



## Radioactivity in the Risø District January-June 2009

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# Radioactivity in the Risø District January-June 2009

Risø-R-Report

Sven P. Nielsen, Jytte L. Clausen and Arne Miller  
Risø-R-1708(ed.2)(EN)  
December 2009

Risø DTU  
National Laboratory for Sustainable Energy

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**Author:** Sven P. Nielsen, Jytte L. Clausen and Arne Miller  
**Title:** Radioactivity in the Risø District January-June 2009  
**Division:** Radiation Research

**Abstract (max. 2000 char.):** The environmental surveillance of the Risø environment was continued in January - June 2009. The mean concentrations in air were:  $0.49 \pm 0.27 \mu\text{Bq m}^{-3}$  of  $^{137}\text{Cs}$ ,  $3.62 \pm 1.42 \text{ mBq m}^{-3}$  of  $^7\text{Be}$  and  $0.24 \pm 0.15 \text{ mBq m}^{-3}$  of  $^{210}\text{Pb}$  ( $\pm 1$  S.D.;  $N = 26$ ). The depositions by precipitation at Risø in the first half of 2009 were:  $0.064 \text{ Bq m}^{-2}$  of  $^{137}\text{Cs}$ ,  $381 \text{ Bq m}^{-2}$  of  $^7\text{Be}$ ,  $22.7 \text{ Bq m}^{-2}$  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  $83 \text{ nSv h}^{-1}$  compared with  $65 \pm 5 \text{ nSv h}^{-1}$  ( $\pm 1$  S.D.;  $N = 4$ ) in the four zones around Risø.

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# 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), January - June 2009. (Unit:  $\mu\text{Bq m}^{-3}$ )

Date	$^7\text{Be}$	$^{137}\text{Cs}$	$^{210}\text{Pb}$
29-Dec-08 – 05-Jan-09	2563	0.631	165
05-Jan-09 – 12-Jan-09	4504	0.505	171
12-Jan-09 – 19-Jan-09	4869	0.724	362
19-Jan-09 – 27-Jan-09	3233	0.317	90
27-Jan-09 – 02-Feb-09	2669	0.411	354
02-Feb-09 – 09-Feb-09	2244	1.148	746
09-Feb-09 – 16-Feb-09	1933	0.306	148
16-Feb-09 – 23-Feb-09	1813	0.504	114
23-Feb-09 – 02-Mar-09	2636	0.495	180
02-Mar-09 – 09-Mar-09	3186	1.292	464
09-Mar-09 – 17-Mar-09	1599	0.362	96
17-Mar-09 – 23-Mar-09	3832	0.646	165
23-Mar-09 – 30-Mar-09	2954	0.274	126
30-Mar-09 – 03-Apr-09	2905	0.475	144
03-Apr-09 – 14-Apr-09	3620	0.449	244
14-Apr-09 – 20-Apr-09	6167	0.630	403
20-Apr-09 – 27-Apr-09	6671	0.700	376
27-Apr-09 – 04-May-09	5472	0.719	434
04-May-09 – 11-May-09	4350	0.232	173
11-May-09 – 18-May-09	3556	0.329	162
18-May-09 – 25-May-09	5627	0.207	251
25-May-09 – 02-Jun-09	3533	0.335	150
02-Jun-09 – 08-Jun-09	2963	0.336	132
08-Jun-09 – 16-Jun-09	3184	0.233	148
16-Jun-09 – 22-Jun-09	2176	0.148	77
22-Jun-09 – 29-Jun-09	5857	0.287	274
Mean	3620	0.488	237
SD	1418	0.274	154

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

Month	<sup>7</sup> Be	<sup>137</sup> Cs	<sup>210</sup> Pb
January	1862	0.149	175
February	1987	0.203	145
March	1411	0.228	87
April	3065	1.256	152
May	3494	1.043	163
June	1204	0.091	64

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

Month	Precipitation (m)	<sup>7</sup> Be	<sup>137</sup> Cs	<sup>210</sup> Pb
January	0.019	35	0.0027	3.3
February	0.035	70	0.0072	5.1
March	0.036	51	0.0083	3.2
April	0.007	22	0.0090	1.1
May	0.028	97	0.0289	4.5
June	0.088	106	0.0079	5.6
Sum	0.213	381	0.0640	22.7

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

Month	1 m <sup>2</sup> rain collector	10 m <sup>2</sup> rain collector
January	< 2.7	< 2.7*
February	< 2.7	3.6 ± 1.3
March	< 2.7	< 2.7
April	< 2.7	3.7 ± 0.2
May	< 2.7	< 2.7
June	< 2.7	3.1 ± 0.6

Double determinations. The error term is 1 S.E. of the mean.

