

Peer Review of the RPII's Environmental Monitoring Programme 2009

Foundation Document

B. Overview of Continuous Monitoring Undertaken in the Current Programme

1. Introduction

The key elements of the RPII Environmental Monitoring Programme implemented on a continuous¹ basis include:

- Assessment of ambient radioactivity based on measurements of radioactivity in air and of external gamma dose rate at permanent monitoring stations located throughout the country
- Assessment of levels of radioactivity in foodstuffs based on measurements of total diet, milk and miscellaneous ingredients
- Assessment of the levels of radioactivity in drinking water sourced from major supplies
- Assessment of levels of radioactivity in the Irish marine environment based on sampling and measurement of seawater, sediment, seaweed, fish and shellfish

Around 2,000 samples from fixed locations are analysed annually by a variety of a radio-analytical and radiochemical techniques. An overview of the RPII monitoring network, analytical techniques employed and typical minimum detectable activities (MDA) is provided in Annex 1. The continuous monitoring programme is reviewed annually by the RPII, taking account of temporal and spatial trends in the activities measured, as well as cost and available resources. The sampling programme for 2009 is reproduced in Annex 2.

It is noted that Commission Recommendation 2000/437/Euratom on the application of Article 36 of the Euratom Treaty (European Commission, 2000) constitutes an important input into the design of the Institute's monitoring programme. Operational aspects of the programme were reviewed by way of an Article 35 verification visit in 2007 (European Commission, 2007).

The results of the RPII's environmental monitoring programme are published in an annual environmental monitoring report (e.g. Fegan et al, 2008) and on the RPII website². Monitoring data is also reported annually to the Joint Research Centre

¹ Note that the definition of 'continuous monitoring' from Commission Recommendation 2000/473/Euratom (European Commission, 2000b) is assumed. That is 'depending on the medium monitored, ...:

(i) continuous sampling and assessment; (ii) continuous sampling and periodic assessment; (iii) periodic sampling and periodic assessment; (iv) direct continuous measurement;

² www.rpii.ie/Monitoring-Stations.aspx

(JRC) in fulfilment of Ireland's obligations under Article 36 of the Euratom Treaty. These data also form the basis of national reports to OSPAR.

RPII monitoring data is also made available on the RPII's website, including 'real time' display of external gamma dose rate measurements. Gamma dose rate data is also published hourly on the EURDEP public and restricted-access websites.

2. Legislation

National and European legislation relevant to the RPII Environmental Monitoring Programme is outlined in Supplementary Document A.

Of particular relevance to continuous monitoring are the general requirements defined in Section 7 of the Radiological Protection Act, 1991 for monitoring of food, drinking water and the environment (7.—(1) (a)) and individuals (7.—(1) (b)). This monitoring facilitates realistic population dose assessments as required by the Ionising Radiation Order (S.I. No. 125 of 2000) for compliance with European Union Basic Safety Standards.

The continuous monitoring programme also complements the analysis of individual samples with regard to the particular function to issue Certificates of Radioactivity Measurement as defined in Section 8.—(i) of the Radiological Protection Act.

3. Aims and Objectives

The aims and objectives of the RPII Monitoring Programme are laid out in the Overview of the Peer Review.

Of particular relevance to continuous monitoring are the measurement of temporal and geographical distributions of concentrations of artificial and natural radionuclides in the environment and the use of this data to assist in the assessment of doses to individuals and the population. There is special emphasis on exposure through consumption of foodstuffs and, in the marine programme, through time spent at, on or near the coast.

The marine monitoring programme is focused on doses received from anthropogenic radioactivity arising from the Sellafield nuclear reprocessing plant.

Specific aims are laid out in the following sections which present each aspect of the continuous monitoring performed.

4. The Terrestrial Monitoring Programme

4.1 Low Volume Aerosol Sampling

4.1.1 *Specific Objectives*

- To maintain the capability to assess environmental contamination in the event of a nuclear or radiological emergency
- To provide confidence regarding the levels of radioactivity in the Irish Environment with regards to protection of food and agriculture
- To comply with Articles 35 and 36 of the Euratom treaty with specific reference to the “dense network” and to demonstrate compliance with the Basic Safety Standards
- To provide real time data on radionuclide concentrations in air. This provides valuable information in the event of an actual or rumoured release into the atmosphere with the potential to impact on Ireland

4.1.2 *Measurements*

The National Radioactivity Monitoring Network currently features 12 aerosol sampling locations. Five of these stations include an online system which measures gross alpha and gross beta radioactivity on the filter in real time and automatically transmits the measurement data to the RPII.

