

# Radioactivity in the Risø District July-December 2009

Risø-R-Report

Sven P. Nielsen, Kasper G. Andersson and Arne Miller  
Risø-R-1737(EN)  
June 2010

Risø DTU  
National Laboratory for Sustainable Energy

---



**Author:** Sven P. Nielsen, Kasper G. Andersson and Arne Miller  
**Title:** Radioactivity in the Risø District July-December 2009  
**Division:** Radiation Research

**Risø-R-1737(EN)**  
**June 2010**

**Abstract (max. 2000 char.):** The environmental surveillance of the Risø environment was continued in July - December 2009. The mean concentrations in air were:  $0.34 \pm 0.19 \mu\text{Bq m}^{-3}$  of  $^{137}\text{Cs}$ ,  $3.55 \pm 1.09 \text{mBq m}^{-3}$  of  $^7\text{Be}$  and  $0.25 \pm 0.11 \text{mBq m}^{-3}$  of  $^{210}\text{Pb}$  ( $\pm 1$  S.D.;  $N = 26$ ). The depositions by precipitation at Risø in the second half of 2009 were:  $0.031 \text{Bq m}^{-2}$  of  $^{137}\text{Cs}$ ,  $586 \text{Bq m}^{-2}$  of  $^7\text{Be}$ ,  $34.2 \text{Bq m}^{-2}$  of  $^{210}\text{Pb}$  and  $< 1.0 \text{kBq m}^{-2}$  of  $^3\text{H}$ . The average background dose rate (TLD) at Risø (Zone I) was  $72 \text{nSv h}^{-1}$  compared with  $63 \pm 5 \text{nSv h}^{-1}$  ( $\pm 1$  S.D.;  $N = 4$ ) in the four zones around Risø.

**ISSN 0106-2840**  
**ISBN 978-87-550-3829-5**

**Contract no.:**

**Group's own reg. no.:**  
1400103-07

**Sponsorship:**

**Cover :**

**Pages: 24**  
**Tables: 14**  
**References:**

Information Service Department  
Risø National Laboratory for  
Sustainable Energy  
Technical University of Denmark  
P.O.Box 49  
DK-4000 Roskilde  
Denmark  
Telephone +45 46774005  
[bibl@risoe.dtu.dk](mailto:bibl@risoe.dtu.dk)  
Fax +45 46774013  
[www.risoe.dtu.dk](http://www.risoe.dtu.dk)

# Contents

Table 1.	Radionuclides in air	5
Table 2.1.	Radionuclides in precipitation	6
Table 2.2.	Radionuclides in precipitation	6
Table 2.3.	Tritium in precipitation	7
Table 2.4.	Tritium in precipitation	7
Table 3.1.	Radionuclides in sediment samples	8
Table 4.1.	Radionuclides in seawater	8
Table 4.2.	Tritium in seawater	8
Table 5.1.	Radionuclides in grass	9
Table 5.2.	Radionuclides in sea plants	10
Table 7.1.	Waste water	11
Table 8.1.	Background dose rates around the border of Risø (TLD)	12
Table 8.2.	Background dose rates around Risø (TLD)	13
Table 8.3.	Terrestrial dose rates at the Risø zones (NaI(Tl) detector)	14
Fig. 1.	Map of Risø	15
Fig. 1.1.	Caesium-137 in air	16
Fig. 1.2.	Beryllium-7 and lead-210 in air	16
Fig. 2.3.1	Tritium in precipitation (1 m <sup>2</sup> rain collector)	17
Fig. 2.3.2	Tritium in precipitation (10 m <sup>2</sup> rain collector)	17
Fig. 3.1	Caesium-137 in sediment samples	18
Fig. 4.1	Caesium-137 in seawater	19
Fig. 4.2	Tritium in seawater	19
Fig. 7.1	Total-beta radioactivity in waste water	20
Fig. 8.1.	Map of Risø with locations for TLD measurements	21
Fig. 8.2.	The environment of Risø	22



Table 1. Radionuclides in ground level air collected at Risø (cf. Figs. 1, 1.1 and 1.2), July - December 2009. (Unit:  $\mu\text{Bq m}^{-3}$ )

