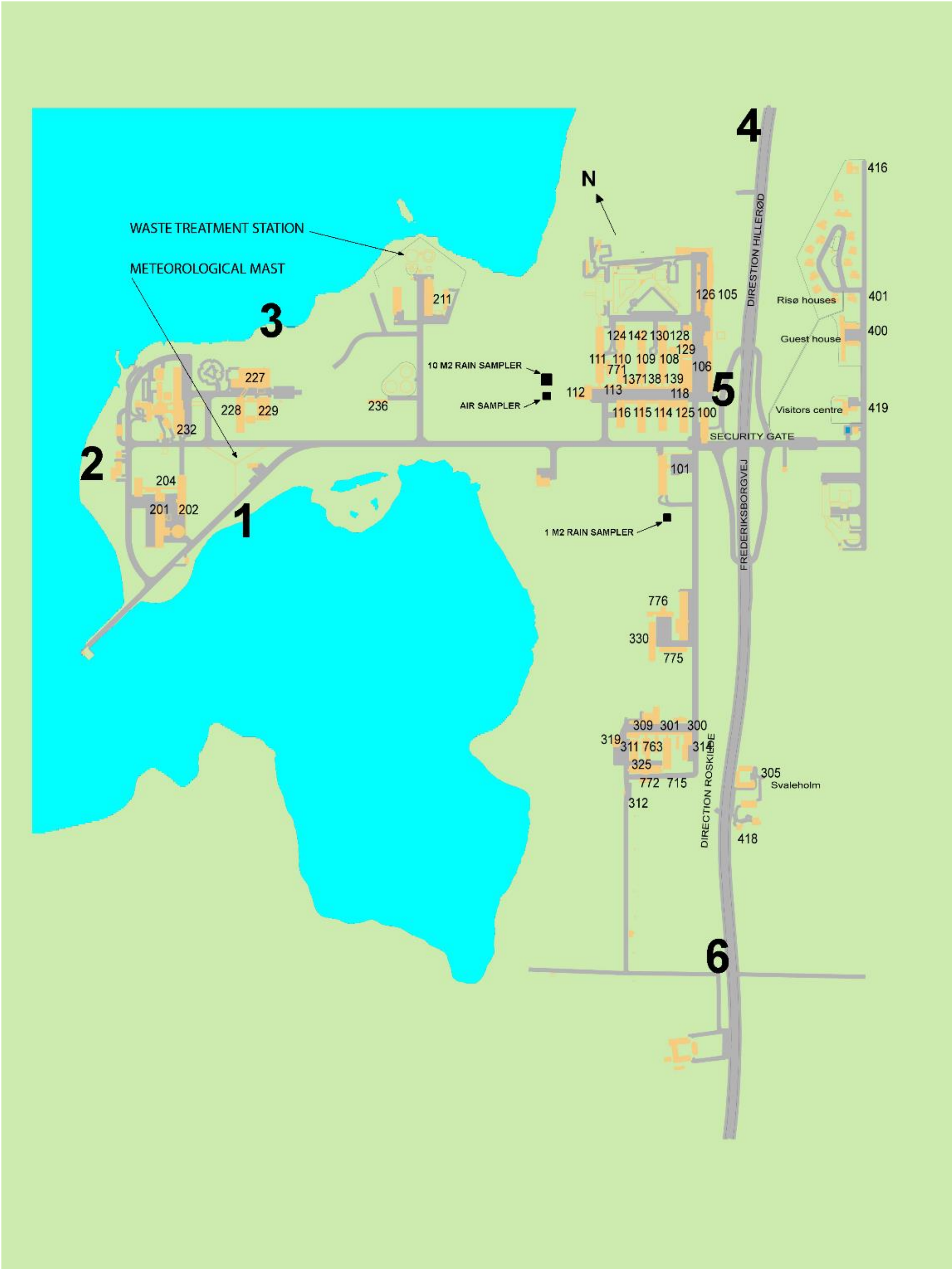

Fig. 8.1. Locations (1-6) for TLD measurements around the border of Risø (cf. Table 8.1).

Fig. 8.2. Locations for measurements of background radiation around Risø in Zones III, IV and V.

Materials and methods

External gamma dose rate monitoring

Monitoring of external gamma dose rate is carried out with the following devices

- Thermolumiscence dosimeters TLD: LiF, TLD equipment manufacturer: Harshaw
- NaI detector: 3x3 inch, SAM 935 Surveillance and Measurement System, Berkeley Nucleonics Cooperation, USA, visual read-out

Calibration of TLD is carried out at the Danish Health Authority, Radiation Protection. Traceability of delivered doses is ensured through calibration of the dose rate of the calibration irradiator by the Danish Health Authority, Radiation Protection. Further information on, e.g., the reported dosis, associated uncertainty and the lower detection limit is given by the Danish Health Authority, Radiation Protection at https://www.sst.dk/-/media/Opgaver/Strålebeskyttelse/Selvbetjening/Helkropsdosimeter_Infoseddel.ashx?la=da&hash=B6E03F283B84F87BF76CB1138912716608854948. The NaI detector is calibrated periodically vs. a Reuter Stokes high-pressure ionisation chamber.

Air sampler

The sampler at Risø is manufactured by DTU. Air is drawn through a polypropylene filter at a rate of about 2000 m^3/h. The filter is normally changed weekly. 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 intermittently.

DTU analyse the filters 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 repeated gamma analysis. Filters are analysed for ^{137}Cs, ^{7}Be and ^{210}Pb and other gamma emitters.

Deposition collector

The Risø site operates 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. The 10 m^2 collector provides monthly samples of rain water analysed for tritium and ion exchange resin which is analysed by gamma spectrometry for ^{7}Be, ^{137}Cs and ^{210}Pb and other gamma emitters.

Water and sediment

A waste water sample from the Waste Treatment Station is collected weekly and analysed for total beta radioactivity and the radionuclides ^{131}I, ^{137}Cs and ^{226}Ra. Water samples from Roskilde Fjord are collected each quarter and analysed for tritium, annually for ^{137}Cs. A sediment sample is collected annually from Roskilde Fjord and analysed for ^{137}Cs.

Terrestrial and aquatic biota and flora

Grass samples are collected weekly at the Risø site and analysed by gamma spectrometry. Samples are bulked to monthly samples which are analysed for ^{137}Cs.

Seaweed samples are collected annually from Roskilde Fjord at Risø and analysed for ^{137}Cs.

Sample reception and preparation

Sample identification numbers are entered in log books. Sample preparation methods include drying, freeze drying, ashing, sorting and sieving. Selected samples are archived.

Sample measurements

Radioactivity in samples is measured by total beta counting and gamma spectrometry.

Measurement devices

- Ge detectors for gamma spectrometry. Calibration of detectors is based on mixed-nuclide standards used occasionally. Monthly checks are made of detector efficiency and energy resolution. Background measurements of gamma systems are made a few times per year.
- Low-level Geiger-Müller counters for total beta counting, manufactured by DTU. Calibration based on standards of KCl. Counting efficiency and background are checked monthly.
- Liquid scintillation spectrometer for analysis of tritium in water. Samples are analysed with a calibration standard.

Analytical results, data handling and reporting tools

Analytical results are printed on paper, recorded in log books and stored in a data base on intranet. Results below detection limits recorded as such. Spreadsheets are used for calculating results from raw data.

Quality assurance, laboratory accreditation and intercomparison exercises

Analytical results are checked by experienced staff and discussed with senior scientists if questions arise.

DTU is accredited to testing for radioactivity by DANAK according to the international standard ISO 17025. The accreditation covers testing for certain non-gamma emitting radionuclides but not for radionuclides occurring in the environment and food in general.

DTU participate regularly in international intercomparisons on laboratory analyses of radionuclides.

Conclusions

The environmental surveillance of the Risø environment was continued in January-June 2023. The mean concentrations in air were: 0.20±0.14 μBq m^{-3} of ^{137}Cs, 3.04±1.54 mBq m^{-3} of ^{7}Be and 0.19±0.13 mBq m^{-3} of ^{210}Pb (±1 standard uncertainty). The depositions by precipitation at Risø in the first half of 2023 were: 0.021±0.003 Bq m^{-2} of ^{137}Cs, 305±21 Bq m^{-2} of ^{7}Be, 15.9±1.8 Bq m^{-2} of ^{210}Pb and <0.5 kBq m^{-2} of ^{3}H. The average background dose rate (TLD) at Risø (Zone I) was measured as 0.09 µSv h^{-1} compared with 0.10 µSv h^{-1} in the four zones around Risø. None of the recorded levels of radioactivity and radiation have given rise to concern, although an increase in ^{137}Cs air concentration was measured in March, at which time a forest fire was reported in the Chernobyl area.

DTU SUSTAIN is working to develop new environmentally friendly and sustainable technologies and disseminate this knowledge to society and new generations of engineers. Research in Radioecology & Tracer Studies (RTS) aims at developing methods and instruments for analysing manmade and naturally recurring radionuclides in the environment and samples from nuclear facilities. The RTS Group under the Climate and Monitoring Section in DTU SUSTAIN is responsible for caring out the environmental radioactivity monitoring program in Denmark.

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DTU SUSTAIN

Radioactivity in the Risø District July-December 2022

Radioactivity in the Risø District July-December 2022

Report DTU-ENV-RAS-0007
2023

By
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Preface

A specific monitoring programme in the vicinity of the nuclear installations at the Risø site is carried out by DTU Environment on behalf of and as a contractor to Danish Decommissioning (DD). This report presents the analytical results of the monitoring and sampling carried out in the period July-December 2022. The materials and methods used in connection with the monitoring programme are described in pages 27-28.

Risø, October 2023

Contents

Summary

The environmental surveillance of the Risø environment was continued in July-December 2022. The mean concentrations in air were: 0.17±0.11 μBq m^{-3} of ^{137}Cs, 2.46±0.98 mBq m^{-3} of ^{7}Be and 0.22±0.11 mBq m^{-3} of ^{210}Pb (±1 standard uncertainty). The depositions by precipitation at Risø in the second half of 2022 were: 0.027±0.004 Bq m^{-2} of ^{137}Cs, 384±46 Bq m^{-2} of ^{7}Be, 37.5±4.5 Bq m^{-2} of ^{210}Pb and <0.5 kBq m^{-2} of ^{3}H. The average background dose rate (TLD) at Risø (Zone I) was measured as 0.09 µSv h^{-1} compared with 0.09 µSv h^{-1} in the four zones around Risø.

Table 1. Radionuclides in ground level air collected at Risø (cf. Figs. 1, 1.1 and 1.2), July-December 2022 (Unit: μBq m^{-3}). Figures in brackets are relative standard uncertainties.

Date			^{7}Be	^{137}Cs	^{210}Pb
01-07-2022	–	08-07-2022	2447(11%)	0.043(13%)	95(11%)
08-07-2022	–	15-07-2022	1746(11%)	0.036(13%)	65(11%)
15-07-2022	–	22-07-2022	4120(11%)	0.171(12%)	224(11%)
22-07-2022	–	29-07-2022	1956(11%)	0.056(12%)	92(11%)
29-07-2022	–	05-08-2022	3271(11%)	0.121(12%)	172(11%)
05-08-2022	–	12-08-2022	2490(11%)	0.078(12%)	130(11%)
12-08-2022	–	19-08-2022	5148(11%)	0.431(11%)	537(11%)
19-08-2022	–	26-08-2022	4272(11%)	0.228(11%)	275(11%)
26-08-2022	–	02-09-2022	2478(11%)	0.340(12%)	232(11%)
02-09-2022	–	09-09-2022	3573(11%)	0.172(12%)	204(11%)
09-09-2022	–	16-09-2022	1678(11%)	0.368(12%)	163(11%)
16-09-2022	–	23-09-2022	789(11%)	0.090(11%)	119(11%)
23-09-2022	–	30-09-2022	3037(11%)	0.154(12%)	354(11%)
30-09-2022	–	07-10-2022	2010(11%)	0.078(11%)	147(11%)
07-10-2022	–	14-10-2022	2025(11%)	0.084(12%)	139(11%)
14-10-2022	–	21-10-2022	2408(11%)	0.127(11%)	231(11%)
21-10-2022	–	28-10-2022	2451(11%)	0.124(12%)	258(11%)
28-10-2022	–	04-11-2022	2877(11%)	0.119(12%)	368(11%)
04-11-2022	–	11-11-2022	2253(11%)	0.086(12%)	160(11%)
11-11-2022	–	18-11-2022	1985(11%)	0.100(12%)	217(11%)
18-11-2022	–	25-11-2022	1488(11%)	0.199(12%)	212(11%)
25-11-2022	–	02-12-2022	1546(11%)	0.224(12%)	282(11%)
02-12-2022	–	09-12-2022	2273(11%)	0.262(11%)	333(11%)
09-12-2022	–	16-12-2022	1457(11%)	0.287(11%)	278(11%)
16-12-2022	–	23-12-2022	2476(11%)	0.362(11%)	285(11%)
23-12-2022	–	28-12-2022	1759(11%)	0.144(12%)	79(11%)
Mean			2462	0.172	217
SD			976	0.109	107

Table 2.1. Radionuclides in precipitation in the 10 m² rain collector at Risø (cf. Fig. 8.1), July - December 2022. (Unit: Bq m⁻³)

Month	^{7}Be	^{137}Cs	^{210}Pb
July	2880(11%)*	0.180(13%)	234(11%)
August	2224(11%)	0.239(12%)	305(11%)
September	981(11%)	0.065(12%)	70(11%)
October	1576(11%)	0.062(14%)	111(11%)
November	2192(11%)	0.121(15%)	266(11%)
December	1375(11%)	0.058(13%)	108(11%)

*Figures in brackets are relative standard uncertainties

Table 2.2. Radionuclides in precipitation in the 10 m² rain collector at Risø (cf. Fig. 8.1), July - December 2022. (Unit: Bq m⁻²)

Month	Precipitation (m)	^{7}Be	^{137}Cs	^{210}Pb
July	0.017(10%)*	50(17%)	0.0030(17%)	4.0(17%)
August	0.054(10%)	121(17%)	0.0130(16%)	16.6(17%)
September	0.070(10%)	68(17%)	0.0045(16%)	4.9(17%)
October	0.039(10%)	62(17%)	0.0024(17%)	4.4(17%)
November	0.012(10%)	27(17%)	0.0015(18%)	3.2(17%)
December	0.041(10%)	56(17%)	0.0024(16%)	4.4(17%)
Sum	0.233(5%)	384(12%)	0.0268(15%)	37.5(12%)

*Figures in brackets are relative standard uncertainties

Table 2.3. Tritium in precipitation collected at Risø (cf. Figs. 1, 8.1, 2.3.1 and 2.3.2). July - December 2022. (Unit: kBq m^{-3})

Month	10 m^2 rain collector*
July	3.1(19%)[a]
August	3.5(16%)
September	1.5(27%)
October	<1.3
November	<1.3
December	<1.3

* Double determinations.

[a] Figures in brackets are relative standard uncertainties. '<' means detection limit.

Table 2.4. Tritium in precipitation collected at Risø (cf. Fig. 1). July - December 2022 (Unit: kBq m^{-2})

Month	Precipitation (m)	10 m^2 rain collector
July	0.017(10%)*	0.053(21%)[a]
August	0.054(10%)	0.189(19%)
September	0.070(10%)	0.105(29%)
October	0.039(10%)	< 0.051
November	0.012(10%)	< 0.016
December	0.041(10%)	< 0.053
Sum	0.233(5%)	< 0.467

[a] Figures in brackets are relative standard uncertainties. '<' means detection limit.