The online systems were installed in 2006 – 2007. Prior to that there were a total of 9 offline stations monitoring aerosols. Two of the offline stations were replaced with online systems but there are still 7 offline stations in operation. There are no immediate plans to change this.

At the 7 offline stations the filter is changed once per week and returned to RPII. One filter per month from each offline station is analysed for gamma emitters and gross beta activity. The volume of air sampled by these systems is sufficient to detect elevated levels of radioactivity but not to measure current ambient levels.

All stations are equipped with a charcoal filter which can be inserted and used to detect radioiodine in the event of an emergency.

4.1.3 *Overview of Results*

Only the gross beta activities from the air filters are reported in the RPII's annual monitoring report. These range between 0.08 and 0.52 mBq/m³ with no geographical or temporal trends having been noted in the past.

The results of the gamma analyses of the air filters are not reported. The measurements made are essentially screening for elevated levels of Cs-137 and

other gamma emitters but the results have been in recent years below the limits of detection.

4.2 High Volume Air Sampling

4.2.1 *Specific Objectives*

- To assess population exposure from airborne radioactivity via inhaled dose
- To provide baseline data on levels of airborne radioactivity from which any deviation from those baseline concentrations can be evaluated
- To comply with Articles 35 and 36 of the Euratom treaty with specific reference to the “sparse network” and to demonstrate compliance with the Basic Safety Standards

4.2.2 *Measurements*

One high volume air sampler is located on a roof site at UCD, Belfield. The filter is typically changed once per month. This system is sufficiently sensitive to allow ambient levels of Cs-137 and Be-7 to be measured.

An additional high volume air sampler was located in Beggars Bush, Dublin. Measurements at this location were discontinued in 2005 once the Belfield had been commissioned.

Krypton-85 in air was also measured in Clonskeagh from 1993-2007 to monitor concentrations in Ireland resulting from aerial discharges from the reprocessing facilities at Sellafield in the UK and Cap la Hague in France. The method employed was a 2 hour grab sampling of air onto an activated charcoal trap. This trap was then sent to the University of Ghent for analysis. There are currently no immediate plans to re-introduce this sampling. Staff in the Radiation Monitoring Section are still trained in the method and however and the required equipment has been retained.

4.2.3 *Overview of Results*

Be-7 is measured for quality assurance purposes. The levels of Cs-137 measured are typically in the 10^{-7} Bq/m³ range.

Kr-85 measurements indicated an overall increasing trend from 1993 to 2004. From 2005 to 2007 an apparent reduction in concentrations was noted, this could be accounted for by the reduced discharges from Sellafield after the enforced shutdown of THORP. It is unlikely that THORP will reopen before 2011.

4.3 Gamma Dose Rate

4.3.1 *Specific Objectives*

- To enable a rapid indication of increased levels of radioactivity in the event of a radiological emergency via real time data
- To provide a first indication of the distribution of radioactivity across the country in the event of a major nuclear/ radiological emergency.
- To provide baseline data on levels of airborne radioactivity so that any deviation from those baseline concentrations can be established

4.3.2 *Measurements*

The National Radioactivity Monitoring Network features 15 gamma dose rate monitors. These measure gamma dose rates with a sampling interval time of 1 minute. Ten-minute and hourly averages are automatically transmitted to a database in the RPII. In the event of a high reading or technical problem occurring a spontaneous data transfer is performed.

Gamma dose data is made available to the EC via EURDEP and can be viewed in real time on the RPII's website. Gamma dose rate data is also available to the RPII on an hourly basis from the UK RIMNET network.

4.3.3 *Overview of Results*

The results reported from the monitoring stations range from ~ 70 – 120 nSv/hour.

4.4 Rainwater

4.4.1 *Specific Objectives*

- To maintain the capacity to assess environmental contamination in the event of a nuclear or radiological emergency
- To provide an indication of deposited radionuclides in such an event

4.4.2 *Measurements*

Rainwater samples are collected continuously at 13 stations throughout the country. These samples will only be analysed in the event of an actual or rumoured radiological incident and are therefore not measured on a regular basis. However, the Clonskeagh rainwater sample is screened on a monthly basis for gamma emitting radionuclides.

