DTU SUSTAIN

Radioactivity in the Risø District January-June 2025

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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 2025. The materials and methods used in connection with the monitoring programme are described in pages 27-28.

Risø, December 2025

Contents

Summary

The environmental surveillance of the Risø environment was continued in January-June 2025. The mean concentrations in air were: 0.24±0.24 μBq m^{-3} of ^{137}Cs, 2.57±1.02 mBq m^{-3} of ^{7}Be and 0.58±0.49 mBq m^{-3} of ^{210}Pb (±1 standard uncertainty). The depositions by precipitation at Risø in the first half of 2025 were: 0.025±0.003 Bq m^{-2} of ^{137}Cs, 214±19 Bq m^{-2} of ^{7}Be, 29.1±2.6 Bq m^{-2} of ^{210}Pb and <0.6 kBq m^{-2} of ^{3}H. The average background dose rate (TLD) at Risø (Zone I) was measured as 0.16 μSv h^{-1} compared with 0.16 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 2025 (Unit: μBq m^{-3})**

Date			^{7}Be	^{137}Cs	^{210}Pb
26-12-2024	–	03-01-2025	1015(11%)	0.057(12%)	152(11%)
03-01-2025	–	10-01-2025	1283(11%)	0.101(11%)	181(11%)
10-01-2025	–	17-01-2025	1479(11%)	0.208(11%)	264(11%)
17-01-2025	–	24-01-2025	2209(11%)	0.207(12%)	791(11%)
24-01-2025	–	31-01-2025	1851(11%)	0.141(11%)	247(11%)
31-01-2025	–	07-02-2025	2086(11%)	0.307(11%)	561(11%)
07-02-2025	–	14-02-2025	3909(11%)	1.255(11%)[a]	2182(11%)[a]
14-02-2025	–	21-02-2025	2007(11%)	0.244(11%)	523(11%)
21-02-2025	–	28-02-2025	2622(11%)	0.294(11%)	963(11%)
28-02-2025	–	07-03-2025	2881(11%)	0.180(12%)	614(11%)
07-03-2025	–	14-03-2025	3649(11%)	0.406(12%)	1886(11%)
14-03-2025	–	21-03-2025	3398(11%)	0.291(12%)	446(11%)
21-03-2025	–	28-03-2025	3087(11%)	0.453(12%)	686(11%)
28-03-2025	–	04-04-2025	1858(11%)	0.198(11%)	418(11%)
04-04-2025	–	11-04-2025	3317(11%)	0.250(11%)	453(11%)
11-04-2025	–	18-04-2025	2668(11%)	0.298(11%)	945(11%)
18-04-2025	–	25-04-2025	1305(11%)	0.093(11%)	386(11%)
25-04-2025	–	02-05-2025	4293(11%)	0.169(11%)	753(11%)
02-05-2025	–	09-05-2025	2604(11%)	0.095(11%)	314(11%)
09-05-2025	–	16-05-2025	4715(11%)	0.153(11%)	693(11%)
16-05-2025	–	23-05-2025	4297(11%)	0.279(11%)	631(11%)
23-05-2025	–	28-05-2025	1973(11%)	0.041(12%)	211(11%)
28-05-2025	–	06-06-2025	1420(11%)	0.029(12%)	70(11%)
06-06-2025	–	13-06-2025	2566(11%)	0.104(11%)	146(11%)
13-06-2025	–	20-06-2025	2316(11%)	0.202(11%)	374(11%)
20-06-2025	–	27-06-2025	1934(11%)	0.071(12%)	264(11%)
Mean			2567	0.236	583
SD			1016	0.235	494

*Figures in brackets are relative standard uncertainties. [a]High value compared with last year - historically not so unusual

Table 2.1. Radionuclides in precipitation in the 10 m^2 rain collector at Risø (cf. Fig. 8.1), January-June 2025. (Unit: Bq m^{-3})

Month	^{7}Be	^{137}Cs	^{210}Pb
January	1202(11%)*	0.045(12%)	106(11%)
February	1286(11%)	0.132(12%)	136(11%)
March	906(11%)	0.226(12%)	131(11%)
April	2218(11%)	0.444(13%)	389(11%)
May	1029(11%)	0.195(12%)	131(11%)
June	1632(11%)	0.160(12%)	277(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 2025. (Unit: Bq m^{-2})

