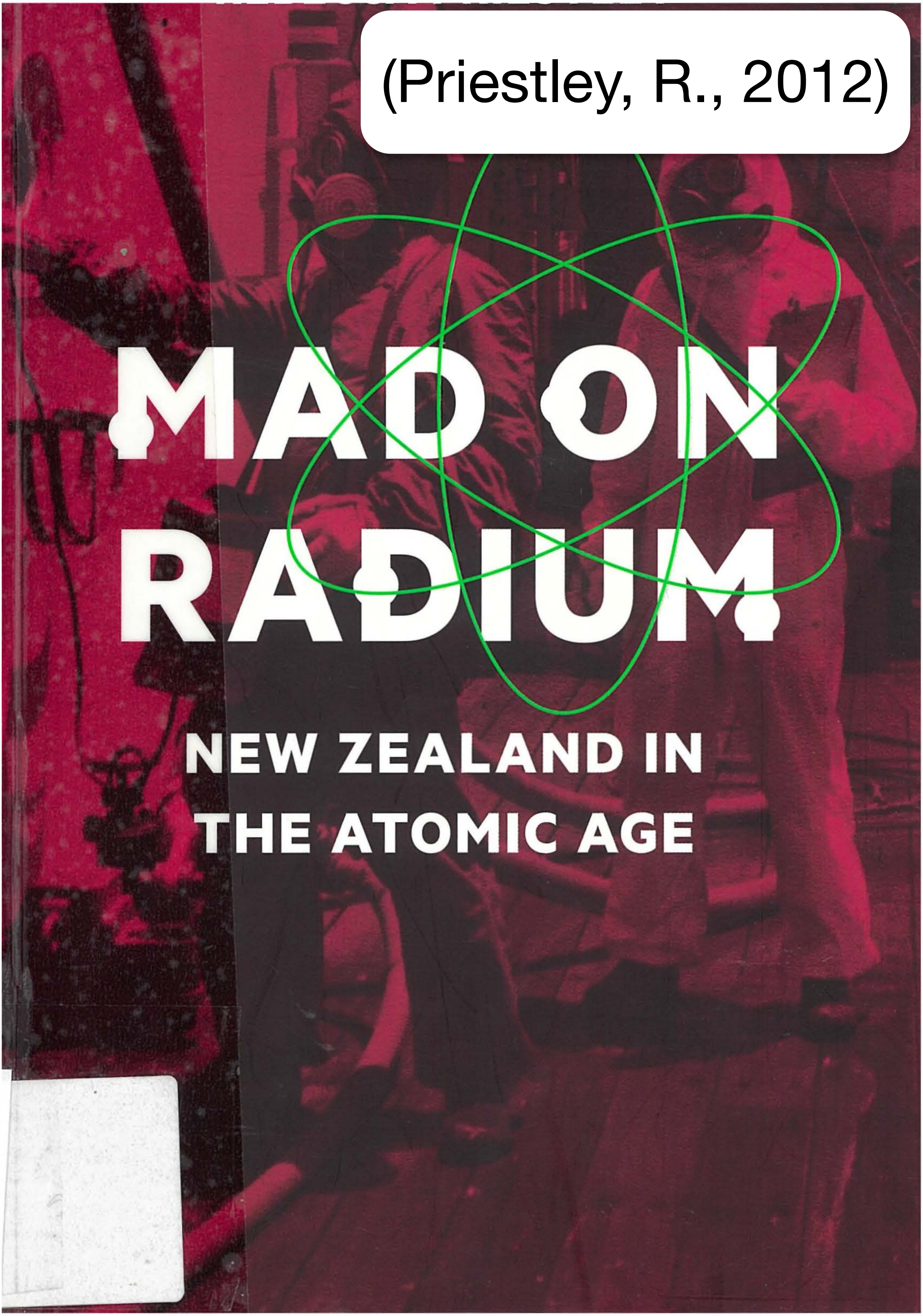
(Priestley, R., 2012)



