RPII - 99/2

Environmental Radioactivity Surveillance Programme

1997 and 1998

Radiological Protection Institute of Ireland
An Institiúid Éireannach um Chosaint Raideolaíoch

ENVIRONMENTAL RADIOACTIVITY

SURVEILLANCE PROGRAMME

1997 and 1998

S. Sequeira
D. Pollard
V. Smith
D. Howett
E. Hayden
M. Fegan
A. Dowdall
B. Brogan
M. O'Colmáin
J. D. Cunningham

December 1999

CONTENTS

LIST OF FIGURES

LIST OF TABLES

SUMMARY

This report presents the results of the terrestrial monitoring programme carried out by the Radiological Protection Institute of Ireland (RPII) during 1997 and 1998. The principal objective of this programme is to assess the exposure to the Irish population arising from radioactivity in the Irish terrestrial environment. The programme also fulfils Irish obligations under Article 35 of the EURATOM Treaty whereby each Member State of the European Union is required to monitor continuously levels of radioactivity in the environment, thus ensuring compliance with basic safety standards.

No abnormal readings were observed during this reporting period for gamma dose rate, radioactivity in airborne particulates or radioactivity in rainwater. The measured concentrations of strontium-90 in milk and caesium-137 in air and milk were consistent with global fallout levels at these latitudes.

Atmospheric concentrations of krypton-85, which is released into the atmosphere as a result of nuclear fuel reprocessing, reflected the gradual build up of this radionuclide in the troposphere of the northern hemisphere with corresponding increases in skin and effective dose. However, none of the increases observed were of significance from a radiological safety point of view.

Drinking water supplies showed a significant variation in gross alpha activity concentrations. Supplies with levels exceeding the 100 mBq/l screening level were investigated further. The results of these investigations indicated that these supplies were in compliance with the WHO guidelines pertaining to radioactivity in drinking water.

The levels of artificial radioactivity recorded during this reporting period in air, rainwater, drinking water and milk continue to be insignificant from a radiological safety point of view and do not pose a significant risk to human health.

1 INTRODUCTION

This report presents the results of the terrestrial monitoring programme implemented by the Radiological Protection Institute of Ireland during 1997 and 1998 and is the latest in a series of periodic reports (Sequeira et al., 1995; Pollard et al., 1997). This programme includes the routine sampling and testing for radioactivity of samples of air, rainwater, drinking water and milk. Sampling is undertaken in conjunction with Met Éireann, the Department of the Environment and Local Government, the Department of Agriculture and Food, local authorities and health boards. Figure 1 shows the locations of the stations at which continuous monitoring was undertaken during the reporting period. The types of measurements made at each of these stations are listed in Table 1. The results of the Institute's marine environmental monitoring programme are published in a separate series of reports, which are available from the Institute.

Under Article 35 of the EURATOM Treaty, each Member State of the European Union is required to establish the facilities necessary to carry out continuous monitoring of the levels of radioactivity in the environment and to ensure compliance with the European Union Basic Safety Standards. The terrestrial monitoring programme fulfils Irish obligations under this provision. As required under Article 36 of the Treaty, information on this programme is communicated periodically to the Commission of the European Union. The Commission in turn publishes compilations of the information received from Member States (European Commission, 1996).

2 AIRBORNE RADIOACTIVITY

During the reporting period the Institute monitored airborne radioactivity at 10 stations of which 9 were equipped with low volume particulate samplers, one with a high volume particulate sampler and one with atmospheric krypton-85 measuring equipment. Low volume particulate samples were routinely assessed for total beta activity and high volume samples for gamma emitting radionuclides such as caesium-137 and beryllium-7. Atmospheric krypton-85 concentrations are measured at the Institute's laboratory in Clonskeagh.

2.1 Low Volume Particulate Sampling

The locations of the low volume airborne particulate sampling stations are presented in Table 1. Particulates were collected by drawing air continuously through a 47 mm glass microfibre filter. The sampling equipment includes a microprocessor based volume totaliser and has an unloaded flow rate of approximately 10 m^3/h. The sampling period was normally 1 week and the volume of air sampled during this time typically ranged between 500 and 1500 m^3.

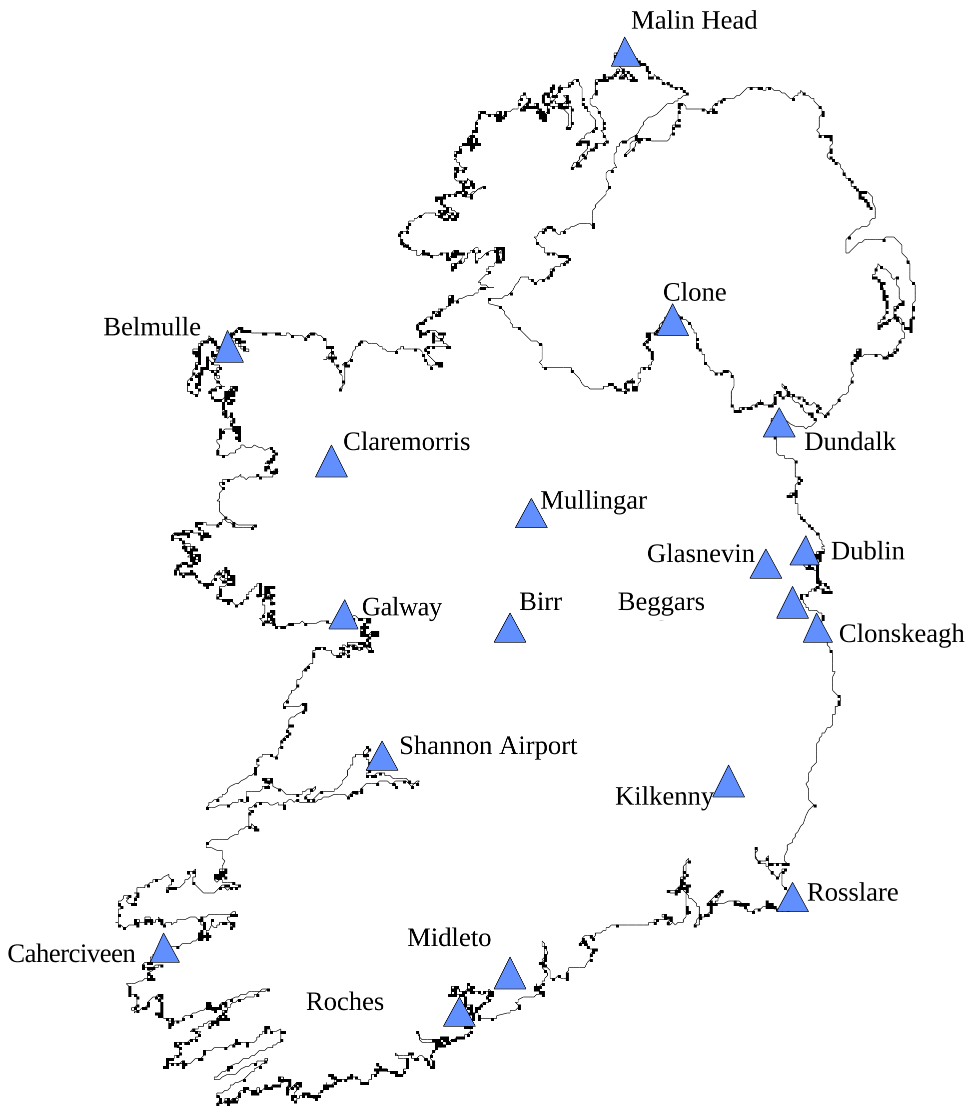

Figure 1 Stations carrying out Continuous Monitoring of Air and Precipitation

After sampling, the filters were left in a dust free environment for three days before analysis to ensure that short lived naturally occurring radionuclides had decayed to non-detectable levels prior to measurement. The filters were analysed for gross beta activity using a gas-flow proportional counter with a gross beta counting efficiency of 35% and a mean background of 2.8 cpm. The 95% detection limit for a two hour count was 15 mBq.