Month	Precipitation (m)	^{7}Be	^{137}Cs	^{210}Pb
January	0.041(10%)*	49(12%)	0.0023(16%)	6.0(12%)
February	0.020(10%)	26(12%)	0.0014(16%)	4.2(12%)
March	0.014(10%)	13(12%)	0.0076(16%)	5.7(12%)
April	0.009(10%)	20(12%)	0.0074(16%)	5.2(12%)
May	0.032(10%)	33(12%)	0.0065(16%)	4.2(12%)
June	0.045(10%)	73(12%)	0.0089(16%)	6.8(12%)
Sum	0.161(5%)	214(9%)	0.0251(12%)	29.1(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 2025. (Unit: kBq m^{-3})

Month	10 m^2 rain collector*
January	<3.1
February	<3.1
March	<3.1
April	<3.1
May	<3.1
June	<3.1
Double determinations*.	

'<' means detection limit.

Table 2.4. Tritium in precipitation collected at Risø. January – June 2025 (Unit: kBq m^{-2})

Month	Precipitation (m)	10 m^2 rain collector
January	0.041(10%)*	<0.127
February	0.020(10%)	<0.063
March	0.014(10%)	<0.043
April	0.009(10%)	<0.028
May	0.032(10%)	<0.100
June	0.045(10%)	<0.140
Sum	0.161(5%)	< 0.501

[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 2025. (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) January - June 2025. (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) January – June 2025 [a].*

Month	kBq m^{-3}
March	<3.1
June	<3.1

* 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 2025. (**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	10 January	3.7(11%)	<0.2	
4	24 January	5.0(11%)	<0.2	
6	07 February	4.2(11%)	<0.3	
8	21 February	3.3(11%)	<0.3	
10	07 March	4.8(11%)	<0.4	
12	21 March	6.6(11%)	<0.3	
14	04 April	5.4(12%)	<0.5	
16	18 April	5.0(10%)	<0.3	
18	02 May	5.7(11%)	<0.4	
20	16 May	5.6(11%)	<0.3	
22	28 May	4.0(12%)	<0.2	
24	13 June	5.8(11%)	<0.7	
26	27 June	3.9(11%)	<0.3	
**January		3.3(11%)	0.062(14%)	0.021(14%)
**February		3.4(11%)	<0.029	<0.009
**March		5.9(11%)	0.023(11%)	0.006(11%)
**April		6.6(12%)	<0.057	<0.015
**May		6.0(12%)	0.032(11%)	<0.016(11%)
**June		4.6(12%)	0.033(11%)	<0.008(11%)

[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 2025. (Unit: Bq kg^{-1} dry)

Date	^{137}Cs	K*	% dry matter
18 June	1.4(11%)[a]	21(12%)	24(12%)
*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 2025.

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	56(21%)[a]	<32	<33	<68
2	36(29%)	<52	<65	<113
3	50(22%)	<84	<105	<182
4	61(19%)	<66	<86	<104
5	57(20%)	<32	<32	<64
6	75(17%)	<86	<113	<173
7	80(16%)	<84	<135	<179
8	67(18%)	<89	<109	<194
9	93(15%)	<74	<109	<154
10	93(15%)	<80	<97	<164
11	81(16%)	<63	<87	<131
12	93(15%)	<82	<110	<167
13	116(14%)	<90	<116	<181
14	98(14%)	<84	<106	<181
15	115(14%)	<86	<105	<182
16	126(13%)	<84	<137	<176
17	124(13%)	<52	<73	<113
18	141(12%)	<87	<118	<185
19	142(12%)	<83	<102	<176
20	162(12%)	<80	<103	<173
21	161(12%)	<86	<106	<181
22	160(12%)	<75	<108	<155
23	157(12%)	<64	<84	<111
24	152(12%)	<84	<123	<174
25	150(12%)	<79	<121	<169
26	147(12%)	<78	<107	<170
Mean	107.0	<75	<100	<155
SD	39.9			

[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 2024 – May 2025. (Results are normalized to μSv h^{-1}).

Location	μSv h^{-1}
1	0.16[a,]
2	0.16
3	0.16
4	0.16
5	0.16
6	0.16
Mean	0.16

[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 2024 – May 2025. (Results are normalized to μSv h^{-1}). See texts on p. 16 marked 'a' for Tables 8.1 and 8.2.