4.4.3 *Overview of Results*

The results of Clonskeagh samples screened for gamma emitting radionuclides are below limits of detection

4.5 Drinking Water

4.5.1 *Specific Objectives*

- To demonstrate the safety of major Irish public water supplies with respect to radioactivity by assessing compliance with parametric values set in the Drinking Water Directive
- To comply with Articles 35 and 36 of the Euratom treaty and to demonstrate compliance with the Basic Safety Standards
- To provide public reassurance regarding the quality of Irish water supplies used for drinking and for food production from the point of view of radiological contaminants

4.5.2 *Measurements*

Testing of public water supplied is organised on a rotational basis so that all supplies serving a population in excess of 10,000 are sampled at least once every four years. The way in which this rotation was organised was changed in 2007. Prior to 2007 samples from Cork, Dublin, Galway and Limerick were tested on an annual basis while supplies from outside these counties were sampled on a 4 year rotation. From 2007 the rotation was organised on a county basis so that each county was addressed at least once every four years. In each county all supplies serving in excess of 10,000 are sampled and in counties with no single supply of this size the largest supply in the county is sampled.

All samples are tested for compliance with the parametric value for Total Indicative Dose (TID) as set down in the Drinking Water Directive. Practical arrangements for assessing compliance with this standard were to have been set out in an Annex to the Directive, which as not yet been finalised by the European Commission. In the absence of this Annex, the RPII uses the assessment methodology set out in the World Health Organisation recommendations on drinking water (WHO, 1993). In accordance with this methodology, water samples are tested for gross alpha and beta alpha activity. If these measurements are below the screening values of 100 and 1000 mBq/l respectively then the sample is judged to be in compliance with the parametric value for TID. Where the screening level is exceeded individual radionuclide concentrations are determined and the TID is calculated in accordance with the WHO methodology.

Between 2001 and 2007, tritium was measured in routine water samples. This sampling was discontinued on the basis that there was no source in the catchments and the results of monitoring showed no detectable levels of this radionuclide (see below).

See Foundation Document H for more details.

4.5.3 Overview of Results

In the case of large supplies (serving > 10,000), which are mostly surface sources, more than 95% of samples tested by RPII over the last 10 years were below both total alpha and total beta screening levels. In all cases to date, where one of the screening levels were exceeded, subsequent analyses showed the TID to be less than the parametric value set in the DWD.

In addition to large supplies, the RPII has tested a limited number of samples from small ground water sources. In the case of these samples a larger proportion were found to exceed the screening level for total alpha. However, in all cases to date subsequent analyses of these samples also indicated compliance with the DWD parametric value for TID. The RPII is currently undertaking a systematic national survey to assess levels of radioactivity in ground water sources.

Tritium activities in routine drinking water samples when measured have always been below the detectable limits of approximately 3 Bq/l and so the analysis of these samples for H-3 was discontinued in 2007

4.6 Terrestrial Foodstuffs including Milk

4.6.1 *Specific Objectives*

- To assess population exposure from consumption of radionuclides in food
- To demonstrate the safety of Irish foodstuffs with respect to radioactivity and thereby to protect confidence in the food and agriculture business
- To provide baseline data against which any future increases could be evaluated
- To underpin the product certification programme
- To comply with Articles 35 and 36 of the Euratom treaty and to demonstrate compliance with the Basic Safety Standards

4.6.2 *Measurements*

Samples of complete meals (mixed diet) are collected from restaurant facilities in Dublin and Drogheda annually and Cork and Galway biennially, these samples are analysed for gamma emitting radionuclides.

Milk samples are delivered on a monthly basis from four milk processing plants that collect milk from a wide geographic area. These samples are bulked and analysed quarterly for Sr-90 and gamma emitting radionuclides. Up until 2004 milk samples from 10 dairies were collected and analysed for Cs-137 and Sr-90 but this was reduced to the current 4 in 2005 following a review of milk production and on the basis of the low levels of Cs-137 and Sr-90 being detected.