The ranges of gross beta activity concentrations in airborne particulates at the nine stations for the 1997-1998 period are presented in Tables 2 and 3. The activity levels observed were insignificant from a radiological protection perspective, not exceeding 1.33 mBq/m^3 at any station.

2.2 High Volume Particulate Sampling

The high volume air sampler is located at the Geological Survey of Ireland at Beggars Bush in Dublin. The unit employs a large format (25 cm x 20 cm) particulate filter and has an unloaded flow rate of approximately 100 m^3/h. Filters were bulked on a two monthly basis and were analysed by high resolution gamma spectroscopy. The results of measurements carried out between 1997 and 1998 are presented in Table 4. These data are consistent with global fallout levels at these latitudes.

2.3 Krypton-85 Monitoring

Krypton-85 is an inert radioactive gas which is present in the atmosphere primarily as a result of the reprocessing of nuclear fuel. There are two major nuclear fuel reprocessing plants in Western Europe, at Sellafield on the north-west coast of England and at La Hague on the north coast of France. Reprocessing is also carried out in Russia.

In late 1993 the Institute began a programme to measure the concentration of krypton-85 in air at Clonskeagh, Dublin. The purpose was to establish a baseline krypton-85 concentration before start-up of the new Thermal Oxide Reprocessing Plant (THORP) at Sellafield and to measure the effect of its operation on the krypton-85 concentrations. There have been small increases in the quantities of krypton-85 released annually from Sellafield in recent years with, for example, 9.9 TBq discharged during 1998.

The krypton sampling system used at the Institute was designed and built by the radon research group at the University of Gent in Belgium. The measurement technique is comprised of separate sampling and measurement stages. The sampling stage is carried out at the Institute and the measurement stage is carried out at the University of Gent. Sampling involves drawing air over an activated charcoal trap at liquid nitrogen temperature, after which the krypton sample is transferred by distillation from the charcoal trap to a copper coil containing a molecular sieve. The copper coil is then sent to Belgium for analysis, which involves gas chromatographic separation of krypton gas followed by liquid scintillation counting to determine the krypton-85 concentration. Each air sample was collected over a two hour period twice monthly with the exception of a period during 1998 when the sampling equipment was out of service.

The results of measurements carried out in 1997 and 1998 are presented in Table 5. The uncertainty on individual measurements is approximately ± 5% and all measurements have been corrected to standard temperature and pressure (STP). A trend of increasing atmospheric concentrations was observed over the period since measurements were begun in 1993 (Howett and

(Poffijn, 1996; Weiss, 1989). A few measurements have been recorded which were two to three times the expected value. However it is not possible to relate them to any specific release. The results do not therefore demonstrate conclusively that krypton-85 levels in Dublin are directly affected by increased discharges of the gas from Sellafield since THORP went into operation in 1994.

For each year from 1993, the annual equivalent skin dose and the whole body effective dose were calculated using the ICRP 30 dose coefficient for submersion in a semi-infinite cloud (ICRP, 1979) and the ICRP 68 effective dose rates for inert gases (ICRP, 1994) respectively. The doses were calculated on the basis of the annual geometric mean concentration of krypton-85 in air measured at Clonskeagh. These data are presented in Table 6. Krypton-85, because of its inertness and low solubility, does not participate in metabolic processes and, when present in the atmosphere, irradiates man primarily by skin beta dose. It can be seen that the whole body effective dose is very much less than the skin dose. These doses are very small and do not represent a health hazard.

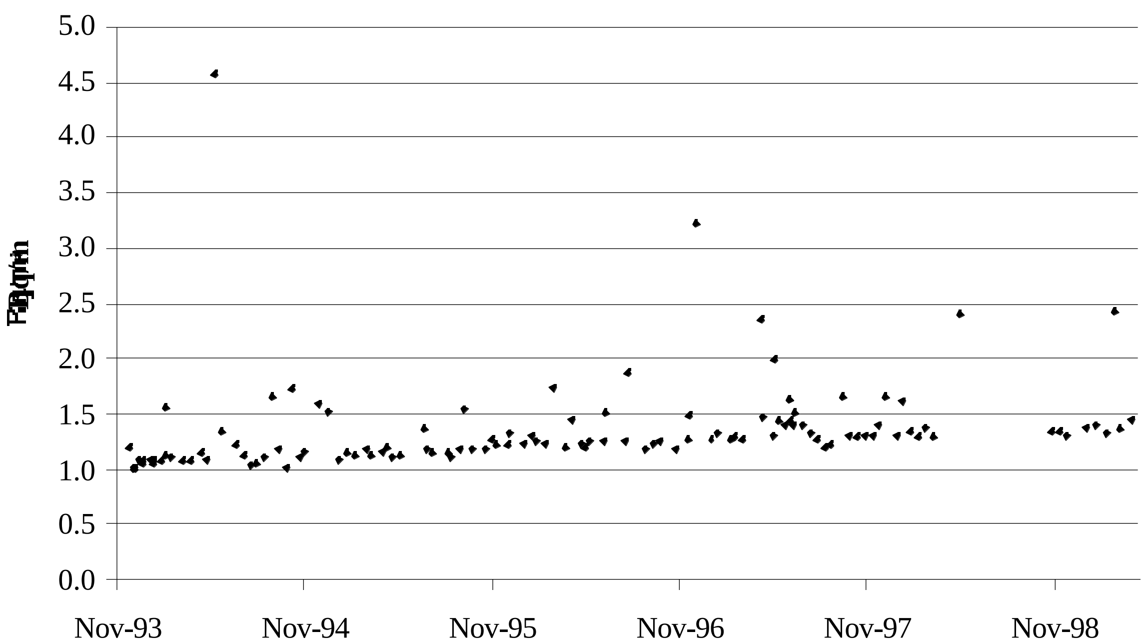

Figure 2 Krypton-85 in Air at Clonskeagh (Dublin), 1993 - 1998

3 RAINWATER

Rainwater samples were collected monthly at each of the twelve rainwater stations listed in Table 1. Each monthly sample from Clonskeagh was analysed individually while samples from all other stations were bulked proportionately on a quarterly basis in accordance with the monthly rainfall measurements. All samples were analysed by high resolution gamma spectroscopy using a three-

No caesium-137 was detected in any of the samples measured. The derived minimum detectable activities for wet deposition of caesium-137 ranged between 1 and 39 Bq/m^2 – these were calculated by multiplying the minimum detectable activity concentration (Bq/l) of the sample by the corresponding precipitation (mm) for the period of measurement obtained from Met Éireann data.