Risø zone	Location	μSv h^{-1}
I	1	0.16[a]
I	2	0.16
I	3	0.16
I	4	0.16
I	5	0.16
Mean		0.16
II	P1	0.16
II	P2	0.16
II	P3	0.13
II	P4	0.16
Mean		0.15
III	P1	0.16
III	P2	0.16
III	P3	0.16
Mean		0.16
IV	P1	0.16
IV	P2	0.16
IV	P3	0.16
IV	P4	0.16
IV	P5	0.16
IV	P6	0.16
IV	P7	0.16
Mean		0.16
V	P1	0.16
V	P2	0.16
V	P3	0.18
V	P4	0.16
V	P5	0.16
V	P6	0.16
V	P7	0.16
V	P8	0.13
V	P9	0.16
V	P10	0.16
Mean		0.16

Table 8.3. Terrestrial dose rates at the Risø zones (cf. Fig. 8.2 and Fig. 1) October 2024 – May 2025. Measured with a NaI(Tl) detector. (Unit: $\mu Sv\ h^{-1}$)[a]

Risø zone	Location	May
I	P1	0,040(10%)
I	P2	0,040(10%)
I	P3	0,128(10%)
I	P4	0,041(10%)
I	P5	0,042(10%)
Mean		0.058(5%)
II	P1	0,040(10%)
II	P2	0,040(10%)
II	P3	0,036(10%)
II	P4	0,039(10%)
Mean		0.039(4%)
III	P1	0.045(10%)
III	P2	0.045(10%)
III	P3	0.042(10%)
Mean		0.044(6%)
IV	P1	0,037(10%)
IV	P2	0,045(10%)
IV	P3	0,044(10%)
IV	P4	0,041(10%)
IV	P5	0,039(10%)
IV	P6	0,038(10%)
IV	P7	0,042(10%)
Mean		0.041(4%)
V	P1	0,037(10%)
V	P2	0,044(10%)
V	P3	0,048(10%)
V	P4	0,044(10%)
V	P5	0,047(10%)
V	P6	0,044(10%)
V	P7	0,043(10%)
V	P7a	0,041(10%)
V	P8	0,041(10%)
V	P9	0,037(10%)
V	P10	0,037(10%)
Mean		0.042(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)

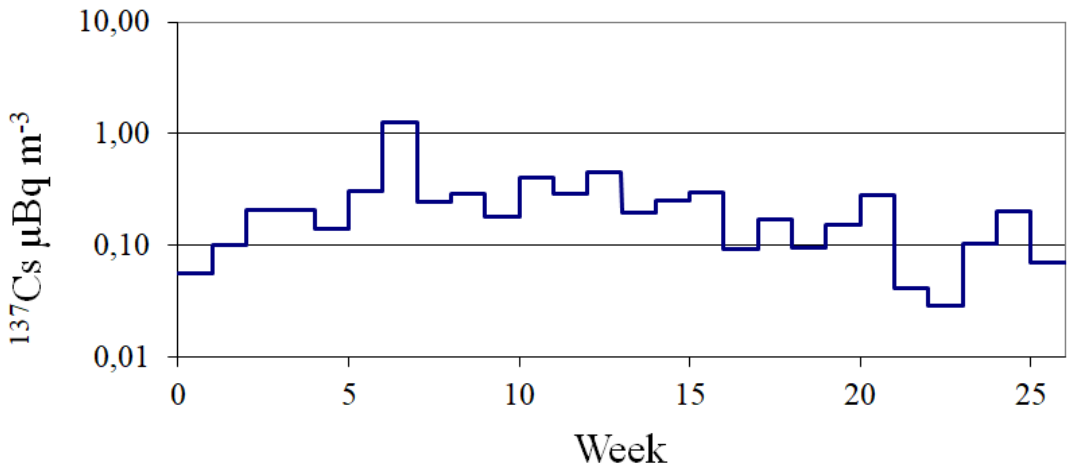

Fig. 1.1. Caesium-137 in ground level air collected at Risø in January-June 2025. (Unit: µBq m^{-3})