MAD ON RADIUM

NEW ZEALAND IN THE ATOMIC AGE

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For Jonathan

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1960
World's first nuclear submarine visits New Zealand

(Priestley, 2012: 155

V2

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ADIAT N RISKS

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n safety measures, and had to take
users of radioactive materials who
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Atoms for Pe[ace]
Nuclear science in New Zealand in the atomic age

A country backward in nuclear science can only stumble blindly in the atomic age, ignorant of opportunities, deficient in technique and the pawn of countries more advanced. — J. WILLIAMS, REPORT ON DEVELOPMENT OF NUCLEAR SCIENCES IN NEW ZEALAND, 19 JULY 1956[1]

A new source of power to light the homes of the people and turn the wheels of industry; an order to build a ship that will cross the seas without coal or oil fuel. This atomic age is indeed beginning to show signs of an assured future. — *THE DOMINION*, 17 OCTOBER 1956[2]

In the 1950s, the United States launched its Atoms for Peace programme — an international programme initiated by President Dwight D. Eisenhower that promoted so-called peaceful uses of atomic technology. New Zealanders bought into Eisenhower's utopian vision of an atomic future, and when the United States nuclear submarine USS *Halibut* visited New Zealand in 1960 thousands of Aucklanders and Wellingtonians flocked to the ports to welcome the vessel — the world's first nuclear-powered submarine. New Zealand's National Film Unit included the visit in their regular *Pictorial Parade*, describing the 'sleek dark shape' entering Wellington Harbour in the

1964
Nuclear reactor established in University of Canterbury

(Priestley, 2012:178-83)

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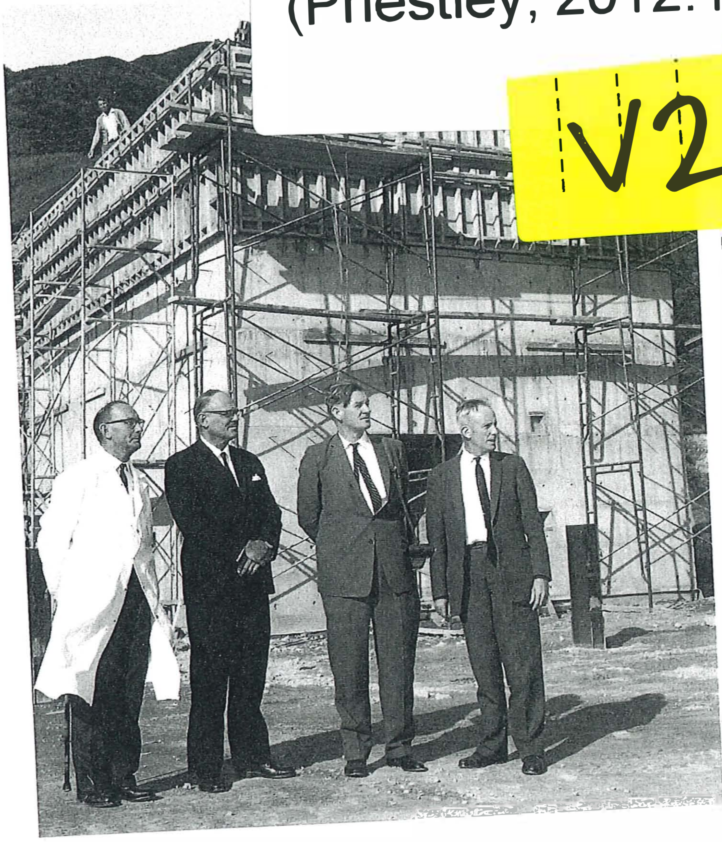
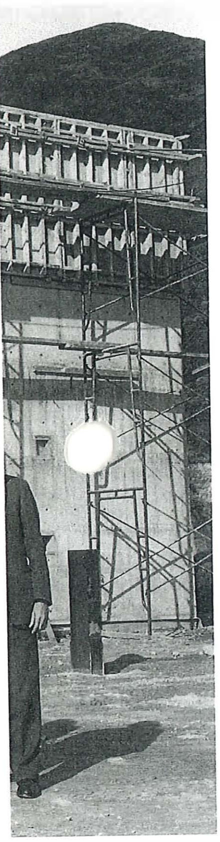


