Environmental Radioactivity Surveillance Programme: Results for 2007 and 2008

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ABSTRACT

This report is the latest of a series in which the results of the Health Protection Agency (formerly National Radiation Protection Board (NRPB)) environmental radioactivity surveillance programme are presented. It contains the measurement data for the years 2007 and 2008. Within the main programme, samples of airborne dust and milk are collected routinely from selected locations within the UK, the Channel Islands and the Isle of Man. The activity concentrations of various radionuclides are measured. In general, the radionuclides detected result from nuclear weapons tested in the atmosphere in earlier years and from the nuclear reactor accident at Chernobyl in the Ukraine in 1986, although the programme is able to detect any other sources of significant contamination. The results indicate that concentrations of artificial radionuclides in the general environment remain at the very low levels observed in recent years. In addition to the main programme, samples of airborne dust have been collected in the vicinity of the Sellafield nuclear fuel reprocessing plant in west Cumbria. The results are consistent with those published by the site operator and government agencies.

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Approval: October 2010
Publication: November 2010
£13.00
ISBN 978-0-85951-679-2

This work was undertaken under the Environmental Assessment Department's Quality Management System, which has been approved by Lloyd's Register Quality Assurance to the Quality Management Standards ISO 9001:2008 and TickIT Guide Issue 5.5, Certificate No: LRQ 0956546.

The measurements included in this report were performed at laboratories at HPA-RPD (UKAS accredited testing laboratories No 1269 and 1502). All the analyses and measurements are included within the relevant UKAS accreditation schedules.

Version 1

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1 INTRODUCTION

The Centre for Radiation, Chemical and Environmental Hazards of the Health Protection Agency (HPA-CRCE), formerly the National Radiological Protection Board (NRPB), has carried out an environmental radioactivity surveillance programme since the 1970s. Of necessity during that period, the programme has changed due to differing circumstances. A more complete history of the programme prior to 1998 is given in a previous report in this series [Hammond et al, 2000]. In 1999, the overall responsibility for the programme was moved from NRPB Scotland to the Environmental Investigations Group in NRPB headquarters at Chilton. In 2005, the NRPB became part of the HPA as part of a Government initiative to consolidate agencies dealing with public health protection issues.

The primary intention of this series of reports is to provide a compendium of surveillance data, detailed radiological or radio-ecological assessments using these data being outside the remit. A principal objective of the main part of the programme is to provide data typical of the UK against which site specific monitoring data can be compared. The main part of the programme of milk sampling on the UK mainland makes use of dairy farms close to the HPA-CRCE laboratories in Chilton, Leeds and Glasgow. Milk is also collected from the Channel Islands and the Isle of Man, and the data provide a convenient means of monitoring the effects of authorised discharges from the nearby nuclear fuel reprocessing plants at Cap de la Hague and Sellafield, respectively.

The air filter measurements made at Seascale, which is in the vicinity of the Sellafield reprocessing plant, enable trends resulting from authorised discharges to the environment to be determined and the effects of any episodic discharges to be discerned. Since April 2007 the local environment around Sellafield has been monitored extensively by the site operator, Sellafield Ltd, (formerly the British Nuclear Group Sellafield Limited (BNGSL), and prior to that British Nuclear Fuels plc), the Environment Agency (EA) and the Food Standards Agency (FSA). The results of these programmes are published annually, the latest reports being the annual report of 2008 for Sellafield Ltd [Sellafield Ltd, 2008] and RIFE 14 [Environment Agency et al, 2008] for the Government Agencies, respectively. However, the results of the HPA surveillance programme provide independent evidence that could be used in support of responses to queries about the impact of Sellafield discharges to the environment. In addition, the data may find an application in the validation of predictive models of behaviour of radionuclides in the environment.

2 SAMPLING AND ANALYSIS

The sampling programme planned for 2007 and 2008 is shown in Table 1.