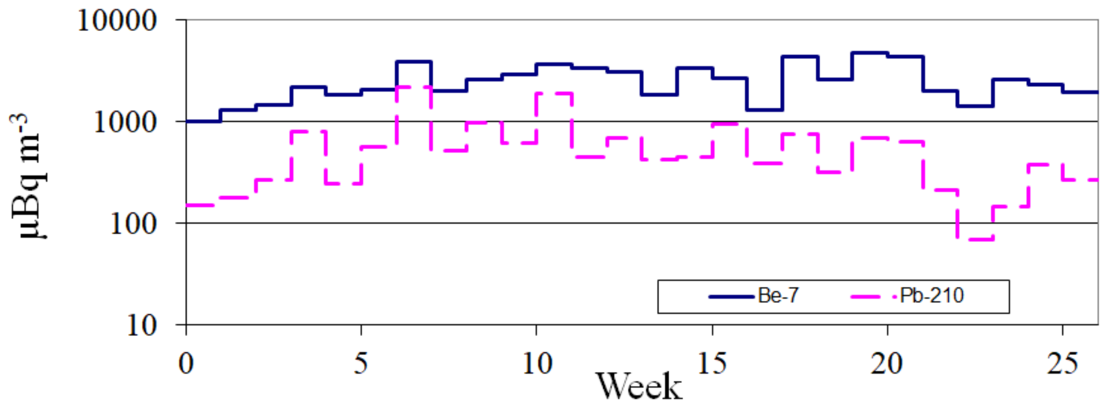

Fig. 1.2. Beryllium-7 and Lead-210 in ground level air collected at Risø in January-June 2025. (Unit: µBq m^{-3})

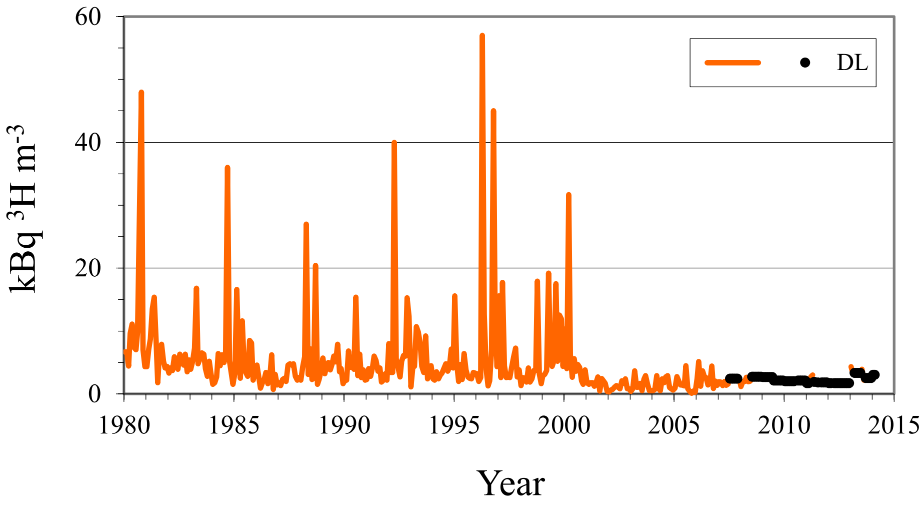

Fig. 2.3.1. Tritium in precipitation collected at Risø (1 m² rain collector) 1980 - 2013. (Unit: kBq m⁻³; DL = detection limit). This rain collector was taken out of operation in 2013.