\*Single determination

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

Month	Precipitation (m)	1 m <sup>2</sup> rain collector	10 m <sup>2</sup> rain collector
January	0.019	< 0.049	< 0.049
February	0.035	< 0.093	0.128
March	0.036	< 0.095	< 0.095
April	0.007	< 0.019	0.027
May	0.028	< 0.073	< 0.073
June	0.088	< 0.231	0.272
Sum	0.213	< 0.560	< 0.644



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

Date	<sup>137</sup> Cs	K*
29 June	2.8	15.8

\*Unit: g kg<sup>-1</sup> dry

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

No samples

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

Month	kBq m <sup>-3</sup>	Salinity in ‰
January	< 2.7 *	11.7
February	< 2.7 *	12.3
March	< 2.7 *	11.8
April	< 2.7 *	11.5
May	< 2.7 *	12.5
June	< 2.7 *	13.1

\* Double determinations

Table 5.1. Radionuclides in grass (\*snow) collected at Risø (near the Waste Treatment Station (cf. Fig. 1)), January - June 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> )
2	5 January	3.6	<0.4	
3	12 January	4.9	<0.9	
4	19 January	2.5	<0.5	
5	26 January	3.6	<0.5	
6	2 February	6.9	<0.7	
7	9 February	2.6	<0.6	
8	16 February*	-	<0.2	
9	23 February*	-	<0.2	
10	2 March	2.5	<0.5	
11	9 March	3.0	<0.4	
12	16 March	3.2	<0.5	
13	23 March	5.8	<0.8	
14	30 March	3.8	<0.6	
15	6 April	5.8	<0.6	
16	14 April	6.0	<0.5	
17	20 April	6.7	<0.6	
18	27 April	2.2	<0.6	
19	4 May	5.7	<0.4	
20	11 May	5.0	<0.5	
21	18 May	4.3	<0.5	
22	25 May	4.0	<0.5	
23	2 June	6.0	<0.6	
24	8 June	6.1	<0.5	
25	15 June	5.7	<0.5	
26	22 June	4.7	<0.5	
27	29 June	6.3	<0.6	
**January		3.3	0.27	0.108
**February		4.7	0.198	0.073
**March		4.0	0.057	0.022
**April		6.9	0.066	0.026
**May		5.2	0.039 A	0.0199
**June		6.3	0.198	0.062

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

Date	<sup>137</sup> Cs	K*	% dry matter
29 June	3.9	29	21

\*Unit: g kg<sup>-1</sup> dry

Table 7.1. Waste water collected at Risø (cf. Fig. 1), January - June 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> )
2	119	<118	<132	<250
3	54	<119	<123	680
4	81	<118	<126	350 B
5	76	<111	<127	<232
6	88	<117	<120	<221
7	75	<116	<126	250 B
8	63	<117	<125	<223
9	82	<122	<118	290 B
10	141	<113	<118	<220
11	85	<118	<124	<231
12	66	<117	<117	<220
13	179	<122	<129	<238
14	140	<116	<123	<224
15	144	<102	<115	<213
16	132	<112	<115	<214
17	104	<114	<116	<230
18	110	<113	<114	<221
19	154	<75	<57	300 A
20	129	<111	<118	<228
21	103	<108	<118	360 A
22	121	<110	<113	<216
23	128	<116	<118	<226
24	125	<111	<114	<218
25	80	<104	<112	<211
26	72	<111	<112	<215
27	125	<111	<118	<211
Mean	107			
SE	6.3			