Table 3.1. Radionuclides in sediment samples collected at Bolund in Roskilde Fjord.(cf. Fig. 3.1) July - December 2022. (Unit: Bq kg^{-1} dry)

No samples in this period. Samples are only taken/measured once per year.

Table 4.1. Radionuclides in seawater collected in Roskilde Fjord (cf. Fig. 4.1) July - December 2022. (Unit: Bq m^{-3})

No samples in this period. Samples are only taken/measured once per year.

*Table 4.2. Tritium in seawater collected in Roskilde Fjord (Risø pier) (cf. Fig. 4.2) July - December 2022[*a].*

Month	kBq m^{-3}
September	1.5(23.4%)
December	<1.3

* Double determinations

[a] Figures in brackets are relative standard uncertainties. '<' means detection limit.

*Table 5.1. Radionuclides in grass collected at Risø near the Waste Treatment Station, location I P3, Fig. 1, July - December 2022. (**Measured on bulked ash samples)*

Week no. or month	Date	K ($g\ kg^{-1}$ fresh)	^{137}Cs ($Bq\ kg^{-1}$ fresh)	^{137}Cs ($Bq\ m^{-2}$)
28	15 July	6.1(11%) [a]	<0.3	
30	29 July	7.0(11%)	<0.6	
32	12 August	9.8(11%)	<0.3	
34	26 August	9.3(11%)	<0.4	
36	09 September	5.4(11%)	<0.2	
38	23 September	5.0(11%)	<0.3	
40	07 October	7.2(11%)	<0.3	
42	21 October	4.6(11%)	<0.3	
44	04 November	7.9(11%)	<0.3	
46	18 November	5.3(11%)	<0.2	
48	02 December	5.4(11%)	<0.2	
50	16 December	5.3(11%)	<0.2	
52	28 December	5.2(11%)	<0.2	
**July		5.5(11%)	0.037(13%)	0.013(13%)
**August		8.3(11%)	<0.031	<0.007
**September		4.8(11%)	<0.024	<0.008
**October		5.7(11%)	<0.039	<0.013
**November		5.7(11%)	0.030(24%)	0.010(24%)
**December		5.1(11%)	0.037(12%)	0.014(12%)

[a] Figures in brackets are relative standard uncertainties. '<' means detection limit.

Table 5.2. Radionuclides in Fucus vesiculosus collected at Bolund in Roskilde Fjord. July - December 2022. (Unit: Bq kg^{-1} dry)

No samples in this period. Samples are only taken/measured once per year.

Table 7.1. Waste water collected at Risø (cf. Fig. 1), July - December 2022.

Week Number	Total beta (eqv. mg KCl l^{-1})	^{137}Cs (Bq m^{-3})	^{131}I (Bq m^{-3})	^{226}Ra (Bq m^{-3})
27	143(11%)[a]	<41	<57	<90
28	145(11%)	<54	<66	<109
29	141(10%)	<44	<41	<190
30	148(10%)	<77	<96	<157
31	166(10%)	<71	<83	<154
32	148(11%)	<59	<77	<125
33	192(10%)	<69	<82	<144
34	184(10%)	<53	<65	<119
35	120(11%)	<79	<82	<159
36	121(10%)	<55	<67	<129
37	127(10%)	<77	<82	<162
38	119(10%)	<79	<88	<162
39	108(11%)	<51	<59	<112
40	116(10%)	<50	<61	<122
41	129(10%)	<54	<63	<105
42	131(10%)	<75	<86	<157
43	117(10%)	<78	<90	<169
44	132(10%)	<53	<60	<113
45	144(11%)	<68	<64	<130
46	130(11%)	<56	<71	<119
47	135(10%)	<50	<58	<107
48	138(11%)	<78	<95	<162
49	133(11%)	<83	<105	<170
50	150(10%)	<89	<98	<177
51	148(10%)	<87	<176	<186
52	125(10%)	<75	<105	<150
Mean	136.8	<66	<80	<142
SD	21.4			

[a] Figures in brackets are relative standard uncertainties. '<' means detection limit.

Table 8.1. Background dose rates around the border of Risø (cf. Fig. 8.1) measured with thermoluminescence dosimeters (TLD) in the period May 2022 – October 2022. (Results are normalized to μSv h^{-1})

Location	μSv h^{-1}
1	0.09[a]
2	0.09
3	0.09
4	0.09
5	0.09
6	0.09
Mean	0.09

[a] In relation to the uncertainty on dose rate values reported in Tables 8.1 and 8.2 the Danish Health Authority, Radiation Protection that carries out the dose determination state that for a dose of 0.1 mSv the uncertainty will for a measurement period of 1 month or 3 months be respectively ca. 50 % and 100 % (95 % confidence). At doses higher than 1 mSv the uncertainty is a bit less than 25 % (95 % confidence) regardless of the length of the measurement period. The values in these tables are a bit in the high end compared with those typically reported in previous years when the dose determination was made at DTU, and with the NaI(Tl) detector measurements in Table 8.3, but considered to agree reasonably taking the clearly high uncertainty into account. Anyway all dose rates reported are very low and close to the TLD detection limit.

Table 8.2. Background dose rates around Risø (cf. Fig. 8.2 and Fig. 1) measured with thermoluminescence dosimeters (TLD) in the period May 2022– October 2022. (Results are normalized to µSv h^{-1})

Risø zone	Location	µSv h^{-1} ¤
I	1	0.09[a]
I	2	0.09
I	3	0.11
I	4	0.09
I	5	0.09
Mean		0.09
II	P1	0.09
II	P2	0.11
II	P3	0.09
II	P4	0.09
Mean		0.10
III	P1	0.09
III	P2	0.09
III	P3	0.09
Mean		0.09
IV	P1	0.09
IV	P2	0.09
IV	P3	0.09
IV	P4	0.09
IV	P5	0.09
IV	P6	0.09
IV	P7	0.11
Mean		0.09
V	P1	0.11
V	P2	0.09
V	P3	0.09
V	P4	0.11
V	P5	0.09
V	P6	0.09
V	P7	0.11
V	P8	0.09
V	P9	0.09
V	P10	0.09
Mean		0.10

Table 8.3. Terrestrial dose rates at the Risø zones (cf. Fig. 8.2 and Fig. 1) May 2022– October 2022. Measured with a NaI(Tl) detector. (Unit: µSv h^{-1})

Risø zone	Location	May
I	P1	0.040(10%)
I	P2	0.057(10%)
I	P3	0.330(10%)
I	P4	0.048(10%)
I	P5	0.046(10%)
Mean		0.104(5%)
II	P1	0.047(10%)
II	P2	0.045(10%)
II	P3	0.042(10%)
II	P4	0.043(10%)
Mean		0.044(4%)
III	P1	0.047(10%)
III	P2	0.049(10%)
III	P3	0.046(10%)
Mean		0.048(6%)
IV	P1	0.041(10%)
IV	P2	0.050(10%)
IV	P3	0.043(10%)
IV	P4	0.040(10%)
IV	P5	0.042(10%)
IV	P6	0.040(10%)
IV	P7	0.045(10%)
Mean		0.043(4%)
V	P1	0.044(10%)
V	P2	0.048(10%)
V	P3	0.056(10%)
V	P4	0.053(10%)
V	P5	0.053(10%)
V	P6	0.050(10%)
V	P7	0.044(10%)
V	P7a	0.041(10%)
V	P8	0.047(10%)
V	P9	0.041(10%)
V	P10	0.038(10%)
Mean		0.047(4%)

[a] Figures in brackets are relative standard uncertainties

Fig. 1. Locations for measurements of gamma-background radiation Zone I and II (cf. Tables 8.2 and 8.3)

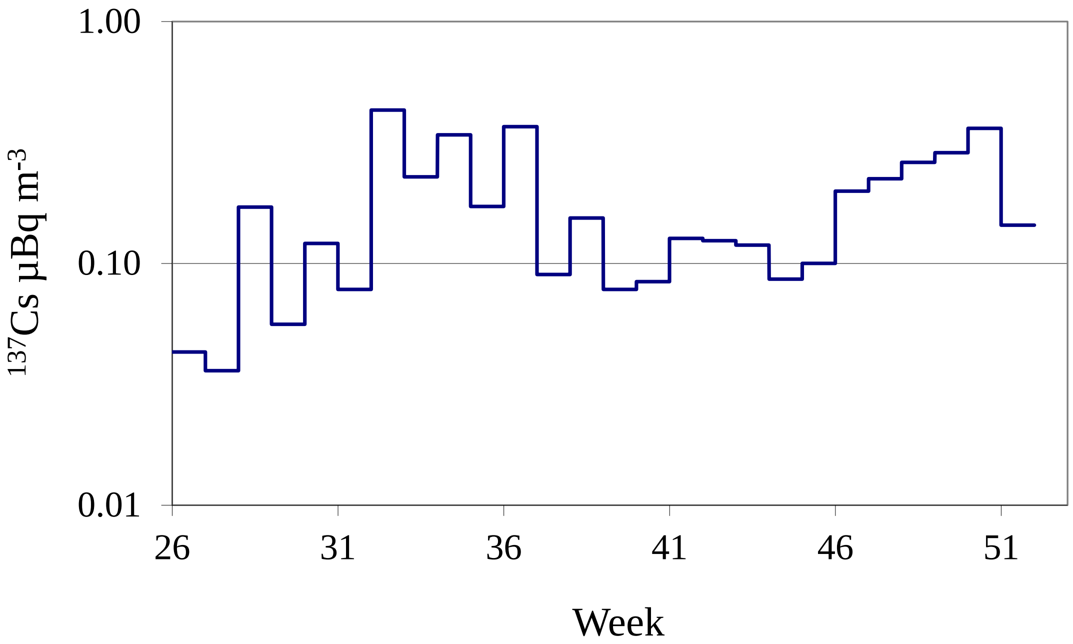

Fig. 1.1. Caesium-137 in ground level air collected at Risø in July-December 2022. (Unit: µBq m^{-3})

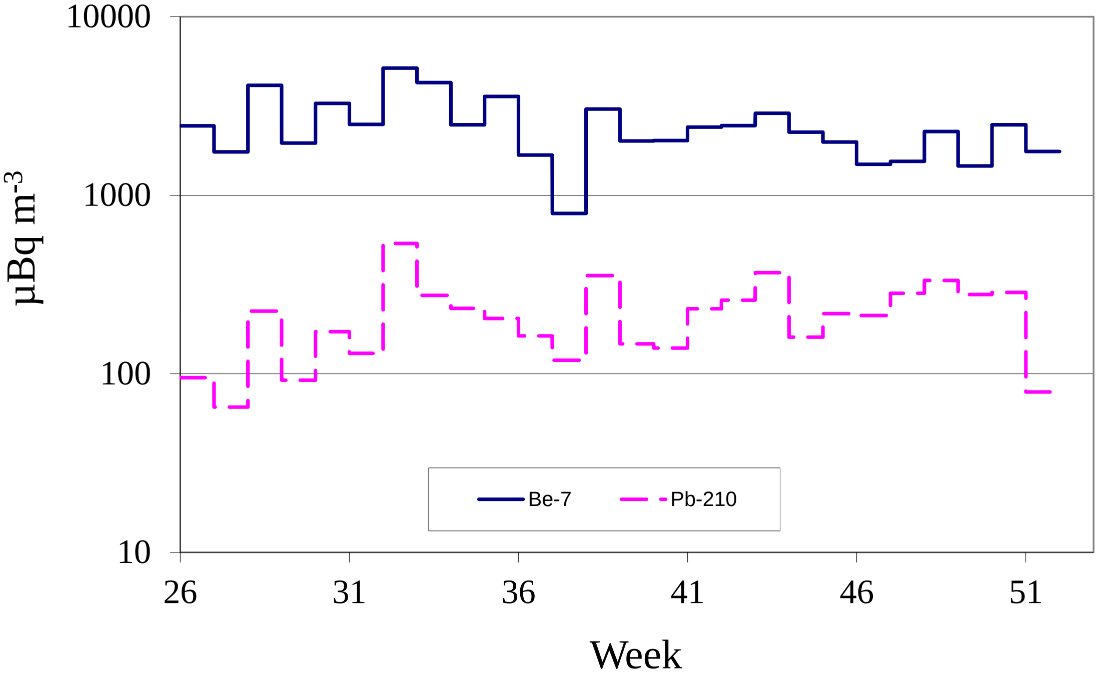

Fig. 1.2. Beryllium-7 and Lead-210 in ground level air collected at Risø in July-December 2022. (Unit: µBq m^{-3})

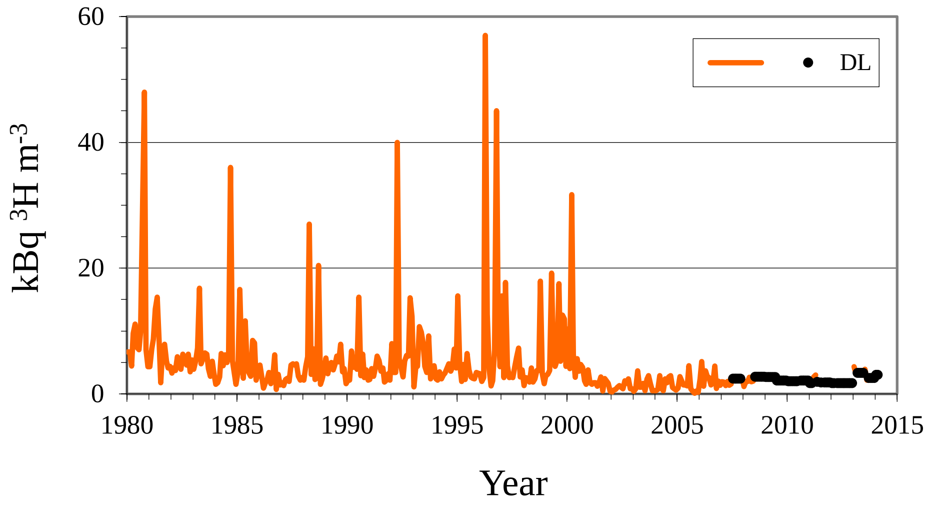

Fig. 2.3.1. Tritium in precipitation collected at Risø (1 m² rain collector) 1980 - 2013. (Unit: kBq m⁻³; DL = detection limit). This rain collector was taken out of operation in 2013.

