

Environmental Radioactivity Report

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1. Executive Summary

The Institute of Environmental Science and Research (ESR) operates monitoring stations for radioactivity in New Zealand and the Cook Islands. As part of the Monitoring Programme for Radioactivity in the Environment, ESR provides the following services to the Ministry of Health:

Atmospheric monitoring

Particulate matter:

ESR manages three atmospheric radioactivity monitoring stations in New Zealand and the Cook Islands. We review the measurements for atmospheric particulate concentrations of Caesium-134, Caesium-137 and Iodine-131.

Deposition:

ESR collects rainwater samples from the South Island West Coast on an approximately weekly basis and analyses them for Caesium-134, Caesium-137, Iodine-131, Total Alpha and Total Beta activity concentration.

Monitoring of radioactivity in milk powders

ESR receives milk powder samples from Waikato, Taranaki, and South Island West Coast regions on an approximately monthly basis and analyses them for Caesium-134, Caesium-137 and Iodine-131.

Monitoring of Cs-137 in seawater

ESR collects seawater samples from NZ waters and analyses them for Caesium-134 and Caesium-137.

This report collates the results of the Monitoring Programme for the period 1 July 2023 to 30 June 2024. During the period of this report the activity concentrations detected by all monitoring regimes were well below those considered to constitute a radiological risk to human health.

2. Overview

Atmospheric Monitoring

Atmospheric transport of materials from a distant source is the most likely means by which remote countries such as New Zealand and other Pacific Nations would receive radioactive contamination. The National Radiation Laboratory, and now ESR's National Centre for Radiation Science, have monitored atmospheric radioactivity in the New Zealand and South Pacific region since 1960. The programme was initially set up to monitor radioactive fallout from nuclear weapons tests in the Pacific. Without any significant releases of radioactivity in the region in recent times, the programme continues to monitor for any potential influx of radioactivity.

Three atmospheric monitoring sites are operated by ESR as part of the International Monitoring System (IMS) of the Comprehensive Nuclear-Test-Ban Treaty Organisation (CTBTO). The main purpose of these stations is the verification of the Comprehensive Nuclear-Test-Ban Treaty (CTBT); but the data is also analysed as part of New Zealand's environmental monitoring programme for radioactivity.

These monitoring sites are:

Kaitaia (RN47); Lat: -35.068, Long: 173.287

Chatham Islands (RN46); Lat: -43.816, Long: -176.475

Cook Islands (RN23); Lat: -21.201, Long: -159.813

These sites are equipped with Senya JL-900 Snow White air samplers that sample between 23 and 24 hours each day, collecting between 19,000 to 24,000 m³ of air. Air filters are collected daily and analysed on site using Canberra CP5+ electrically cooled High Purity Germanium detectors. Between two and six samples per year are sent to accredited laboratories within the IMS for re-analysis. This is part of the ongoing quality control and quality assurance programme.

In addition, ESR operates a rainwater sampling site at Hokitika. Hokitika's geographical exposure and climatic characteristics make it the most suitable site for rainwater collection (atmospheric deposition). The sampling location is at:

Hokitika; Lat: -42.715, Long: 170.984

The site is equipped with custom-made large and small area rainwater collectors. Rainwater is collected at the site for a period of one week (at times two weeks) and sent to ESR for analysis.

Monitoring of radioactivity in milk powders

Dairy products in general are of high relevance to the NZ consumer and NZ economy. Milk powder samples are excellent environmental sensors for radioactive contaminants such as Caesium-137.

Milk powder samples are supplied to the laboratory monthly by participating producers from the Waikato, Taranaki, and Westland regions. Samples are analysed for I-131, Cs-134 and Cs-137 on High Purity Germanium detectors.

Monitoring of Cs-134 and Cs-137 in seawater

Seawater samples are taken from Lyttelton Harbour (Lat: -43.607, Long: 172.717) on a monthly basis. The samples, which have a typical sample volume of 600 mL, are brought to the laboratory, and analysed directly by gamma spectrometry.

3. Results

Radioactivity units used throughout this report are becquerels (Bq), millibecquerels (mBq = 10^{-3} Bq) and microbecquerels ($\mu\text{Bq} = 10^{-6}$ Bq). One becquerel is defined as one nuclear transformation per second.

