



NRL

National Radiation Laboratory

Environmental Radioactivity in New Zealand and Rarotonga – Annual Report 2007

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Summary

Artificial radioactivity in the environment in New Zealand and Rarotonga monitored during 2007 continued to be at trace levels only, typical of recent years during which there has been no significant change in the radioactivity status of the environment.

Atmospheric radioactivity was monitored at Kaitaia, Rarotonga and Chatham Islands; deposited radioactivity was monitored at Hokitika; and radioactivity in milk was monitored in the Waikato, Taranaki and Westland regions. The annual total beta concentration in deposition in Hokitika was $340 \pm 17 \text{ Bq/m}^2$. The annual average levels of caesium-137 (^{137}Cs) in milk powder were:

^{137}Cs in milk in Waikato:	$0.63 \pm 0.24 \text{ Bq/kg}$
^{137}Cs in milk in Taranaki:	$1.05 \pm 0.30 \text{ Bq/kg}$
^{137}Cs in milk in Westland:	$0.50 \pm 0.21 \text{ Bq/kg}$

1 Introduction

The National Radiation Laboratory (NRL) has monitored environmental radioactivity levels in the New Zealand and South Pacific regions since 1960, as described in earlier reports in this series.^{1,2} Monitoring was initially conducted for radioactive fallout from nuclear weapons tests in the Northern Hemisphere, and then for fallout from the French testing programme in the Tuamotu Archipelago. When the French atmospheric testing programme was terminated in 1974, monitoring continued for residues from atmospheric tests, and in order to detect any venting from the underground tests.

By 1985, levels of weapons-test debris in the atmosphere and rainwater had decreased to near the limits of detection for the monitoring techniques then in use, and the extensive monitoring network was scaled down³ to three monitoring sites, with two in New Zealand (Kaitaia and Hokitika) and one in the Cook Islands (Rarotonga). The sensitivity of weekly atmospheric monitoring at these sites was increased with the installation of 150 m³ per hour high-volume air samplers.⁴

Following the signing of the Comprehensive Nuclear-Test-Ban Treaty (CTBT)⁵ by the United Nations member countries in September 1996, verification of treaty compliance is now an important international issue. New Zealand signed the CTBT on 27 September 1996, and ratified the CTBT on 19 March 1999, with the passing of the Nuclear-Test-Ban Act.

To enforce the Treaty, the International Monitoring System has been designed to provide, on a global scale, passive monitoring capable of detecting and locating nuclear explosions. The four monitoring techniques are seismic, radionuclide, infrasound and hydro acoustic. The planned radionuclide-monitoring network will consist of 80 particulate radionuclide stations. These stations are to be distributed over 39 countries and their territories. As of Mid 2007 about 50 radionuclide stations have been installed. These include stations located at Kaitaia and Chatham Islands, New Zealand, and Rarotonga, Cook Islands.

In 2000 and in accordance with the CTBT, stations at Rarotonga and Kaitaia were upgraded and a new station was commissioned in the Chatham Islands. These stations are now capable of daily monitoring with a greater sensitivity resulting from the installation of 900 m³ per hour high-volume air samplers.

In conjunction with radionuclide detection, meteorological “back-tracking” provides information on any radionuclide source location through analysis of wind patterns in the preceding days and weeks of measurement. Meteorological stations operating to World Meteorological Organisation (WMO) standards are located at each site.

The present monitoring programme, consisting of wet and dry deposition radioactivity monitoring and the monitoring of radioactivity in milk, is intended to provide warning of any influx of radioactivity into the New Zealand and South Pacific regions from any source and to monitor trends in levels. The monitoring programme provides the basis for certification of the radioactivity content of foodstuffs. It also serves as the basis of consumer and commercial advisory services concerning radioactivity, and for comparisons of the environmental radioactivity status of the South Pacific region with that of other regions.

In order to maintain a high standard of capability in radiochemical analysis, NRL takes part in quality assurance programmes and international analytical intercomparison exercises run by the IAEA, the Comprehensive Nuclear-Test-Ban Treaty Organisation (CTBTO), the National Physical Laboratory (UK), and the US Department of Energy.

Although the environmental monitoring programme is designed primarily to detect and monitor levels of artificial radioactivity, measurements include naturally occurring radioactive materials, for comparative and scientific purposes. The atmospheric monitoring therefore includes measurements of concentrations of lead-210 (^{210}Pb) and beryllium-7 (^7Be) in the atmosphere. Beryllium-7 is a cosmogenic nuclide (a product of spallation reactions of cosmic radiation within the upper atmosphere), while ^{210}Pb is the decay products of gaseous radon-222, which diffuses out of soil.

The 1993 report⁶ provided full discussion of trends in atmospheric ^{137}Cs levels, radionuclides which contribute to the measured atmospheric beta activity, the age of aerosols collected in the NRL monitoring network, current concentrations of ^{137}Cs in New Zealand soils, and radiation exposure due to fallout (both natural and artificial) in diet.

In 2004 NRL stopped monitoring levels of strontium-90 (^{90}Sr) in milk powders. The concentration levels have fallen below the detection limit and are far below the reference level of 120 Bq/kg. The present fallout-monitoring programme would detect any new deposition of ^{90}Sr .