In addition one 'wild' foodstuff (e.g. wild honey, berries, fresh water fish, etc) is sampled annually and tested for gamma emitting radionuclides. In 2009 the additional food product measured was honey. In 2008 it was a lake fish.

A range of miscellaneous food samples are tested by gamma spectroscopy on behalf of certification customers (approx 500 samples per year).

After the Chernobyl accident monitoring of sheep meat was performed. However this was discontinued in 2004 when levels of radiocaesium in sheep meat had fallen considerably.

4.6.3 *Overview of Results*

All mixed diet samples analysed since 2000 have had radiocaesium levels below detectable limits. The large majority of food samples analysed to date as part of our certification service also have radiocaesium levels below limits of detection. The only exceptions to this in the past few years have been concentrates of berry samples used in the production of soft drinks. However, even in this case the final concentrations in the reconstituted drinks, would (with dilution) have been

significantly below the levels set in Council Regulation (EEC) 737/90 (European Communities, 1990) and would not have posed a radiological hazard to consumers.

Cs-137 activities in the bulked milk samples are below limits of detection (< 3 Bq/l). Sr-90 activities are typically between 0.01 – 0.9 mBq/l.

5. The Marine Monitoring Programme

5.1 Introduction

Samples from the marine environment have been collected and analysed for various radionuclides by RPII/ NEB since 1982. Between 1977 and 1981 a limited number of seafood samples were collected by Irish authorities and sent to MAFF for analysis. The results of these measurements were published in the MAFF reports of the time.

RPII monitoring focuses primarily on the North East coast where levels of radionuclides originating from Sellafield are highest. Doses are reported to two notional consumer groups based on artificial radioactivity in fish and shellfish landed at north east ports. These notional consumer groups referred to as “typical” and “heavy” consumers were intended to represent respectively individuals who consume typical and significantly above average quantities of seafood. Consumption rates assumed for these groups were based on national consumption data rather than on specific habit survey data.

While the structure of the marine monitoring programme has remained broadly similar since the mid eighties, the programme is reviewed annually and modified if necessary depending on the levels and types of radioactivity measured previously and on geographical and temporal trends. Changes to the programme during the period include: changes in the range of fish species sampled, discontinuation of Cs-134 reporting in 1993 and the inclusion of Tc-99 measurements from 1995 following the commissioning of EARP at Sellafield. In recent years levels of anthropogenic radioactivity in samples has decreased very significantly. In particular on the west coast levels of anthropogenic radioactivity are now at, or close to, levels associated with global fallout. This has led to some further changes in the programme in 2005 including: discontinuation of off-shore sampling in the south Irish Sea and reducing the frequency of coastline sampling on the west coast from annually to every two years.

It is noted also that Cs-137 concentrations in the western Irish sea are now dominated by remobilisation from sediment of historic discharges rather than by current discharges. This clearly has implications going forward for the design of the programme.

In 2008 CEFAS were commissioned by the RPII to carry out a marine habits survey along the north east coast of Ireland (Clyne et al, 2009). The aim of this work was to identify aquatic exposure pathways and to collect comprehensive information on the habits of the public to enable realistic assessments of doses to be calculated. Specifically investigations were conducted into the consumption of aquatic foods, the occupancy of intertidal areas, the handling of fishing gear and catch, the handling of sediment, the occupancy in or on water and any unusual exposure pathways. The report, while concluding that the RPII programme was broadly satisfactory, included a number of recommendations relating to the critical groups, fish species, sampling

frequency for some shellfish types and assessment of external exposure pathways. These recommendations have been addressed in the 2009 monitoring programme.

5.2 Specific Objectives

- To facilitate advice to Government on the current levels of radioactivity in the marine environment and on likely future trends
- To assess the population exposure arising from discharges from nuclear installations in the UK to the Irish sea based on seafood landed or farmed in the North-East coast of Ireland
- To demonstrate the safety of Irish foodstuffs with respect to radioactivity and thereby to protect confidence in the seafood food industry
- To provide baseline data against which any future increases could be evaluated
- To provide monitoring data to OSPAR

5.3 Seawater

5.3.1 *Measurements*

Seawater is sampled routinely around the coast of Ireland and annually from the western Irish Sea using the RV Celtic Voyager. Coastal sampling is undertaken most frequently along the north east coastline (monthly to quarterly) and least frequently along the south and west coasts (annually until 2004 and currently biennially). Seawater samples are tested for Cs-137, Tc-99. It is planned to introduce H-3 in seawater measurements from late 2009.