TABLE 1 The planned sampling programme for 2007 and 2008

Sample	Location	Frequency	Determinants
Airborne dust	Glasgow	Fortnightly	Gamma-ray emitters
	Seascale	Fortnightly, bulked monthly for actinide analysis	Gamma-ray emitters, isotopes of Pu and Am
	Guernsey[a]	Fortnightly	Gamma-ray emitters
Cows Milk	Chilton	10 litres each quarter	^{137}Cs, ^{90}Sr
	Leeds	10 litres each quarter	^{137}Cs, ^{90}Sr
	Glasgow	10 litres each quarter	^{137}Cs, ^{90}Sr
	Isle of Man	1.5 litres per month, bulked quarterly	^{137}Cs, ^{90}Sr
	Channel Islands	1.5 litres per month, bulked quarterly	^{137}Cs, ^{90}Sr

a) 2008 only

Airborne dust is sampled continuously by drawing air through a polycarbonate filter at a flow rate of about 1 m^3 min^{-1} using a centrifugal fan assembly; the flow rate is measured by an axial flowmeter. The filters are changed twice per month. Each filter is compressed into a defined geometry and the activity concentrations of gamma-ray emitting radionuclides are determined directly using hyper-pure germanium detectors housed in a purpose-built low background facility and appropriately calibrated. Measurements of filters from Glasgow were carried out at CRCE's laboratory in Glasgow whilst Seascale filters were analysed at Chilton as in previous years. Measurements of isotopes of plutonium (Pu) and americium-241 (^{241}Am) are carried out on monthly bulk samples from Seascale using α-spectrometry following radiochemical separation.

With the agreement of the Guernsey and Jersey authorities, air filter sampling units have been set up on both islands. Guernsey has since supplied air filter samples for the latter half of 2008. Samples from Jersey are expected early in 2009.

Milk is sampled from the bulk tank at farms or creameries. In this way, the milk is representative of either the whole herd of cows or a number of herds. Samples are despatched to the Chilton laboratory soon after collection. On receipt at Chilton, milk is freeze-dried, after which caesium-137 (^{137}Cs) is determined directly using gamma-ray spectrometry. Strontium-90 (^{90}Sr) is measured by extraction of its yttrium daughter (^{90}Y) followed by beta counting several times over a period of a few days using a low-background gas-flow proportional counter. Measurements and analyses at Chilton are carried out under a quality system accredited to ISO 17025 by the United Kingdom Accreditation Service (accreditation number 1269). Measurements at Glasgow are carried out under a similar system also accredited to ISO 17025 (accreditation number 1502).

3 RESULTS AND DISCUSSION

The uncertainties quoted are based on standard uncertainties multiplied by a coverage factor of k=2 which provides a level of confidence of approximately 95%. The Minimum Detectable Activity quoted is the value for which there is a 5% probability of not detecting that activity if it is present in a sample.

3.1 Airborne dust

The 2007 and 2008 results from gamma-ray spectrometric measurements on samples of airborne dust at Glasgow, are listed in Table 2. The 2008 results from gamma-ray spectrometric measurements on samples of airborne dust at Guernsey are listed in Table 3. These results are derived from the data from the fortnightly samples, averaged over a three monthly period. Activity concentrations of ^{137}Cs were below detection limits whilst activity concentrations of cosmogenic beryllium-7 (^{7}Be) at both locations were typical of those observed in previous years at Glasgow.

TABLE 2: Activity concentrations of ^{7}Be and ^{137}Cs in airborne dust at Glasgow in 2007 and 2008 (μBq m^{-3})

Year/Quarter	^{7}Be	^{137}Cs
2007 / 1	2340 ± 210	< 1
2007 / 2	2910 ± 310	< 1.2
2007 / 3	2060 ± 220	< 1
2007/ 4	2910 ± 310	< 1.3
2008 / 1	2680 ± 280	< 1.5
2008 / 2	2670 ± 280	< 1.0
2008 / 3	2220 ± 230	< 1.0
2008 / 4	2260 ± 240	< 1.0

TABLE 3: Activity concentrations of ^{7}Be and ^{137}Cs in airborne dust at Guernsey from mid 2008 (μBq m^{-3})

Quarter	^{7}Be	^{137}Cs
1	N/S	N/S
2	N/S	N/S
3	2070 ± 440	< 3.0
4	1380 ± 350	< 4.0

N/S No sample received, air sampling not started until mid 2008.

Results from Seascale for ^{7}Be and ^{137}Cs and alpha emitting radionuclides are shown in Table 4 for 2007 and Table 5 for 2008. The observed values were consistent with the low levels reported in previous years, the results for actinides being lower than those published by the site operator. With the occasional exception of antimony-125 (^{125}Sb) at low levels, no other gamma-ray emitting radionuclides of artificial origin were detected.