… of … nces building, on the hillside above Gracefield in Lower Hutt, had thick concrete walls to shield the high radiation levels sometimes generated by the 3 MW Van de Graaff accelerator. From left: Athol Rafter, first head of the Institute of Nuclear Sciences; Maurice Timbs, from the Australian Atomic Energy Commission; and Gordon Robb and Jim O'Leary from the New Zealand Atomic Energy Committee. Courtesy GNS Science.

de Graaff accelerator was damaged and the warranty had expired while it was in storage. Nonetheless, once repaired, the accelerator soon became an important tool for nuclear science research and environmental and industrial monitoring and was the institute's most significant piece of equipment until a more powerful tandem accelerator replaced it in 1986.

US NUCLEAR EQUIPMENT GRANT AND NEW ZEALAND'S FIRST NUCLEAR REACTOR

New Zealand science was as under-funded in the 1950s as it is today, and free laboratory equipment was always going to be well received by the DSIR and the universities, so when the USAEC offered gifts to support research in



This Institute of Nuclear Sciences building, on the hillside above Gracefield in Lower Hutt, had thick concrete walls to shield the high radiation levels sometimes generated by the 3 MW Van de Graaff accelerator. From left: Athol Rafter, first head of the Institute of Nuclear Sciences; Maurice Timbs, from the Australian Atomic Energy Commission; and Gordon Robb and Jim O'Leary from the New Zealand Atomic Energy Committee. Courtesy GNS Science.

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ignifi piece of equipment until
aced it in 1986.

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ACTOR

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ng to be well received by the DSIR
offered gifts to support research in

nuclear science, they were accepted with no apparent suspicions of ulterior motives on the part of the Americans.

The first proposal for a nuclear reactor in New Zealand had come from Marsden and Watson-Munro in 1947. Their plan was for an Australasian low-energy pile, which they believed would have 'defence significance'. This proposal never came to fruition, and later plans for a research reactor at the Institute of Nuclear Sciences were continuously deferred. In 1961, however, New Zealand did get a nuclear reactor, although rather than being associated with the DSIR it was installed in Canterbury University's engineering school.

After the USAEC visit in 1958, the American ambassador had suggested to Holloway that certain items of equipment that the visitors considered would be of immediate use in New Zealand institutions for research and training might be made available by the United States authorities under arrangements allowed for in the 1956 bilateral agreement. In March 1959, the Labour Prime Minister Walter Nash formally replied to the American ambassador to express New Zealand's interest in the proposal, attaching a list of equipment requested by Auckland and Canterbury universities and the Institute of Nuclear Sciences. The physics and chemistry departments of the University of Auckland asked for laboratory equipment worth US$65,672, the nuclear engineering laboratory of the Department of Electrical Engineering of the University of Canterbury requested funding for a sub-critical research reactor and ancillary equipment worth US$130,000, and the Institute of Nuclear Sciences requested a mass spectrometer and other equipment worth US$102,280 — a total request of US$297,952 (worth more than US$2 million in 2012 terms).

So while the Institute of Nuclear Sciences was still expecting to gain a nuclear reactor at some stage in the future, the University of Canterbury was the site of New Zealand's first — and only — nuclear reactor. Nuclear power was seen as inevitable for future power generation, and this was a valuable opportunity to train nuclear engineers in New Zealand. The sub-critical reactor at the University of Canterbury arrived in the electrical engineering department in 1961, under the care of professor of electrical engineering Norm MacElwee, who a few years earlier was reported as saying that 'it does not appear that nuclear power would have any advantages over hydro-electric power in the near future'.[33] The sub-critical reactor, by definition, had no critical mass of fuel to produce a chain reaction; its operation depended on neutrons being continuously added from an outside source.