Date	$^7\text{Be}$	$^{137}\text{Cs}$	$^{210}\text{Pb}$
29-Jun-09 – 06-Jul-09	6006	0.420	522
06-Jul-09 – 13-Jul-09	2975	0.091	120
13-Jul-09 – 20-Jul-09	3819	0.100	177
20-Jul-09 – 27-Jul-09	3385	0.102	174
27-Jul-09 – 03-Aug-09	5465	0.171	206
03-Aug-09 – 10-Aug-09	5767	0.369	346
10-Aug-09 – 17-Aug-09	2952	0.150	127
17-Aug-09 – 24-Aug-09	4945	0.164	189
24-Aug-09 – 01-Sep-09	4286	0.334	218
01-Sep-09 – 07-Sep-09	3607	0.203	198
07-Sep-09 – 14-Sep-09	4429	0.355	326
14-Sep-09 – 21-Sep-09	3659	0.654	371
21-Sep-09 – 28-Sep-09	3822	0.167	198
28-Sep-09 – 05-Oct-09	2146	0.155	65
05-Oct-09 – 12-Oct-09	3069	0.288	141
12-Oct-09 – 19-Oct-09	2574	0.742	158
19-Oct-09 – 26-Oct-09	2067	0.500	407
26-Oct-09 – 02-Nov-09	2896	0.420	390
02-Nov-09 – 09-Nov-09	1843	0.431	321
09-Nov-09 – 16-Nov-09	2177	0.300	199
16-Nov-09 – 23-Nov-09	4243	0.220	270
23-Nov-09 – 30-Nov-09	3417	0.190	121
30-Nov-09 – 07-Dec-09	3238	0.565	297
07-Dec-09 – 14-Dec-09	2874	0.599	423
14-Dec-09 – 21-Dec-09	3826	0.565	369
21-Dec-09 – 28-Dec-09	2923	0.472	239
Mean	3554	0.336	253
SD	1089	0.185	112

Table 2.1. Radionuclides in precipitation in the 10 m<sup>2</sup> rain collector at Risø (cf. Fig. 1), July - December 2009. (Unit: Bq m<sup>-3</sup>)

Month	<sup>7</sup> Be	<sup>137</sup> Cs	<sup>210</sup> Pb
July	2759	0.111	119
August	3299	0.219	224
September	1236	0.148	111
October	1588	0.086	83
November	1160	0.054	86
December	1493	0.082	82

Table 2.2. Radionuclides in precipitation in the 10 m<sup>2</sup> rain collector at Risø (cf. Fig. 1), July - December 2009. (Unit: Bq m<sup>-2</sup>)

Month	Precipitation (m)	<sup>7</sup> Be	<sup>137</sup> Cs	<sup>210</sup> Pb
July	0.073	202	0.0081	8.7
August	0.023	77	0.0051	5.2
September	0.025	31	0.0038	2.9
October	0.046	73	0.0040	3.8
November	0.097	113	0.0052	8.5
December	0.060	90	0.0050	5.0
Sum	0.325	586	0.0312	34.2

Table 2.3. Tritium in precipitation collected at Risø (cf. Figs. 1, 2.3.1 and 2.3.2). July - December 2009. (Unit: kBq m<sup>-3</sup>)

Month	1 m <sup>2</sup> rain collector*	10 m <sup>2</sup> rain collector*
July	< 2.1	< 2.1
August	< 2.1	< 2.1
September	< 2.1	< 2.1
October	< 2.1	< 2.1
November	2.7	< 2.1
December	< 2.1	< 2.1
Double determinations*.		

Table 2.4. Tritium in precipitation collected at Risø (cf. Fig. 1). July – December 2009. (Unit: kBq m<sup>-2</sup>)

Month	Precipitation (m)	1 m <sup>2</sup> rain collector	10 m <sup>2</sup> rain collector
July	0.073	< 0.153	< 0.153
August	0.023	< 0.048	< 0.048
September	0.025	< 0.053	< 0.053
October	0.046	< 0.097	< 0.097
November	0.097	0.262	< 0.204
December	0.060	< 0.126	< 0.126
Sum	0.325	< 0.739	< 0.681

*Table 3.1. Radionuclides in sediment samples collected at Bolund in Roskilde Fjord.(cf. Fig. 3.1) July - December 2009. (Unit: Bq kg<sup>-1</sup> dry)*

No samples in this period

*Table 4.1. Radionuclides in seawater collected in Roskilde Fjord (cf. Fig. 4.1) July - December 2009. (Unit: Bq m<sup>-3</sup>)*

Date	<sup>137</sup> Cs	<sup>40</sup> K
2 July	13.8	0.01

*Table 4.2. Tritium in seawater collected in Roskilde Fjord (Risø pier) (cf. Fig. 4.2) July - December 2009.*

Month	kBq m <sup>-3</sup>
July	2.6 *
August	2.4 *
September	< 2.1 *
October	< 2.1 *
November	2.2 *
December	< 2.1 *