*Table 8.1. Background dose rates around the border of Risø (cf. Fig. 8.1) measured with thermoluminescence dosimeters (TLD) in the period October 2008 – April 2009. (Results are normalized to nSv h<sup>-1</sup>)*

Location	nSv h <sup>-1</sup>
1	70
2	60
3	54
4	64
5	73
6	76
Mean	66

Table 8.2. Background dose rates around Risø (cf. Fig. 8.2 and Fig. 1) measured with thermoluminescence dosimeters (TLD) in the period October 2008 – April 2009. (Results are normalized to nSv h<sup>-1</sup>)

Risø zone	Location	nSv h <sup>-1</sup>
I	1	60
I	2	73
I	3	129
I	4	76
I	5	74
Mean		83
II	P1	69
II	P2	67
II	P3	54
II	P4	75
Mean		66
III	P1	55
III	P2	63
III	P3	62
Mean		60
IV	P1	58
IV	P2	56
IV	P3	67
IV	P4	72
IV	P5	73
IV	P6	56
IV	P7	-
Mean		64
V	P1	71
V	P2	72
V	P3	85
V	P4	59
V	P5	80
V	P6	58
V	P7	63
V	P8	79
V	P9	68
V	P10	73
Mean		71

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

Risø zone	Location	January	April
I	1	37	37
I	2	43	43
I	3	390	374
I	4	39	42
I	5	40	40
Mean		110	107
II	P1	38	39
II	P2	38	41
II	P3	35	36
II	P4	38	39
Mean		37	39
III	P1		45
III	P2		44
III	P3		41
Mean			43
IV	P1		37
IV	P2		46
IV	P3		37
IV	P4		39
IV	P5		37
IV	P6		36
IV	P7		40
Mean			39
V	P1		39
V	P2		46
V	P3		53
V	P4		50
V	P5		45
V	P6		43
V	P7		40
V	P8		38
V	P9		43
V	P10		35
Mean			43



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



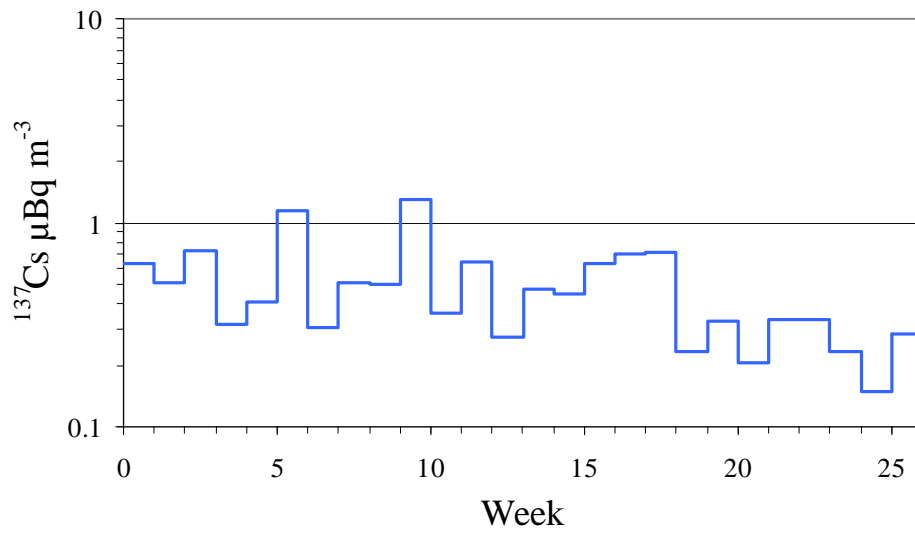


Fig. 1.1. Caesium-137 in ground level air collected at Risø in January-June 2009. (Unit:  $\mu\text{Bq m}^{-3}$ )