4 DRINKING WATER SUPPLIES

The Institute implements a county-based sampling programme for drinking water with, as a minimum, one supply from each county sampled every four years. In addition, supplies to certain major population centres are sampled annually. Where practicable drinking water is sampled at the point at which the treated water is released into the distribution network. Sampling is normally carried out on behalf of the Institute by the relevant local authority or health board. Fourteen counties were surveyed in the 1997-1998 period. Additional samples were collected and analysed as part of an MSc research project designed to study water supplies (mainly groundwater) in Counties Carlow, Kildare, Dublin and Meath. Samples from the supplies at Dunboyne and Monasterevin, which had been targeted for re-sampling on the basis of the results obtained in the previous sampling programme (Pollard *et al.*, 1997), were also included.

Samples were tested for both naturally and artificially occurring radionuclides. These data were assessed in line with the 1993 World Health Organization (WHO) guidelines for drinking water quality pertaining to radioactivity (WHO, 1993).

4.1 WHO Guidelines for Drinking Water Quality

The WHO guidelines recommend a reference level based on a committed effective dose of 0.1 mSv from one year's consumption of drinking water. This reference level of dose represents less than 5% of the average effective dose attributable annually to natural background radiation. In accordance with these guidelines, below this reference level of dose, the drinking water is considered acceptable for human consumption, and any action to reduce the radioactivity is deemed to be unnecessary.

The WHO guidelines also recommend that, for practical purposes, screening levels based on activity concentration be used. The recommended screening levels are 100 mBq/l for gross alpha and 1000 mBq/l for gross beta activity. If the radioactivity concentrations of water supplies are below the screening values then the water is considered to be in compliance with the reference level. If they exceed these levels then individual radionuclide concentrations should be

It should be noted that the WHO recommendations apply to routine operational conditions of existing or new water supplies. They are not intended to apply to a water supply contaminated during an emergency involving the release of radionuclides into the environment. In addition, they do not differentiate between natural and man-made radionuclides.

4.2 Analytical Methods

Samples were acidified with nitric acid as soon as practicable after sampling to minimise the adsorption of radioactivity on the walls of the bottle. An aliquot of between 100 and 500 ml (depending on the concentration of dissolved solids) from each sample was evaporated to dryness and analysed for gross alpha and beta activities. The detection limits (95% confidence) for this procedure were typically 35 mBq/1 and 45 mBq/1 for alpha and beta respectively. Radium was measured by co-precipitation of radium with barium sulphate followed by gamma spectroscopy after an ingrowth period to allow the daughter nuclides to reach secular equilibrium. Radium-226 was determined using the gamma rays of its daughters lead-214 and bismuth-214 while radium-228 was determined using the gamma rays of actinium-228. Uranium and thorium mass concentrations were measured by the Analytical and Regional Geochemistry Group of the British Geological Survey in Nottingham, England.

4.3 Results and Discussion

The results of gross alpha and gross beta activity screening measurements carried out in 1997 and 1998 are presented in Table 7. The gross beta activity concentrations in all the water samples were below the WHO gross beta guideline of 1000 mBq/l. Seventeen of the samples were found to have gross alpha activity concentrations of greater than 100 mBq/l and these were the subject of further investigation. These samples were determined for radium-226 and elemental thorium and uranium. Activity concentrations for thorium and uranium radioisotopes were estimated from the elemental measurements making the assumption that all of the elemental thorium was thorium-232 and that uranium isotopes were present in natural isotopic abundance in accordance with Table 8. Radium-226, uranium and thorium concentrations are presented in Table 9. Ingestion doses were calculated on the basis of a daily per capita consumption rate of 2 litres and using ICRP 72 dose conversion coefficients (Table 8)(ICRP, 1996). The individual radionuclide doses were summed to calculate the total dose for each supply (Table 10).

In all cases the total doses were below the WHO reference level of 0.1 mSv. A total of 4 supplies were found to exceed 0.01 mSv and these will be targeted for resampling during the course of future programmes. The maximum total indicative dose calculated was 0.04 mSv for a sample was concluded that all of the drinking water supplies investigated were in compliance with the WHO guidelines. It was recognised that considerable variability exists, however, between supplies with regard to the concentration of naturally occurring radioactivity.

In general there was good agreement between the gross alpha measurements and the summed individual radionuclide concentrations indicating that most of the activity present was accounted for by the nuclide specific measurements. In most cases the bulk of the activity was accounted for by uranium. In estimating the uranium activity concentration from the chemical concentration, uranium-234 was assumed to be in secular equilibrium with the uranium-238 parent (Table 8). This approach was considered to be conservative, as it may underestimate the uranium activity concentration and thereby overestimate the portion of the total alpha activity due to other more radiotoxic radionuclides. Uranium-238 has the lowest radiotoxicity of those natural alpha emitters commonly found in drinking water (Table 8). The sources where anomalies exist between the gross alpha measurement and the sum of the nuclide specific measurements have been targeted for resampling in 1999.

5 MILK

During 1997 and 1998, milk was sampled monthly at 10 milk processing plants. Samples were bulked quarterly and analysed for strontium-90 and gamma emitting radionuclides.

The activity of gamma emitting radionuclides was measured using high resolution gamma spectroscopy. The strontium-90 activity in milk samples was determined by radiochemical separation involving liquid-liquid extraction followed by Cerenkov counting of yttrium-90. Typical detection limits (95% confidence) for caesium-134, caesium-137 and strontium-90 were 0.3 Bq/l, 0.2 Bq/l and 0.05 Bq/l, respectively.

The results of measurements of radioactivity in milk samples are presented in Tables 11 and 12. In all cases strontium-90 concentrations were found to be less than or equal to 0.09 Bq/l. Caesium-134 was below the detection limit for all samples. Caesium-137 was detected in one sample (0.23 Bq/l) out of a total of 120 samples with the remainder below the limit of detection. It should be noted that, because of the difference in analytical techniques, the detection limit for strontium-90 is lower than the detection limit for caesium-137. In general, the data are similar to those for the previous reporting period and reflect the continued reduction in global fallout levels due to radioactive decay and reduced bioavailability.

The committed effective dose to children and adults from the consumption of milk was estimated for strontium-90 and its daughter product yttrium-90. The dose from caesium-137 was not considered as the levels of caesium-137 in all but one of the samples analysed were below the dependent dose coefficients (ICRP, 1996)(Table 13) and the mean annual strontium-90 activity concentrations for the whole country. Milk consumption rates were obtained from two sources, the Irish National Nutrition Survey (Irish Nutrition and Dietetic Institute, 1990), for ages ranging between 8 and 18+ years, and the 1993 UNSCEAR report on the Sources and Effects of Ionizing Radiation (UNSCEAR, 1993), for children under 8 years of age. These results are presented in Table 14. Infants under the age of one are the most sensitive group, receiving doses of 1.24 and 1.19 μSv in 1997 and 1998, respectively. All doses were very low and do not pose a risk to human health. No significant difference in dose was observed between 1997 and 1998.

6 EXTERNAL GAMMA DOSE RATE MONITORING

The external gamma dose rate was monitored continuously at the stations listed in Table 1. The dose rate was recorded every twenty minutes and the readings transmitted automatically to the Institute's computer database at Clonskeagh. This monitoring network provides early notification of any abnormal increase in the dose rate at a station. Each station is fitted with an alarm, which is triggered in the event of a high reading. Arrangements are in place to notify the Institute's Duty Officer immediately of such an occurrence.