5.3.2 *Overview of Results*

The levels of Cs-137 and Tc-99 in seawater around the Irish coastline are, as expected, highest on the north-east coast.

The activities of Cs-137 typically range between 10-20 mBq/l for the north-east coast and between 1-5 mBq/l for the south and west coast. These levels have remained unchanged over the past 10 years approximately

Tc-99 activities are between 5-20 mBq/l for the north-east coast and between 0.1-1 mBq/l for the south and west coast. These levels have been falling since the mid 1990's.

5.4 Seaweed and Sediment

5.4.1 *Measurements*

Seaweed samples are taken at or near the same coastal locations as seawater samples. The sampling frequency is identical as the seawater samples, with the exception of Balbriggan. Until 2007 seaweed samples were taken every month from Balbriggan but this has now been reduced to quarterly.

All seaweed samples are dried homogenised and measured for Cs-137 (and other gamma emitting radionuclides), Tc-99 and C-14.

Sediment grab samples are collected annually from three locations in the Irish Sea. These samples are also analysed for Cs-137 (and other gamma emitting radionuclides). In the past, these samples were dried and homogenised before analysis. More recently the RPII have investigated the analysis of cores in 5cm slices for Cs-137 and Tc-99.

As a result of a recommendation in the CEFAS marine habit survey (Clyne et al, 2009), the RPII have in 2009 re-introduced the sampling of surface sediments at coastal locations for gamma emitting radionuclides in order to determine the gamma dose rates from the sediments,

5.4.2 *Overview of Results*

The levels of Cs-137 and Tc-99 in seaweed around the Irish coastline are, like the seawater samples, highest on the north-east coast.

The activities of Cs-137 typically range between 3 – 7 Bq/kg (dry weight) for the north-east coast and between <0.4 – 1 Bq/kg (dry weight) for the south and west coast. These levels have remained unchanged over the past 10 years approximately.

Tc-99 activities are between 800 – 1000 Bq/kg (dry weight) for the north-east coast and between 800 – 1000 Bq/kg for the south and west coast. These levels have been falling since the mid 1990's.

C-14 in seaweed results are relatively constant at around 150 Bq/kg (dry weight).

Cs-137 activities in the offshore sediment samples range between 10 – 30 Bq/kg (dry weight).

5.5 Seafood

5.5.1 *Measurements*

Fish (range of species), crustacean (currently prawns) and mollusc (currently mussels) samples are collected quarterly from key north east landing ports and aquaculture centres. Fish and crustacean samples from key south and west coast landing ports are tested annually. These ports are Killybegs (west coast) and Kilmore Quay (south coast), these ports are chosen so as to provide a representative sample of fish caught in the Atlantic Ocean and Irish Sea respectively. Until 2005, samples were collected from Dunmore East and Galway as well. Mollusc samples from the south coast (Bantry) are tested every two years.

All seafood samples are tested by gamma spectroscopy. East coast seafood samples are composited annually by landing port and tested for Tc-99, Pu-238 and Pu-239/240.

The range of species collected at each landing port have been reviewed in light of the outcomes from the CEFAS marine habit survey (Clyne et al, 2009).

5.5.2 *Overview of Results*

The activities of Cs-137 in fish and shellfish samples typically range between 0.2 and 1 Bq/kg (fresh weight) for all samples, irrespective of their landing port. These levels are similar to those measured in previous years.

Tc-99 activities in fish samples are between 0.05 – 0.2 Bq/kg (fresh weight) for the north-east coast and the levels since the mid 1990's have shown large variation, however the mean Tc-99 activity concentration post-EARP at Sellafield is approximately 3 times higher than the pre-EARP baseline.

The mean annual Tc-99 activity concentrations in prawns and mussels sampled on the North-East coast range between approximately 5 – 15 Bq/kg (fresh weight). A reduction of the activity in prawns and mussels has been observed but the Tc-99 activity is still approximately 6 times higher than the pre-EARP baseline for prawns and 3 times higher for Mussels.

Pu-238 and Pu-239/240 activities are higher in shellfish than in fish.