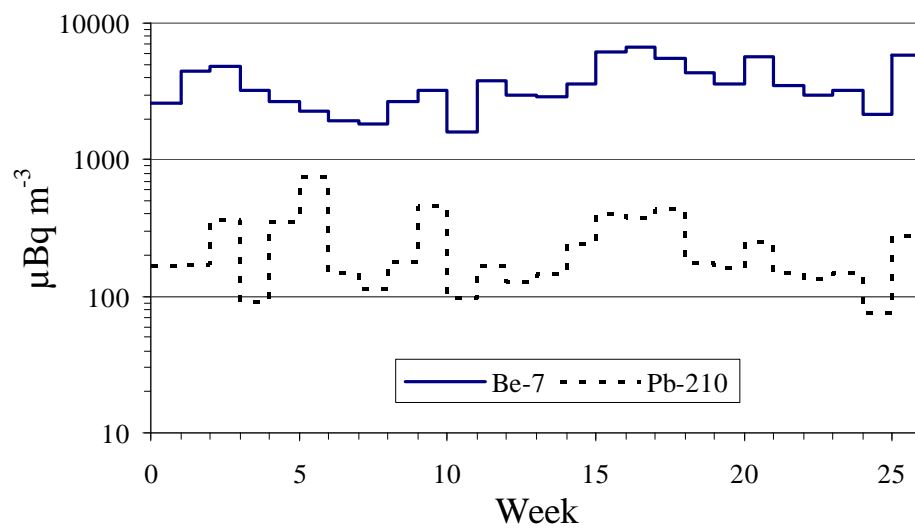


Fig. 1.2. Beryllium-7 and lead-210 in ground level air collected at Risø in January-June 2009. (Unit:  $\mu\text{Bq m}^{-3}$ )

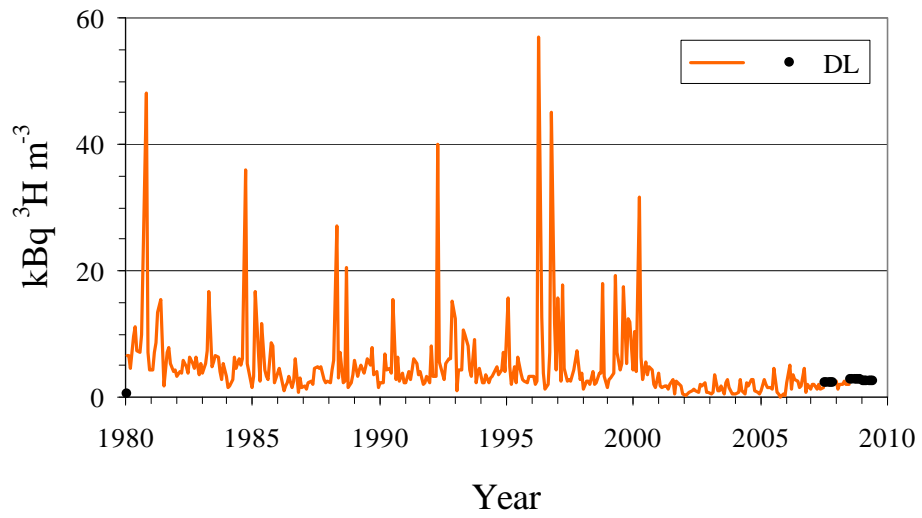


Fig. 2.3.1. Tritium in precipitation collected at Risø (  $1\text{ m}^2$  rain collector ) 1980 - 2009. (Unit:  $\text{kBq m}^{-3}$ ; DL = detection limit)

