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ENVIRONMENTAL RADIOACTIVITY ANNUAL REPORT

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SUMMARY

The New Zealand environmental radioactivity programme was modified during 1986, with a reduction in the number of monitoring stations and an increase in the sensitivity to airborne radioactivity of the remaining stations. During 1986 artificial environmental radioactivity in the New Zealand and South Pacific areas continued to be at the very low level typical of recent years.

The total beta activity in air averaged 0.07 mBq m^{-3}. The average strontium-90 deposition for the year was 0.2 MBq km^{-2}. Strontium-90 in dairy milk ranged from 0.014 to 0.062 Bq gCa^{-1} and caesium-137 ranged from <0.04 to 0.86 Bq gK^{-1}.

Emissions from the damaged Chernobyl nuclear reactor were not detected in the region.

CONTENTS

INTRODUCTION

This report continues the series on environmental radioactivity monitoring in New Zealand and the South Pacific, published since 1961.[1,2]

The National Radiation Laboratory has been conducting this monitoring since 1960, for radioactive fallout initially arising from Northern Hemisphere nuclear weapons tests and later from the French testing programme which commenced in the Tuamotu Archipelago in 1966. The French programme changed from atmospheric to underground testing in 1975. Monitoring continued for residues from atmospheric tests and in order to detect any atmospheric venting of fission products from the underground test series.

After 1975 environmental levels of artificial radioactivity in the New Zealand and South Pacific regions decreased steadily, soon approaching limits of detection. Trends in levels were fully illustrated in earlier reports.[3,4] Changes to the monitoring programme were therefore proposed in 1984,[3] partially implemented in 1985[4] and fully implemented in 1986. The initial programme of continuous monitoring of air and rainwater beta (β) activity at 5 Pacific island and 4 New Zealand stations, strontium-90 (^{90}Sr) in rainwater at 9 New Zealand and 2 island stations, and ^{90}Sr and caesium-137 (^{137}Cs) in dairy milk from 9 New Zealand regions, was reduced to the same monitoring at 2 New Zealand and 1 island station, and milk sampling from 3 regions. This new monitoring programme commenced on 1 July 1986 and results are here reported separately for each programme in the first and second half-year periods.

Environmental monitoring since July has been conducted only at Kaitaia and Hokitika in New Zealand, and at Rarotonga. These sites were chosen strategically: Hokitika as an area of relatively heavy deposition and exposed to the prevailing westerly air movements; Kaitaia as being exposed to northern air masses; and Rarotonga as a central South Pacific site as close as practicable to the Tuamotu Archipelago. The 3 milk monitoring regions were also strategically selected: Auckland as an area supplying a large fraction of the New Zealand population, Taranaki as an atypical area with relatively high ^{137}Cs levels in milk due to soil factors,[5] and Westland as an area with relatively heavy deposition. Monitoring is therefore conducted only at sites which have special characteristics and is intended to indicate trends and detect changes rather than to assess country-wide averages.

Earlier annual reports[1] and special reports on French atmospheric tests[2] give information on terms of reference, potential health hazard, reference levels and technical information.[2,3,4] The high-volume air samplers which play a major role in the new environmental monitoring programme, were fully described in the 1985 Annual Report.[4] These samplers were installed at Hokitika, Kaitaia and Rarotonga in August 1985, November 1985 and March 1986 respectively.

The following reference levels, with which reported levels may be compared, have been adopted for New Zealand: mixed fission products between 10 and 80 days old (total β activity), in rain - 220 becquerels (Bq) per litre, and in air - 11 Bq per cubic metre; ^{90}Sr in milk - 10 Bq per gram of calcium (Ca); ^{137}Cs in milk - 260 Bq per gram of potassium (K). One litre of milk contains approximately 1.2 g Ca and 1.4 gK.

1986 MONITORING RESULTS

Results for 1986 are summarized in Tables 1-6. The precision of measurement, when given, is based on a counting error of 2 Poisson standard deviations.

