Environmental Radioactivity Surveillance Programme: Results for 2009

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ABSTRACT

This report is the latest of a series in which the results of the Health Protection Agency environmental radioactivity surveillance programme are presented. It contains the measurement data for the year 2009. 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 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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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.

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1 INTRODUCTION

The Centre of Radiation, Chemical, 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].

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. The local environment around Sellafield is 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 Sellafield Ltd. annual report for 2009 [Sellafield Ltd, 2010] and Radioactivity In Food and the Environment (RIFE) report for 2009 [Environment Agency et al, 2010] 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 originally planned for 2009 is shown in Table 1.

TABLE 1: The planned sampling programme for 2009

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	Fortnightly	Gamma-ray emitters
	Jersey[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) Airborne dust sampling on Jersey was started part way through 2009

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 plutonium (Pu) and americium (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 now been set up on both islands. Guernsey supplied air filter samples for the whole of 2009 whilst samples from Jersey were received for the 3rd and 4th quarters of 2009 only.

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}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 results from gamma-ray spectrometric measurements on samples of airborne dust at Guernsey and Glasgow are listed in Tables 2 and 3, respectively. Due to mechanical problems following the installation of the air sampler on Jersey, some assumptions had to be made in estimating activity concentration in airborne dust and consequently these have not been reported. However, the estimated values are similar to those measured on Guernsey over the same period. The results in Tables 2 and 3 are derived from the data from the fortnightly samples, averaged over a three month period. Activity concentrations of ^{137}Cs were below detection limits at both Channel island locations with beryllium-7 (^{7}Be) levels measured on Guernsey similar to those measured at Glasgow. Results from samples of airborne dust from Seascale for ^{7}Be, ^{137}Cs and alpha emitting radionuclides are shown in Table 4. The observed values are 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 2: Activity concentrations of ^{7}Be and ^{137}Cs in airborne dust at Guernsey in 2009 (μBq m^{-3})

Quarter	^{7}Be	^{137}Cs
1	1620 ± 140	< 2.0
2	N/S	N/S
3	2350 ± 490	< 2.0
4	4000 ± 2530	< 5.0

N/S No samples received

TABLE 3: Activity concentrations of ^{7}Be and ^{137}Cs in airborne dust at Glasgow in 2009 (μBq m^{-3})

Quarter	^{7}Be	^{137}Cs
1	2800 ± 170	< 1.0
2	2910 ± 180	< 1.0
3	2070 ± 130	< 1.0
4	2120 ± 170	< 1.0

TABLE 4: Activity concentrations of ^{7}Be, ^{137}Cs and alpha emitting radionuclides in airborne dust at Seascale in 2009 (μBq m^{-3})

Month	^{7}Be	^{137}Cs	^{239,240}Pu	^{238}Pu	^{241}Am
January	2450 ± 790	<1.46	0.070 ± 0.008	0.099 ± 0.011	0.11 ± 0.012
	2020 ± 410	1.15 ± 0.59			
February	1410 ± 360	1.32 ± 0.74	0.063 ± 0.007	0.058 ± 0.007	0.069 ± 0.009
	2510 ± 540	0.78 ± 0.53			
March	2550 ± 470	8.60 ± 0.61	0.087 ± 0.009	0.019 ± 0.003	0.124 ± 0.014
	2080 ± 380	1.98 ± 1.07			
April	2510 ± 440	1.47 ± 0.68	0.072 ± 0.008	0.016 ± 0.003	0.123 ± 0.014
	2430 ± 420	< 1.09			
May	2290 ± 450	< 1.32	0.100 ± 0.011	0.017 ± 0.003	0.202 ± 0.021
	2110 ± 390	< 1.05			
June	1970 ± 390	1.44 ± 0.82	0.103 ± 0.011	0.014 ± 0.002	0.133 ± 0.014
	2290 ± 430	< 1.15			
July	1930 ± 350	11.1 ± 1.99	0.198 ± 0.021	0.040 ± 0.005	0.368 ± 0.036
	1530 ± 290	3.94 ± 1.08			
August	1590 ± 160	5.5 ± 1.26	0.135 ± 0.015	0.024 ± 0.004	0.297 ± 0.029
	1460 ± 470	< 1.08			
September	2450 ± 520	1.29 ± 0.59	0.119 ± 0.013	0.021 ± 0.003	0.227 ± 0.023
	2340 ± 100	< 1.47			
October	< 2550	< 8.31	0.092 ± 0.011	0.018 ± 0.004	0.17 ± 0.019
	2060 ± 400	< 0.96			
November	1450 ± 360	< 1.41	0.159 ± 0.017	0.029 ± 0.005	0.342 ± 0.034
	1360 ± 350	< 1.59			
December	1660 ± 320	1.64 ± 0.82	0.066 ± 0.008	0.014 ± 0.003	0.093 ± 0.01
	1730 ± 350	1.76 ± 0.72			

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 5 and the corresponding data for ^{90}Sr in Table 6. The ^{137}Cs data from the off shore islands relate to samples that have been bulked on a quarterly basis. However, as the activity concentrations are very low and consistent throughout the year, a decision has been made to bulk these quarterly samples into an annual sample for ^{90}Sr analysis for operational reasons. The individual samples are retained so that if there are indications that the activity concentrations may have varied significantly over the year and further analyses are warranted, the monthly samples can be analysed. Activity concentrations of ^{137}Cs in all milk samples were close to or below detection limits, consistent with the trend observed in previous years [Wilding, 2008; 2010].

The activity concentrations of ^{90}Sr in milk from Guernsey and Jersey were close to 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, 2008; 2010].

TABLE 5: Activity concentrations of ^{137}Cs in milk for 2009 (Bq l^{-1})

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

TABLE 6: Activity concentrations of ^{90}Sr in milk for 2009 (Bq l^{-1})

Location	Annual bulked sample
Chilton	0.021 ± 0.008
Leeds	0.017 ± 0.008
Glasgow	0.028 ± 0.008
Guernsey	0.029 ± 0.009
Jersey	0.019 ± 0.02
Isle of Man	0.042 ± 0.04

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