The monthly average gamma dose rates over the years 1997-1998 ranged between 60 nSv/h and 90 nSv/h. The measured dose rate at individual stations is subject to variation due to factors such as statistical fluctuations associated with the measurement and changes in the concentration levels of radon daughters. During heavy rainfall, radon daughters in the atmosphere are brought to ground level resulting in increased dose rate readings. This increase in dose rate may persist for a period of a few hours. Maximum increases in dose rate readings due to this phenomenon during the reporting period were 60 nSv/h at Cork Airport in November 1997 and 50 nSv/h at Casement in September 1998.

The maximum and minimum dose rate readings for each month, at each station, over the period 1997-1998 are presented in Table 15. The range of readings for April and May 1998 at Caherciveen were slightly depressed due to a fault in the detector, which was replaced in early June.

7 CONCLUSIONS

During the period covered by this report the Institute implemented a wide-ranging programme of radioactivity monitoring of the Irish terrestrial environment so as to assess the level of exposure to radiation of the Irish public.

No abnormal readings were observed during this reporting period for gamma dose rate, from 1993 onwards indicated a trend of increasing krypton-85 concentrations in air with a corresponding increase in skin and effective doses. It is not possible to confirm any link between this trend and discharges from Sellafield. None of the concentrations observed were of significance from a radiological safety point of view. The measured concentrations of strontium-90 in milk and caesium-137 in air and milk are consistent with global fallout levels at these latitudes and pose no significant health risk to the population in Ireland.

Drinking water supplies showed a significant variation in gross alpha activity concentrations. Further investigation of those supplies with levels exceeding the total alpha or beta screening levels indicated that all of the supplies investigated were in compliance with the WHO guidelines pertaining to radioactivity in drinking water. The maximum total indicative dose from one year's consumption for any one supply was estimated to have been 0.04 mSv. This may be compared with the WHO recommended guideline of 0.1 mSv.

The data presented in this report demonstrate that the levels of artificial radioactivity in the Irish terrestrial environment remain extremely low and do not pose a risk to human health.

8 ACKNOWLEDGEMENTS

The valuable assistance provided by the officers of Met Éireann, the Department of the Environment and Local Government, the Department of Agriculture and Food and participating local authorities and health boards in supplying and processing samples is acknowledged with gratitude.

9 REFERENCES

European Commission, 1996. **Environmental Radioactivity in the European Community, 1991**. EUR 16396. Luxembourg: European Commission.

Howett, D. and O'Colmáin, M. 1998. Measurements of krypton-85 in air at Clonskeagh, Dublin 1993-1997. **Journal of Radiological Protection**, 18, (1), 15-21.

ICRP, 1979. **Limits for Intakes of Radionuclides by Workers, Supplement to Part 1**. Annals of the ICRP Vol. 3, ICRP Publications 30. Oxford: Pergamon Press.

ICRP, 1994. **Dose Coefficients for Intakes of Radionuclides by Workers**. Annals of the ICRP Vol. 24 No. 4, ICRP Publication 68. Oxford: Pergamon Press.

ICRP, 1996. **Age-dependent Doses to Members of the Public from Intake of Radionuclides: Part 5. Compilation of Ingestion and Inhalation Dose Coefficients.** Annals of the ICRP Vol. 26, ICRP Publication 72. Oxford: Pergamon Press.

Irish Nutrition and Dietetic Institute, 1990. **National Nutrition Survey, 1990.** Dublin: Irish Nutrition and Dietetic Institute.

Poffijn, A., 1996. Personal communication.

Pollard, D., Smith, V., Howett, D., Hayden, E., Fegan, M., O'Colmáin, M. and Cunningham, J.D., 1997. **Environmental Radioactivity Surveillance Programme, 1994-1996.** Dublin: Radiological Protection Institute of Ireland.

Sequeira, S., Pollard, D., Hayden, E., Fegan, M., O'Colmáin, M., McGarry, A. and Cunningham, J.D., 1995. **Environmental Radioactivity Surveillance Programme, 1990-1993**. Dublin: Radiological Protection Institute of Ireland.

UNSCEAR, 1993. **Sources and Effects of Ionizing Radiation.** UNSCEAR 1993 Report to the General Assembly, with Scientific Annexes. New York: United Nations.

Weiss, W., Sartorius, H. and Stockburger, H., 1989. Global distribution of atmospheric krypton-85. In: **Isotopes of Noble Gases as Tracers in Environmental Studies** - Proceedings of a consultants meeting, Vienna 29 May - 2 June 1989. Vienna: IAEA.

World Health Organization, 1993. **Guidelines for Drinking Water Quality.** Geneva: WHO.

Table 1 Sampling Stations

Station	County	Measurement Types
Beggars Bush	Dublin	Airborne particulates (high volume)
Belmullet	Mayo	Rainwater
Birr	Offaly	Rainwater, Gamma dose rate
Caherciveen	Kerry	Airborne particulates, Rainwater, Gamma dose rate
Casement	Dublin	Gamma dose rate
Claremorris	Mayo	Rainwater, Gamma dose rate
Clones	Monaghan	Airborne particulates, Rainwater, Gamma dose rate
Clonskeagh	Dublin	Airborne particulates, Krypton-85, Rainwater, Gamma dose rate
Cork Airport	Cork	Gamma dose rate
Dublin Airport	Dublin	Rainwater
Dundalk	Louth	Airborne particulates, Gamma dose rate
Galway	Galway	Airborne particulates
Glasnevin	Dublin	Airborne particulates
Kilkenny	Kilkenny	Rainwater, Gamma dose rate
Knock Airport	Mayo	Gamma dose rate
Malin Head	Donegal	Rainwater, Gamma dose rate
Midleton	Cork	Airborne particulates
Mullingar	Westmeath	Airborne particulates, Rainwater
Rosslare	Wexford	Airborne particulates, Rainwater, Gamma dose rate
Shannon Airport	Clare	Rainwater, Gamma dose rate

Table 2 Radioactivity in Airborne Particulates, 1997

	Gross Beta Activity Range (number of readings), mBq/m³				
Month	**Caherciveen**	**Clones**	**Clonskeagh**	**Dundalk**	**Galway**
January	0.22 - 0.38 (4)	0.32 - 0.51 (5)	0.27 - 0.36 (4)	(0)	0.18 - 0.34 (4)
February	0.07 - 0.18 (4)	0.10 - 0.21 (3)	0.08 - 0.16 (4)	(0)	0.12 - 0.23 (4)
March	0.16 - 0.19 (2)	0.08 - 0.47 (5)	0.15 - 0.36 (4)	0.07 (1)	0.13 - 0.40 (4)
April	0.39 - 0.52 (3)	0.23 - 0.49 (4)	0.19 - 0.44 (4)	0.10 – 0.48 (4)	0.22 - 0.43 (3)
May	0.10 - 0.47 (5)	0.15 - 0.32 (5)	0.16 - 0.33 (5)	0.12 – 0.35 (5)	0.17 - 0.22 (2)
June	0.08 - 0.55 (4)	0.18 - 0.53 (4)	0.21 - 0.41 (4)	0.16 – 0.47 (3)	0.17 - 0.35 (3)
July	0.16 - 0.51 (5)	0.17 - 0.54 (5)	0.14 - 0.56 (5)	0.21 – 0.53 (3)	0.17 - 0.40 (4)
August	0.14 - 0.41 (2)	0.21 - 0.66 (3)	0.30 - 0.55 (4)	0.27 – 0.58 (3)	0.12 - 0.43 (4)
September	(0)	0.15 - 0.45 (4)	0.11 - 0.38 (3)	0.18 – 0.20 (3)	0.15 - 0.45 (4)
October	0.22 (1)	0.13 - 0.62 (5)	0.14 - 0.72 (5)	0.29 (1)	0.15 - 0.28 (4)
November	(0)	0.22 - 0.37 (3)	0.21 - 0.37 (4)	0.15 – 0.35 (4)	0.11 - 0.22 (4)
December	0.09 - 0.41 (4)	0.19 - 0.52 (4)	0.11 - 0.48 (5)	0.18 - 0.39 (3)	0.16 - 0.19 (4)