1. Total Beta Activity in Air

The total β activity in air did not exceed the limit of detection at any station where the original low-volume air sampling programme was maintained during the first half-year; i.e., <0.3 mBq m^{-3} at Wellington and Christchurch, and <1.1 mBq^{-3} at Nandi (Fiji), Samoa, Tonga, Aitutaki and Rarotonga (1st Quarter only). (1 mBq m^{-3} = 1 millibecquerel per cubic metre of air.)

The β activity was measurable only at Hokitika, Kaitaia and Rarotonga where the new monitoring programme was conducted. Monthly activity ranges and means at these stations are given in Table 1. There were no significant variations in activity during the year and the 1986 mean at all stations was 0.07 mBq m^{-3}, which is similar to the mean of levels recorded at Kaitaia and Hokitika during late 1985,[4] of 0.06 mBq m^{-3}.

2. Total Beta Activity in Rain

The mean β activity deposition (Table 2) at New Zealand stations during the first half-year was 47 MBq km^{-2} with a mean concentration in rainwater of 0.07 Bq l^{-1}. This deposition was similar to that in the same period in 1985, 34 MBq km^{-2}.

Depositions at Pacific island stations during this period ranged from 40 MBq km^{-2} at Tonga to 115 MBq km^{-2} at Aitutaki with concentrations of 0.01-0.11 Bq l^{-1}.

Hokitika is the only station at which monitoring was conducted for the whole year and the total deposition there was 256 $\pm$ 28 MBq km^{-2}, with a mean concentration of 0.13 $\pm$ 0.02 Bq l^{-1}. This deposition, when normalized for annual rainfall (2636 mm), is very similar to the 1985 level of 176 $\pm$ 24 MBq km^{-2} (1985 rainfall 2052 mm).[4]

The total β activity in rainwater is due mainly to naturally occurring radionuclides, particularly lead-210 and its decay product bismuth-210.

3. Strontium-90 Deposition

Strontium deposition (Table 3) was below the limit of detection (0.1 MBq km^{-2}) at all stations except Hokitika during the first half-year period.

In order to improve detectability the bulking period for strontium extracts was increased from 3 months to 6 months for the second half-year period during which the measured depositions at Kaitaia, Hokitika and Rarotonga were 0.2, 0.3 and 0.1 MBq km^{-2} respectively. The 3-station 1986 average deposition was 0.2 MBq km^{-2}. Future monitoring will continue to involve 6-month aggregates for samples from these stations.

4. Strontium-90 and Caesium-137 in Milk

Quarterly average ^{90}Sr levels (Table 4) in cows' milk ranged from 0.014 Bq gCa^{-1} (Christchurch, 2nd quarter) to 0.062 Bq gCa^{-1} (Auckland, 4th quarter), with a country-wide mean for the first half-year of 0.030 Bq gCa^{-1}, similar to the 1985 annual mean of 0.036 Bq gCa^{-1}.[4] The 3-region mean for the second half-year was 0.051 Bq gCa^{-1}.

Quarterly average ^{137}Cs levels (Table 5) in milk ranged from <0.04 Bq gK^{-1} (Christchurch, 2nd quarter) to 0.86 Bq gK^{-1} (Taranaki, 2nd quarter), with a country-wide mean for the first half-year of 0.22 Bq gK^{-1}, similar to the 1985 annual mean of 0.27 Bq gK^{-1}.[4] The 3-region mean for the second half-year was 0.27 Bq gK^{-1}.

5. Gamma-emitting radionuclides on high-volume air filters

No artificial radionuclides were detected on high-volume air filters from Kaitaia, Hokitika and Rarotonga during 1986. Limits of detection for selected radionuclides were listed in the 1985 report[4] and were of the order of 10^{-7} - 10^{-6} Bq m^{-3}.

Mean natural beryllium-7 levels at Kaitaia, Hokitika and Rarotonga during 1986 were 4, 3 and 3 mBq m^{-3} respectively.