\* Double determinations

Table 5.1. Radionuclides in grass collected at Risø (near the Waste Treatment Station (cf. Fig. 1)), July - December 2009. (\*\*Measured on bulked ash samples)

Week no. or month	Date	K (g kg <sup>-1</sup> fresh)	<sup>137</sup> Cs (Bq kg <sup>-1</sup> fresh)	<sup>137</sup> Cs (Bq m <sup>-2</sup> )
28	6 July	5.7	<0.6	
29	13 July	4.7	<0.4	
30	20 July	5.2	<0.5	
31	27 July	5.5	<0.5	
32	3 August	4.6	<0.4	
33	10 August	2.2	<0.4	
34	17 August	5.5	<0.5	
35	24 August	5.7	<0.4	
36	31 August	7.3	<0.4	
37	7 September	5.7	<0.6	
38	14 September	6.7	<0.5	
39	21 September	5.2	<0.5	
40	28 September	4.3	<0.4	
41	5 October	1.5	<0.5	
42	12 October	5.7	<0.7	
43	19 October	4.7	<0.5	
44	26 October	3.2	<0.4	
45	2 November	3.1	<0.5	
46	9 November	4.4	<0.5	
47	16 November	3.1	<0.4	
48	23 November	4.8	<0.7	
49	30 November	3.6	<0.5	
50	7 December	3.5	<0.4	
51	14 December	3.1	<0.4	
52	21 December	1.0	<0.1	
53	28 December	1.9	<0.3	
**July		5.5	0.109	0.034
**August		5.8	0.033	0.013
**September		5.4	0.028	0.008
**October		4.7	0.053	0.015
**November		3.5	0.063	0.022
**December		1.9	0.147	0.064

*Table 5.2. Radionuclides in Fucus vesiculosus collected at Bolund in Roskilde Fjord. July - December 2009. (Unit: Bq kg<sup>-1</sup> dry)*

No samples in this period

Table 7.1. Waste water collected at Risø (cf. Fig. 1), July - December 2009.

Week number	eqv. mg KCl l <sup>-1</sup>	<sup>137</sup> Cs (Bq m <sup>-3</sup> )	<sup>131</sup> I (Bq m <sup>-3</sup> )	<sup>226</sup> Ra (Bq m <sup>-3</sup> )
28	106	<121	<123	<231
29	118	<125	<130	<248
30	105	<113	<120	<449
31	114	<108	<111	<213
32	112	<115	<117	<212
33	116	<112	<<116	<208
34	103	<116	<123	<230
35	109	<117	<121	<229
36	124	<107	<123	<217
37	109	<110	<115	<222
38	109	<113	<118	<223
39	137	<112	<111	<211
40	151	<114	<116	<227
41	138	<111	<153	<217
42	121	<105	<117	<220
43	121	<103	<105	<200
44	111	<71	<41	<126
45	119	<123	<146	<270
46	102	<115	<115	<217
47	74	<115	<126	<232
48	88	<120	<124	<229
49	72	<120	<118	<227
50	64	<119	<123	<237
51	69	<109	<116	<219
52	57	<79	<238	<157
53	43	<114	<243	<219
Mean	104			
SD	26.2			

*Table 8.1. Background dose rates around the border of Risø (cf. Fig. 8.1) measured with thermoluminescence dosimeters (TLD) in the period May 2009 – October 2009. (Results are normalized to nSv h<sup>-1</sup>)*