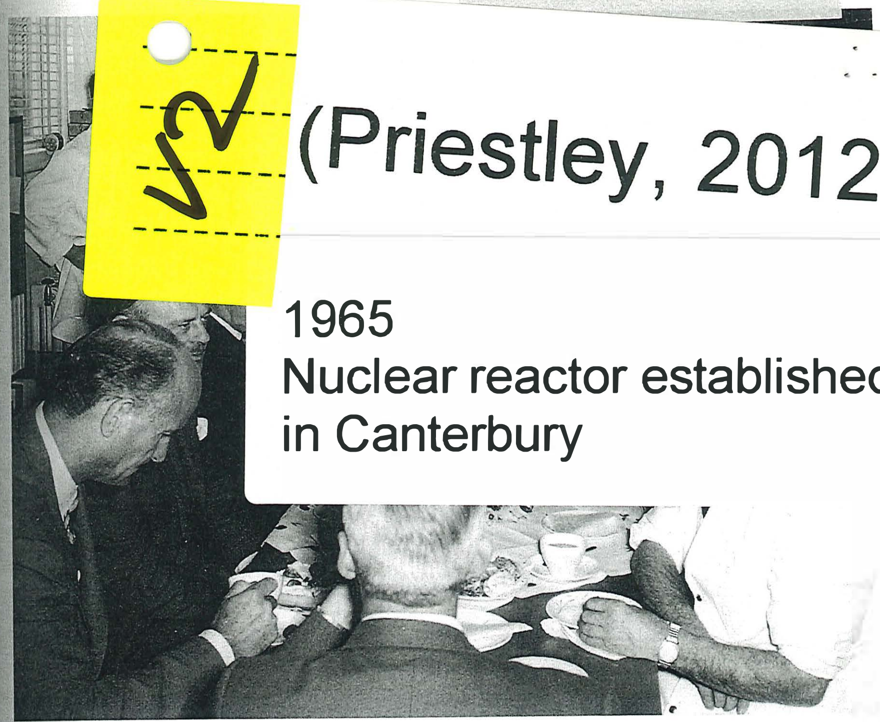
... of natural uran... as a fuel, a solid mixture of ...um and beryllium as a neutron source, and tap water as a moderator. However, a reading of the Dominion X-Ray and Radium Laboratory files suggests that the engineering department accepted the gift without knowing much about what it entailed. In order to approve the importation of radioactive material, required under the Radioactive Substances Act 1949, the Dominion X-Ray and Radium Laboratory needed specific details of the reactor's fuel and source. The laboratory had to write to the USAEC, the donator of the gift, for details, confessing that 'no-one in New Zealand has any information on the physical properties of the uranium — in fact we are not even sure if it is uranium metal or uranium oxide, or whether U235 has been extracted'.[34]

While a nuclear reactor was generally considered to be a positive thing — a functioning piece of machinery that would help to train nuclear engineers for New Zealand's future — there was, by now, a degree of apprehension about the radioactive materials needed to fuel the reactor. The secretary of the NZAEC, Jim O'Leary, described in a letter to the Dominion X-Ray and Radium Laboratory that there could be 'a great deal of loose talk and emotion regarding the danger involved in such material'.[35] As predicted, the October 1961 delivery of the plutonium/beryllium neutron sources, which arrived by ship to Lyttelton, was considered newsworthy — although in today's light it is remarkable what little excitement a shipment of plutonium aroused. *The Press* reported that the 'plutonium' label in the ship's manifest caused 'a stir' amongst the crew when the cargo came on board, but they were reassured by shipping authorities, who in turn had been assured by the Dominion X-Ray and Radium Laboratory, that the cargo was safe.[36] This shipment, the first shipment of plutonium and the most powerful neutron source ever to arrive in New Zealand, consisted of three small cylinders, each about 2.5 centimetres in diameter and 4 centimetres long, sealed inside a large drum filled with paraffin wax to absorb any neutrons emitted from the cylinders.