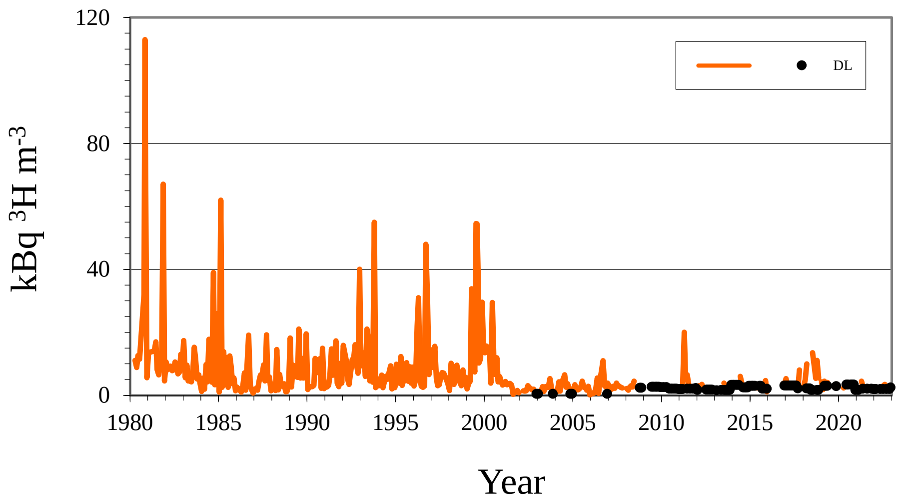

Fig. 2.3.2. Tritium in precipitation collected at Risø (10 m² rain collector) 1980 - 2022. (Unit: kBq m⁻³; DL = detection limit)

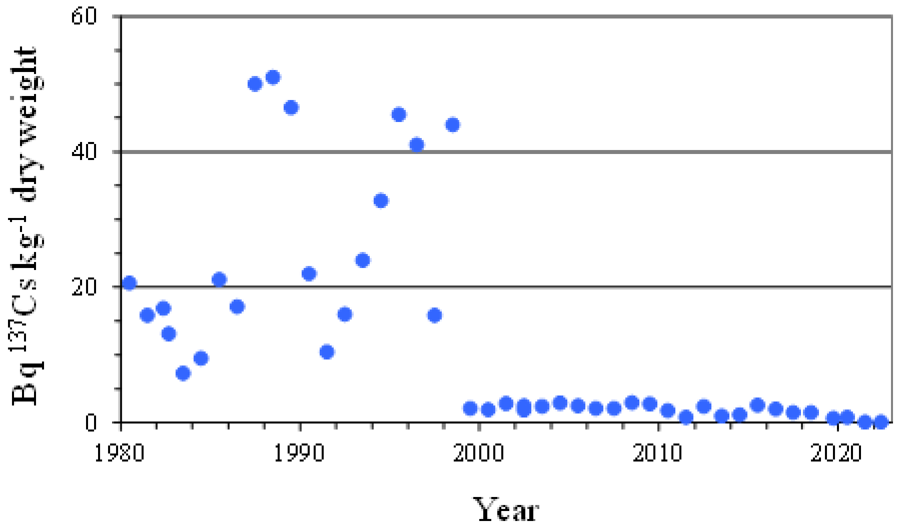

Fig. 3.1. Caesium–137 in sediment samples collected at Bolund in Roskilde Fjord. 1980 – 2022. (Unit: Bq kg^{-1} dry matter)

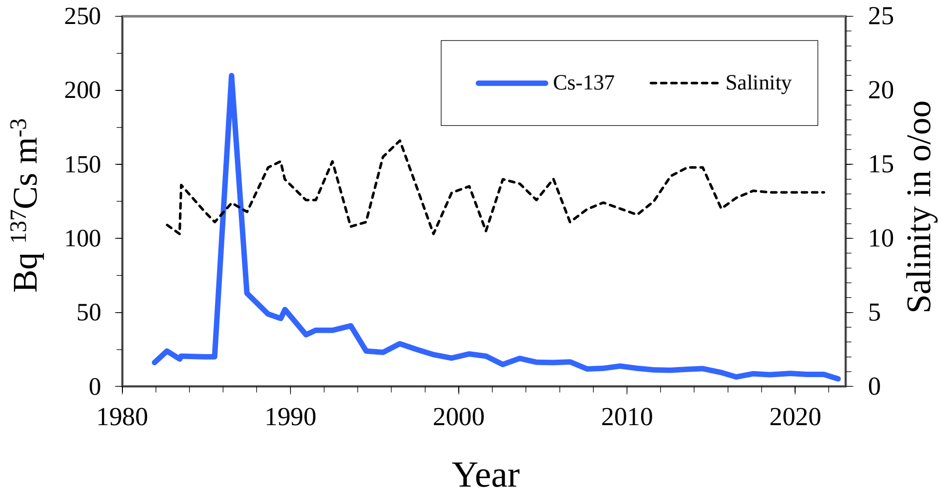

Fig. 4.1. Caesium–137 in seawater collected in Roskilde Fjord 1980 – 2022. (Unit: Bq m^{-3})

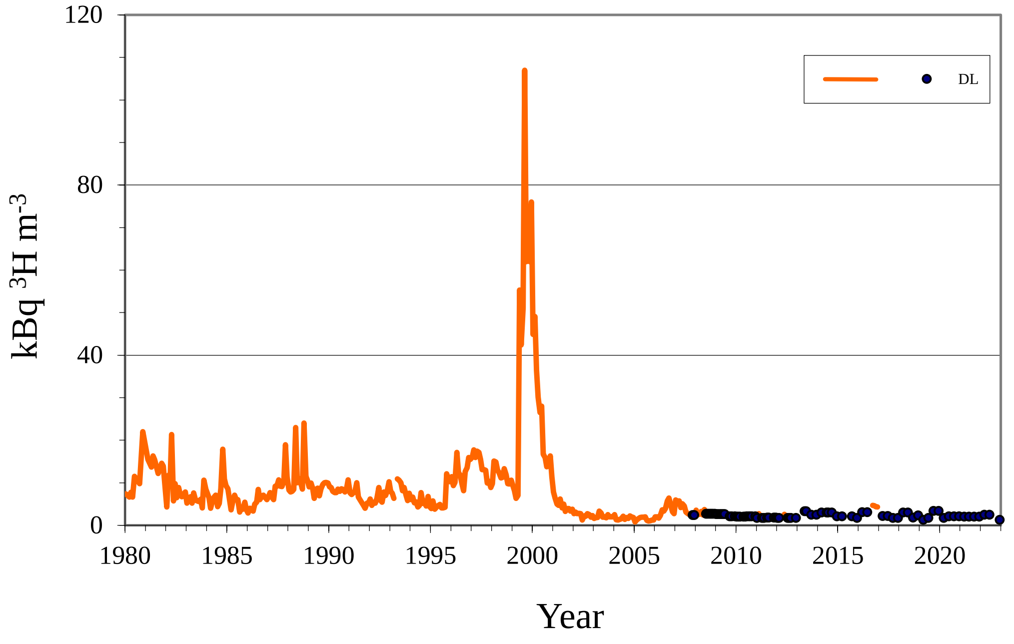

Fig. 4.2. Tritium in seawater collected in Roskilde Fjord 1980 - 2022. (Unit: kBq m^{-3}; DL = detection limit)

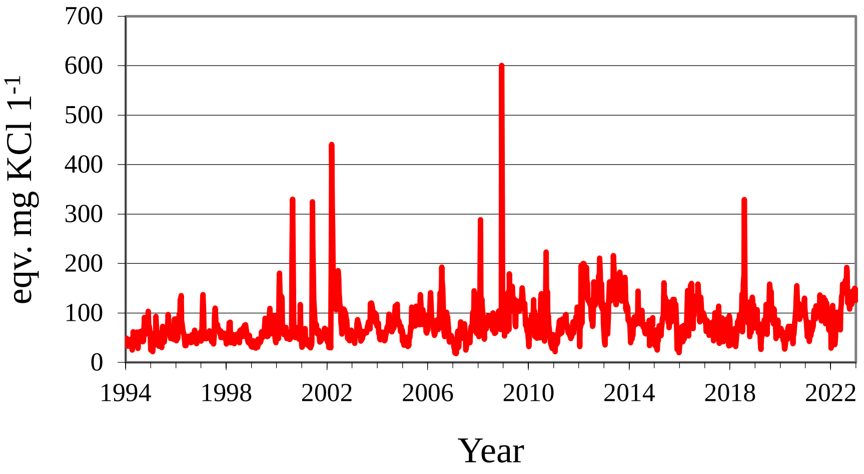

Fig. 7.1. Total-beta radioactivity in waste water collected at Risø 1994 - 2022. (Unit: eqv. mg KCl l^{-1})

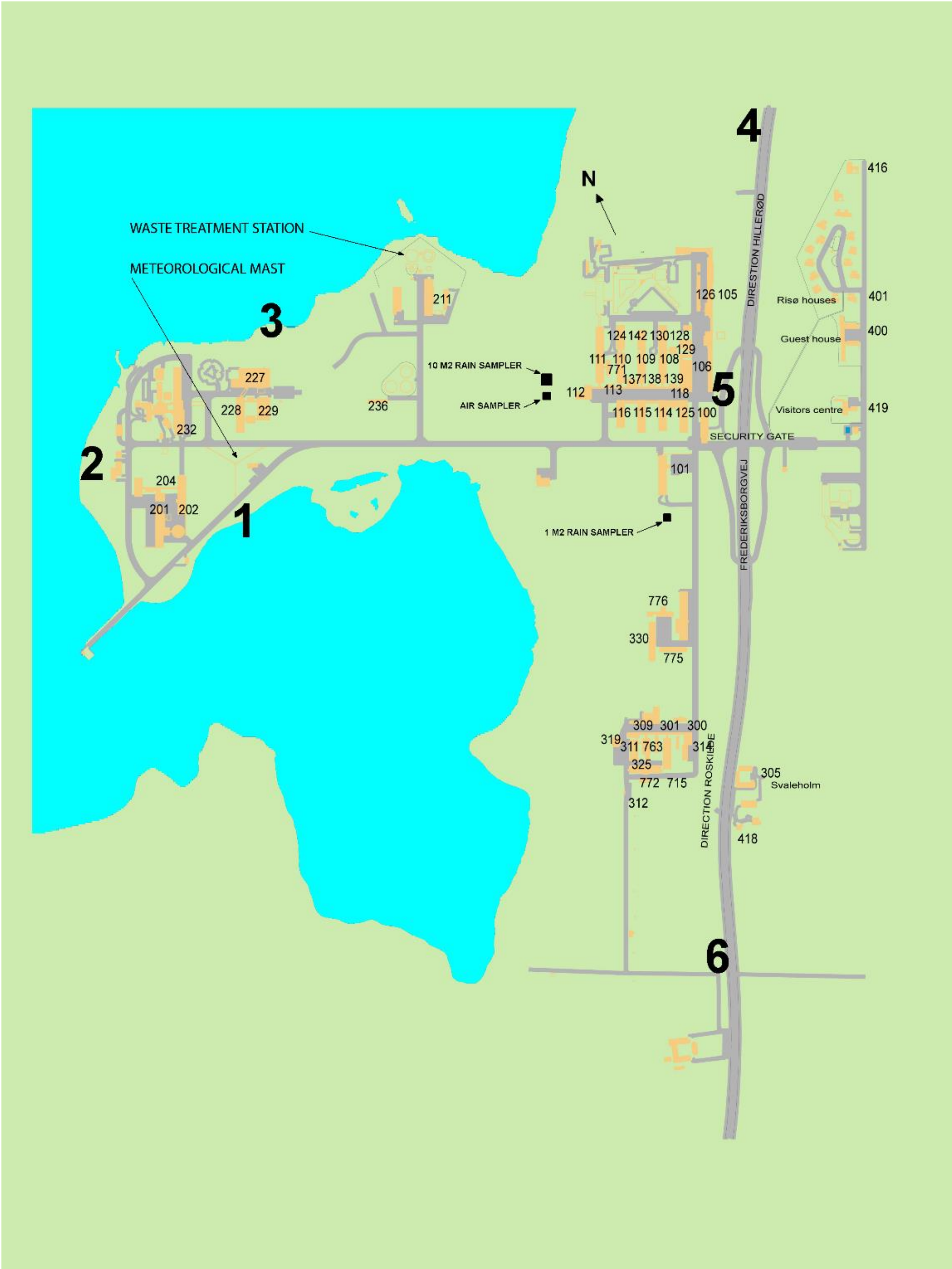

Fig. 8.1. Locations (1-6) for TLD measurements around the border of Risø (cf. Table 8.1).

Fig. 8.2. Locations for measurements of background radiation around Risø in Zones III, IV and V.

Materials and methods

External gamma dose rate monitoring

Monitoring of external gamma dose rate is carried out with the following devices

- Thermolumiscence dosimeters TLD: LiF, TLD equipment manufacturer: Harshaw
- NaI detector: 3x3 inch, SAM 935 Surveillance and Measurement System, Berkeley Nucleonics Cooperation, USA, visual read-out

Calibration of TLD is carried out at the Danish Health Authority, Radiation Protection. Traceability of delivered doses is ensured through calibration of the dose rate of the calibration irradiator by the Danish Health Authority, Radiation Protection. Further information on, e.g., the reported dosis, associated uncertainty and the lower detection limit is given by the Danish Health Authority, Radiation Protection at https://www.sst.dk/-/media/Opgaver/Strålebeskyttelse/Selvbetjening/Helkropsdosimeter_Infoseddel.ashx?la=da&hash=B6E03F283B84F87BF76CB1138912716608854948. The NaI detector is calibrated periodically vs. a Reuter Stokes high-pressure ionisation chamber.

Air sampler

The sampler at Risø is manufactured by DTU. Air is drawn through a polypropylene filter at a rate of about 2000 m^3/h. The filter is normally changed weekly. 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 intermittently.

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Water and sediment

A waste water sample from the Waste Treatment Station is collected weekly and analysed for total beta radioactivity and the radionuclides ^{131}I, ^{137}Cs and ^{226}Ra. Water samples from Roskilde Fjord are collected each quarter and analysed for tritium, annually for ^{137}Cs. A sediment sample is collected annually from Roskilde Fjord and analysed for ^{137}Cs.

Terrestrial and aquatic biota and flora

Grass samples are collected weekly at the Risø site and analysed by gamma spectrometry. Samples are bulked to monthly samples which are analysed for ^{137}Cs.

Seaweed samples are collected annually from Roskilde Fjord at Risø and analysed for ^{137}Cs.

Sample reception and preparation

Sample identification numbers are entered in log books. Sample preparation methods include drying, freeze drying, ashing, sorting and sieving. Selected samples are archived.

Sample measurements

Radioactivity in samples is measured by total beta counting and gamma spectrometry.

Measurement devices

- Ge detectors for gamma spectrometry. Calibration of detectors is based on mixed-nuclide standards used occasionally. Monthly checks are made of detector efficiency and energy resolution. Background measurements of gamma systems are made a few times per year.
- Low-level Geiger-Müller counters for total beta counting, manufactured by DTU. Calibration based on standards of KCl. Counting efficiency and background are checked monthly.
- Liquid scintillation spectrometer for analysis of tritium in water. Samples are analysed with a calibration standard.

Analytical results, data handling and reporting tools

Analytical results are printed on paper, recorded in log books and stored in a data base on intranet. Results below detection limits recorded as such. Spreadsheets are used for calculating results from raw data.

Quality assurance, laboratory accreditation and intercomparison exercises

Analytical results are checked by experienced staff and discussed with senior scientists if questions arise.

DTU is accredited to testing for radioactivity by DANAK according to the international standard ISO 17025. The accreditation covers testing for certain non-gamma emitting radionuclides but not for radionuclides occurring in the environment and food in general.

DTU participate regularly in international intercomparisons on laboratory analyses of radionuclides.

Conclusions

This report shows the results of the environmental surveillance monitoring programme carried out at and around the Risø site in July-December 2022. The mean concentrations in air were: 0.17±0.11 μBq m^{-3} of ^{137}Cs, 2.46±0.98 mBq m^{-3} of ^{7}Be and 0.22±0.11 mBq m^{-3} of ^{210}Pb (±1 standard uncertainty). The depositions by precipitation at Risø in the second half of 2022 were: 0.027±0.004 Bq m^{-2} of ^{137}Cs, 384±46 Bq m^{-2} of ^{7}Be, 37.5±4.5 Bq m^{-2} of ^{210}Pb and <0.5 kBq m^{-2} of ^{3}H. The average background dose rate (TLD) at Risø (Zone I) was measured as 0.09 µSv h^{-1} compared with 0.09 µSv h^{-1} in the four zones around Risø.