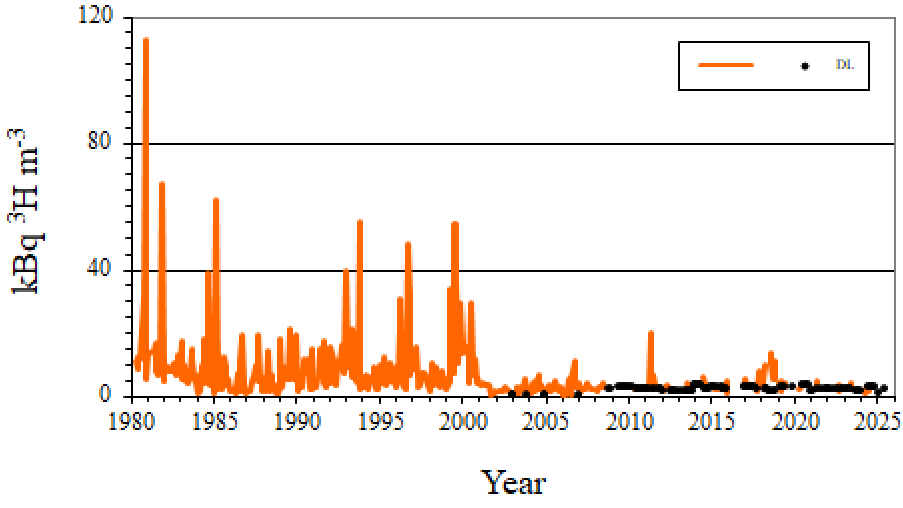

Fig. 2.3.2. Tritium in precipitation collected at Risø (10 m² rain collector) 1980 - 2025. (Unit: kBq m⁻³; DL = detection limit)

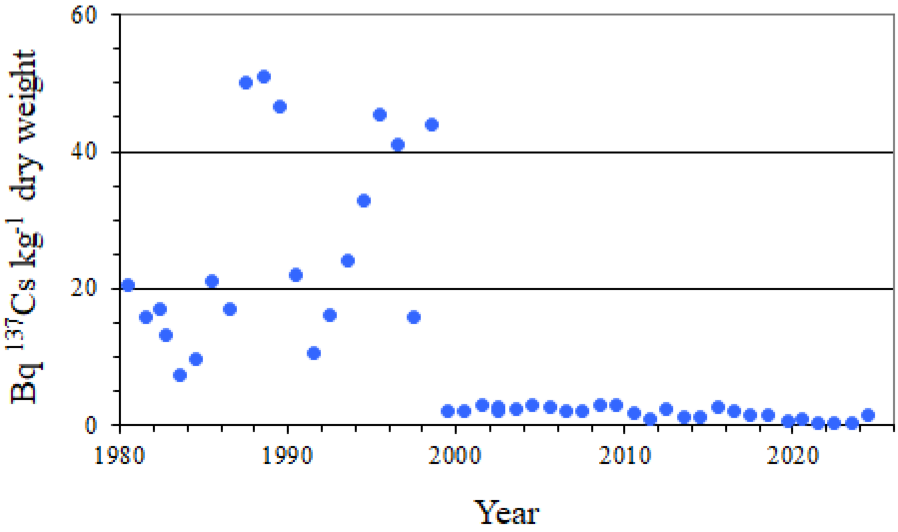

Fig. 3.1. Caesium–137 in sediment samples collected at Bolund in Roskilde Fjord. 1980 – 2025. (Unit: Bq kg^{-1} dry matter)

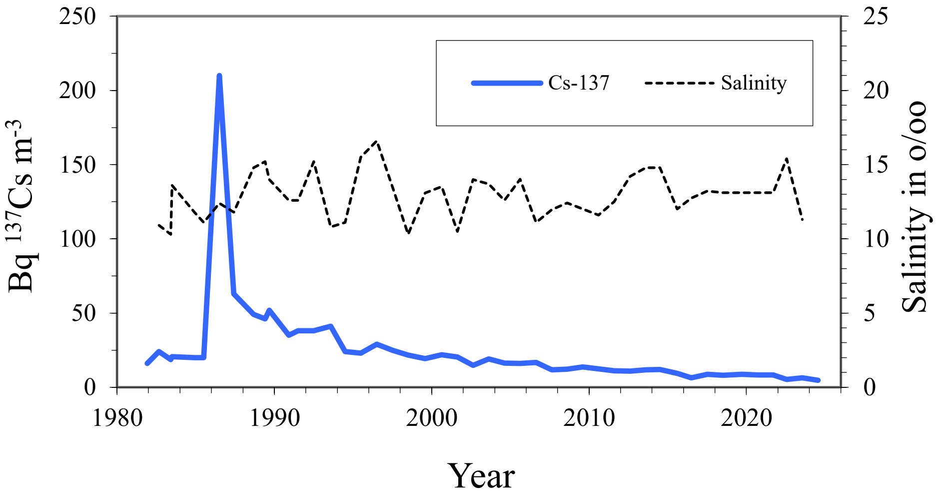

Fig. 4.1. Caesium–137 in seawater collected in Roskilde Fjord 1980 – 2025. (Unit: Bq m⁻³)