The University of Canterbury's sub-critical nuclear reactor was soon operational. From 1964 onwards, the School of Engineering prospectuses advised that all third professional year electrical engineering students would attend a short lecture course on the electrical aspects of nuclear engineering. A later elective course, Advanced Electrical Engineering, focused almost entirely on nuclear engineering and used the reactor for laboratory

(Priestley, 2012)

1965
Nuclear reactor established in Canterbury



The Institute of Nuclear Sciences put on pikelets and a cream sponge to welcome American Ambassador Anthony Akers, and members of the NZAEC, in 1962. Seated at the table, from front left, are: Akers, Gordon Robb, Sir Ernest Marsden, Ian Dick and Dick Willett. At front right is Athol Rafter. Courtesy GNS Science.

demonstrations and experiments, although for some reason this was not made explicit in the name of the course. It is also surprising that neither the engineering school annual prospectus, nor *Student Engineer*, an annual booklet published by the Engineering Society of the School of Engineering, mentioned the sub-critical reactor, which as the only nuclear reactor ever to operate in New Zealand would surely have been a drawcard for the school.

But there was nothing secret about the reactor. Richard Duke, an electrical engineering student who took the nuclear engineering course in 1973, recalls the reactor being installed in a room with internal windows, through which the general student population and visitors could observe its daily use. The reactor seemed to draw no opposition, and at the School of Engineering's annual open days 'there were always long queues of people waiting to climb the steps to peer into the reactor tank and see the rods,' recalls Duke.[37] In 1981, by which time it was clear that New Zealand had

YEAR	FIXED CONTRIBUTION (US$)	NUCLEAR SECURITY FUND (NZ$)
1958	16,356	
1959	20,378	
1960	22,788	
1961	24,055	
1962	25,816	
1963	27,066	
1964	27,436	
1965	29,309	
1966	29,465	
1967	31,191	
1968	34,556	
1969	35,929	
1970	39,115	
1971	44,061	
1972	44,914	
1973	56,305	
1974	72,723	
1975	78,138	
1976	100,411	
1977	108,775	
1978	149,102	
1979	177,409	
1980	216,869	
1981	227,078	
1982	215,632	
1983	226,796	
1984	238,682	
1985	235,137	
1986	289,098	
1987	332,720	
1988	353,020	
1989	357,457	
1990	408,172	
1991	480,699	
1992	459,209	
1993	506,895	
1994	524,409	
1995	579,195	
1996	643,499	
1997	606,890	
1998	541,328	
1999	506,745	
2000	458,040	
2001	411,114	
2002	474,958	
2002/03	560,735	25,000
2003/04	670,126	20,000
2004/05	704,182	20,000
2005/06	699,922	25,000
2006/07	748,611	25,000
2007/08	995,446	-
2008/09	945,618	75,000
2009/10	1,084,185	40,000
2010/11	1,159,816	75,000
2011/12	1,190,401	75,000

Sources: Adapted from figures provided by New Zealand's Ministry of Foreign Affairs and Trade, Vienna and Wellington, by emails to author 2002, 2010, 2012. Figures from 1958 to 2002 were provided to the author in US$. Subsequent figures have been calculated from figures provided in a mix of €, US$ and NZ$, and are approximate.

University of Canterbury ceased offering the nuclear engineering course, closed down the nuclear engineering laboratory, and dismantled the reactor. The uranium in it went to the Institute of Nuclear Sciences, and the neutron sources containing the plutonium went to the university's physics department where it was used in research before being recalled to the United States after reaching its 30-year lifespan.