6. Lead-210 deposition

Deposition rates of naturally occurring lead-210 have been measured in conjunction with that of ^{90}Sr. Deposition in the first half-year period ranged from 10 MBq km^{-2} at Christchurch to 73 MBq km^{-2} at Hokitika with a country-wide mean for that period of 31 MBq km^{-2}. The 1986 total depositions were Kaitaia 100 MBq km^{-2}, Hokitika 113 MBq km^{-2} and Rarotonga 31 MBq km^{-2}.

THE CHERNOBYL REACTOR INCIDENT

The most serious nuclear reactor incident to date took place at Chernobyl, USSR, on 26 April 1986. Damage to the reactor resulted in an estimated release of more than 5% of the total reactor radioactivity inventory.[6] The entire inventory of noble gas fission products and 2×10^{18} Bq of non-gaseous radionuclides were released to the atmosphere. Up to 20% of the reactor content of volatile fission products such as iodine-131 (^{131}I) and 4% of less volatile products such as ^{90}Sr were released.[6] Radioactive debris from the reactor were detected in countries throughout the Northern Hemisphere. It was not expected that emissions would be detected in the Southern Hemisphere because Chernobyl is situated well north of the Equator (51°N) and the atmospheric release was confined to the troposphere.

The New Zealand fallout monitoring programme, with its new high-volume air samplers, provides a very sensitive measurement of environmental radioactivity levels. The measurement of total beta activity in air, in particular, allows rapid and sensitive detection of any changes in airborne radioactivity levels.

Results of that programme have been presented fully in Table 1 where it can be seen that there were no significant fluctuations during the year, with levels pre-and post-Chernobyl being similar.

Similarly, the results reported for beta activity and ^{90}Sr in rain, and ^{90}Sr and ^{137}Cs in milk are all at normal levels. ^{131}I was not detected in any sample.

It is concluded, therefore, that no measurable quantities of emissions reached the South Pacific and New Zealand regions.

The National Radiation Laboratory played an active role in giving advice and comment to the public and the news media following the incident and has since been involved in monitoring radioactivity levels in foodstuffs imported from European countries, and also in certifying levels in exported New Zealand produce.

The Department of Health adopted the same limits as EEC countries[7] for radioactivity levels in agricultural products originating in countries which may have been contaminated with Chernobyl fallout. All agricultural imports from European countries were required to be certified as complying with the EEC regulation: i.e., milk products and infant foods to contain less than 370 Bq $^{134+137}Cs$ per kilogram, and all other foods to contain less than 600 Bq kg^{-1}. Samples of any uncertified foodstuffs were analyzed for $^{134+137}Cs$ content by the National Radiation Laboratory.

During 1986 samples of dried fruits and herbs from Turkey, preserved fruit from Poland and Hungary, and "Inka" coffee substitute from Poland were tested. The Turkish imports only were found to contain ^{137}Cs in the range 8 - 53 Bq kg^{-1}. No imports were found to be contaminated to levels near the prescribed limit.

A description of the Chernobyl incident and a summary of its potential effects was published.[8]