None of the recorded levels of radioactivity and radiation have given rise to concern.

DTU Sustain is working to develop new environmentally friendly and sustainable technologies and disseminate this knowledge to society and new generations of engineers. Research in Radioecology & Tracer Studies (RTS) aims at developing methods and instruments for analysing manmade and naturally recurring radionuclides in the environment and samples from nuclear facilities. The RTS Section is responsible for caring out the environmental radioactivity monitoring program in Denmark.

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DTU SUSTAIN

Radioactivity in the Risø District January-June 2022

Radioactivity in the Risø District January-June 2022

Report DTU-ENV-RAS-0006
2021

By
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Preface

A specific monitoring programme in the vicinity of the nuclear installations at the Risø site is carried out by DTU Environment on behalf of and as a contractor to Danish Decommissioning (DD). This report presents the analytical results of the monitoring and sampling carried out in the period January - June 2022. The materials and methods used in connection with the monitoring programme are described in pages 27-28.

Risø, December 2022

Contents

Summary

The environmental surveillance of the Risø environment was continued in January-June 2022. The mean concentrations in air were: 0.13±0.08 μBq m^{-3} of ^{137}Cs, 2.93±1.43 mBq m^{-3} of ^{7}Be and 0.13±0.08 mBq m^{-3} of ^{210}Pb (±1 standard uncertainty). The depositions by precipitation at Risø in the first half of 2021 were: 0.029±0.004 Bq m^{-2} of ^{137}Cs, 271±19 Bq m^{-2} of ^{7}Be, 21.6±2.4 Bq m^{-2} of ^{210}Pb and <0.5 kBq m^{-2} of ^{3}H. The average background dose rate (TLD) at Risø (Zone I) was measured as 0.10 μSv h^{-1} compared with 0.10 μSv h^{-1} in the four zones around Risø.

*Table 1. Radionuclides in ground level air collected at Risø (cf. Figs. 1, 1.1 and 1.2), January-June 2022 (Unit: μBq m⁻³)**

Date			^{7}Be	^{137}Cs	^{210}Pb
31-dec-21	–	07-jan-22	2432(11%)	0.131(12%)	74(11%)
07-jan-22	–	14-jan-22	2217(11%)	0.212(11%)	95(11%)
14-jan-22	–	21-jan-22	2495(11%)	0.156(12%)	41(11%)
21-jan-22	–	28-jan-22	1586(11%)	0.137(12%)	58(11%)
28-jan-22	–	04-feb-22	1577(11%)	0.133(12%)	35(11%)
04-feb-22	–	11-feb-22	1937(11%)	0.085(12%)	15(11%)
11-feb-22	–	18-feb-22	2596(11%)	0.124(12%)	75(11%)
18-feb-22	–	25-feb-22	1971(11%)	0.063(12%)	37(11%)
25-feb-22	–	04-mar-22	1996(11%)	0.268(12%)	120(11%)
04-mar-22	–	11-mar-22	2206(11%)	0.379(11%)	164(11%)
11-mar-22	–	18-mar-22	3465(11%)	0.458(11%)	206(11%)
18-mar-22	–	25-mar-22	8529(11%)	1.332(11%)#	384(11%)
25-mar-22	–	01-apr-22	3510(11%)	0.454(11%)	240(11%)
01-apr-22	–	08-apr-22	1595(11%)	0.122(11%)	64(11%)
08-apr-22	–	15-apr-22	1884(11%)	0.213(11%)	91(11%)
15-apr-22	–	22-apr-22	2968(11%)	0.315(12%)	183(11%)
22-apr-22	–	29-apr-22	2684(11%)	0.221(12%)	137(11%)
29-apr-22	–	06-may-22	2791(11%)	0.134(12%)	122(11%)
06-may-22	–	12-may-22	3875(11%)	0.142(12%)	159(11%)
12-may-22	–	20-may-22	3562(11%)	0.140(12%)	171(11%)
20-may-22	–	25-may-22	4289(11%)	0.091(12%)	131(11%)
25-may-22	–	03-jun-22	2184(11%)	0.059(12%)	89(11%)
03-jun-22	–	10-jun-22	2578(11%)	0.063(12%)	185(11%)
10-jun-22	–	17-jun-22	3030(11%)	0.046(12%)	105(11%)
17-jun-22	–	24-jun-22	3235(11%)	0.062(12%)	110(11%)
24-jun-22	–	01-Jul-22	4980(11%)	0.169(11%)	246(11%)
Mean			2930	0.220	128
SD			1429	0.254	81

*Figures in brackets are relative standard uncertainties. # Elevated value: see text under Table 2.1.

Table 2.1. Radionuclides in precipitation in the 10 m² rain collector at Risø (cf. Fig. 8.1), January-June 2022. (Unit: Bq m⁻³)

Month	^{7}Be	^{137}Cs	^{210}Pb
January	1941(11%)*	0.070(27%)	109(11%)
February	889(11%)	0.020(18%)	32(11%)
March	2275(11%)	2.010(12%)#	637(11%)
April	841(11%)	0.266(13%)	102(11%)
May	4213(11%)	0.428(13%)	367(11%)
June	3117(11%)	0.204(12%)	248(11%)

* Figures in brackets are relative standard uncertainties

The caesium concentration in March was somewhat elevated, coinciding with a slight increase in air concentration (see Table 1) and very low precipitation rate (and thus little plume depletion). This small increase has no implications for health, but coincides in time with a reported forest fire very near to the Chernobyl NPP, where the flames were according to Ukrainian officials difficult to fight due to Russian control of the area.

Table 2.2. Radionuclides in precipitation in the 10 m² rain collector at Risø (cf. Fig. 8.1), January-June 2022. (Unit: Bq m⁻²)

Month	Precipitation (m)	^{7}Be	^{137}Cs	^{210}Pb
January	0.020(10%)*	27(12%)	0.0013(29%)	2.2(12%)
February	0.073(10%)	59(12%)	0.0015(20%)	2.3(12%)
March	0.004(10%)	10(12%)	0.0077(16%)	2.5(12%)
April	0.025(10%)	19(12%)	0.0066(16%)	2.5(12%)
May	0.016(10%)	78(12%)	0.0068(17%)	5.8(12%)
June	0.026(10%)	78(12%)	0.0054(16%)	6.3(12%)
Sum	0.164(5%)	271(7%)	0.0293(14%)	21.6(9%)

* Figures in brackets are relative standard uncertainties

Table 2.3. Tritium in precipitation collected at Risø (cf. Figs. 1, 2.3.1 and 2.3.2). January – June 2022. (Unit: kBq m^{-3})

Month	10 m^2 rain collector*
January	<2.5
February	2.8(60%)[a]
March	<2.5
April	<2.5
May	<2.5
June	<2.5
Double determinations*.	

[a] Figures in brackets are relative standard uncertainties

Table 2.4. Tritium in precipitation collected at Risø (cf. Fig. 1). January – June 2022 (Unit: kBq m^{-2})

Month	Precipitation (m)	10 m^2 rain collector
January	0.020(10%)[a]	<0.050
February	0.073(10%)	0.204(61%)[a]
March	0.004(10%)	<0.010
April	0.025(10%)	<0.063
May	0.016(10%)	<0.040
June	0.026(10%)	< 0.065
Sum	0.139(5%)	< 0.432

[a] Figures in brackets are relative standard uncertainties

Table 3.1. Radionuclides in sediment samples collected at Bolund in Roskilde Fjord.(cf. Fig. 3.1) January - June 2022. (Unit: Bq kg^{-1} dry)

Date	^{137}Cs	K*
8 June	<0.12	13.7(11%)[a]
*Unit: g kg^{-1} dry		

[a] Figures in brackets are relative standard uncertainties

Table 4.1. Radionuclides in seawater collected in Roskilde Fjord (cf. Fig. 4.1) January - June 2022. (Unit: Bq m–3)

Date	^{137}Cs
3 June	5.2(12%)[a]

[a] Figures in brackets are relative standard uncertainties

Table 4.2. Tritium in seawater collected in Roskilde Fjord (Risø pier) (cf. Fig. 4.2) January – June 2022 [a].*

Month	kBq m^{-3}
March	<2.5
June	<2.5
* Double determinations	

[a] Figures in brackets are relative standard uncertainties

Table 5.1. Radionuclides in grass (snow) collected at Risø near the Waste Treatment Station, location I P3, Fig. 1, January – June 2022. (**Measured on bulked ash samples)*

Week no. or month	Date	K (g kg^{-1} fresh)	^{137}Cs (Bq kg^{-1} fresh)	^{137}Cs (Bq m^{-2})
2	14 January	5.9(12%) [a]	<0.3	
4	28 January	3.2(12%)	<0.2	
6	11 February	3.9(12%)	<0.4	
8	25 February	2.6(13%)	<0.2	
10	11 March	4.6(12%)	<0.2	
12	25 March	5.6(12%)	<0.2	
14	08 April	4.3(12%)	<0.2	
16	22 April	6.3(12%)	<0.2	
18	06 May	7.0(12%)	<0.2	
20	20 May	5.3(12%)	<0.2	
22	03 June	4.2(12%)	<0.2	
24	17 June	5.4(12%)	<0.2	
26	01 July	6.1(12%)	<0.3	
**January		4.3(11%)	0.074(13%)	0.023(16%)
**February		3.4(11%)	0.072(16%)	0.021(20%)
**March		6.3(11%)	0.171(15%)	0.044(18%)
**April		6.2(11%)	0.050(21%)	0.019(24%)
**May		6.7(11%)	0.067(19%)	0.016(21%)
**June		5.7(11%)	<0.036	<0.010

[a] Figures in brackets are relative standard uncertainties

Table 5.2. Radionuclides in Fucus vesiculosus collected at Bolund in Roskilde Fjord. January – June 2022. (Unit: Bq kg^{-1} dry)

Date	^{137}Cs	K*	% dry matter
08 June	2.0(12%)[a]	29(11%)	15(10%)
*Unit: g kg^{-1} dry			

[a] Figures in brackets are relative standard uncertainties

Table 7.1. Waste water collected at Risø (cf. Fig. 1), January – June 2022.

Week Number	Total beta (eqv. mg KCl l^{-1})	^{137}Cs (Bq m^{-3})	^{131}I (Bq m^{-3})	^{226}Ra (Bq m^{-3})
1	29(11%)[a]	<70	<70	<138
2	36(12%)	<80	<70	<168
3	56(13%)	<79	<99	<165
4	115(11%)	<59	<73	<131
5	61(12%)	<67	<65	<154
6	63(10%)	<70	<86	<158
7	56(11%)	<41	<46	<83
8	37(13%)	<74	<89	<163
9	36(14%)	<56	<58	<124
10	52(12%)	<47	<50	<100
11	85(10%)	<74	<81	<160
12	95(12%)	<76	<92	<178
13	101(11%)	<75	<83	<155
14	92(11%)	<73	<85	<160
15	88(11%)	<47	<66	<113
16	82(10%)	<46	<54	<108
17	80(11%)	<55	<58	<121
18	91(12%)	<69	<84	<151
19	93(11%)	<50	<61	<100
20	66(11%)	<76	<180	<170
21	105(11%)	<70	<116	<156
22	119(10%)	<73	<91	<159
23	134(10%)	<70	<84	<153
24	138(11%)	<68	<84	<136
25	158(11%)	<50	<52	<105
26	157(10%)	<75	<84	<157
Mean	85.6	<65	<79	<141
SD	36.4			

[a] Figures in brackets are relative standard uncertainties

Table 8.1. Background dose rates around the border of Risø (cf. Fig. 8.1) measured with thermoluminescence dosimeters (TLD) in the period October 2021 – May 2022. (Results are normalized to µSv h^{-1}).

Location	µSv h^{-1}
1	0.09[a]
2	0.09
3	0.09
4	0.09
5	0.09
6	0.09
Mean	0.09

[a] In relation to the uncertainty on dose rate values reported in Tables 8.1 and 8.2 the Danish Health Authority, Radiation Protection that carries out the dose determination state that for a dose of 0.1 mSv the uncertainty will for a measurement period of 1 month or 3 months be respectively ca. 50 % and 100 % (95 % confidence). At doses higher than 1 mSv the uncertainty is a bit less than 25 % (95 % confidence) regardless of the length of the measurement period. The values in these tables are a bit in the high end compared with those typically reported in previous years when the dose determination was made at DTU, and with the NaI(Tl) detector measurements in Table 8.3, but considered to agree reasonably taking the clearly high uncertainty into account. Anyway all dose rates reported are very low and close to the TLD detection limit.

Table 8.2. Background dose rates around Risø (cf. Fig. 8.2 and Fig. 1) measured with thermoluminescence dosimeters (TLD) in the period October 2021 – May 2022. (Results are normalized to μSv h^{-1}).

Risø zone	Location	μSv h^{-1} ¤
I	1	0.09[a]
I	2	0.11
I	3	0.11
I	4	0.09
I	5	0.11
Mean		0.10
II	P1	0.09
II	P2	0.09
II	P3	0.09
II	P4	0.11
Mean		0.09
III	P1	0.11
III	P2	0.09
III	P3	0.11
Mean		0.10
IV	P1	0.09
IV	P2	0.09
IV	P3	0.09
IV	P4	0.09
IV	P5	0.09
IV	P6	0.11
IV	P7	0.11
Mean		0.10
V	P1	0.09
V	P2	0.11
V	P3	0.11
V	P4	0.09
V	P5	0.09
V	P6	0.11
V	P7	0.09
V	P8	0.11
V	P9	0.09
V	P10	0.11
Mean		0.10

Table 8.3. Terrestrial dose rates at the Risø zones (cf. Fig. 8.2 and Fig. 1) October 2021 – May 2022. Measured with a NaI(Tl) detector. (Unit: µSv h–1)

Risø zone	Location	May
I	P1	0.039(10%)
I	P2	0.055(10%)
I	P3	0.325(10%)
I	P4	0.045(10%)
I	P5	0.044(10%)
Mean		0.102(5%)
II	P1	0.043(10%)
II	P2	0.044(10%)
II	P3	0.040(10%)
II	P4	0.041(10%)
Mean		0.042(4%)
III	P1	0.047(10%)
III	P2	0.047(10%)
III	P3	0.046(10%)
Mean		0.047(6%)
IV	P1	0.038(10%)
IV	P2	0.049(10%)
IV	P3	0.043(10%)
IV	P4	0.041(10%)
IV	P5	0.041(10%)
IV	P6	0.039(10%)
IV	P7	0.045(10%)
Mean		0.042(4%)
V	P1	0.043(10%)
V	P2	0.046(10%)
V	P3	0.055(10%)
V	P4	0.052(10%)
V	P5	0.047(10%)
V	P6	0.050(10%)
V	P7	0.045(10%)
V	P7a	0.040(10%)
V	P8	0.042(10%)
V	P9	0.038(10%)
V	P10	0.037(10%)
Mean		0.045(4%)

[a] Figures in brackets are relative standard uncertainties

Fig. 1. Locations for measurements of gamma-background radiation Zone I and II (cf. Tables 8.2 and 8.3)