While the American gifts under the Atoms for Peace programme were of benefit to the New Zealand scientists and institutions whose laboratories they went to, it was not altruism on the part of the United States. The terms of the USAEC's gifts of research equipment to the University of Auckland's physics and radiochemistry laboratories were that the results of any research deriving from the use of equipment and materials would be provided to the United States. The equipment arrived in November 1960, and Ted Collins of the physics department wrote of the 'fever of excitement in the Chemistry Department as they open up their Xmas Box from Uncle Sam'.[38] When American Ambassador Anthony Akers visited the university's new radiochemistry and physics laboratories in October 1961, he expressed his view 'that your countrymen share the American dream of a world at peace and it is with great pleasure that I participate here today in this programme reflective of the peaceful use of the atom'. A year later, the United States was testing more hydrogen bombs in the Pacific, despite Akers's assurance that it was 'the cherished hope of the American people that nuclear energy might be used only for peaceful purposes'.[39]

ATOMS FOR PEACE

While New Zealand scientists did not embrace the nuclear age with th enthusiasm that their American friends might have hoped, atomic energy wa still part of New Zealand's vision of the future, and the United States nuclea submarine USS *Halibut* was greeted with awe and enthusiasm when it visite Auckland and Wellington in 1960.

The Institute of Nuclear Sciences was well established by the mic 1960s and was conducting original research as well as providing service to agriculture, industry and medicine. Director Athol Rafter continued t hope for the long-promised nuclear reactor, telling a visiting group from th

1965
High Voltage Direct Current submarine cable links the North and South Islands

V2

(Priestley, 2012: 192)

calls f[...]
launch[...]
Zealan[...]
cable p[...]
would [...]
conduc[...] with the view [...]
distinct possibility for the future.

The State Hydro-electric Department duly reported in 1958 that atomic energy was a 'promising source of power'. It continued, however, to say that New Zealand had 'natural sources which, at the moment and for some few years ahead, seem likely to provide power more economically and with less drain on overseas funds'.[20] It recommended that atomic energy be reconsidered in five years. The report continued by approving the construction of a new hydroelectric station at Benmore on the Waitaki River, initially to supply power to the South Island, and deferred a decision on linking the islands with a Cook Strait cable.

By 1961, after numerous technical issues had been resolved, the Government approved the scheme to link the North and South Island power systems, and a contract for manufacturing and laying the cables was placed. In 1965 a submarine high-voltage DC cable — only the third of its kind in the world — finally linked the North and South Islands. Most of the power from the Benmore station was carried across the cable to provide the growing population of the North Island with, at last, a plentiful and reliable source of electricity. But while the Cook Strait cable had won the toss-up between nuclear power and a link between the North and South Islands, it now seemed that both solutions would eventually be required.

The annual reports of the New Zealand Electricity Department (NZED)'s Planning Committee on Electric Power Development in New Zealand continued to project future electricity demand and detail plans for future power sources for New Zealand.* The 1964 report of the planning committee contained the first mention of nuclear power as a possible source of electricity for New Zealand. In this report, hydro, geothermal, natural gas, oil, coal and nuclear sources were all considered to meet New Zealand's future and rapidly escalating demand for power. In considering nuclear power as an

* The State Hydro-electric Department had become the New Zealand Electricity Department in 1958, reflecting the country's diversifying sources of electricity.

to health from radioactive fallo… …d's goal of a comprehensive nuclear test …

Despite the protes… …first bomb at French Polynesia's Moruroa Atoll … …e to concerns about an increase in radioac… …tional Radiation Laboratory inter… …in the South Pacific. Levels of … …d and at a chain of Pacific … …liue, and what were then … …public of Kiribati and … …amma-ray monitors … …test zone. At other … …s were measured … …odine-131.

… …n the French nuclear … …tory commented that 'there … …the exposure of people to fallout fr… …ompared levels of radiation attributable fa… …mits set by the International Commission on …lic… …l and with radiation exposure from background radiatio… …on the data collected, and comparison with these levels, the Natio… …l Radiation Laboratory regularly reported that the French tests 'constituted no public health hazard'.[5] Although the laboratory was dealing with factual data, comparing one figure against another, their refusal to say that the French tests were contributing dangerous levels of radioactive contamination to the Pacific Islands gave some people the impression they were condoning the French testing or even hiding information from the public. In 1972, media attention was given to a Fijian biologist's criticism of the National Radiation Laboratory's interpretation of the monitoring results, along with his comments that radioactive elements like strontium-90 were concentrated in the food chain; for example, as small fish ate contaminated plankton and larger fish ate smaller fish. He advised that a more meaningful monitoring programme would measure levels of radioactive isotopes in the fish that were part of the staple diet of most Pacific Islands people.