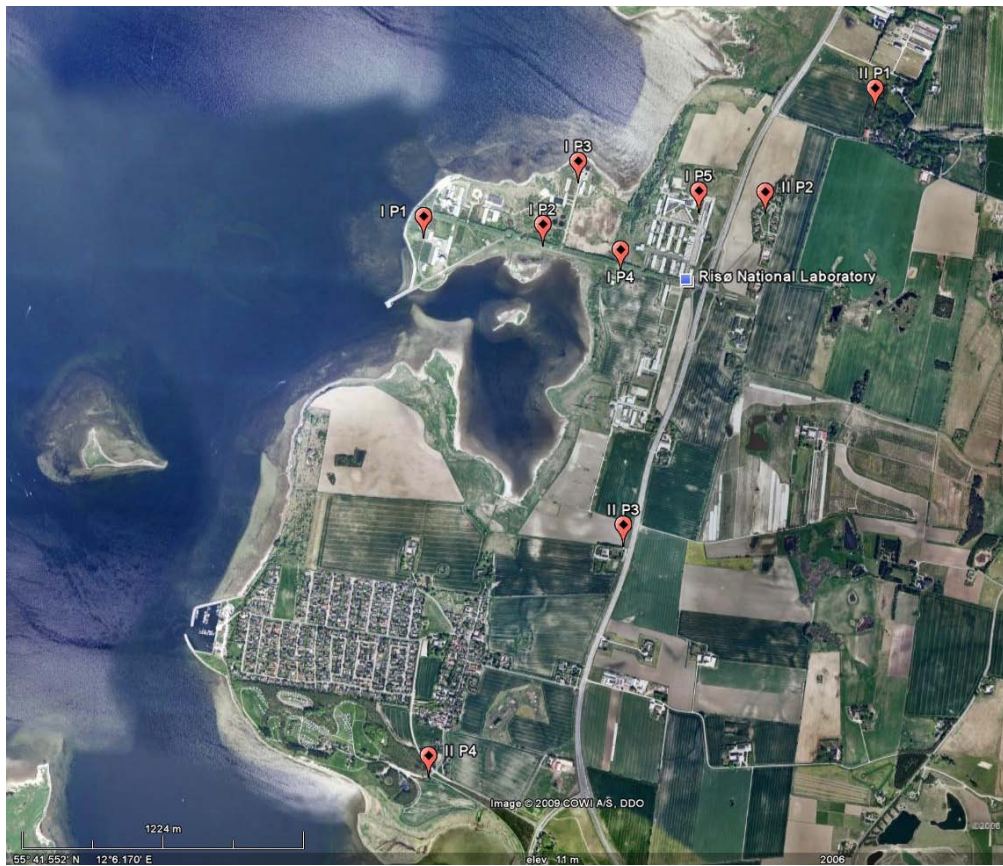
Location	nSv h <sup>-1</sup>
1	55
2	56
3	50
4	67
5	64
6	65
Mean	60

Table 8.2. Background dose rates around Risø (cf. Fig. 8.2 and Fig. 1) measured with thermoluminescence dosimeters (TLD) in the period May 2009 – October 2009. (Results are normalized to  $\text{nSv h}^{-1}$ )

Risø zone	Location	$\text{nSv h}^{-1}$
I	1	44
I	2	64
I	3	121
I	4	76
I	5	55
Mean		72
II	P1	56
II	P2	79
II	P3	77
II	P4	46
Mean		65
III	P1	62
III	P2	67
III	P3	66
Mean		65
IV	P1	47
IV	P2	50
IV	P3	56
IV	P4	69
IV	P5	58
IV	P6	46
IV	P7	62
Mean		55
V	P1	62
V	P2	-
V	P3	75
V	P4	57
V	P5	70
V	P6	55
V	P7	63
V	P8	72
V	P9	73
V	P10	69
Mean		66

Table 8.3. Terrestrial dose rates at the Risø zones (cf. Fig. 8.2 and Fig. 1) July - December 2009. Measured with a NaI(Tl) detector. (Unit: nSv h<sup>-1</sup>)

Risø zone	Location	July	October
I	P1	38	37
I	P2	47	48
I	P3	354	392
I	P4	42	43
I	P5	42	41
Mean		105	112
II	P1	39	39
II	P2	41	42
II	P3	35	37
II	P4	39	41
Mean		38	40
III	P1		45
III	P2		49
III	P3		42
Mean			45
IV	P1		36
IV	P2		45
IV	P3		38
IV	P4		42
IV	P5		40
IV	P6		37
IV	P7		42
Mean			40
V	P1		38
V	P2		45
V	P3		56
V	P4		51
V	P5		52
V	P6		48
V	P7		43
V	P7a		40
V	P8		43
V	P9		45
V	P10		36
Mean			46