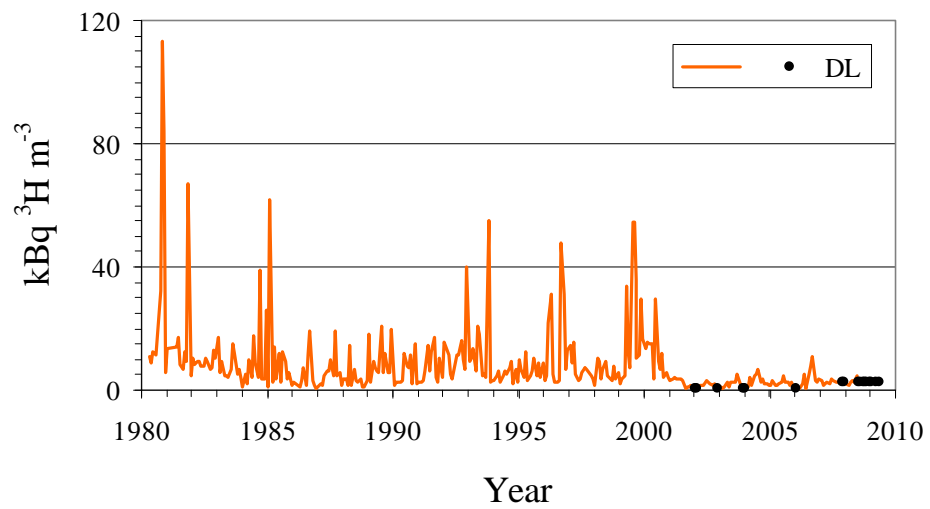


Fig. 2.3.2. Tritium in precipitation collected at Risø (  $10\text{ m}^2$  rain collector ) 1980 - 2009. (Unit:  $\text{kBq m}^{-3}$ ; DL = detection limit)

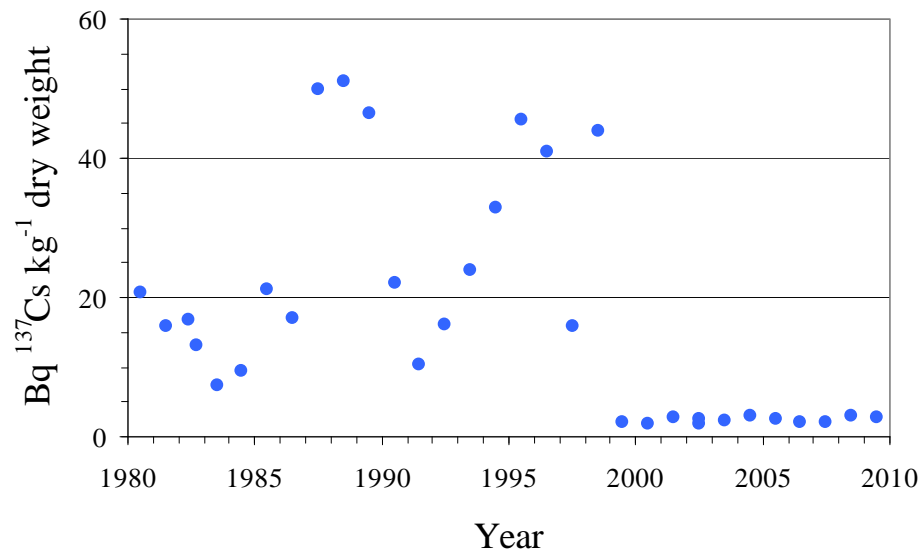


Fig. 3.1. Caesium-137 in sediment samples collected at Bolund in Roskilde Fjord. 1980 – 2009. (Unit: Bq kg<sup>-1</sup> dry matter)

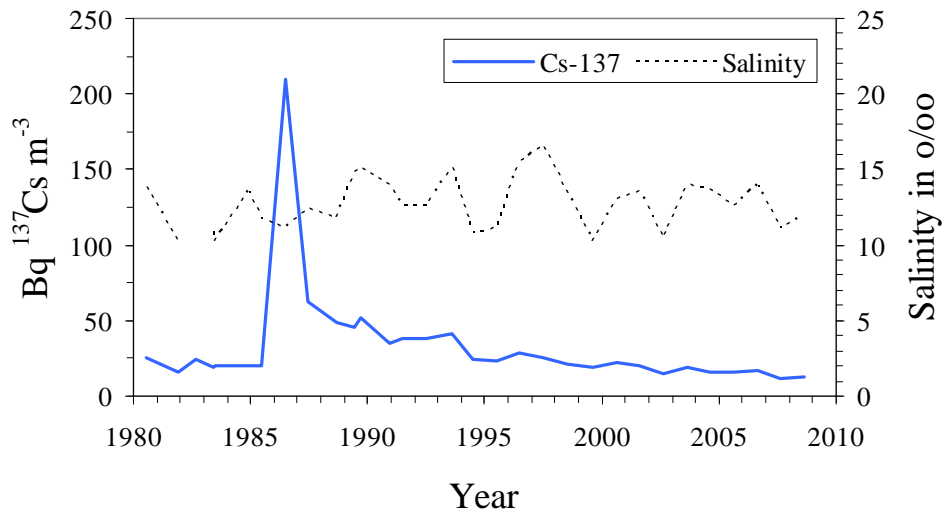


Fig. 4.1. Caesium-137 in seawater collected in Roskilde Fjord 1980 - 2009. (Unit:  $\text{Bq m}^{-3}$ )