6. Certification Service

On request, the RPII provides a service testing and certify the radioactivity of Irish produce which may be required by producers exporting to certain markets outside of the EU. Certificates of Radioactivity Measurement are issued on the basis of both individual sample results for the product concerned and the national monitoring programme.

Products which the RPII regularly tests and certifies include:

- Beef
- Lamb
- Pork
- Milk powders
- Pharmaceutical products
- Dairy products
- A range of processed foods.

7. Issues for Consideration by the Peer Review Group

The terms of reference are laid out in the Overview of the Peer Review. The opinion of the committee is sought on the scope of the current programme and its capacity to meet the stated aims and objectives effectively and efficiently.

This document has outlined the continuous monitoring currently performed in some detail. In particular comment by the group is sought regarding the following:

- Is the programme sufficiently broad to cover: legal requirements, international obligations and international best practice? In this regard, comment on recent developments in relation to protection of the environment and exposure from natural sources is also welcome.
- Is the programme adequate with respect to accuracy of public dose assessment and demonstration of compliance with relevant standards?
- Is the programme adequate with respect to the need to provide public reassurance?
- Is the programme adequate with respect to the need to provide accurate, up to date and scientifically based advice to Government?
- Is the programme adequate with respect to the need to maintain the capability to respond effectively in the event of an accident resulting in actual or potential contamination of the Irish environment?

For each sample type comment is sought specifically with regard to:

- Frequency of sampling and analysis for each sample type
- Density of sampling locations for each sample type
- Seasonality
- Analysis techniques performed, with particular regard to the usefulness of the results derived

The group is asked also to comment on information gaps or research needs going forward to underpin and support the programme.

8. References

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9. Annex 1: Overview of the RPII Monitoring Network, Analytical Techniques Employed and Typical Minimum Detectable Activities

Table 1: Terrestrial Monitoring Locations

Sampling Location	Sample Types
Ballyrichard, Co. Wicklow.	External gamma dose rate
Belfield, Co. Dublin	Airborne particulates (high volume sampler)
Belmullet, Co. Mayo	Rainwater
Birr, Co. Offaly	External gamma dose rate, rainwater
Cahirciveen, Co. Kerry	Airborne particulates, external gamma dose rate, rainwater
Casement, Co. Dublin	External gamma dose rate, rainwater
Clones, Co. Monaghan	Airborne particulates, external gamma dose rate, rainwater
Clonskeagh, Co. Dublin	Airborne particulates, external gamma dose rate, krypton-85, rainwater
Cork Airport, Co. Cork	Airborne particulates, external gamma dose rate, rainwater
Dublin Airport, Co. Dublin	Rainwater
Dundalk, Co. Louth	External gamma dose rate
Galway, Co. Galway	Airborne particulates
Glasnevin, Co. Dublin	Airborne particulates
Kilkenny, Co. Kilkenny	External gamma dose rate, rainwater
Kilmeadan, Co. Waterford	External gamma dose rate
Kiltrough, Co. Meath	External gamma dose rate
Knock Airport, Co. Mayo	Airborne particulates, external gamma dose rate
Malin Head, Co. Donegal	External gamma dose rate, rainwater
Mullingar, Co. Westmeath	Airborne particulates, rainwater
Rosslare, Co. Wexford	Airborne particulates, external gamma dose rate, rainwater
Shannon Airport, Co. Clare	Airborne particulates, external gamma dose rate, rainwater

Table 2: Marine Monitoring Locations

Sampling Point	Sample Types
Balbriggan, Co. Dublin	Seawater, seaweed
Cahore, Co. Wexford	Seawater, seaweed
Carlingford, Co. Louth	Shellfish
Clogherhead, Co. Louth	Fish, shellfish
Greenore, Co. Louth	Seawater, seaweed
Howth, Co. Dublin	Fish, shellfish
Killybegs, Co. Donegal	Fish
Kilmore Quay, Co. Wexford	Fish
N1 - Irish Sea, 53:25N 6:01W	Seawater
N2 - Irish Sea, 53:36N 5:56W	Seawater
N3 - Irish Sea, 53:44N 5:25W	Seawater
N4 - Irish Sea, 53:52N 5:14W	Seawater, sediment
N5 - Irish Sea, 53:53N 5:33W	Seawater, sediment
N6 - Irish Sea, 53:52N 5:53W	Seawater, sediment