2 Monitoring programme

The environmental radioactivity monitoring programme comprised of the following measurements during 2007:

Atmospheric radioactivity: Atmospheric monitoring is regarded as the most important component of the monitoring programme because any radioactive pollution reaching the region would inevitably have been transported in the atmosphere, and the high-sensitivity monitoring would provide early warning of any influx or changing trend in environmental radioactivity levels. Daily collections of particulates were performed at Kaitaia, Rarotonga and Chatham Islands stations.

At the stations at Kaitaia, Rarotonga and Chatham Islands a Physik-Technik-Innovation (PTI) ASS-500 air sampler is used to draw air through 2025 cm² filters (3M filter, polypropylene BMF) at a flow rate of approximately 13 m³/min, with a daily sample volume of approximately 19 000 m³. These filters are analysed by high resolution gamma spectrometry (Canberra high purity n-type germanium BEGE5030 detector) for gamma-emitting artificial and natural radionuclides. The minimum detectable concentration for the fission product ¹³⁷Cs in the daily filter analyses ranged from 1 to 5 µBq/m³.

Radioactive deposition: Total beta-activity concentration in deposition was monitored at Hokitika with weekly (small-area rain collector 0.021 m²) sample collection. Total beta concentration is determined at NRL using a liquid scintillation counter.

The large-area rain collector at Hokitika allows the monitoring of weekly depositions of the artificial radionuclides in rainwater. A stainless-steel rain collector (1 m²) has an ion-exchange resin column attached to its base. The resin retains any cationic species present in the rainwater, which percolates through it. The column remains attached to the collector for the one-week sampling period, after which it is returned to NRL for gamma spectrometric analysis. Beryllium-7 measurements were used as a quality control for the performance of the sampling system.

Radioactivity in milk: Caesium-137 concentrations were monitored in dairy milk powders by gamma spectrometry with monthly sample collection from three New Zealand regions: Waikato, Taranaki and Westland.

3 2007 Monitoring results

Radioactivity units used throughout this report are becquerels (Bq), millibecquerels (mBq) and microbecquerels (μBq): 1 Bq = 1 nuclear transformation per second.

The uncertainties reported are standard deviations of the mean values multiplied by a coverage factor (k) = 2, providing a level of confidence of 95%.

3.1 Atmospheric radioactivity

No significant concentrations of artificial radionuclides were detected by gamma-spectroscopic analysis of daily air filters collected from each monitoring station during 2007.

Beryllium-7 continued to be the most significant radionuclide detected on the air filters during 2007. Lead-210 levels were similar at all three monitoring sites. The annual average concentrations of ^7Be and ^{210}Pb in air filters from Kaitaia, Rarotonga and Chatham Island are presented in Table 1.

Table 1. The annual average concentrations of ^7Be and ^{210}Pb in air filters in 2007 at three monitoring stations.

Sampling site	^7Be ($\mu\text{Bq}/\text{m}^3$)	^{210}Pb ($\mu\text{Bq}/\text{m}^3$)
Kaitaia	4892 ± 45	104.1 ± 9.7
Chatham Island	3424 ± 42	74.5 ± 9.7
Rarotonga	3692 ± 45	80.6 ± 7.4

The annual trend in ^7Be levels continued to demonstrate the normal cycle of summer maxima and winter minima for the New Zealand monitoring stations.

3.2 Radioactive deposition

No artificial radionuclides were detected in the deposition samples by gamma-spectrometric analysis. The TBC deposition for 2007 at Hokitika was $340 \pm 17 \text{ Bq}/\text{m}^2$ with 2460 mm of rainfall. The average weekly deposition was $6.9 \pm 1.7 \text{ Bq}/\text{m}^2$.

3.3 Radioactivity in milk

The radioactivity content of cows' milk was assessed by gamma spectroscopic analysis monthly in three regions. Caesium-137 was the only detectable artificial radionuclide. Results are summarised in Table 2.

Table 2. Annual average ^{137}Cs concentrations in milk powder for Waikato, Taranaki and Westland for 2007.

Region	^{137}Cs (Bq/kg)
Waikato	0.63 ± 0.24
Taranaki	1.05 ± 0.30
Westland	0.50 ± 0.21

4 Quality Management

Quality management is an essential feature of any measurement laboratory's operations. In December 2001 NRL was awarded a certificate of approval for its quality management system to the quality standard "AS/NZS ISO 9001:2000. Quality management systems – requirements".

In March 2008 the Environmental Laboratory's accreditation to international standard NZS/ISO/IEC17025 "General requirements for the competence of testing and calibration laboratories" was reassessed and confirmed. The scope of accreditation includes environmental monitoring and analyses of foodstuffs and waters.

During 2007 the Environmental Laboratory participated in six intercomparison exercises, conducted by the International Atomic Energy Agency, the British National Physical Laboratory, the Comprehensive Test Ban Treaty Organisation, and the US Department of Energy, involving analysis of air filters, soil, vegetation and water.

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The Environmental Laboratory of the NRL organised the monitoring and analysed the samples.

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