TABLE 4: Activity concentrations of ^{7}Be, ^{137}Cs and alpha emitting radionuclides in airborne dust at Seascale in 2007 (μBq m^{-3})

Month	^{7}Be	^{137}Cs	^{239,240}Pu	^{238}Pu	^{241}Am
January	2190 ± 370	3.39 ± 1.01	0.218 ± 0.022	0.052 ± 0.006	0.367 ± 0.035
	1480 ± 250	3.16 ± 0.81			
February	2070 ± 350	1.82 ± 0.93	0.151 ± 0.016	0.010 ± 0.002	0.134 ± 0.014
	1800 ± 310	< 1.91			
March	2050 ± 340	0.91 ± 0.69	0.170 ± 0.017	0.021 ± 0.003	0.178 ± 0.018
	2580 ± 420	3.05 ± 0.78			
April	3400 ± 570	2.30 ± 1.30	0.091 ± 0.010	0.017 ± 0.003	0.089 ± 0.010
	2630 ± 430	2.99 ± 0.91			
May	2070 ± 350	3.61 ± 1.26	0.100 ± 0.011	0.016 ± 0.003	0.144 ± 0.015
	1900 ± 320	1.19 ± 0.61			
June	2790 ± 460	1.93 ± 1.02	0.121 ± 0.013	0.017 ± 0.003	0.110 ± 0.012
	1390 ± 230	1.84 ± 0.73			
July	1080 ± 190	< 1.3	0.084 ± 0.009	0.016 ± 0.003	0.192 ± 0.023
	1490 ± 240	1.22 ± 0.71			
August	1420 ± 230	2.48 ± 1.03	0.103 ± 0.011	0.022 ± 0.003	0.198 ± 0.02
	1870 ± 310	3.50 ± 1.29			
September	2010 ± 320	2.50 ± 0.91	0.159 ± 0.017	0.024 ± 0.004	0.26 ± 0.026
	1680 ± 260	1.83 ± 0.82			
October	1840 ± 300	< 1.36	0.076 ± 0.009	0.015 ± 0.003	0.139 ± 0.014
	2200 ± 340	1.45 ± 0.86			
November	2770 ± 430	2.09 ± 0.65	0.090 ± 0.010	0.018 ± 0.003	0.160 ± 0.017
	1560 ± 260	1.17 ± 0.87			
December	1900 ± 300	5.53 ± 1.36	0.114 ± 0.012	0.018 ± 0.003	0.200 ± 0.021
	2510 ± 390	0.83 ± 0.70			

TABLE 5: Activity concentrations of ^{7}Be, ^{137}Cs and alpha emitting radionuclides in airborne dust at Seascale in 2008 (μBq m^{-3})

Month	^{7}Be	^{137}Cs	^{239,240}Pu	^{238}Pu	^{241}Am
January	<4510	1.31 ± 0.92	0.109 ± 0.012	0.018 ± 0.003	0.215 ± 0.021
	< 3550	< 1.19			
February	2540 ± 180	1.29 ± 0.65	0.124 ± 0.014	0.018 ± 0.003	0.148 ± 0.016
	1980 ± 160	1.77 ± 0.96			
March	< 2180	< 0.85	0.094 ± 0.010	0.016 ± 0.003	0.189 ± 0.020
	2320 ± 100	1.56 ± 0.75			
April	1750 ± 840	1.92 ± 0.71	0.052 ± 0.006	0.007 ± 0.002	0.082 ± 0.009
	2500 ± 960	0.83 ± 0.67			
May	3470 ± 930	2.44 ± 0.87	0.086 ± 0.010	0.009 ± 0.002	0.071 ± 0.009
	3670 ± 890	7.39 ± 1.53			
June	N/S	N/S	N/S	N/S	N/S
	2350 ± 120	1.98 ± 1.50			
July	1650 ± 530	< 0.98	0.095 ± 0.011	0.013 ± 0.003	0.112 ± 0.012
	2240 ± 630	0.85 ± 0.74			
August	1610 ± 450	2.94 ± 0.74	0.105 ± 0.012	0.016 ± 0.003	0.173 ± 0.018
	2230 ± 490	< 1.24			
September	1610 ± 410	1.98 ± 1.09	0.075 ± 0.011	0.013 ± 0.004	0.142 ± 0.015
	2790 ± 500	2.04 ± 0.77			
October	1420 ± 330	2.88 ± 1.24	0.093 ± 0.011	0.016 ± 0.004	0.127 ± 0.013
	1610 ± 290	2.04 ± 0.72			
November	1610 ± 280	1.02 ± 0.70	0.13 ± 0.014	0.025 ± 0.004	0.242 ± 0.024
	1380 ± 270	< 1.31			
December	1260 ± 220	3.01 ± 1.01	0.103 ± 0.013	0.016 ± 0.004	0.164 ± 0.017
	2650 ± 420	< 1.05			