Table 2 (continued) Radioactivity in Airborne Particulates, 1997

	Gross Beta Activity Range (number of readings), mBq/m³			
Month	**Glasnevin**	**Midleton**	**Mullingar**	**Rosslare**
January	0.23 - 0.40 (5)	0.21 - 0.44 (4)	0.22 - 0.39 (4)	0.29 - 0.48 (5)
February	0.08 - 0.15 (4)	0.11 - 0.27 (3)	0.10 - 0.60 (4)	0.10 - 0.14 (3)
March	0.17 - 0.39 (4)	0.39 (1)	0.10 - 0.59 (5)	0.20 - 0.45 (4)
April	0.16 - 0.34 (5)	(0)	0.27 - 0.37 (4)	0.24 - 0.47 (4)
May	0.18 - 0.33 (4)	(0)	0.17 - 0.40 (5)	0.18 - 0.30 (5)
June	0.17 - 0.42 (4)	0.23 - 0.48 (4)	0.18 - 0.46 (4)	0.17 - 0.55 (4)
July	0.11 - 0.47 (5)	0.21 - 0.33 (4)	0.17 - 0.55 (3)	0.21 - 0.49 (5)
August	0.22 - 0.72 (4)	(0)	0.19 - 0.53 (5)	0.18 - 0.63 (4)
September	0.18 - 0.20 (2)	(0)	0.13 - 0.46 (3)	0.14 - 0.49 (4)
October	0.16 - 0.45 (4)	0.18 - 0.54 (4)	0.11 - 0.47 (4)	0.22 - 0.58 (4)
November	0.11 - 0.27 (4)	0.20 - 0.55 (4)	0.15 - 0.52 (5)	0.17 - 0.59 (4)
December	0.09 - 0.37 (4)	0.20 - 0.40 (3)	0.17 - 0.36 (4)	0.18 - 0.26 (2)

Table 3 Radioactivity in Airborne Particulates, 1998

	Gross Beta Activity Range (number of readings), mBq/m³				
Month	**Caherciveen**	**Clones**	**Clonskeagh**	**Dundalk**	**Galway**
January	0.11 -1.02 (4)	0.07 - 0.40 (5)	0.10 - 0.28 (4)	0.12 - 0.29 (4)	0.10 - 0.19 (4)
February	0.10 - 0.39 (4)	0.26 - 0.40 (3)	0.21 - 0.41 (4)	0.24 - 0.43 (4)	0.13 - 0.36 (4)
March	0.09 - 0.27 (4)	0.07 - 0.33 (5)	0.09 - 0.23 (4)	0.08 - 0.33 (4)	0.06 - 0.23 (5)
April	0.12 - 0.20 (5)	0.13 - 0.25 (5)	0.11 - 0.22 (4)	0.06 - 0.16 (4)	0.08 - 0.18 (4)
May	0.23 - 0.56 (3)	0.21 - 0.53 (4)	0.21 - 0.52 (5)	0.15 - 0.45 (5)	0.17 - 0.66 (5)
June	0.14 - 0.23 (2)	0.25 - 0.37 (4)	0.18 - 0.31 (5)	0.21 - 0.26 (2)	0.09 - 0.19 (5)
July	0.09 - 0.14 (2)	0.09 - 0.22 (4)	0.15 - 0.22 (5)	0.11 - 0.24 (4)	0.10 - 0.18 (4)
August	0.10 - 0.24 (6)	0.15 - 0.24 (4)	0.17 - 0.32 (4)	0.18 - 0.32 (3)	0.12 - 0.27 (5)
September	0.10 - 0.59 (3)	0.13 - 0.43 (4)	0.16 - 0.40 (5)	0.09 - 0.45 (3)	0.08 - 0.69 (5)
October	0.21 - 0.93 (5)	0.13 - 0.58 (4)	0.20 - 0.77 (5)	0.16 - 0.82 (5)	0.20 - 0.38 (4)
November	0.17 - 0.18 (3)	0.14 - 0.35 (4)	0.22 - 0.30 (3)	0.18 - 0.30 (3)	0.13 - 0.20 (3)
December	0.25 (1)	0.95 (2)	0.26 - 0.54 (3)	0.28 (1)	0.23 (1)

Table 3 (continued) Radioactivity in Airborne Particulates, 1998

	Gross Beta Activity Range (number of readings), mBq/m³			
Month	**Glasnevin**	**Midleton**	**Mullingar**	**Rosslare**
January	0.11 - 0.26 (4)	0.13 - 0.38 (4)	0.11 - 0.39 (5)	0.06 - 0.31 (5)
February	0.22 - 0.52 (4)	0.30 - 0.74 (4)	0.24 - 0.35 (4)	0.20 - 0.69 (4)
March	0.06 - 0.33 (4)	0.08 - 0.36 (4)	0.12 - 0.33 (4)	0.12 - 0.42 (5)
April	0.13 - 0.36 (5)	0.12 - 0.27 (4)	0.13 - 0.19 (4)	0.08 - 0.34 (5)
May	0.24 - 0.56 (4)	0.17 - 0.57 (5)	0.16 - 0.57 (5)	0.21 - 0.32 (3)
June	0.18 - 0.29 (4)	0.16 - 0.23 (4)	0.17 - 0.29 (4)	0.13 - 0.19 (3)
July	0.11 - 0.25 (5)	0.15 - 0.26 (5)	0.10 - 0.30 (4)	0.13 - 0.27 (6)
August	0.20 - 0.36 (4)	0.26 - 0.31 (2)	0.15 - 0.26 (5)	0.17 - 0.40 (4)
September	0.13 - 0.69 (5)	0.17 - 0.49 (5)	0.10 - 0.54 (7)	0.17 - 0.75 (3)
October	0.30 - 0.46 (4)	0.32 - 0.57 (4)	0.12 - 0.43 (5)	0.29 - 1.33 (4)
November	0.13 - 0.21 (4)	0.15 - 0.32 (5)	0.16 - 0.39 (4)	0.20 - 0.39 (4)
December	0.23 (2)	(0)	0.46 (1)	0.54 (1)

Table 4 Caesium-137 and Beryllium-7 in Air at Beggars Bush (Dublin), 1997 and 1998