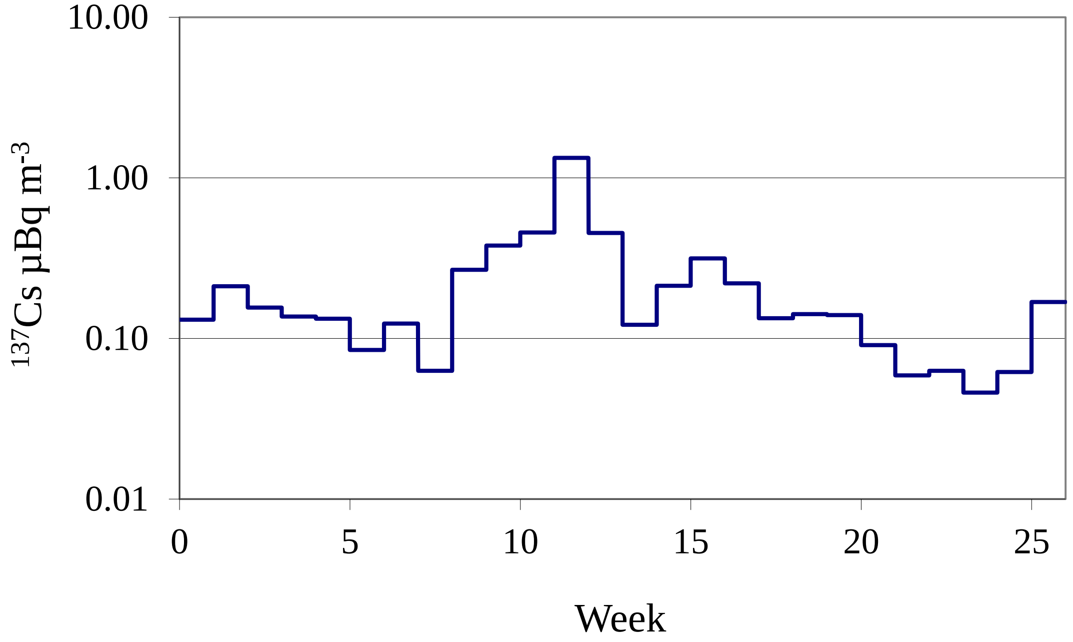

Fig. 1.1. Caesium-137 in ground level air collected at Risø in January-June 2022. (Unit: µBq m^{-3})

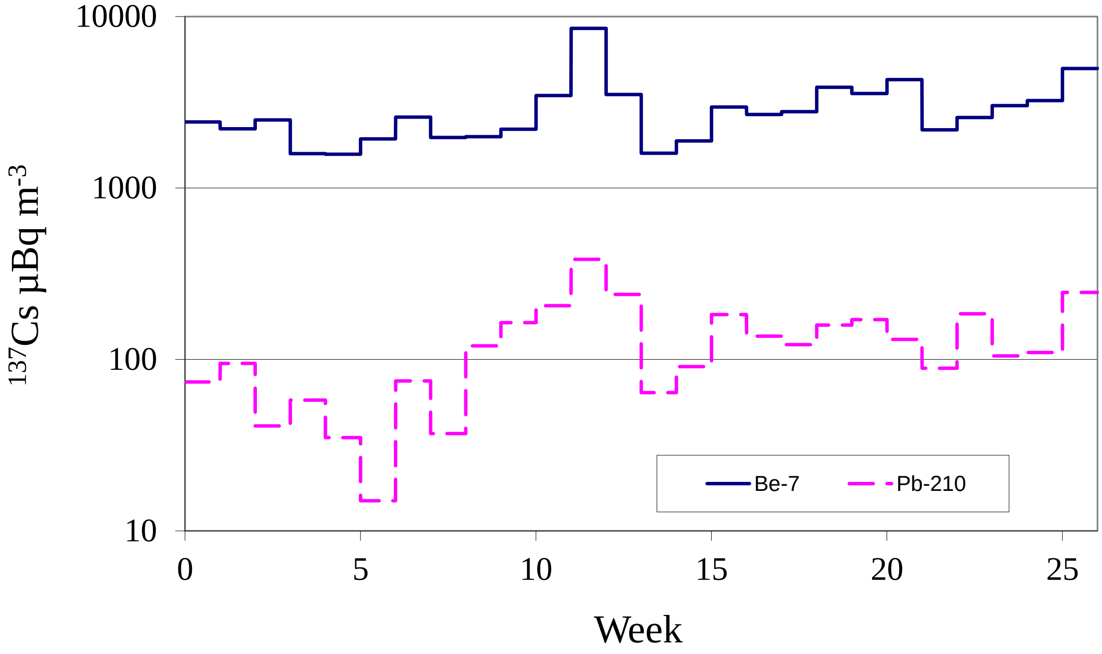

Fig. 1.2. Beryllium-7 and Lead-210 in ground level air collected at Risø in January-June 2022. (Unit: µBq m^{-3})

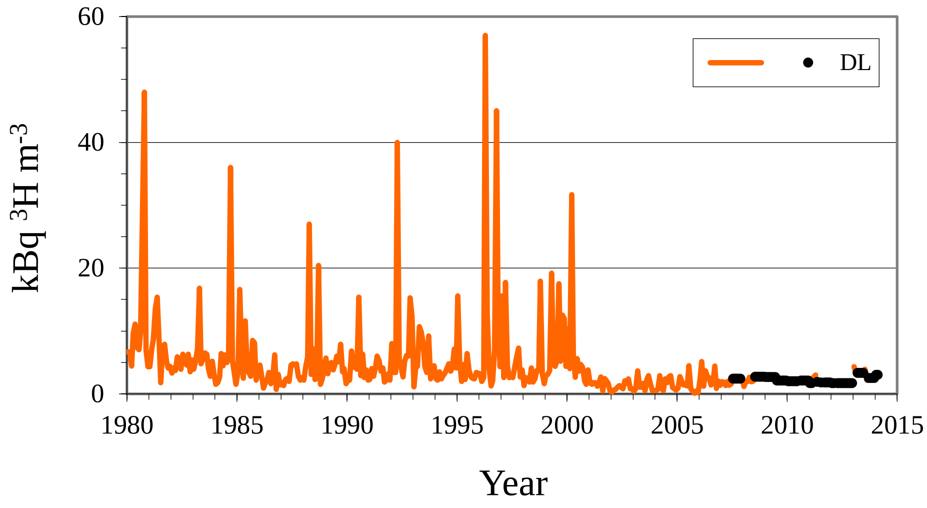

Fig. 2.3.1. Tritium in precipitation collected at Risø (1 m² rain collector) 1980 - 2013. (Unit: kBq m⁻³; DL = detection limit). This rain collector was taken out of operation in 2013.

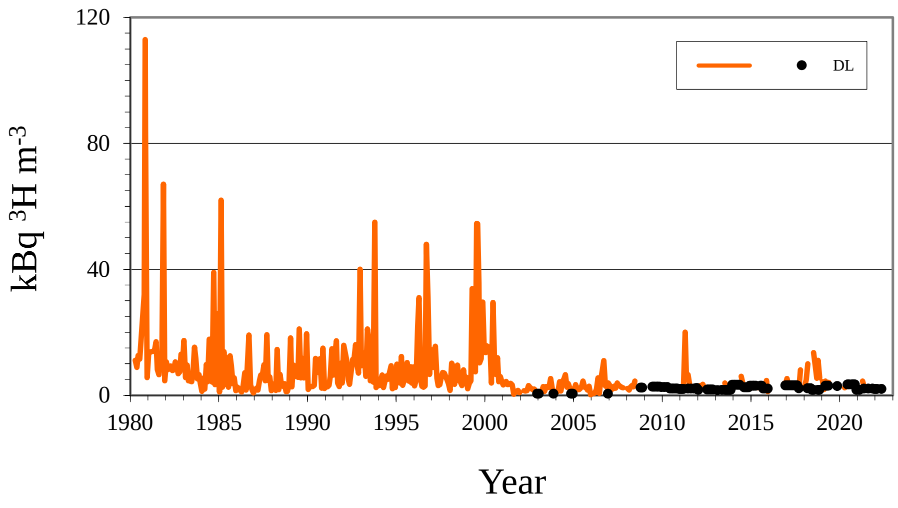

Fig. 2.3.2. Tritium in precipitation collected at Risø (10 m² rain collector) 1980 - 2022. (Unit: kBq m⁻³; DL = detection limit)

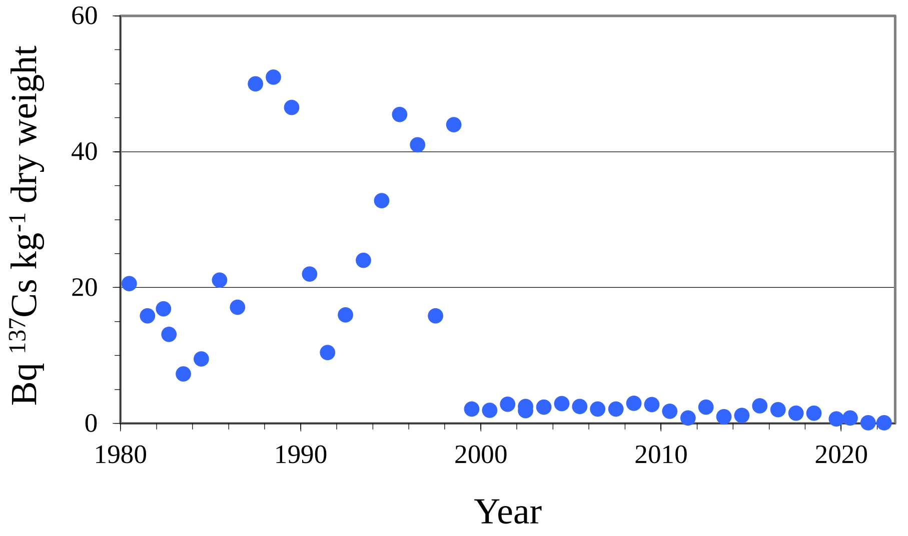

Fig. 3.1. Caesium–137 in sediment samples collected at Bolund in Roskilde Fjord. 1980 – 2022. (Unit: Bq kg^{-1} dry matter)

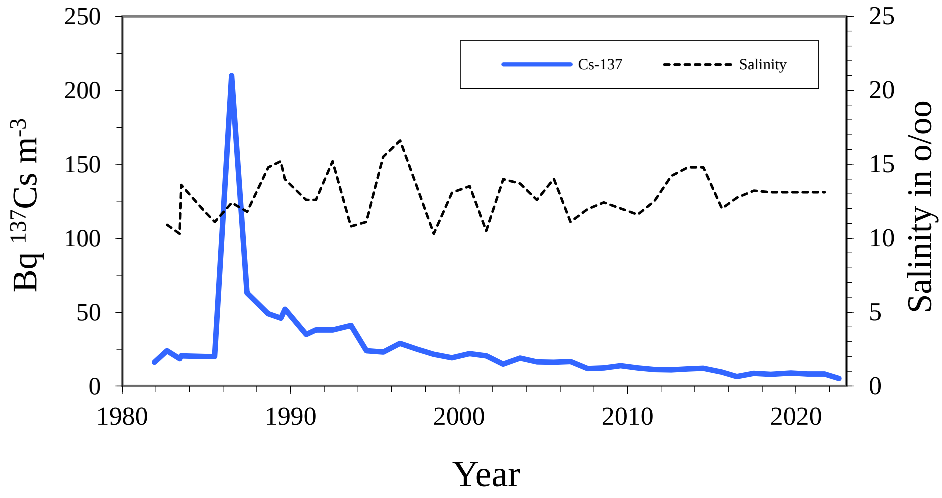

Fig. 4.1. Caesium–137 in seawater collected in Roskilde Fjord 1980 – 2022. (Unit: Bq m^{-3})

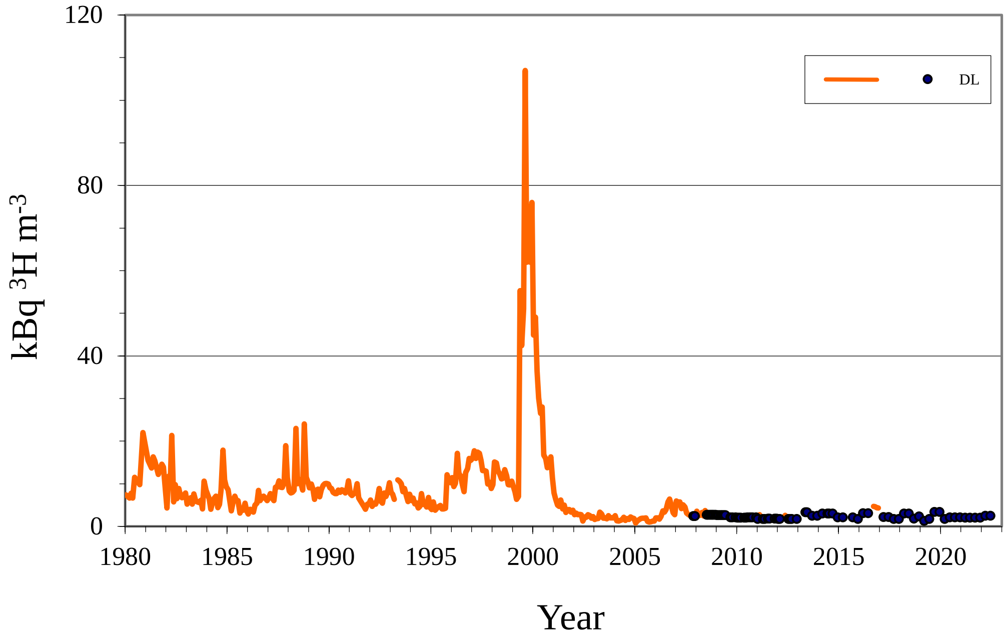

Fig. 4.2. Tritium in seawater collected in Roskilde Fjord 1980 - 2022. (Unit: kBq m^{-3}; DL = detection limit)

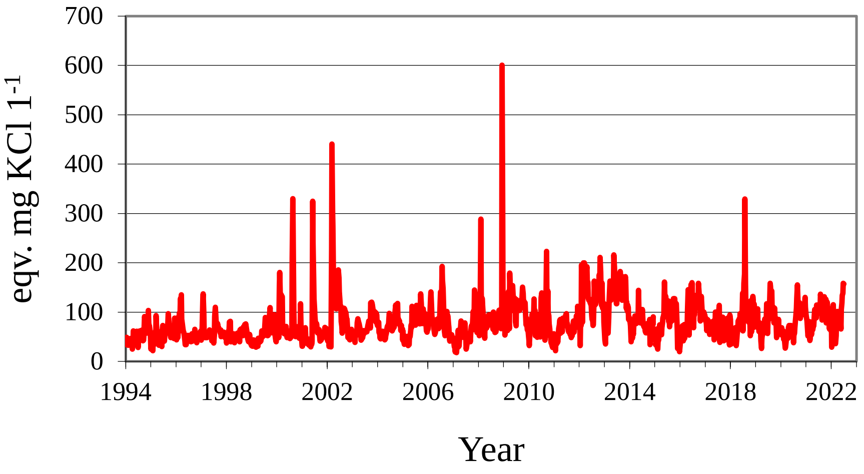

Fig. 7.1. Total-beta radioactivity in waste water collected at Risø 1994 - 2022. (Unit: eqv. mg KCl l^{-1})