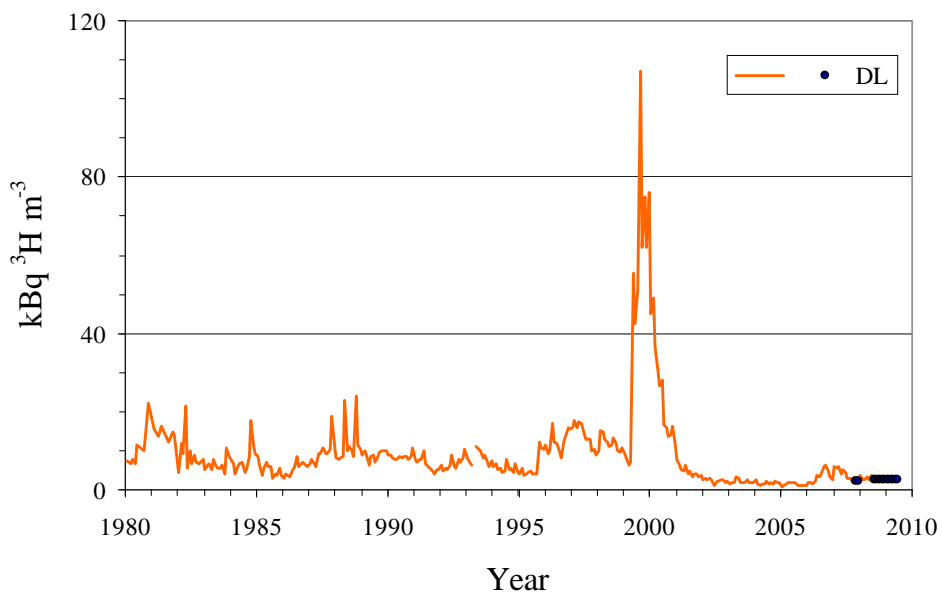
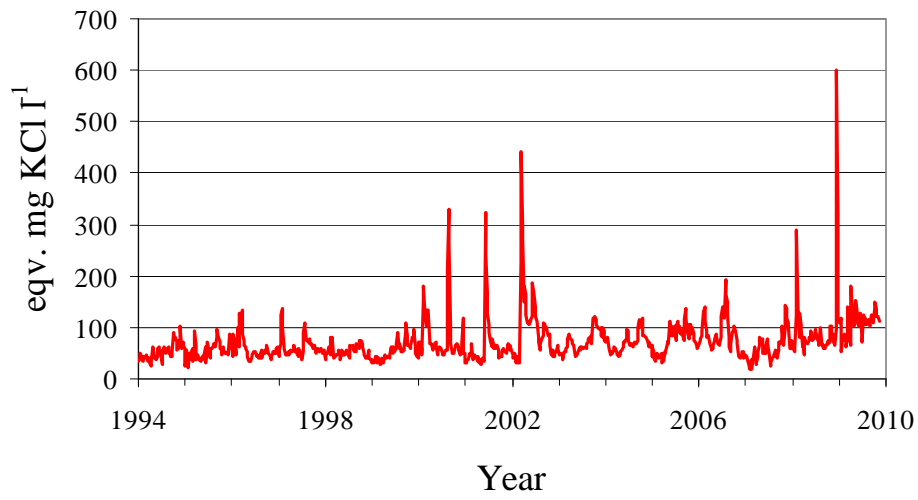


Fig. 4.2. Tritium in seawater collected in Roskilde Fjord 1980 - 2009. (Unit:  $\text{kBq m}^{-3}$ ; DL = detection limit)