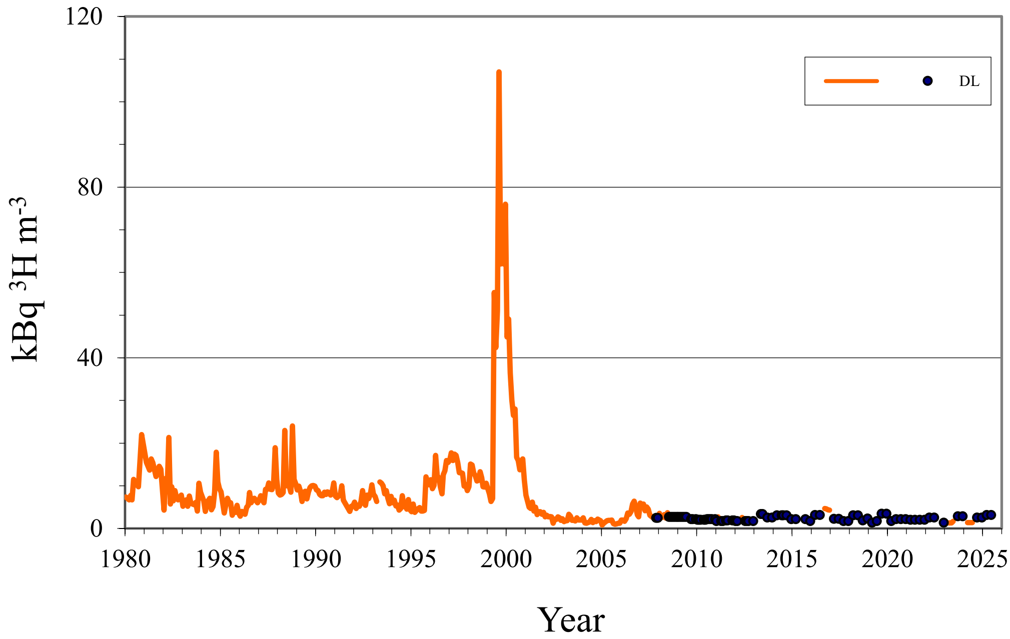

Fig. 4.2. Tritium in seawater collected in Roskilde Fjord 1980 - 2025. (Unit: kBq m⁻³; DL = detection limit)

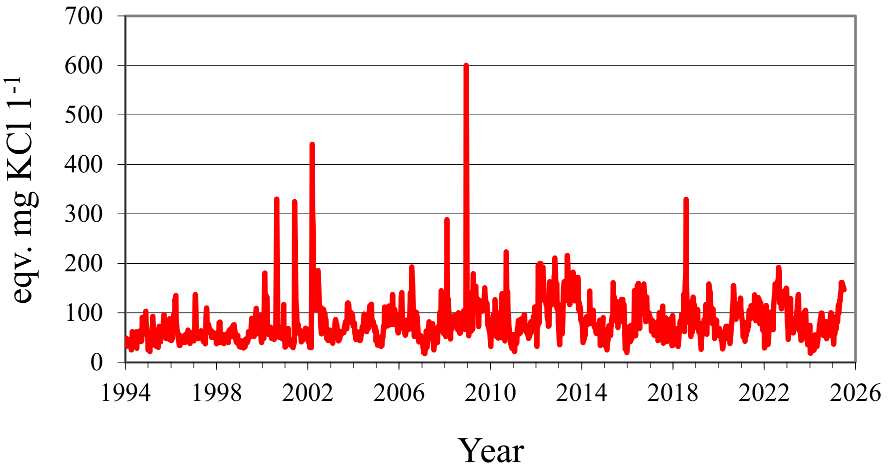

Fig. 7.1. Total-beta radioactivity in waste water collected at Risø 1994 - 2025. (Unit: eqv. mg KCl l^{-1})