Sampling Period		Activity Concentration in Air (Bq/m^3)	
Start Date	**End Date**	**Cs-137**	**Be-7**
24-Mar-97	23-May-97	$< 1.2 \times 10^{-6}$	3.7×10^{-3}
23-May-97	17-Jul-97	$< 1.0 \times 10^{-6}$	3.2×10^{-3}
17-Jul-97	24-Sep-97	$< 1.0 \times 10^{-6}$	4.8×10^{-3}
12-May-98	07-Jul-98	$< 6.0 \times 10^{-7}$	3.1×10^{-3}
07-Jul-98	25-Aug-98	$< 2.7 \times 10^{-6}$	2.4×10^{-3}
01-Sep-98	04-Nov-98	$< 1.1 \times 10^{-6}$	2.6×10^{-3}
04-Nov-98	04-Jan-99	$< 1.1 \times 10^{-6}$	1.6×10^{-3}

Table 5 Krypton-85 Measurements at Clonskeagh (Dublin), 1997 and 1998

Date of Measurement	Activity Concentration Bq/m^3 (corrected to STP)[1]
Jan-97	1.271
Jan-97	1.325
Feb-97	1.263
Feb-97	1.280
Mar-97	1.266
Apr-97	2.355
Apr-97	1.456
May-97	1.306
May-97	1.981
May-97	1.432
Jun-97	1.388
Jun-97	1.633
Jun-97	1.627
Jun-97	1.418
Jun-97	1.386
Jun-97	1.506
Jul-97	1.397
Jul-97	1.323
Aug-97	1.268
Aug-97	1.194
Sep-97	1.206
Sep-97	1.640
Oct-97	1.293
Oct-97	1.273
Nov-97	1.297
Nov-97	1.301
Dec-97	1.383
Dec-97	1.634
Jan-98	1.299
Jan-98	1.611
Feb-98	1.344
Feb-98	1.289
Mar-98	1.371
Mar-98	1.275
May-98	2.409
Nov-98	1.340
Nov-98	1.343
Dec-98	1.306

Notes [1] STP is 0 °C and 760 mm of Hg. In previous reports krypton-85 concentrations were reported corrected to 20 °C and 760 mm of Hg. To convert these measurements to STP multiply by 1.0732.

Table 6 Krypton-85 Annual Skin and Effective Doses, 1993 - 1998

Year	Geometric Mean Bq/m^3	Skin Dose μSv/year	Effective Dose μSv/year
1993	1.05	0.43	0.008
1994	1.25	0.52	0.010
1995	1.19	0.49	0.010
1996	1.37	0.56	0.011
1997	1.41	0.58	0.011
1998	1.43	0.59	0.011

Table 7 Gross Alpha and Beta Activities in Drinking Water, 1997 and 1998

County	Supply	Sampling Date	Activity Concentration (mBq/l)	
			Gross Alpha	Gross Beta
Carlow	Bagenalstown	19-Aug-97	174	134
	Bagenalstown (Private well)	23-Nov-97	216	212
	Bagenalstown	09-Dec-97	172	169
	Bagenalstown	09-Mar-98	252	245
	Bagenalstown	09-Mar-98	291	285
	Ballyloo	09-Mar-98	1345	779
	Carlow Town	19-Aug-97	484	192
	Carlow Town	09-Dec-97	365	215
	Newtown	09-Mar-98	170	266
	Leighlinbridge	09-Mar-98	554	366
Cork	Inniscarra	12-Aug-97	<31	92
Dublin	Leixlip	15-Aug-97	85	130
	Kilternan	12-Aug-97	249	36
	Vartry (Bray Urban Supply)	07-Oct-98	28	69
Galway	Ahascragh	17-Sep-97	158	93
	Terryland	26-Aug-97	<33	96
Kerry	Dromin Water Supply (Listowel)	15-Jun-98	< 34	135
	North-east Kerry (Lyreacrompane)	11-Jun-98	99	107
Kildare	Monasterevin and Newbridge	05-Jan-98	281	145
Kilkenny	Radestown	11-Jun-98	< 35	100
	Troyswood	16-Jun-98	< 40	156
Leitrim	South Leitrim Regional	28-Jun-98	109	85
Louth	Ardee	27-Jun-98	133	142
	Greenmount	27-Jun-98	< 42	135
Mayo	Lough Mask Regional (Castlebar)	17-Jun-98	< 36	61

Table 7 (continued) Gross Alpha and Beta Activities in Drinking Water, 1997 and 1998

County	Supply	Sampling Date	Activity Concentration (mBq/l)	
			Gross Alpha	Gross Beta
Meath	Dunboyne	29-Aug-97	109	122
Monaghan	Carrickmacross	16-Jun-98	51	127
	Castleblayney	16-Jun-98	< 35	135
	Donaghmoyne GWS	16-Jun-98	52	98
	Monaghan Town	16-Jun-98	< 59	67
	Stranooden GWS	16-Jun-98	< 35	160
	Tydavnet GWS	16-Jun-98	<41	80
Sligo	Lough Gill	24-Sep-98	44	75
	Lough Talt	24-Sep-98	< 34	53
Tipperary	Carrick-on-Suir (Crotty's Lake)	15-Jun-98	< 11	19
	Carrick-on-Suir (Lingaun River)	15-Jun-98	95	86
	Galtee Regional	3-Nov-98	15	35
Waterford	Ballinamuck (Dungarvan)	13-May-98	< 40	98
	Waterford City	26-Mar-98	< 35	67
	Lismore/Cappoquin/Ballyduff	03-Nov-98	39	24
	Tramore/Dunmore East	03-Nov-98	72	111
Westmeath	Athlone	16-Jun-98	< 38	112
	Lough Lene	16-Jun-98	114	111

Table 8 Data Used to Calculate Ingested Doses from Individual Radionuclides

Radionuclide	Specific Activity (Bq/μg)	Natural Abundance (%)	Ingested Dose Coefficient for Adults (Sv/Bq)
Ra-226	3.70×10^{4}	100	2.80×10^{-7}
Th-232	4.07×10^{-3}	100	2.30×10^{-7}
U-234	2.30×10^{2}	0.0057	4.90×10^{-8}
U-235	8.00×10^{-2}	0.72	4.70×10^{-8}
U-238	1.22×10^{-2}	99.27	4.50×10^{-8}

Table 9 Alpha Emitting Radionuclides in Drinking Water, 1997 and 1998

Location	Gross Alpha (mBq/l)	Thorium (μg/l)	Th-232 (mBq/l)	Uranium (μg/l)	Uranium (mBq/l)	Ra-226 (mBq/l)
Ahascragh/ 17-Sep-97	158	nm	nm	nm	nm	< 9
Ardee/ 27-Jul-98	133	< 0.03	$< 1.22 \times 10^{-4}$	1.09	28	< 15
Bagenalstown/ 19-Aug-97	174	nm	nm	6.90	179	< 14
Bagenalstown (Private well)/ 23-Nov-97	216	< 0.005	$< 2.04 \times 10^{-5}$	1.32	34	nm
Bagenalstown/ 09-Dec-97	172	< 0.005	$< 2.04 \times 10^{-5}$	6.42	166	nm
Bagenalstown/ 09-Mar-98	252	0.03	1.22×10^{-4}	10.97	283	nm
Bagenalstown/ 09-Mar-98	291	< 0.01	$< 4.07 \times 10^{-5}$	8.99	232	nm
Ballyloo, Carlow/ 09-Mar-98	1345	< 0.01	$< 4.07 \times 10^{-5}$	49.02	1265	nm
Carlow Town/ 19-Aug-97	484	nm	nm	11.79	305	nm
Carlow Town/ 09-Dec-97	365	0.011	4.48×10^{-5}	12.20	315	< 13
Newtown, Carlow/ 09-Mar-98	170	< 0.01	$< 4.07 \times 10^{-5}$	6.95	91	nm
Dunboyne/ 29-Aug-97	109	nm	nm	nm	nm	< 14
Kilternan/ 12-Aug-97	249	< 0.01	4.07×10^{-5}	7.78	102	nm
Leighlinbridge/ 09-Mar-98	554	< 0.01	$< 4.07 \times 10^{-5}$	18.2	469	
Lough Lene Westmeath/ 16-Jun-98	114	< 0.03	$< 1.22 \times 10^{-4}$	2.98	77	< 43
Monasterevin and Newbridge 05-Jan-98	281	0.005	$< 2.04 \times 10^{-5}$	3.67	94	21

nm = not measured

Table 10 Annual Dose to Adults from Individual Radionuclides in Drinking Water, 1997 and 1998