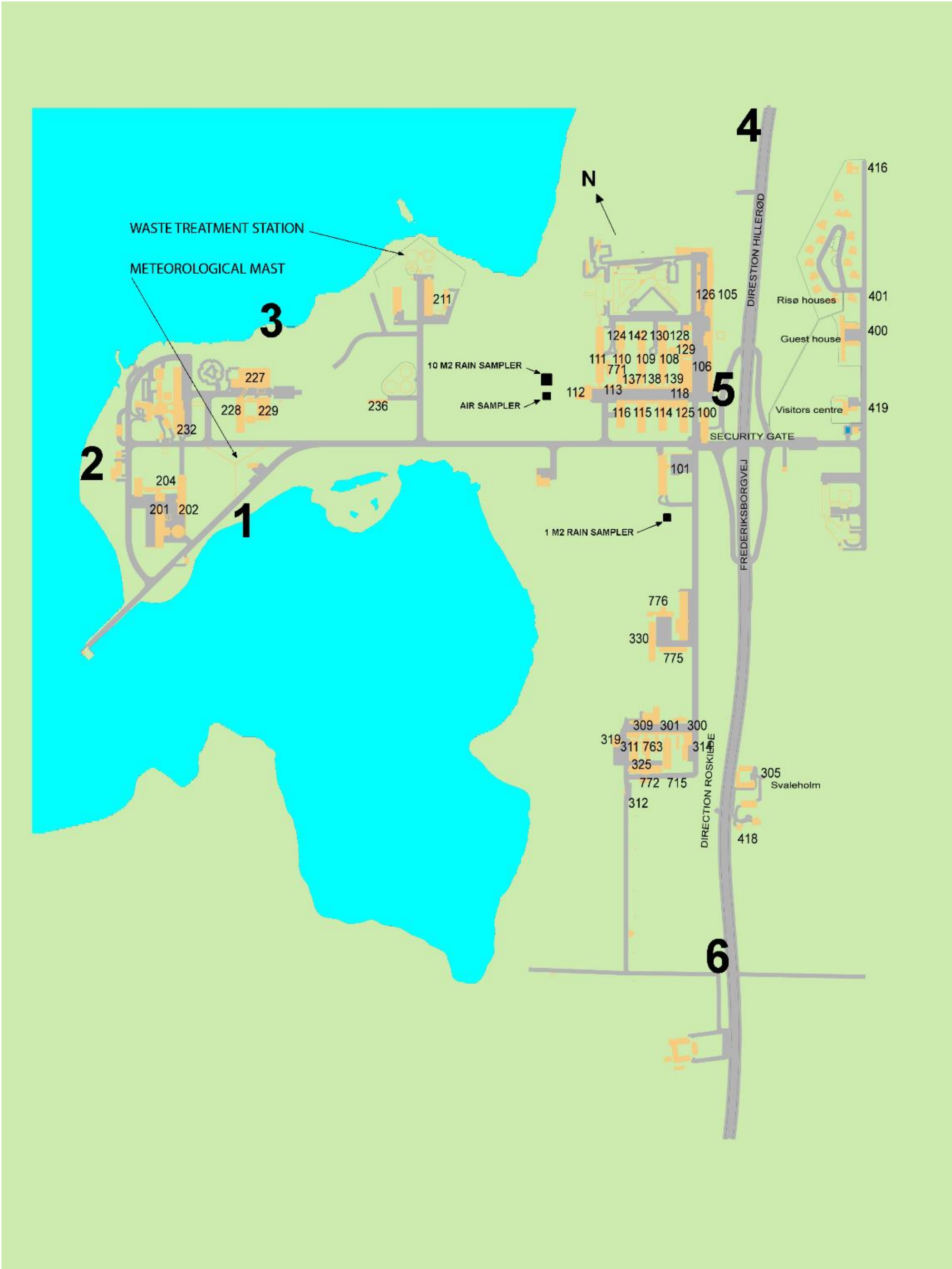

Fig. 8.1. Locations (1-6) for TLD measurements around the border of Risø (cf. Table 8.1).

Fig. 8.2. Locations for measurements of background radiation around Risø in Zones III, IV and V.

Materials and methods

External gamma dose rate monitoring

Monitoring of external gamma dose rate is carried out with the following devices

- Thermolumiscence dosimeters TLD: LiF, TLD equipment manufacturer: Harshaw
- NaI detector: 3x3 inch, SAM 935 Surveillance and Measurement System, Berkeley Nucleonics Cooperation, USA, visual read-out

Calibration of TLD is carried out at the Danish Health Authority, Radiation Protection. Traceability of delivered doses is ensured through calibration of the dose rate of the calibration irradiator by the Danish Health Authority, Radiation Protection. Further information on, e.g., the reported dosis, associated uncertainty and the lower detection limit is given by the Danish Health Authority, Radiation Protection at https://www.sst.dk/-/media/Opgaver/Strålebeskyttelse/Selvbetjening/Helkropsdosimeter_Infoseddel.ashx?la=da&hash=B6E03F283B84F87BF76CB1138912716608854948. The NaI detector is calibrated periodically vs. a Reuter Stokes high-pressure ionisation chamber.

Air sampler

The sampler at Risø is manufactured by DTU. Air is drawn through a polypropylene filter at a rate of about 2000 m^3/h. The filter is normally changed weekly. 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 intermittently.

DTU analyse the filters 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 repeated gamma analysis. Filters are analysed for ^{137}Cs, ^{7}Be and ^{210}Pb and other gamma emitters.

Deposition collector

The Risø site operates 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. The 10 m^2 collector provides monthly samples of rain water analysed for tritium and ion exchange resin which is analysed by gamma spectrometry for ^{7}Be, ^{137}Cs and ^{210}Pb and other gamma emitters.

Water and sediment

A waste water sample from the Waste Treatment Station is collected weekly and analysed for total beta radioactivity and the radionuclides ^{131}I, ^{137}Cs and ^{226}Ra. Water samples from Roskilde Fjord are collected each quarter and analysed for tritium, annually for ^{137}Cs. A sediment sample is collected annually from Roskilde Fjord and analysed for ^{137}Cs.

Terrestrial and aquatic biota and flora

Grass samples are collected weekly at the Risø site and analysed by gamma spectrometry. Samples are bulked to monthly samples which are analysed for ^{137}Cs.

Seaweed samples are collected annually from Roskilde Fjord at Risø and analysed for ^{137}Cs.

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- Liquid scintillation spectrometer for analysis of tritium in water. Samples are analysed with a calibration standard.

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Quality assurance, laboratory accreditation and intercomparison exercises

Analytical results are checked by experienced staff and discussed with senior scientists if questions arise.

DTU is accredited to testing for radioactivity by DANAK according to the international standard ISO 17025. The accreditation covers testing for certain non-gamma emitting radionuclides but not for radionuclides occurring in the environment and food in general.

DTU participate regularly in international intercomparisons on laboratory analyses of radionuclides.

Conclusions

The environmental surveillance of the Risø environment was continued in January-June 2022. The mean concentrations in air were: 0.13±0.08 μBq m^{-3} of ^{137}Cs, 2.93±1.43 mBq m^{-3} of ^{7}Be and 0.13±0.08 mBq m^{-3} of ^{210}Pb (±1 standard uncertainty). The depositions by precipitation at Risø in the first half of 2021 were: 0.029±0.004 Bq m^{-2} of ^{137}Cs, 271±19 Bq m^{-2} of ^{7}Be, 21.6±2.4 Bq m^{-2} of ^{210}Pb and <0.5 kBq m^{-2} of ^{3}H. The average background dose rate (TLD) at Risø (Zone I) was measured as 0.10 µSv h^{-1} compared with 0.10 µSv h^{-1} in the four zones around Risø. None of the recorded levels of radioactivity and radiation have given rise to concern, although an increase in ^{137}Cs air concentration was measured in March, at which time a forest fire was reported in the Chernobyl area.

DTU SUSTAIN is working to develop new environmentally friendly and sustainable technologies and disseminate this knowledge to society and new generations of engineers. Research in Radioecology & Tracer Studies (RTS) aims at developing methods and instruments for analysing manmade and naturally recurring radionuclides in the environment and samples from nuclear facilities. The RTS Group under the Climate and Monitoring Section in DTU SUSTAIN is responsible for caring out the environmental radioactivity monitoring program in Denmark.

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DTU SUSTAIN

Radioactivity in the Risø District July-December 2021

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Report DTU-ENV-RAS-0005
2021

By
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Preface

A specific monitoring programme in the vicinity of the nuclear installations at the Risø site is carried out by DTU Environment on behalf of and as a contractor to Danish Decommissioning (DD). This report presents the analytical results of the monitoring and sampling carried out in the period July-December 2021. The materials and methods used in connection with the monitoring programme are described in pages 27-28.

Risø, June 2022

Contents

Summary

The environmental surveillance of the Risø environment was continued in July-December 2021. The mean concentrations in air were: 0.16±0.11 μBq m^{-3} of ^{137}Cs, 2.92±0.89 mBq m^{-3} of ^{7}Be and 0.17±0.10 mBq m^{-3} of ^{210}Pb (±1 standard uncertainty). The depositions by precipitation at Risø in the second half of 2020 were: 0.021±0.003 Bq m^{-2} of ^{137}Cs, 447±51 Bq m^{-2} of ^{7}Be, 31.3±3.8 Bq m^{-2} of ^{210}Pb and <0.7 kBq m^{-2} of ^{3}H. The average background dose rate (TLD) at Risø (Zone I) was measured as 0.10 µSv h^{-1} compared with 0.11 µSv h^{-1} in the four zones around Risø.

Table 1. Radionuclides in ground level air collected at Risø (cf. Figs. 1, 1.1 and 1.2), July-December 2021 (Unit: μBq m^{-3}). Figures in brackets are relative standard uncertainties.

Date			^{7}Be	^{137}Cs	^{210}Pb
05-Jul-21	–	09-Jul-21	4201(11%)	0.045(14%)	138(11%)
09-Jul-21	–	16-Jul-21	4935(11%)	0.097(12%)	269(11%)
16-Jul-21	–	23-Jul-21	2654(11%)	0.070(12%)	103(11%)
23-Jul-21	–	30-Jul-21	4315(11%)	0.105(12%)	211(11%)
30-Jul-21	–	06-Aug-21	2692(11%)	0.069(12%)	83(11%)
06-Aug-21	–	13-Aug-21	2650(11%)	0.077(12%)	117(11%)
13-Aug-21	–	20-Aug-21	2278(11%)	0.049(12%)	67(11%)
20-Aug-21	–	27-Aug-21	2288(11%)	0.083(12%)	116(11%)
27-Aug-21	–	03-Sep-21	3323(11%)	0.262(11%)	283(11%)
03-Sep-21	–	10-Sep-21	4550(11%)	0.125(12%)	292(11%)
10-Sep-21	–	17-Sep-21	2760(11%)	0.072(12%)	232(11%)
17-Sep-21	–	24-Sep-21	3280(11%)	0.116(12%)	190(11%)
24-Sep-21	–	01-Oct-21	2670(11%)	0.087(12%)	120(11%)
01-Oct-21	–	08-Oct-21	2725(11%)	0.101(12%)	167(11%)
08-Oct-21	–	15-Oct-21	3130(11%)	0.354(12%)	288(11%)
15-Oct-21	–	22-Oct-21	3473(11%)	0.096(12%)	167(11%)
22-Oct-21	–	29-Oct-21	2679(11%)	0.100(12%)	131(11%)
29-Oct-21	–	05-Nov-21	3981(11%)	0.279(12%)	399(11%)
05-Nov-21	–	12-Nov-21	2080(11%)	0.109(12%)	55(11%)
12-Nov-21	–	19-Nov-21	2910(11%)	0.284(11%)	358(11%)
19-Nov-21	–	26-Nov-21	1820(11%)	0.082(12%)	37(11%)
26-Nov-21	–	03-Dec-21	1716(11%)	0.121(12%)	63(11%)
03-Dec-21	–	10-Dec-21	2980(11%)	0.257(12%)	207(11%)
10-Dec-21	–	17-Dec-21	1870(11%)	0.313(11%)	93(11%)
17-Dec-21	–	23-Dec-21	1756(11%)	0.296(12%)	95(11%)
23-Dec-21	–	30-Dec-21	2182(11%)	0.385(11%)	191(11%)
Mean			2919	0.155	172
SD			886	0.105	97

Table 2.1. Radionuclides in precipitation in the 10 m^2 rain collector at Risø (cf. Fig. 8.1), July - December 2021. (Unit: Bq m^{-3})

Month	^{7}Be	^{137}Cs	^{210}Pb
July	2266(11%)*	0.246(12%)	165(11%)
August	1660(11%)	0.101(13%)	110(11%)
September	1831(11%)	0.116(12%)	160(11%)
October	1121(11%)	0.036 (14%)	83(11%)
November	1874(11%)	0.050(17%)	165(11%)
December	1425(11%)	0.024(19%)	67(11%)

*Figures in brackets are relative standard uncertainties

Table 2.2. Radionuclides in precipitation in the 10 m^2 rain collector at Risø (cf. Fig. 8.1), July - December 2021. (Unit: Bq m^{-2})

Month	Precipitation (m)	^{7}Be	^{137}Cs	^{210}Pb
July	0.022(10%)*	52(17%)	0.0056(16%)	3.8(17%)
August	0.062(10%)	103(17%)	0.0063(16%)	6.9(17%)
September	0.032(10%)	59(17%)	0.0037(16%)	5.1(17%)
October	0.065(10%)	73(17%)	0.0024(17%)	5.5(17%)
November	0.026(10%)	48(17%)	0.0013(20%)	4.3(17%)
December	0.079(10%)	112(17%)	0.0019(21%)	5.7(17%)
Sum	0.286(5%)	447(12%)	0.0212 (15%)	31.3(12%)

*Figures in brackets are relative standard uncertainties

Table 2.3. Tritium in precipitation collected at Risø (cf. Figs. 1, 8.1, 2.3.1 and 2.3.2). July - December 2021. (Unit: kBq m^{-3})

Month	10 m^2 rain collector*
July	3.4(25%)[a]
August	<2.0
September	2.6(26%)
October	<2.0
November	2.3(42%)
December	<2.0

* Double determinations.

[a] Figures in brackets are relative standard uncertainties

Table 2.4. Tritium in precipitation collected at Risø (cf. Fig. 1). July - December 2021 (Unit: kBq m^{-2})

Month	Precipitation (m)	10 m^2 rain collector
July	0.022(10%)*	0.078(27%)[a]
August	0.062(10%)	<0.124
September	0.032(10%)	< 0.083(28%)
October	0.065(10%)	<0.130
November	0.026(10%)	0.060(43%)
December	0.079(10%)	< 0.158
Sum	0.286(5%)	< 0.633

[a] Figures in brackets are relative standard uncertainties

Table 3.1. Radionuclides in sediment samples collected at Bolund in Roskilde Fjord.(cf. Fig. 3.1) July - December 2021. (Unit: Bq kg^{-1} dry)

Date	^{137}Cs	K*
3 July	<0.11	14.0(11%)[a]

*Unit: g kg^{-1} dry

[a] Figures in brackets are relative standard uncertainties

Table 4.1. Radionuclides in seawater collected in Roskilde Fjord (cf. Fig. 4.1) July - December 2021. (Unit: Bq m^{-3})

Date	^{137}Cs
4 September	8.2(12%)[a]

[a] Figures in brackets are relative standard uncertainties

Table 4.2. Tritium in seawater collected in Roskilde Fjord (Risø pier) (cf. Fig. 4.2) July - December 2021[a].*

Month	kBq m^{-3}
June	<2.0
September	<2.0
December	<2.0

* Double determinations

[a] Figures in brackets are relative standard uncertainties

Table 5.1. Radionuclides in grass (snow) collected at Risø near the Waste Treatment Station, location I P3, Fig. 1, July - December 2021. (**Measured on bulked ash samples)*

Week no. or month	Date	K ($g\ kg^{-1}$ fresh)	^{137}Cs ($Bq\ kg^{-1}$ fresh)	^{137}Cs ($Bq\ m^{-2}$)
28	16 July	7.0(11%) [a]	<0.3	
30	30 July	4.0(11%)	<0.2	
32	13 August	6.4(11%)	<0.3	
34	27 August	3.8(11%)	<0.2	
36	10 September	8.2(11%)	<0.3	
38	24 September	6.0(11%)	<0.2	
40	08 October	5.1(11%)	<0.3	
42	22 October	5.7(11%)	<0.2	
44	5 November	5.4(11%)	<0.2	
46	19 November	6.7(11%)	<0.3	
48	03 December	5.5(11%)	<0.2	
50	17 December	3.4(11%)	<0.2	
52	31 December	3.7(11%)	<0.2	
**July		4.0(10%)	0.076(13%)	0.029(15%)
**August		4.6(10%)	<0.022	<0.007
**September		5.4(11%)	<0.023	<0.010
**October		5.0(10%)	<0.026	<0.009
**November		5.6(11%)	<0.024	<0.007
**December		3.9(10%)	0.038(16%)	0.017(18%)

[a] Figures in brackets are relative standard uncertainties

Table 5.2. Radionuclides in Fucus vesiculosus collected at Bolund in Roskilde Fjord. July - December 2021. (Unit: Bq kg^{-1} dry)

Date	^{137}Cs	K*	% dry matter
3 July	2.1(11%)[a]	28(11%)	16(10%)
*Unit: g kg^{-1} dry			

[a] Figures in brackets are relative standard uncertainties

Table 7.1. Waste water collected at Risø (cf. Fig. 1), July - December 2021.