We report measured activity concentrations of artificial radionuclides and their uncertainties for atmospheric particulate matter at CTBTO stations. In addition, we report annual means and the standard deviations of the underlying distributions for atmospheric particulate matter and milk powder samples. This includes natural daily and seasonal variations, the measurement uncertainties of individual results are significantly smaller.

Atmosphere – Particulate matter

A total of 1065 daily atmospheric samples were collected at Kaitaia, Chatham Islands and Cook Islands. The three stations had a combined downtime of 30 days due to maintenance. The samples were measured on site by high-resolution gamma spectrometry. The data was analysed for the artificial radionuclides I-131, Cs-134 and Cs-137, and the naturally occurring radionuclides Be-7 and Pb-212.

Detections of these artificial radionuclides are listed in Table 1. Aside from these detections, all other samples had concentrations of I-131, Cs-134 and Cs-137 below Minimum Detectable Concentrations (MDCs), which were in the range of 1 to 4 $\mu\text{Bq}/\text{m}^3$.

TABLE 1: Detections of artificial radionuclides I-131, Cs-134 and Cs-137 in the atmosphere. Measurement uncertainties at a coverage factor of $k=1$.

Sampling site	Date (UTC)	I-131 ($\mu\text{Bq}/\text{m}^3$)	Cs-134 ($\mu\text{Bq}/\text{m}^3$)	Cs-137 ($\mu\text{Bq}/\text{m}^3$)
Chatham Islands	15/02/2024	0.68 ± 0.22	< MDC	< MDC
Kaitaia	17/02/2024	< MDC	< MDC	0.85 ± 0.92
Chatham Islands	22/04/2024	0.71 ± 0.21	< MDC	< MDC
Cook Islands	28/05/2024	< MDC	1.46 ± 0.45	< MDC

The naturally occurring radionuclides Be-7 and Pb-212 were present in every atmospheric sample. Their annual means are given in Table 2.

TABLE 2: Annual means and standard deviations of the underlying distributions of daily activity concentrations in the atmosphere for naturally occurring Be-7 and Pb-212.

Sampling site	Be-7 (mBq/m ³)		Pb-212 (mBq/m ³)	
	Mean	Std. Dev.	Mean	Std. Dev.
Cook Islands	3.7	1.7	52	40
Chatham Islands	2.4	1.4	5.4	5.8
Kaitaia	2.6	1.3	6.7	7.0

Atmosphere – Deposition

48 weekly and 2 fortnightly rainwater samples were collected at Hokitika. The samples were analysed for total beta-activity concentration using a liquid scintillation counter, and for artificial nuclides using gamma spectrometry. Be-7 measurements were used as a quality control for the performance of the sampling system.

No artificial radionuclides were detected. Based on the Minimum Detectable Concentrations for Cs-137, the upper limit for weekly deposition of Cs-137 was determined to be 0.3 Bq/m² which corresponds to 0.005 Bq/L.

The total annual deposition of beta emitters was 410 Bq/m² with 2339 mm of total collected rainfall. The mean weekly beta activity from deposition was 7.9 Bq/m² and the observed standard deviation 10.7 Bq/m². This activity is almost entirely due to naturally occurring radionuclides.

Milk Powder

33 monthly milk powder samples (in some cases liquid milk samples) were obtained from the Waikato, Taranaki, and Westland regions¹. These were analysed for I-131, Cs-134 and Cs-137 by gamma spectrometry. Cs-137 was the only detectable artificial radionuclide. Milk powders from the Taranaki region remain the ones with the highest Cs-137 concentration. The Cs-137 levels in samples from the Westland region are commonly below the Minimum Detectable Concentration of 0.2-0.5 Bq/kg.

TABLE 3: Annual means and standard deviations of the underlying distributions of Cs-137 activity concentrations in monthly milk powder samples.

Region	Number of samples	Number of detections	Cs-137 (Bq/kg)	
			Mean	Std. Dev.
Waikato	11	8	0.429	0.136
Taranaki	11	10	0.588	0.190
Westland	11	3	0.203	0.038

Seawater

12 monthly seawater samples were obtained from Lyttleton Harbour and analysed by gamma spectrometry for the presence of artificial nuclides. None of the analysed samples showed detectable concentrations of I-131, Cs-134 or Cs-137. The Minimum Detectable Concentration for Cs-137 was 0.22 Bq/L. No other artificial gamma emitters have been detected.

¹ Exceptions are the July 2023 sample from the Westland region and June 2024 samples from the Waikato and the Taranaki regions, which were not provided.



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