Location	Committed Effective Dose (mSv)			
	Th-232	Uranium	Ra-226	Sum for measured radionuclides
Ahascragh/ 17-Sep-97	nm	nm	$< 2 \times 10^{-3}$	$< 2 \times 10^{-3}$
Ardee/ 27-Jul-98	$< 2.02 \times 10^{-5}$	9.51×10^{-4}	$< 3 \times 10^{-3}$	$< 3 \times 10^{-3}$
Bagenalstown/ 19-Aug-97	nm	6.05×10^{-3}	$< 3 \times 10^{-3}$	$< 9 \times 10^{-3}$
Bagenalstown/ 23-Nov-97	$< 3.37 \times 10^{-6}$	1.15×10^{-3}	nm	1.15×10^{-3}
Bagenalstown/ 09-Dec-97	$< 3.37 \times 10^{-6}$	5.60×10^{-3}	nm	5.60×10^{-3}
Bagenalstown/ 09-Mar-98	2.02×10^{-5}	9.58×10^{-3}	nm	9.58×10^{-3}
Bagenalstown/ 09-Mar-98	$< 6.74 \times 10^{-6}$	7.85×10^{-3}	nm	7.85×10^{-3}
Ballyloo, Carlow/ 09-Mar-98	$< 6.74 \times 10^{-6}$	4.28×10^{-2}	nm	4.28×10^{-2}
Carlow Town/ 19-Aug-97	nm	1.03×10^{-2}	nm	1.03×10^{-2}
Carlow Town 09-Dec-97	7.41×10^{-6}	1.06×10^{-2}	$< 3 \times 10^{-3}$	$< 1.36 \times 10^{-2}$
Newtown, Carlow/ 09-Mar-98	$< 6.74 \times 10^{-6}$	6.07×10^{-3}	nm	6.07×10^{-3}
Dunboyne/ 29-Aug-97	nm	nm	$< 3 \times 10^{-3}$	$< 3 \times 10^{-3}$
Kilternan/ 12-Aug-97	$< 6.74 \times 10^{-6}$	6.79×10^{-3}	nm	6.79×10^{-3}
Leighlinbridge/ 09-Mar-98	$< 6.74 \times 10^{-6}$	1.59×10^{-2}	nm	1.59×10^{-2}
Lough Lene, Westmeath/ 16-Jun-98	$< 2.02 \times 10^{-5}$	2.60×10^{-3}	$< 9 \times 10^{-3}$	$< 11.60 \times 10^{-3}$
Monasterevin and Newbridge 05-Jan-98	$< 3.37 \times 10^{-6}$	3.20×10^{-3}	4×10^{-3}	7.20×10^{-3}

nm = not measured

Table 11 Radioactivity in Milk, 1997

	Activity Concentration (Bq/l)							
	Jan to Mar		Apr to Jun		Jul to Sep		Oct to Dec	
County	Cs-137	Sr-90	Cs-137	Sr-90	Cs-137	Sr-90	Cs-137	Sr-90
Cavan	< 0.25	0.07	< 0.16	< 0.04	< 0.26	< 0.03	< 0.25	0.05
Cork	< 0.22	< 0.04	< 0.16	0.05	< 0.16	0.05	< 0.21	< 0.03
Dublin	< 0.16	< 0.04	< 0.13	< 0.04	< 0.26	< 0.03	< 0.25	< 0.04
Kerry	< 0.14	< 0.05	< 0.20	0.05	< 0.14	< 0.03	< 0.23	0.04
Kilkenny	< 0.15	0.05	< 0.18	0.06	< 0.13	0.05	< 0.23	0.07
Louth	< 0.24	0.03	< 0.16	< 0.06	< 0.15	< 0.03	< 0.25	0.04
Monaghan	< 0.15	< 0.04	< 0.13	< 0.04	< 0.22	< 0.04	< 0.23	< 0.04
Roscommon	< 0.25	< 0.05	< 0.27	< 0.05	< 0.27	< 0.04	< 0.24	0.06
Tipperary	< 0.24	0.04	< 0.13	< 0.05	< 0.21	0.04	< 0.17	< 0.03
Waterford	< 0.16	0.05	< 0.20	0.05	< 0.27	0.04	< 0.17	0.07

Table 12 Radioactivity in Milk, 1998

	Activity Concentration (Bq/l)							
	Jan to Mar		Apr to Jun		Jul to Sep		Oct to Dec	
County	Cs-137	Sr-90	Cs-137	Sr-90	Cs-137	Sr-90	Cs-137	Sr-90
Cavan	< 0.20	< 0.02	< 0.16	0.06	< 0.18	0.03	< 0.16	0.07
Cork	< 0.16	< 0.02	< 0.16	0.05	< 0.09	0.07	< 0.15	0.04
Dublin	< 0.17	0.04	< 0.12	0.03	< 0.15	0.04	< 0.24	0.05
Kerry	< 0.25	0.02	< 0.13	0.07	< 0.18	0.06	< 0.15	0.04
Kilkenny	< 0.26	0.03	< 0.17	0.03	< 0.14	0.04	< 0.16	0.06
Louth	< 0.11	< 0.02	< 0.29	0.05	< 0.17	0.05	< 0.16	0.04
Monaghan	< 0.19	< 0.02	< 0.15	0.05	< 0.18	0.04	< 0.17	0.02
Roscommon	< 0.27	< 0.02	< 0.18	0.05	0.23	0.04	< 0.29	0.04
Tipperary	< 0.15	0.03	< 0.18	0.06	< 0.08	0.04	< 0.19	0.06
Waterford	< 0.11	< 0.02	< 0.11	0.05	< 0.16	0.09	< 0.15	0.06

Table 13 Age-dependent Ingestion Dose Coefficients for Strontium-90 and Yttrium-90

	Ingestion Dose Coefficients (Sv/Bq)*				
	< 1 year	1 - 2 years	7 - 12 years	12 - 17 years	adult
Sr-90	2.3×10^{-7}	7.3×10^{-8}	6.0×10^{-8}	8.0×10^{-8}	2.8×10^{-8}
Y-90	3.1×10^{-8}	2.0×10^{-8}	5.9×10^{-9}	3.3×10^{-9}	2.7×10^{-9}