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

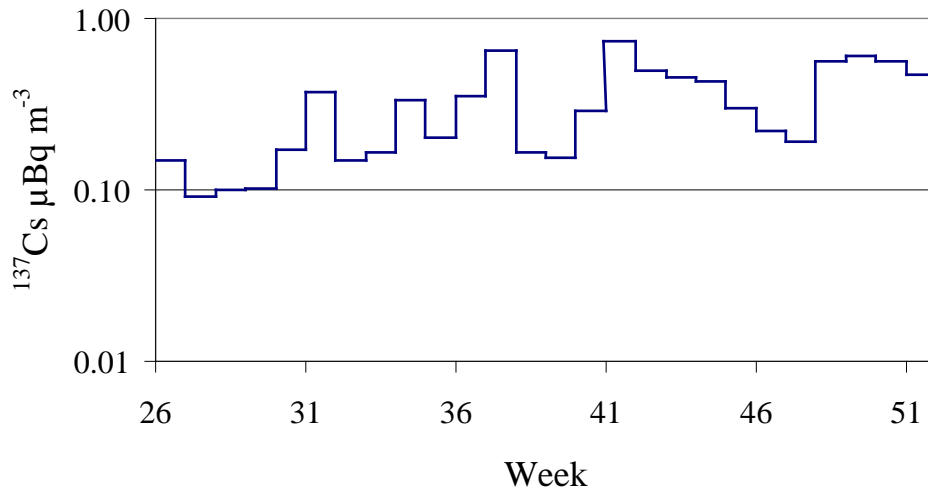


Fig. 1.1. Caesium-137 in ground level air collected at Risø in July-December 2009. (Unit:  $\mu\text{Bq m}^{-3}$ )

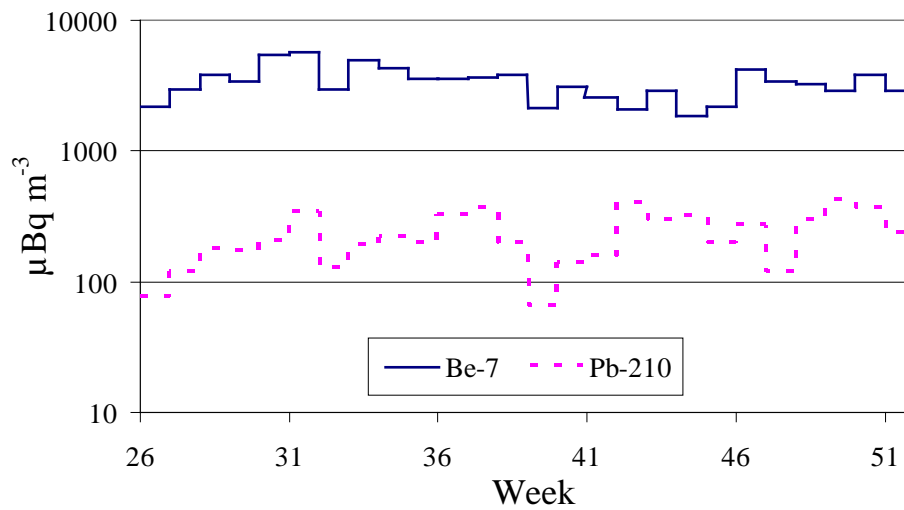


Fig. 1.2. Beryllium-7 and lead-210 in ground level air collected at Risø in July-December 2009. (Unit:  $\mu\text{Bq m}^{-3}$ )

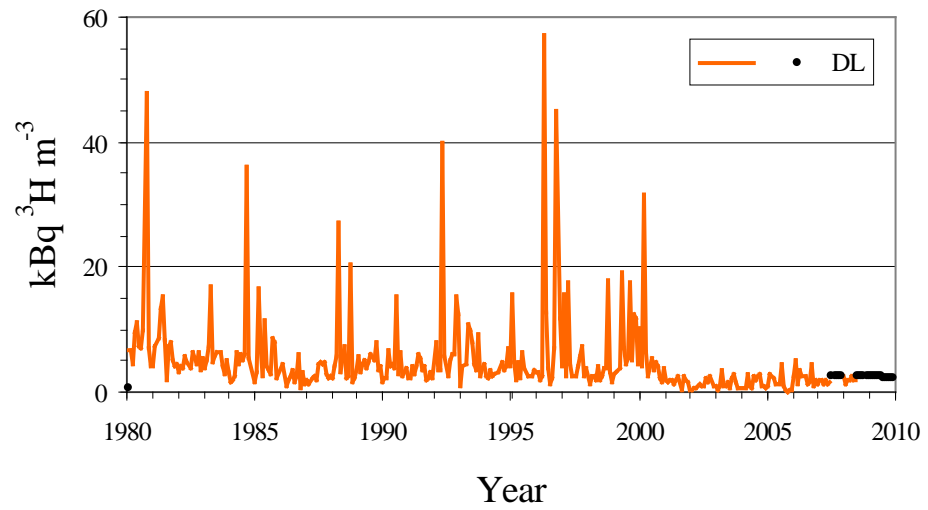


Fig. 2.3.1. Tritium in precipitation collected at Risø (  $1\text{ m}^2$  rain collector ) 1980 - 2009. (Unit:  $\text{kBq m}^{-3}$ ; DL = detection limit )