N/S No sample received due to pump failure

3.2 Milk

Activity concentrations of ^{137}Cs in milk from Chilton, Leeds and Glasgow and the offshore islands (Isle of Man, Guernsey and Jersey) are given in Table 6 for 2007 and Table 7 for 2008. The corresponding data for ^{90}Sr, in 2007 and 2008, are given in Tables 8 and 9, respectively. The data from the off shore islands relate to samples that have been bulked on a quarterly basis. Activity concentrations of ^{137}Cs in all milk samples were mostly close to or below detection limits, consistent with the trend observed in previous years [Wilding and Hammond, 2007; Wilding, 2008].

The 2008 activity concentrations of ^{90}Sr in milk from Guernsey and Jersey were close to or below detection limits as were samples from the Isle of Man. The measured values were very similar to those observed at locations that are more remote from nuclear licensed sites and consistent with the results from previous years [Wilding and Hammond, 2007; Wilding, 2008]. However, the 2007 ^{90}Sr results for Guernsey were compromised because of a counter malfunction and there was insufficient sample to repeat the analysis. Consequently these results have not been reported.

TABLE 6: Activity concentrations of ^{137}Cs in milk for 2007 (Bq l^{-1})

Location	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr
Chilton	< 0.05	< 0.05	< 0.05	< 0.05
Leeds	0.04 ± 0.03	< 0.06	< 0.04	0.04 ± 0.03
Glasgow	< 0.06	< 0.07	< 0.07	0.04 ± 0.03
Guernsey	< 0.07	< 0.08	< 0.07	< 0.08
Jersey	< 0.05	< 0.06	< 0.08	< 0.07
Isle of Man	0.06 ± 0.03	0.10 ± 0.06	0.05 ± 0.04	0.08 ± 0.04

TABLE 7: Activity concentrations of ^{137}Cs in milk for 2008 (Bq l^{-1})

Location	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr
Chilton	< 0.07	< 0.05	< 0.05	0.03 ± 0.02
Leeds	0.04 ± 0.02	< 0.05	< 0.03	< 0.02
Glasgow	< 0.04	N/S	< 0.07	0.03 ± 0.02
Guernsey	N/S	0.11 ± 0.04	< 0.09	< 0.06
Jersey	< 0.06	0.04 ± 0.03	< 0.05	< 0.06
Isle of Man	0.06 ± 0.04	0.08 ± 0.05	0.06 ± 0.04	0.04 ± 0.03

N/S No sample received

TABLE 8: Activity concentrations of ^{90}Sr in milk for 2007 (Bq l^{-1})

Location	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr
Chilton	0.009 ± 0.002	0.01 ± 0.003	0.01 ± 0.003	0.014 ± 0.004
Leeds	0.016 ± 0.003	0.01 ± 0.003	0.013 ± 0.003	0.016 ± 0.004
Glasgow	0.02 ± 0.003	0.02 ± 0.004	0.017 ± 0.005	0.018 ± 0.004
Guernsey*				
Jersey	0.022 ± 0.006	0.019 ± 0.008	0.019 ± 0.009	0.017 ± 0.006
Isle of Man	< 0.012	0.013 ± 0.008	< 0.014	< 0.012

*No results available due to problem with analysis (see text)

TABLE 9: Activity concentrations of ^{90}Sr in milk for 2008 (Bq l^{-1})

Location	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr
Chilton	0.021 ± 0.004	0.022 ± 0.004	0.019 ± 0.005	0.015 ± 0.005
Leeds	0.018 ± 0.004	0.014 ± 0.004	0.019 ± 0.005	0.019 ± 0.006
Glasgow	0.013 ± 0.003	N/S	0.014 ± 0.004	0.014 ± 0.003
Guernsey	N/S	< 0.024	< 0.021	0.016 ± 0.010
Jersey	0.011 ± 0.005	0.024 ± 0.011	0.019 ± 0.009	0.015 ± 0.008
Isle of Man	< 0.027	< 0.024	0.011 ± 0.013	< 0.028

N/S No sample received

4 ACKNOWLEDGEMENTS

The authors are indebted to CRCE Scotland and all organisations and individuals who assisted with the operation of the air sampling stations, and to all the farmers that participated in the milk sampling programme. Thanks are especially due to the creamery managers in Guernsey, Jersey and the Isle of Man for their part in the milk sampling programme.

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