Table 3: Analytical Techniques Employed and Typical Minimum Detectable Activities

Measurements	Sample Types	Analytical Techniques	Typical Minimum Detectable Activities
Cs-137	Foodstuffs	High resolution gamma spectrometry using high purity germanium detectors	0.5 Bq/kg (5 h count)
Cs-137	Air filters (Belfield)	High resolution gamma spectrometry using high purity germanium detectors	1×10^{-7} Bq/m ³ (7 day count)
Cs-137	Milk	High resolution gamma spectrometry using high purity germanium detectors	3 Bq/kg (24 hour count)
Sr-90	Milk	Radiochemical separation followed by liquid scintillation counting	0.02 Bq/l (2 h count)
Gross beta	Air filters	Gas flow proportional counting	0.05 mBq/m ³ (2 h count)
Gross alpha Gross beta	Drinking water	Evaporation and gas flow proportional counting	5 mBq/l (24 h count) 5 mBq/l (24 h count)
Gamma dose rate	Ambient	Continuous monitoring station	10 nSv/hour
Tritium	Drinking water	Liquid scintillation counting	12 Bq/l (30 minute count)
Cs-137 and other gamma emitting radionuclides	Fish, shellfish and seaweed	High resolution gamma spectrometry using high purity germanium detectors	1.0 Bq/kg (I-131) 0.3 Bq/kg (Cs-137)
Kr-85	Air	Grab sampling onto activated charcoal trap at liquid nitrogen temperature. Measurement at University of Gent by gas chromatography and liquid scintillation counting	For a 2 hour grab sample background levels can be measured to an accuracy of $\pm 5\%$
C-14	Seaweed	High temperature catalytic combustion to carbon dioxide followed by liquid scintillation counting	1.0 Bq/kg
Cs-137	Seawater	Radiochemical separation techniques in accordance with the method described by Baker [1975] followed by high resolution gamma spectrometry	0.8 mBq/l
Tc-99	Fish, shellfish, seaweed and seawater	Radiochemical separation techniques in accordance with the method described by Harvey et al. [1991] followed by beta spectrometry using a gas flow proportional counter	0.1 Bq/kg
Pu-238, Pu-239,240	Fish and shellfish	Radiochemical separation techniques followed by alpha spectrometry	0.001 Bq/kg

10. Annex 2: Environmental Monitoring Programme 2009

Marine Monitoring Programme

Sampling:

- Coastal and Offshore sampling locations, frequencies and samples types for 2009 are shown during in Table 4.

Analysis:

- Analysis will be carried out as detailed in Tables 2 and 3.

Table 4: Coastal and Offshore Monitoring

Sampling Location	Sampling Frequency	Sample Types
Carlingford	Quarterly	Shellfish (mussels and oysters – farmed each quarter). One wrinkle sample per year. Sediment quarterly
Greenore	Quarterly	Seawater, Seaweed
Clogherhead (Irish Sea)	Quarterly	Fish, Shellfish (prawns)
Balbriggan	Monthly/ Quarterly	Seawater (monthly), Seaweed (quarterly)
Howth (Ocean Path)	Quarterly	Fish, Shellfish (prawns)
Cahore	Biannually	Seawater, Seaweed
Kilmore Quay (Celtic Sea)	Annually	Fish, Shellfish (prawns)
Galway/Killybegs (Atlantic Ocean)	Annually	Fish, Shellfish (prawns)
Dunmore East ^a	Biennially	Seawater, Seaweed
Castletownbere ^a	Biennially	Seawater, Seaweed
Bantry	Annually	Mussels
Galway ^a	Biennially	Seawater, Seaweed
Killybegs ^a	Biennially	Seawater, Seaweed
Offshore N1: 53:25N 6:01W N2: 53:36N 5:56W N3: 53:44N 5:25W N4: 53:52N 5:14W N5: 53:53N 5:33W N6: 53:52N 5:53W	Annually	Seawater Seawater Seawater Sediment (Cs-137 only), Seawater Sediment, (Cs-137 only), Seawater Sediment (Cs-137 only), Seawater

1. The fish species routinely monitored will be whiting, cod, plaice, herring, mackerel and ray. Haddock to replace whiting from Q2. Herring is discontinued from Q2.