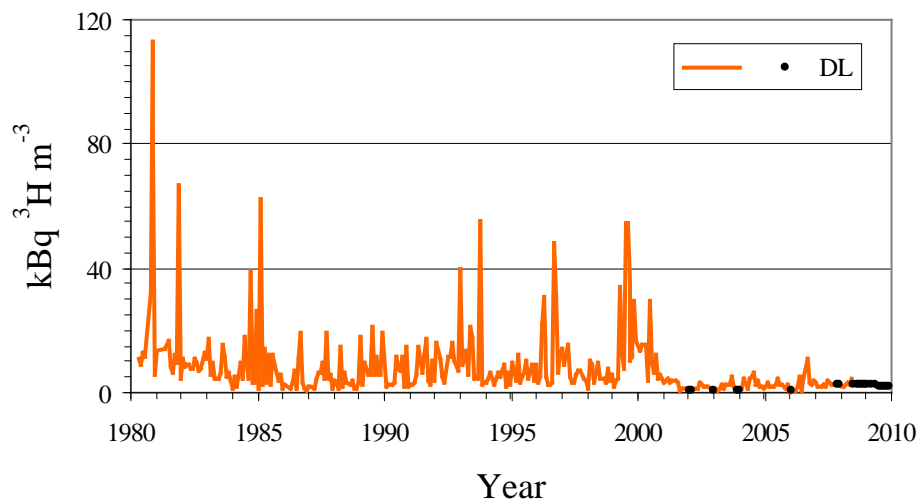


Fig. 2.3.2. Tritium in precipitation collected at Risø (  $10\text{ m}^2$  rain collector ) 1980 - 2009. (Unit:  $\text{kBq m}^{-3}$ ; DL = detection limit )

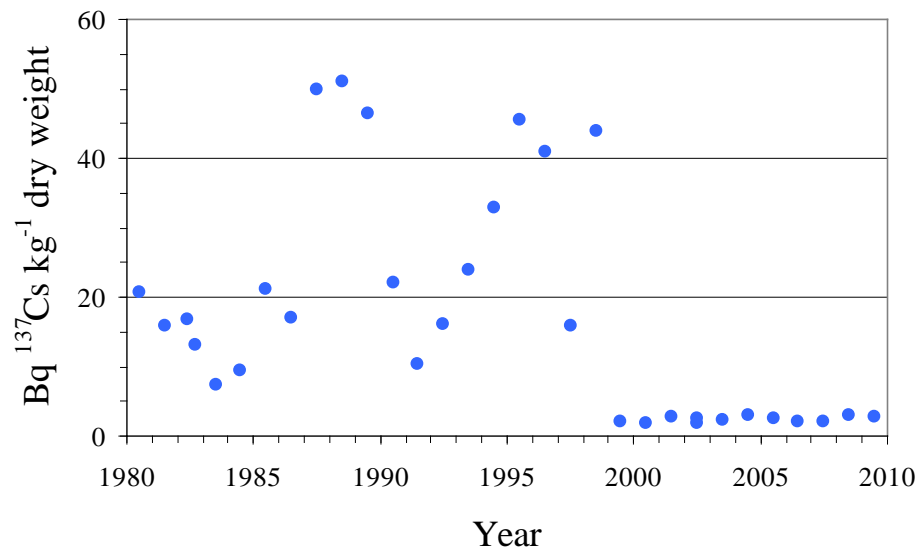


Fig. 3.1. Caesium-137 in sediment samples collected at Bolund in Roskilde Fjord. 1980 – 2009. (Unit: Bq kg<sup>-1</sup> dry matter)