*ICRP, 1996

Table 14 Committed Effective Dose from Strontium-90 and Yttrium-90 in Milk, 1997 and 1998

Age Group (years)	Committed Effective Dose (μSv)			
	Strontium-90		Yttrium-90	
	1997	1998	1997	1998
< 1	1.24	1.19	0.17	0.16
1 to 2	0.39	0.38	0.11	0.10
7 to 12	0.53	0.51	0.05	0.05
12 to 17	0.62	0.59	0.03	0.02
18+	0.17	0.16	0.02	0.02

Table 15 External Gamma Dose Rates, 1997 and 1998

Clonskeagh

Month	Monthly Ranges (nSv/h)	
	1997	1998
Jan	73 - 93	74 - 94
Feb	74 - 94	75 - 90
Mar	74 -89	74 - 94
Apr	75 - 93	75 - 97
May	73 - 100	74 - 92
Jun	75 - 107	73 - 96
Jul	70 - 92	75 - 89
Aug	74 - 96	74 - 91
Sep	74 - 90	76 - 113
Oct	75 - 94	75 - 92
Nov	76 - 114	76 - 103
Dec	75 - 124	75 - 108

Dundalk

Month	Monthly Ranges (nSv/h)	
	1997	1998
Jan	79 - 125	80 - 101
Feb	81 - 99	77 - 96
Mar	80 - 96	79 - 114
Apr	81 - 102	79 - 103
May	81 - 113	78 - 101
Jun	81 - 109	81 - 107
Jul	81 - 104	80 - 96
Aug	79 - 98	79 - 101
Sep	79 - 96	80 - 103
Oct	81 - 99	79 - 100
Nov	81 - 111	79 - 104
Dec	79 - 97	78 - 100

Caherciveen

Month	Monthly Ranges (nSv/h)	
	1997	1998
Jan	69 - 94	67 - 84
Feb	70 - 87	64 - 90
Mar	70 - 83	63 - 81
Apr	69 - 85	57 - 78
May	69 - 92	55 - 86
Jun	69 - 96	69 - 84
Jul	70 - 87	70 - 83
Aug	68 - 108	70 - 89
Sep	67 -89	70 - 98
Oct	67 - 82	70 - 88
Nov	67 - 100	69 - 92
Dec	69 - 94	69 - 97

Cork Airport

Month	Monthly Ranges (nSv/h)	
	1997	1998
Jan	79 - 121	78 - 98
Feb	77 -105	78 - 99
Mar	79 - 102	78 - 129
Apr	80 - 108	83 - 113
May	78 - 110	79 - 128
Jun	77 - 110	76 - 93
Jul	77 - 95	77 - 94
Aug	77 - 113	73 - 122
Sep	73 - 101	78 - 110
Oct	73 - 99	75 - 93
Nov	76 - 141	75 - 116
Dec	76 - 140	76 - 103

Rosslare

Month	Monthly Ranges (nSv/h)	
	1997	1998
Jan	60 - 83	60 - 94
Feb	62 - 109	59 - 74
Mar	61 - 74	59 - 86
Apr	61 - 79	59 - 83
May	62 - 88	60 - 81
Jun	61 - 108	61 - 91
Jul	57 - 77	61 - 89
Aug	60 - 111	60 - 86
Sep	61 - 121	61 - 105
Oct	61 - 75	62 - 78
Nov	62 - 115	61 - 98
Dec	62 - 84	60 - 81

Kilkenny

Month	Monthly Ranges (nSv/h)	
	1997	1998
Jan	60 - 88	59 - 82
Feb	60 - 77	60 - 75
Mar	60 - 76	59 - 84
Apr	60 - 80	60 - 79
May	61 - 93	60 - 77
Jun	60 - 101	59 - 87
Jul	59 - 76	58 - 72
Aug	60 - 85	59 - 86
Sep	59 - 76	59 - 99
Oct	60 - 78	59 - 77
Nov	62 - 115	57 - 100
Dec	60 - 93	60 - 86

Table 15 (continued) External Gamma Dose Rates, 1997 and 1998

Shannon Airport

Month	Monthly Ranges (nSv/h)	
	1997	1998
Jan	62 - 85	60 - 75
Feb	61 - 87	60 - 76
Mar	62 - 72	59 - 99
Apr	58 - 76	61 - 77
May	62 - 81	60 - 79
Jun	63 - 102	60 - 81
Jul	62 - 75	61 - 75
Aug	62 - 81	60 - 77
Sep	60 - 75	63 - 106
Oct	58 - 75	62 - 77
Nov	62 - 105	63 - 89
Dec	61 - 92	61 - 88

Birr

Month	Monthly Ranges (nSv/h)	
	1997	1998
Jan	51 - 93	55-77
Feb	58 - 75	56 - 72
Mar	56 - 71	55 - 80
Apr	58 - 72	57 - 75
May	55 - 76	56 - 75
Jun	56 - 106	55 - 75
Jul	57 - 71	53 - 70
Aug	57 - 87	54 - 72
Sep	56 - 70	56 - 87
Oct	58 - 73	56 - 74
Nov	58 - 101	57 - 86
Dec	57 - 80	57 - 83

Casement

Month	Monthly Ranges (nSv/h)	
	1997	1998
Jan	64 - 80	64 - 86
Feb	65 - 81	65 - 78
Mar	65 - 79	64 - 87
Apr	66 - 81	64 - 88
May	62 - 96	64 - 79
Jun	65 - 100	64 - 96
Jul	64 - 79	65 - 79
Aug	65 - 92	66 - 82
Sep	65 - 85	65 - 124
Oct	66 - 83	64 - 84
Nov	66 - 114	65 - 102
Dec	65 - 106	62 - 89

Knock Airport

Month	Monthly Ranges (nSv/h)	
	1997	1998
Jan	59 - 84	61 - 88
Feb	60 - 80	56 - 73
Mar	59 - 75	59 - 85
Apr	58 - 76	58 - 80
May	58 - 79	57 - 73
Jun	58 - 107	58 - 83
Jul	58 - 81	57 - 75
Aug	57 - 81	56 - 77
Sep	58 - 76	55 - 79
Oct	58 - 79	58 - 83
Nov	59 - 91	59 - 86
Dec	60 - 95	58 - 82

Clones

Month	Monthly Ranges (nSv/h)	
	1997	1998
Jan	63 - 96	60 - 81
Feb	65 - 82	60 - 76
Mar	64 - 80	58 - 95
Apr	64 - 85	60 - 80
May	66 - 99	58 - 75
Jun	67 - 93	59 - 81
Jul	59 - 113	60 - 74
Aug	60 - 77	58 - 82
Sep	59 - 73	58 - 85
Oct	59 - 77	61 - 79
Nov	62 - 93	59 - 80
Dec	61 - 95	60 - 81

Malin Head

Month	Monthly Ranges (nSv/h)	
	1997	1998
Jan	55 - 75	55 - 77
Feb	57 - 72	51 - 69
Mar	56 - 70	55 - 77
Apr	55 - 70	53 - 81
May	57 - 73	55 - 82
Jun	52 - 89	56 - 78
Jul	51 - 81	54 - 71
Aug	53 - 84	53 - 68
Sep	51 - 69	53 - 71
Oct	54 - 73	56 - 82
Nov	57 - 77	55 - 76
Dec	56 - 96	54 - 85