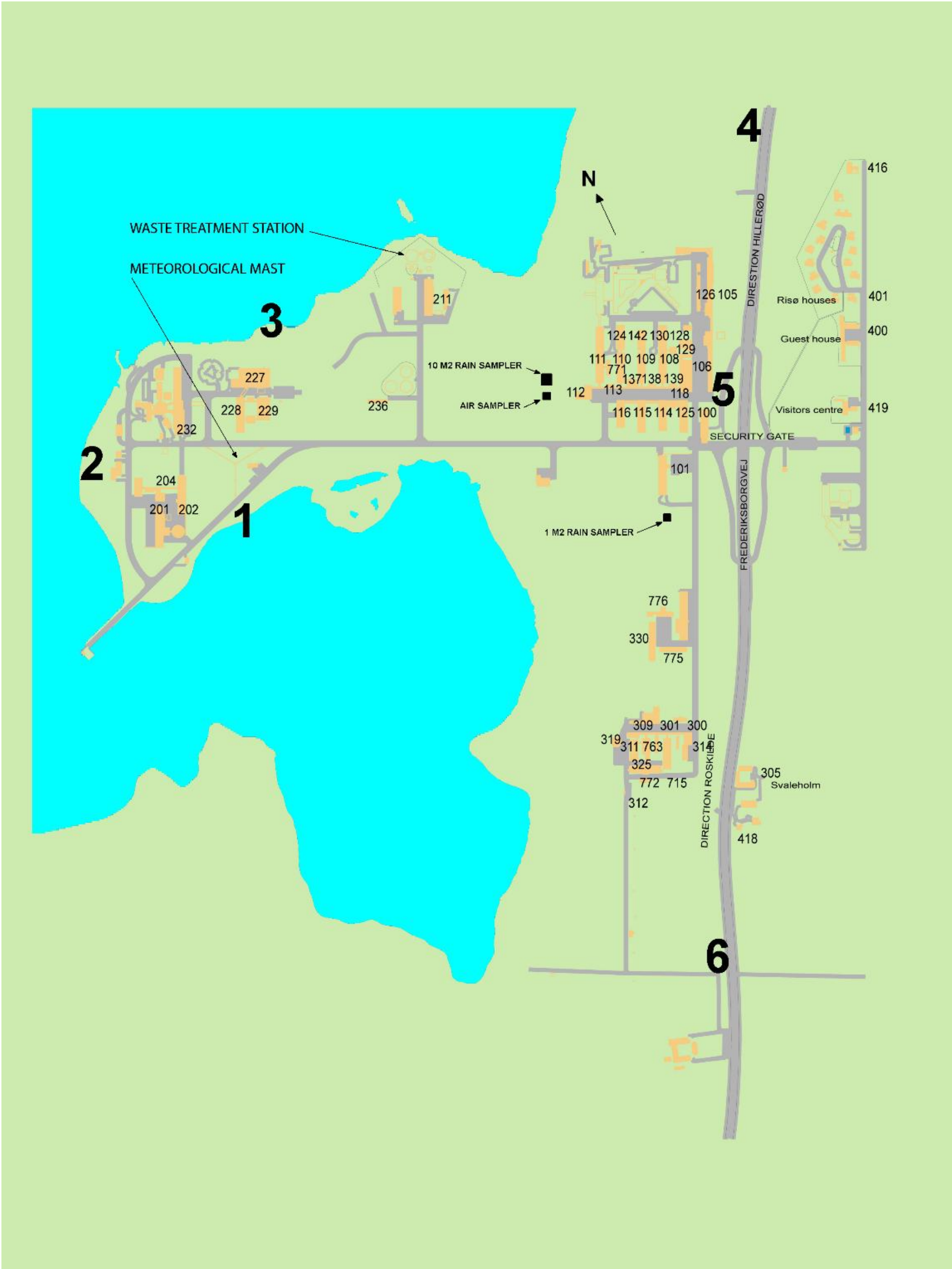

Fig. 8.1. Locations (1-6) for TLD measurements around the border of Risø (cf. Table 8.1).

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 2025. The mean concentrations in air were: 0.24±0.24 μBq m^{-3} of ^{137}Cs, 2.57±1.02 mBq m^{-3} of ^{7}Be and 0.58±0.49 mBq m^{-3} of ^{210}Pb (±1 standard uncertainty). The depositions by precipitation at Risø in the first half of 2025 were: 0.025±0.003 Bq m^{-2} of ^{137}Cs, 214±19 Bq m^{-2} of ^{7}Be, 29.1±2.6 Bq m^{-2} of ^{210}Pb and <0.6 kBq m^{-2} of ^{3}H. The average background dose rate (TLD) at Risø (Zone I) was measured as 0.16 μSv h^{-1} compared with 0.16 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 Group under the Waste, Climate and Monitoring Section in DTU SUSTAIN is responsible for caring out the environmental radioactivity monitoring program in Denmark.

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