2. The seaweed species routinely monitored is *Fucus vesiculosus*.

^a Samples will not be collected from these locations in 2009

Table 5: Radionuclides Measured

Radionuclides measured	Sample Types
K-40, I-131, Cs-137 and other gamma emitting radionuclides	Individual fish, shellfish and seaweed samples
Cs-137	Individual seawater samples
Tc-99	Composite fish and shellfish samples Individual seawater samples – all locations Seaweed from Balbriggan Selected sediment cores
Pu-238 and Pu-239/240	Composite fish and shellfish samples

Table 6: Fish and Shellfish Composite Samples

Sample Type	Composites
Fish	1 composite Howth, 1 composite Clogherhead
Mussels (farmed)	1 composite Carlingford
Oysters (farmed)	1 composite Carlingford
Prawns	1 composite Howth, 1 composite Clogherhead

1. The fish species included in the composite will be whiting, cod, plaice, herring, mackerel and ray.

Foodstuffs Monitoring Programme

Dairy Produce Monitoring - Milk:

- Table 7 details the 2009 (as per 2008) dairy monitoring programme.

Diet and Ingredients Monitoring:

- One composite meal will be analysed from a large consumption outlet in Dublin and Louth, Table 8.

Table 7: Dairy Produce Monitoring

Sampling Location	Sampling Frequency	Radionuclides
Dublin (Glanbia, Ballytore)	Sampled monthly, bulked and analysed quarterly	Cs-137, Sr-90
Cork (Mitchelstown Co-op)	Sampled monthly, bulked and analysed quarterly	Cs-137, Sr-90
Roscommon (Shannonside)	Sampled monthly, bulked and analysed quarterly	Cs-137, Sr-90
Cavan (Glanbia, Virginia)	Sampled monthly, bulked and analysed quarterly	Cs-137, Sr-90

Table 8: Diet and Ingredients Monitoring

Sampling Location	Sampling Frequency	Radionuclides
UCD, Dublin	Annually	Cs-137, C-14
Our Lady of Lourdes Hospital, Louth	Annually	Cs-137, C-14
UCG, Galway ^a	Biennially	Cs-137, C-14
UCC, Cork ^a	Biennially	Cs-137, C-14
'Wild Food', honey	Annually	Cs-137

^a Samples will not be collected from these locations in 2009

Drinking Water Monitoring Programme

Samples from Water Supply Zones with volumes in excess of 10,000 m³/day or the largest supply for a given county will be analysed for gross alpha and gross beta activity concentrations. Samples from all counties will be analysed once every four years. Table 9 shows the 2009 monitoring programme.

Table 9: Drinking Water Monitoring

County	Supplies
Galway	Galway City Council
	Loughrea PWS Mid-Galway RWSS Tuam PS CaherlistraneGWS
Kerry	Lisarboola 404F
Kildare	Ballymore Eustace/Leixlip
Kilkenny	Radestown PWS
Laois	Portlaoise
Leitrim	South Leitrim Regional
Limerick	Limerick City Water
Longford	Longford Central

Airborne Radioactivity Monitoring

The airborne radioactivity monitoring programme will be carried out as detailed in Table 10.

Table 10: Airborne Radioactivity Monitoring

Sampling Location	Sampling Frequency	Radionuclides
Cahirciveen	Sampled weekly, 1 sample measured monthly	Total beta, gamma spec
Clonskeagh	Sampled weekly, 1 sample measured monthly	Total beta, gamma spec
Glasnevin	Sampled weekly, 1 sample measured monthly	Total beta, gamma spec
Cork Airport	Sampled weekly, 1 sample measured monthly	Total beta, gamma spec
Mullingar	Sampled weekly, 1 sample measured monthly	Total beta, gamma spec
Rosslare	Sampled weekly, 1 sample measured monthly	Total beta, gamma spec
Knock Airport	Sampled weekly, 1 sample measured monthly	Total beta, gamma spec
Shannon Airport	Sampled weekly, 1 sample measured monthly	Total beta, gamma spec
UCD	Monthly	Cs-137, Be-7

Rainwater

Samples are collected and stored temporarily at all Met Éireann stations and can be returned to the RPII for analysis if required. Gamma screening is performed on a sample collected at Clonskeagh each month.