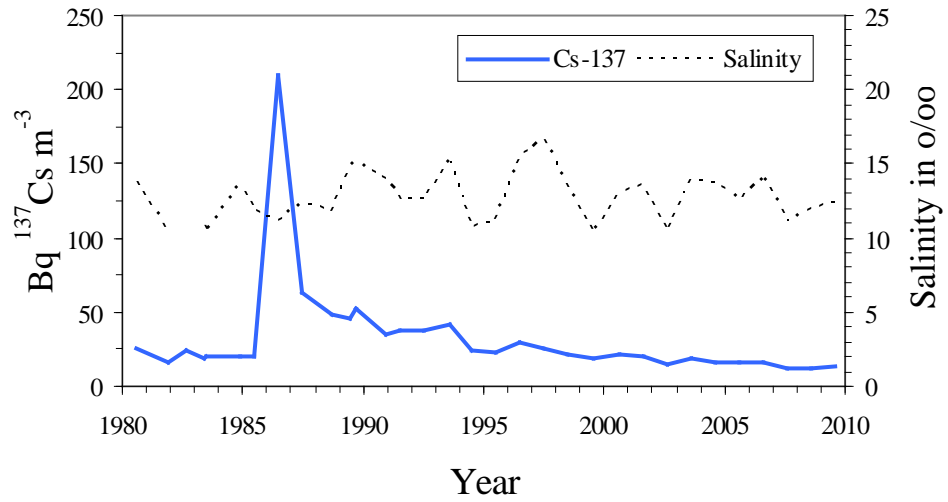


Fig. 4.1. Caesium-137 in seawater collected in Roskilde Fjord 1980 - 2009. (Unit:  $\text{Bq m}^{-3}$ )

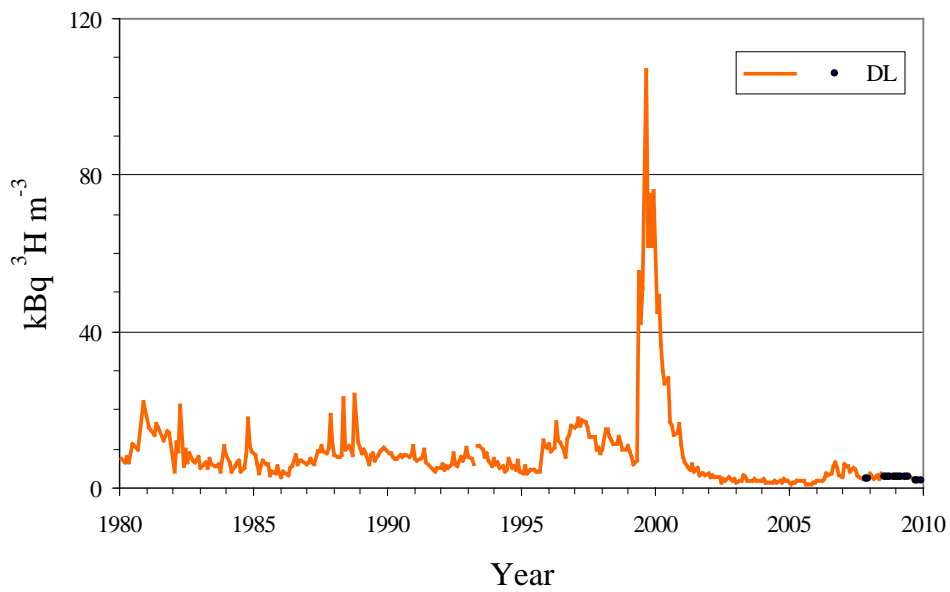
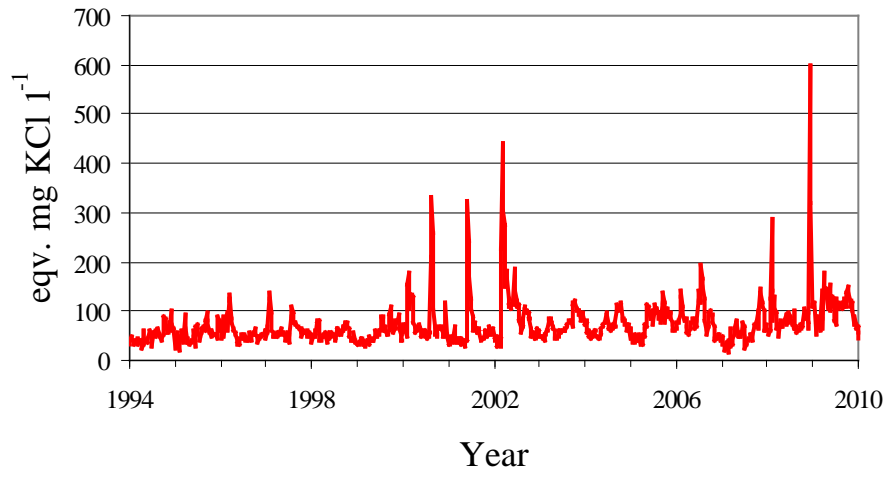


Fig. 4.2. Tritium in seawater collected in Roskilde Fjord 1980 - 2009. (Unit:  $\text{kBq m}^{-3}$ ; DL = detection limit)



*Fig. 7.1. Total-beta radioactivity in waste water collected at Risø 1994 - 2009.  
(Unit: eqv. mg KCl l<sup>-1</sup>)*