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A C McEwan
Director

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TABLE 1

TOTAL BETA ACTIVITY IN AIR

		Monthly Ranges and Means (mBq m^{-3})		
		Kaitaia	Hokitika	Rarotonga
January	range	0.05-0.16	0.05-0.12	
	mean	0.09	0.09	
February	range	<0.04-0.09	0.04-0.07	
	mean	0.06	0.06	
March	range	0.04-0.11	0.04-0.06	<0.04-0.06
	mean	0.07	0.05	0.05
April	range	0.08-0.13	0.04-0.13	<0.04-0.05
	mean	0.10	0.08	0.04
May	range	0.05-0.10	<0.04-0.08	<0.04-0.12
	mean	0.08	0.06	0.06
June	range	0.04-0.06	<0.04-0.06	<0.04-0.09
	mean	0.05	0.04	0.06
July	range	0.04-0.10	0.06-0.13	<0.04-0.12
	mean	0.06	0.08	0.06
August	range	<0.04-0.07	<0.04-0.12	0.07-0.12
	mean	0.04	0.08	0.09
September	range	<0.04-0.11	0.04-0.11	0.08-0.23
	mean	0.05	0.07	0.12
October	range	<0.04-0.14	<0.04-0.07	0.06-0.13
	mean	0.08	0.04	0.10
November	range	0.05-0.19	<0.04-0.10	0.06-0.15
	mean	0.12	0.07	0.11
December	range	<0.04-0.10	<0.04-0.15	<0.04-0.10
	mean	0.06	0.08	0.06
1986	range	<0.04-0.19	<0.04-0.15	<0.04-0.23
	mean	0.07±0.07	0.07±0.06	0.07±0.08

TABLE 2

TOTAL BETA ACTIVITY IN RAIN 1986 (WEEKLY COLLECTION)

Cumulative Rainfall (mm)
Cumulative Deposition (MBq km^{-2})
Average Concentration (Bq l^{-1})

		1st Quarter	2nd Quarter
New Zealand Stations			
Auckland:	mm	419	223
	MBq km^{-2}	21 ± 7	17 ± 7
	Bq l^{-1}	0.05 ± 0.02	0.08 ± 0.03
Wellington:	mm	344	325
	MBq km^{-2}	22 ± 7	29 ± 7
	Bq l^{-1}	0.06 ± 0.02	0.09 ± 0.02
Hokitika:	mm	684	996
	MBq km^{-2}	59 ± 13	73 ± 15
	Bq l^{-1}	0.09 ± 0.02	0.07 ± 0.02
Christchurch:	mm	280	81
	MBq km^{-2}	19 ± 6	15 ± 6
	Bq l^{-1}	0.07 ± 0.02	0.18 ± 0.08
Weighted means:	MBq km^{-2}	24 ± 2	23 ± 2
	Bq l^{-1}	0.07 ± 0.01	0.08 ± 0.01
Pacific Island Stations			
Samoa:	mm	594	756
	MBq km^{-2}	34 ± 19	51 ± 21
	Bq l^{-1}	0.06 ± 0.03	0.07 ± 0.03
Tonga:	mm	493	427
	MBq km^{-2}	35 ± 18	5 ± 23
	Bq l^{-1}	0.07 ± 0.04	0.01 ± 0.05
Aitutaki:	mm	646	582
	MBq km^{-2}	50 ± 20	65 ± 21
	Bq l^{-1}	0.08 ± 0.03	0.11 ± 0.04
Rarotonga:	mm	513	680
	MBq km^{-2}	32 ± 16	28 ± 17
	Bq l^{-1}	0.06 ± 0.03	0.04 ± 0.03

The error term is ± 2 standard deviations.

TABLE 3

STRONTIUM-90 IN RAIN 1986

Rainfall (mm)
Deposition (MBq km^{-2})
Concentration (Bq l^{-1})