Week Number	Total beta (eqv. mg KCl l^{-1})	^{137}Cs (Bq m^{-3})	^{131}I (Bq m^{-3})	^{226}Ra (Bq m^{-3})
27	107(11%)[a]	<50	<43	<106
28	100(11%)	<30	<30	<64
29	109(11%)	<68	<90	<147
30	136(10%)	<73	<101	<175
31	126(10%)	<43	<42	<183
32	125(10%)	<42	<41	<90
33	84(11%)	<52	<74	<113
34	114(11%)	<74	<68	<161
35	94(10%)	<83	<94	<169
36	111(10%)	<74	<85	<156
37	122(11%)	<69	<81	<150
38	131(10%)	<58	<49	<151
39	114(11%)	<86	<76	<181
40	108(10%)	<69	<89	<150
41	126(11%)	<57	<47	<117
42	78(10%)	<64	<85	<144
43	80(12%)	<56	<54	<130
44	120(11%)	<77	<89	<167
45	107(10%)	<71	<95	<165
46	93(11%)	<70	<83	<152
47	107(11%)	<72	<67	<159
48	66(12%)	<71	<64	<147
49	83(11%)	<77	<84	<159
50	64(11%)	<76	<361	<162
51	73(10%)	<31	<110	<69
52	95(10%)	<71	<106	<156
Mean	102.8	<64	<85	<144
SD	20.4			

[a] Figures in brackets are relative standard uncertainties

Table 8.1. Background dose rates around the border of Risø (cf. Fig. 8.1) measured with thermoluminescence dosimeters (TLD) in the period April 2021 – September 2021. (Results are normalized to μSv h^{-1})

Location	μSv h^{-1}
1	0.09[a]
2	0.09
3	0.11
4	0.11
5	0.09
6	0.11
Mean	0.10

[a] In relation to the uncertainty on dose rate values reported in Tables 8.1 and 8.2 the Danish Health Authority, Radiation Protection that carries out the dose determination state that for a dose of 0.1 mSv the uncertainty will for a measurement period of 1 month or 3 months be respectively ca. 50 % and 100 % (95 % confidence). At doses higher than 1 mSv the uncertainty is a bit less than 25 % (95 % confidence) regardless of the length of the measurement period. The values in these tables are a bit in the high end compared with those typically reported in previous years when the dose determination was made at DTU, and with the NaI(Tl) detector measurements in Table 8.3, but considered to agree reasonably taking the clearly high uncertainty into account. Anyway all dose rates reported are very low and close to the TLD detection limit.

Table 8.2. Background dose rates around Risø (cf. Fig. 8.2 and Fig. 1) measured with thermoluminescence dosimeters (TLD) in the period April 2021 – September 2021. (Results are normalized to μSv h^{-1}),

Risø zone	Location	μSv h^{-1} ¤
I	1	0.09[a]
I	2	0.09
I	3	0.11
I	4	0.11
I	5	0.11
Mean		0.10
II	P1	0.11
II	P2	0.09
II	P3	0.13
II	P4	0.11
Mean		0.11
III	P1	0.11
III	P2	0.09
III	P3	0.11
Mean		0.10
IV	P1	0.11
IV	P2	0.11
IV	P3	0.09
IV	P4	0.09
IV	P5	0.09
IV	P6	0.09
IV	P7	0.11
Mean		0.10
V	P1	0.11
V	P2	0.09
V	P3	0.11
V	P4	0.11
V	P5	0.09
V	P6	0.11
V	P7	0.13
V	P8	0.11
V	P9	0.11
V	P10	0.11
Mean		0.11

Table 8.3. Terrestrial dose rates at the Risø zones (cf. Fig. 8.2 and Fig. 1) April 2021 – September 2021. Measured with a NaI(Tl) detector. (Unit: nSv h^{-1})

Risø zone	Location	October
I	P1	39(10%)[a]
I	P2	59(10%)
I	P3	285(10%)
I	P4	49(10%)
I	P5	46(10%)
Mean		95(5%)
II	P1	44(10%)
II	P2	43(10%)
II	P3	40(10%)
II	P4	42(10%)
Mean		42(4%)
III	P1	48(10%)
III	P2	49(10%)
III	P3	46(10%)
Mean		48(6%)
IV	P1	45(10%)
IV	P2	50(10%)
IV	P3	44(10%)
IV	P4	45(10%)
IV	P5	43(10%)
IV	P6	42(10%)
IV	P7	46(10%)
Mean		45(4%)
V	P1	43(10%)
V	P2	49(10%)
V	P3	51(10%)
V	P4	54(10%)
V	P5	48(10%)
V	P6	49(10%)
V	P7	46(10%)
V	P7a	40(10%)
V	P8	46(10%)
V	P9	40(10%)
V	P10	39(10%)
Mean		46(4%)

[a] Figures in brackets are relative standard uncertainties

Fig. 1. Locations for measurements of gamma-background radiation Zone I and II (cf. Tables 8.2 and 8.3)

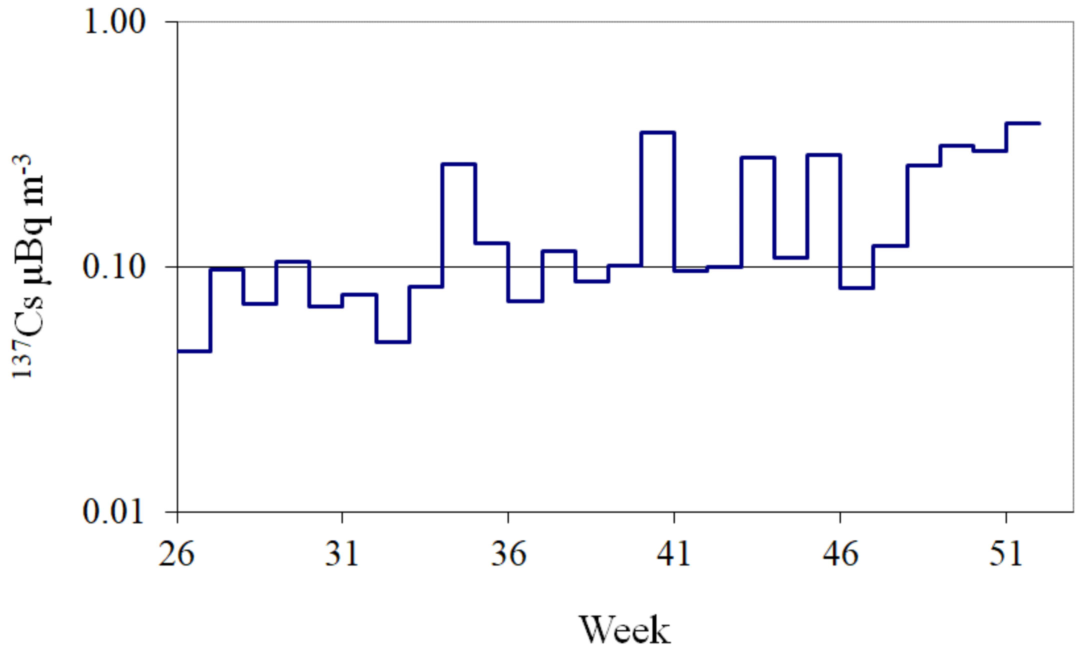

Fig. 1.1. Caesium-137 in ground level air collected at Risø in July-December 2021. (Unit: µBq m^{-3})

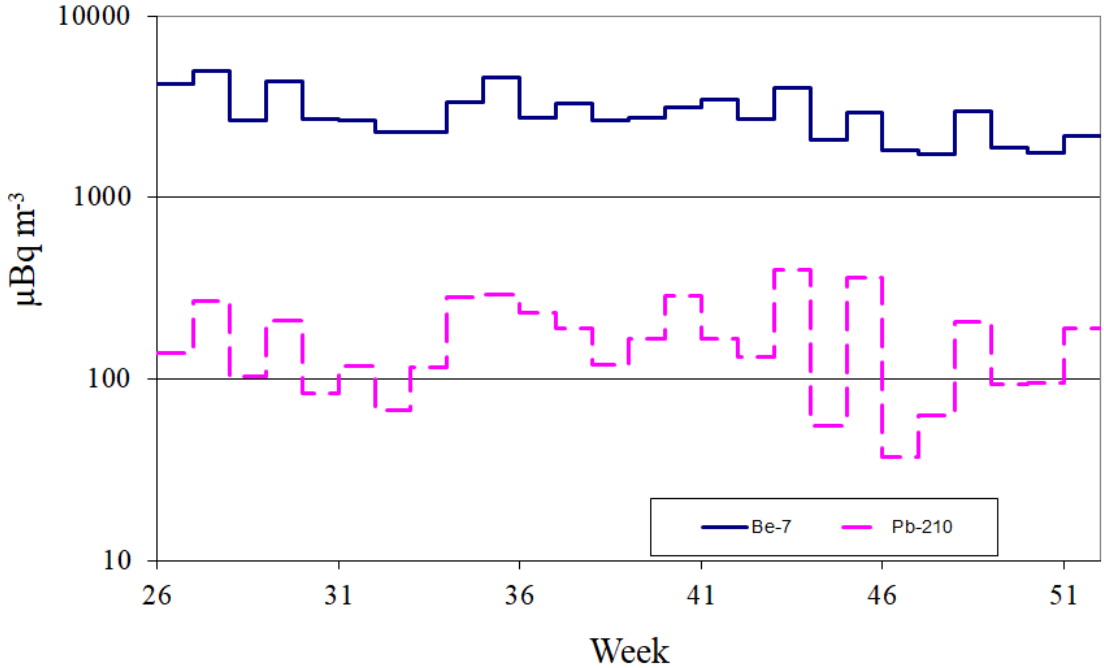

Fig. 1.2. Beryllium-7 and Lead-210 in ground level air collected at Risø in July-December 2021. (Unit: µBq m^{-3})

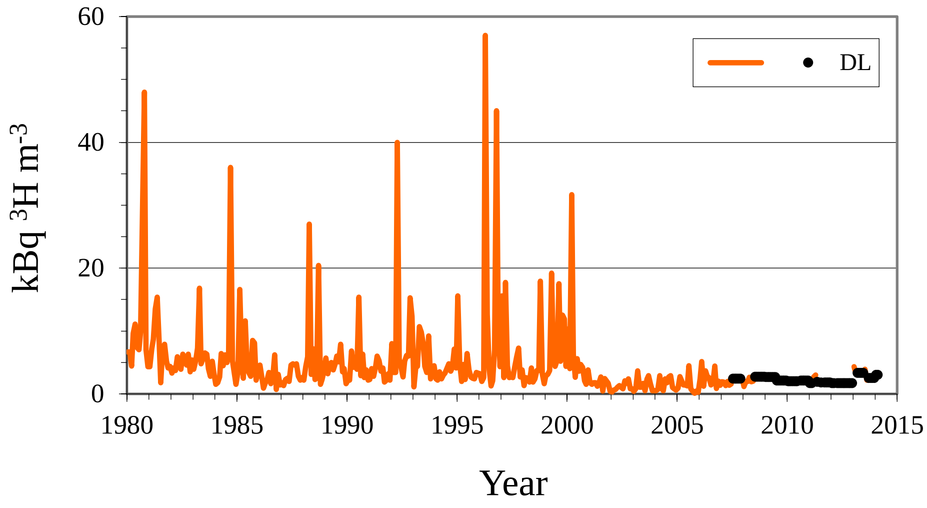

Fig. 2.3.1. Tritium in precipitation collected at Risø (1 m^2 rain collector) 1980 - 2013. (Unit: kBq m^{-3}; DL = detection limit). This rain collector was taken out of operation in 2013.