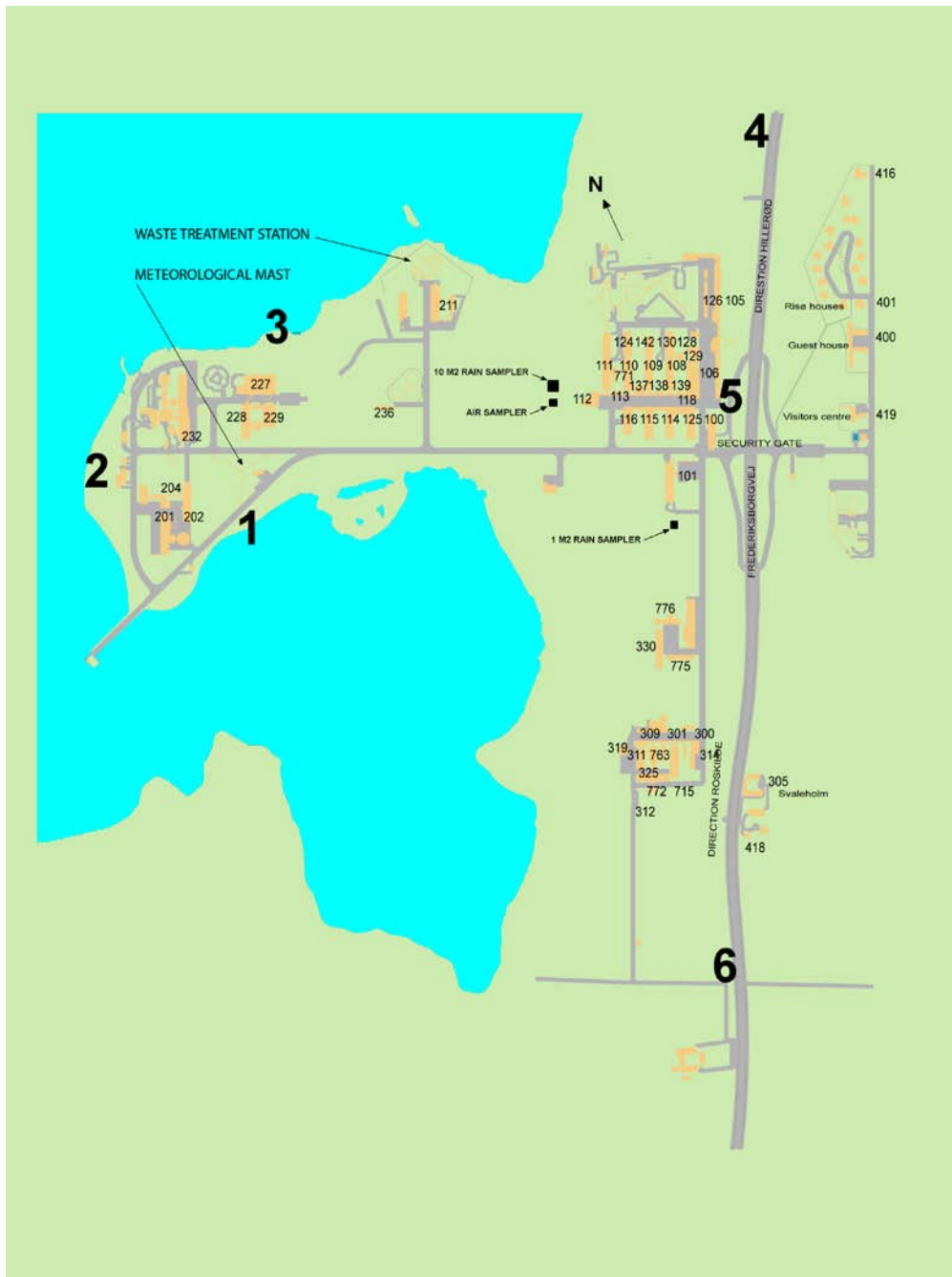


Fig. 8.1. Locations (1-6) for TLD measurements around the border of Risø (cf. Table 8.1).



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



Risø DTU is the National Laboratory for Sustainable Energy. Our research focuses on development of energy technologies and systems with minimal effect on climate, and contributes to innovation, education and policy. Risø has large experimental facilities and interdisciplinary research environments, and includes the national centre for nuclear technologies.

---

**Risø DTU**  
**National Laboratory for Sustainable Energy**  
**Technical University of Denmark**

Frederiksborgvej 399  
PO Box 49  
DK-4000 Roskilde  
Denmark  
Phone +45 4677 4677  
Fax +45 4677 5688

[www.risoe.dtu.dk](http://www.risoe.dtu.dk)