		1st Quarter	2nd Quarter
New Zealand Stations			
Kaitaia:	mm	524	254
	MBq km^{-2}	<0.1	<0.1
	Bq l^{-1}	<0.001	<0.001
Auckland:	mm	378	182
	MBq km^{-2}	<0.1	<0.1
	Bq l^{-1}	<0.001	<0.001
New Plymouth:	mm	410	354
	MBq km^{-2}	<0.1	<0.1
	Bq l^{-1}	<0.001	<0.001
Havelock North:	mm	166	46
	MBq km^{-2}	<0.1	<0.1
	Bq l^{-1}	<0.001	<0.001
Wellington:	mm	378	52
	MBq km^{-2}	<0.1	<0.1
	Bq l^{-1}	<0.001	<0.001
Hokitika:	mm	596	954
	MBq km^{-2}	0.1	0.1
	Bq l^{-1}	<0.001	<0.001
Christchurch:	mm	280	81
	MBq km^{-2}	<0.1	<0.1
	Bq l^{-1}	<0.001	<0.001
Dunedin:	mm	118	182
	MBq km^{-2}	<0.1	<0.1
	Bq l^{-1}	<0.001	<0.001
Invercargill:	mm	295	329
	MBq km^{-2}	<0.1	<0.1
	Bq l^{-1}	<0.001	<0.001
Average:	mm	349	270
	MBq km^{-2}	<0.1	<0.1
	Bq l^{-1}	<0.001	<0.001
Pacific Island Stations			
Suva, Fiji:	mm		346
	MBq km^{-2}	No Result	<0.1
	Bq l^{-1}		<0.001
Rarotonga:	mm	511	741
	MBq km^{-2}	<0.1	<0.1
	Bq l^{-1}	<0.001	<0.001

The counting error for deposition results is about ± 0.08 MBq km^{-2}.

TABLE 4

STRONTIUM-90 IN MILK 1986 (Bq gCa^{-1})

	1st Quarter	2nd Quarter
Northland	0.031	0.025
Auckland	0.034	0.033
Waikato	0.020	0.029
Taranaki	0.053	0.055
Palmerston North	0.023	0.022
Wellington	0.041	0.032
Westland	0.057	0.036
Christchurch	0.016	0.014
Dunedin	0.015	0.019
Average	0.032	0.029

The counting error was approximately ± 0.002 Bq gCa^{-1}.

TABLE 5

CAESIUM-137 IN MILK 1986 (Bq gK^{-1})

	1st Quarter	2nd Quarter
Northland	0.21	0.33
Auckland	0.18	0.25
Waikato	0.24	0.35
Taranaki	0.57	0.86
Palmerston North	0.06	0.05
Wellington	0.13	0.19
Westland	0.18	0.32
Christchurch	<0.04	0.04
Dunedin	0.05	0.06
Average	0.18	0.27

The counting error was approximately ± 0.03 Bq gK^{-1}.

TABLE 6

RESULTS SUMMARY FOR SECOND HALF-YEAR AND FULL YEAR 1986

	Kaitaia	Hokitika	Rarotonga
ENVIRONMENTAL MONITORING			
Strontium-90 in rain:			
Deposition (MBq km^{-2})			
July-Dec	0.2	0.3	0.1
Jan -Dec	0.3	0.4	0.1
Average concentration (Bq l^{-1})	<0.001	<0.001	<0.001
Rainfall (mm)			
July-Dec	693	993	901
Jan -Dec	1471	2543	2153
Lead-210 in rain:			
Deposition (MBq km^{-2})			
July-Dec	49	40	30
Jan -Dec	75	113	46
Total beta activity in rain:			
Deposition (MBq km^{-2})			
3rd quarter		56±14	No Result
4th quarter		68±14	No Result
Jan -Dec		256±28	No Result
Rainfall (mm)			
Jan -Dec		2636	
Average concentration (Bq l^{-1})		0.13±0.02	
Total beta activity in air:			
Range (mBq m^{-3})			
July-Dec	<0.04-0.19	<0.04-0.15	<0.04-0.23
Mean (mBq m^{-3})			
July-Dec	0.07±0.08	0.07±0.08	0.11±0.11
Jan -Dec	0.07±0.07	0.07±0.06	0.07±0.08

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TABLE 6 (contd)

	Auckland	Taranaki	Westland
MILK MONITORING			
Caesium-137 content (Bq gK^{-1})			
3rd quarter	0.17	0.31	0.17
4th quarter	0.10	0.64	0.21
1986 average:	0.18	0.60	0.22
Strontium-90 content (Bq gCa^{-1})			
3rd quarter	0.055	0.040	0.061
4th quarter	0.062	0.031	0.054
1986 average:	0.046	0.045	0.052