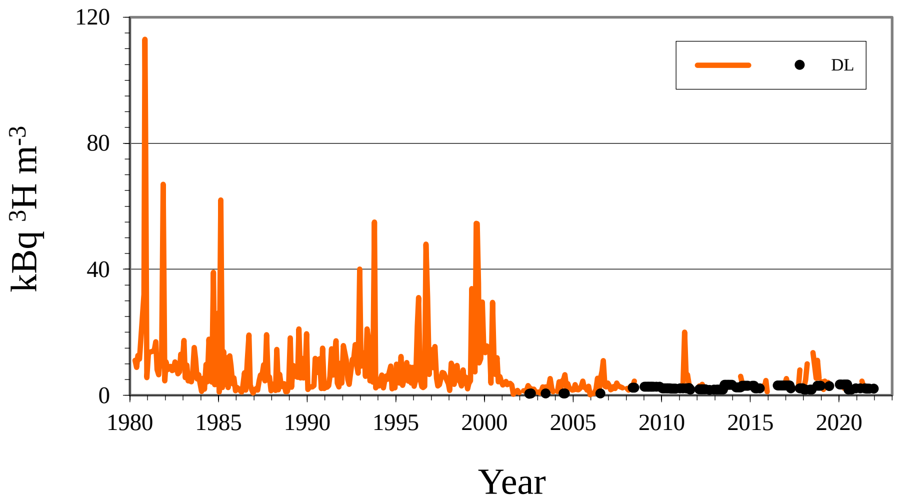

Fig. 2.3.2. Tritium in precipitation collected at Risø (10 m^2 rain collector) 1980 - 2021. (Unit: kBq m^{-3}; DL = detection limit)

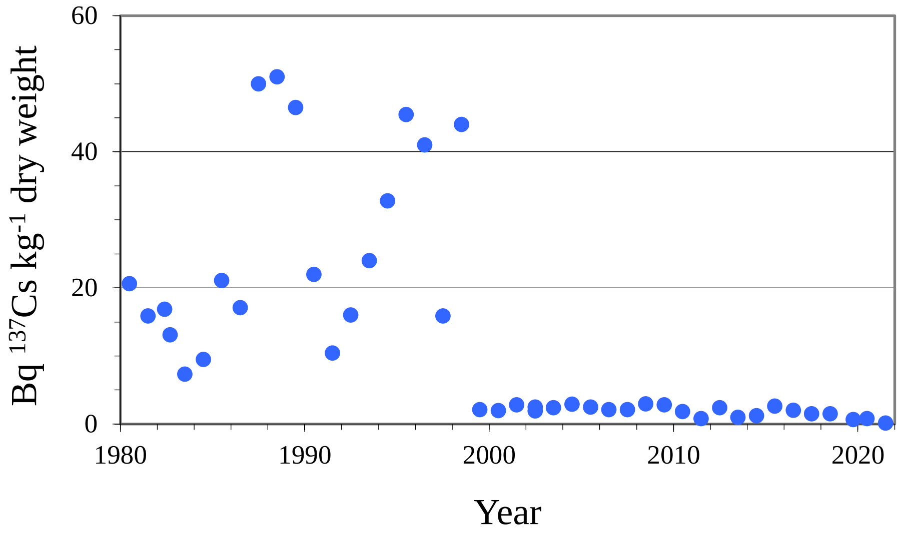

Fig. 3.1. Caesium–137 in sediment samples collected at Bolund in Roskilde Fjord. 1980 – 2021. (Unit: Bq kg^{-1} dry matter)

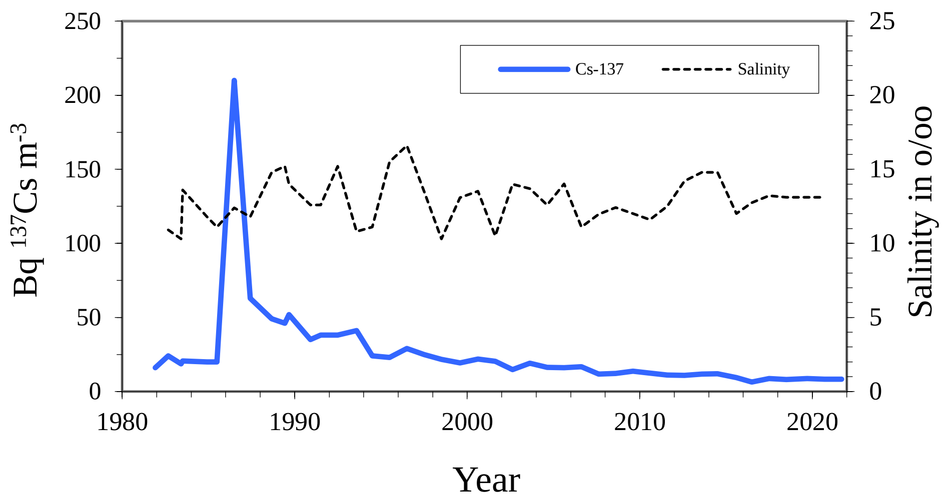

Fig. 4.1. Caesium–137 in seawater collected in Roskilde Fjord 1980 – 2021. (Unit: Bq m⁻³)

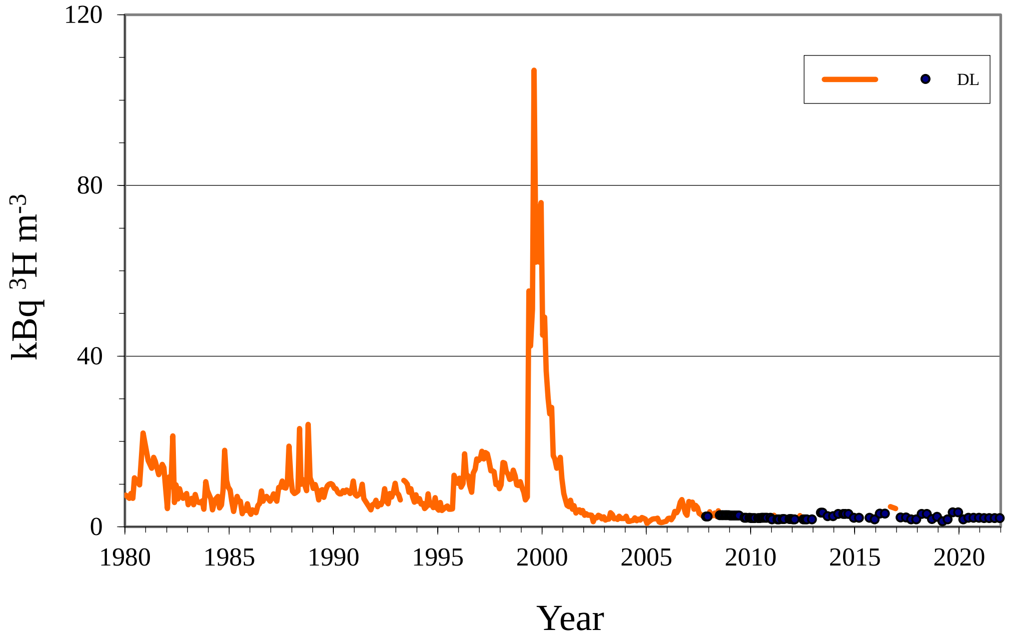

Fig. 4.2. Tritium in seawater collected in Roskilde Fjord 1980 - 2021. (Unit: kBq m^{-3}; DL = detection limit)

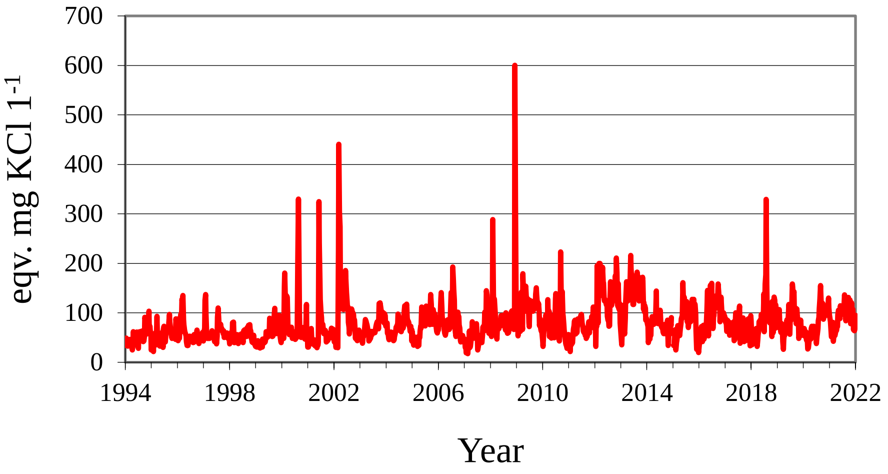

Fig. 7.1. Total-beta radioactivity in waste water collected at Risø 1994 - 2021. (Unit: eqv. mg KCl l^{-1})

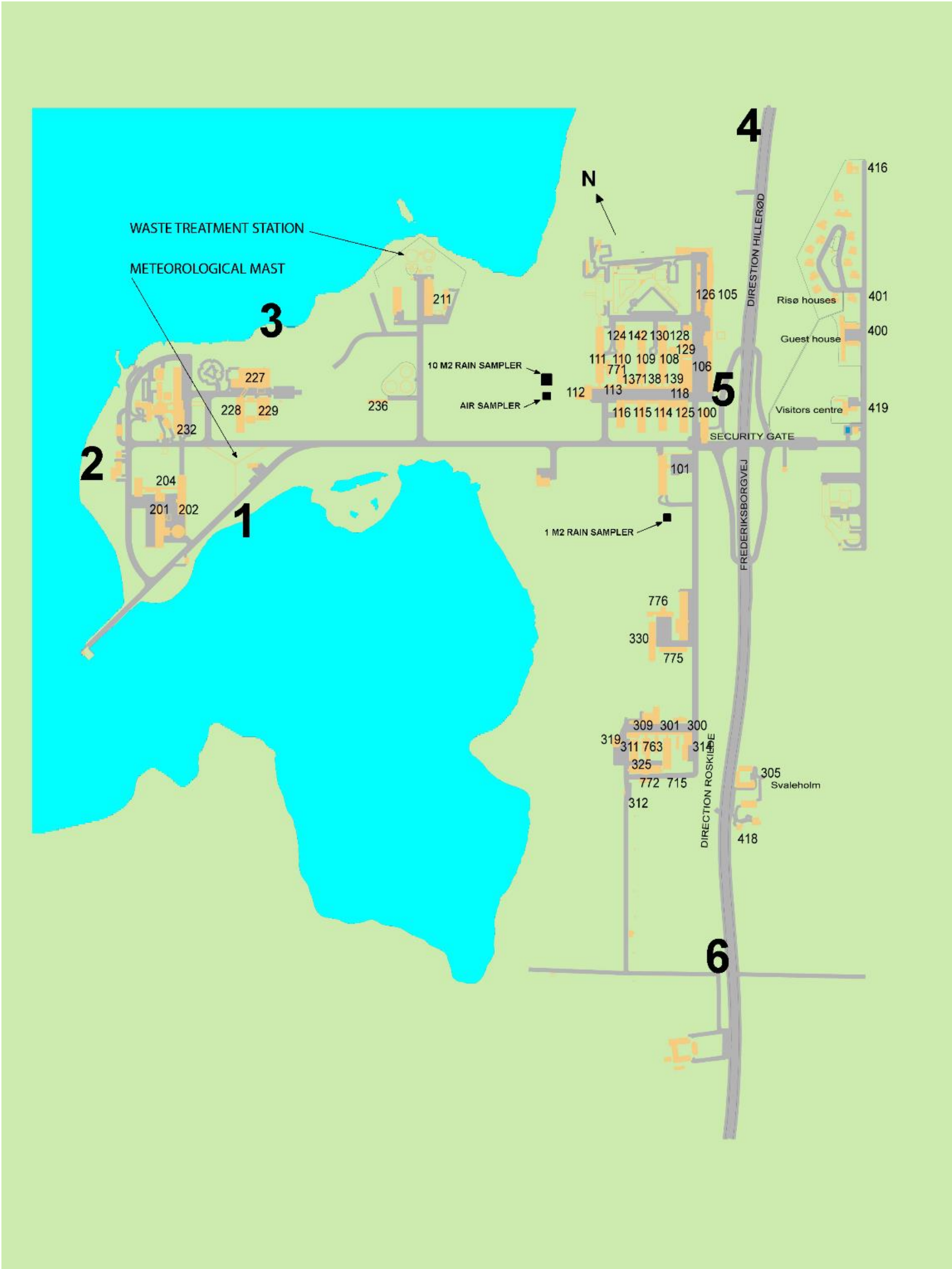

Fig. 8.1. Locations (1-6) for TLD measurements around the border of Risø (cf. Table 8.1).

Fig. 8.2. Locations for measurements of background radiation around Risø in Zones III, IV and V.

Materials and methods

External gamma dose rate monitoring

Monitoring of external gamma dose rate is carried out with the following devices

- Thermolumiscence dosimeters TLD: LiF, TLD equipment manufacturer: Harshaw
- NaI detector: 3x3 inch, SAM 935 Surveillance and Measurement System, Berkeley Nucleonics Cooperation, USA, visual read-out

Calibration of TLD is carried out at the Danish Health Authority, Radiation Protection. Traceability of delivered doses is ensured through calibration of the dose rate of the calibration irradiator by the Danish Health Authority, Radiation Protection. Further information on, e.g., the reported dosis, associated uncertainty and the lower detection limit is given by the Danish Health Authority, Radiation Protection at https://www.sst.dk/-/media/Opgaver/Strålebeskyttelse/Selvbetjening/Helkropsdosimeter_Infoseddel.ashx?la=da&hash=B6E03F283B84F87BF76CB1138912716608854948. The NaI detector is calibrated periodically vs. a Reuter Stokes high-pressure ionisation chamber.

Air sampler

The sampler at Risø is manufactured by DTU. Air is drawn through a polypropylene filter at a rate of about 2000 m^3/h. The filter is normally changed weekly. 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 intermittently.

DTU analyse the filters 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 repeated gamma analysis. Filters are analysed for ^{137}Cs, ^{7}Be and ^{210}Pb and other gamma emitters.

Deposition collector

The Risø site operates 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. The 10 m^2 collector provides monthly samples of rain water analysed for tritium and ion exchange resin which is analysed by gamma spectrometry for ^{7}Be, ^{137}Cs and ^{210}Pb and other gamma emitters.

Water and sediment

A waste water sample from the Waste Treatment Station is collected weekly and analysed for total beta radioactivity and the radionuclides ^{131}I, ^{137}Cs and ^{226}Ra. Water samples from Roskilde Fjord are collected each quarter and analysed for tritium, annually for ^{137}Cs. A sediment sample is collected annually from Roskilde Fjord and analysed for ^{137}Cs.

Terrestrial and aquatic biota and flora

Grass samples are collected weekly at the Risø site and analysed by gamma spectrometry. Samples are bulked to monthly samples which are analysed for ^{137}Cs.

Seaweed samples are collected annually from Roskilde Fjord at Risø and analysed for ^{137}Cs.

Sample reception and preparation

Sample identification numbers are entered in log books. Sample preparation methods include drying, freeze drying, ashing, sorting and sieving. Selected samples are archived.

Sample measurements

Radioactivity in samples is measured by total beta counting and gamma spectrometry.

Measurement devices

- Ge detectors for gamma spectrometry. Calibration of detectors is based on mixed-nuclide standards used occasionally. Monthly checks are made of detector efficiency and energy resolution. Background measurements of gamma systems are made a few times per year.
- Low-level Geiger-Müller counters for total beta counting, manufactured by DTU. Calibration based on standards of KCl. Counting efficiency and background are checked monthly.
- Liquid scintillation spectrometer for analysis of tritium in water. Samples are analysed with a calibration standard.

Analytical results, data handling and reporting tools

Analytical results are printed on paper, recorded in log books and stored in a data base on intranet. Results below detection limits recorded as such. Spreadsheets are used for calculating results from raw data.

Quality assurance, laboratory accreditation and intercomparison exercises

Analytical results are checked by experienced staff and discussed with senior scientists if questions arise.

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DTU participate regularly in international intercomparisons on laboratory analyses of radionuclides.

Conclusions

This report shows the results of the environmental surveillance monitoring programme carried out at and around the Risø site in July-December 2021. The mean concentrations in air were: 0.16±0.11 μBq m^{-3} of ^{137}Cs, 2.92±0.89 mBq m^{-3} of ^{7}Be and 0.17±0.10 mBq m^{-3} of ^{210}Pb (±1 standard uncertainty). The depositions by precipitation at Risø in the second half of 2020 were: 0.021±0.003 Bq m^{-2} of ^{137}Cs, 447±51 Bq m^{-2} of ^{7}Be, 31.3±3.8 Bq m^{-2} of ^{210}Pb and <0.7 kBq m^{-2} of ^{3}H. The average background dose rate (TLD) at Risø (Zone I) was measured as 0.10 µSv h^{-1} compared with 0.11 µSv h^{-1} in the four zones around Risø. None of the recorded levels of radioactivity and radiation have given rise to concern.

DTU Sustain is working to develop new environmentally friendly and sustainable technologies and disseminate this knowledge to society and new generations of engineers. Research in Radioecology & Tracer Studies (RTS) aims at developing methods and instruments for analysing manmade and naturally recurring radionuclides in the environment and samples from nuclear facilities. The RTS Section is responsible for caring out the environmental radioactivity monitoring program in Denmark.

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Appendix 4:

DTU participation in international intercomparison exercises on analyses of radioactivity since 2016

APPENDIX: DTU PARTICIPATION IN INTERNATIONAL INTERCOMPARISON EXERCISES ON ANALYSES OF RADIOACTIVITY SINCE 2016

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

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