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

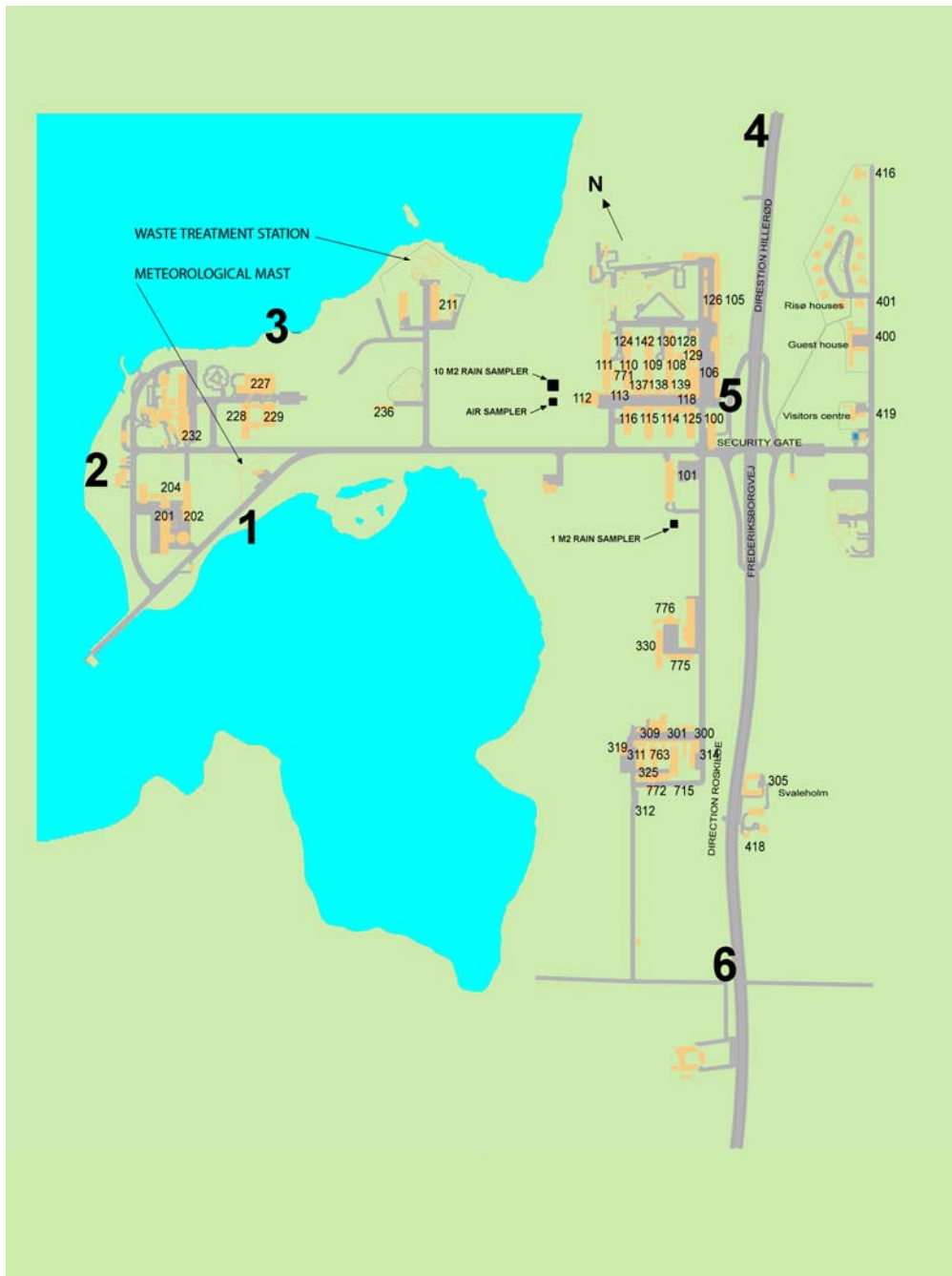


Fig. 8.1. Locations (1-6) for TLD measurements around the border of Risø (cf. Table 8.1).



*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.

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