New Zealand made diplomatic protests after each of France's tests, and continued to work internationally towards disarmament. In 1968, New Zealand signed the Treaty for the Non-Proliferation of Nuclear Weapons, which was designed to limit the spread of nuclear weapons to other states.

FRENCH ATMOSPHERIC NUCLEAR TESTS IN THE PACIFIC, 1966–74

YEAR	DATE	LOCATION	ESTIMATED YIELD
1966	2 July	Moruroa	20–200 kt
	19 July	Fangataufa	20–200 kt
	11 September	Moruroa	20–200 kt
	24 September	Fangataufa	20–200 kt
	4 October	Moruroa	200 kt–1 Mt
1967	5 June	Moruroa	<20 kt
	27 June	Moruroa	20–200 kt
	2 July	Moruroa	20–200 kt
1968	7 July	Moruroa	20–200 kt
	15 July	Moruroa	200 kt–1 Mt
	3 August	Moruroa	20–200 kt
	24 August	Fangataufa	>1 Mt
	8 September	Moruroa	>1 Mt
1970	15 May	Moruroa	<20 kt
	22 May	Moruroa	200 kt–1 Mt
	30 May	Fangataufa	200 kt–1 Mt
	24 June	Moruroa	<20 kt
	3 July	Moruroa	200 kt–1 Mt
	27 July	Moruroa	<20 kt
	2 August	Fangataufa	20–200 kt
	6 August	Moruroa	200 kt–1 Mt
1971	5 June	Moruroa	20–200 kt
	12 June	Moruroa	200 kt–1 Mt
	4 July	Moruroa	<20 kt
	8 August	Moruroa	<20 kt
	14 August	Moruroa	200 kt–1 Mt
1972	25 June	Moruroa	<20 kt
	30 June	Moruroa	<20 kt
	27 July	Moruroa	<20 kt
1973	21 July	Moruroa	<20 kt
	28 July	Moruroa	<20 kt
	18 August	Moruroa	<20 kt
	24 August	Moruroa	<20 kt
	28 August	Moruroa-aircraft	<20 kt
1974	16 June	Moruroa	<20 kt
	7 July	Moruroa	200 kt–1 Mt
	17 July	Moruroa	<20 kt
	25 July	Moruroa-aircraft	<20 kt
	15 August	Moruroa	20–200 kt
	24 August	Moruroa	<20 kt
	14 September	Moruroa	200 kt–1 Mt

Note: kt = kiloton and Mt = megaton: units of explosive force equivalent to 1000 and 1 million tons of TNT, respectively.

Source: Adapted from *New Zealand at the International Court of Justice: French Nuclear Testing in the Pacific*, New Zealand Ministry of Foreign Affairs and Trade, Wellington, 1996, pp. 48–9.

Jim McCahon, second from the left in the back row, travelled on the HMNZS *Otago*, and then the HMNZS *Canterbury*, as radiation safety officer. An employee of the National Radiation Laboratory since the 1950s, McCahon was pleased to be able to 'add my little bit of protest to the whole thing', but in his diary of his journey he said that amongst the naval officers on board he often felt he was the only person actually protesting against the French nuclear tests, rather than simply following Government orders. Next to McCahon, in the dark shirt, is Immigration Minister Fraser Coleman. The other men, all civilians, are a medical officer and the three journalists. Courtesy Jim McCahon.

in Rarotonga,' Warwick Smith, the DSIR's chief seismologist, later recalled. '"What on earth was that?" we thought — because it didn't look like an earthquake! We subsequently realised that what we had seen was a recording of the first French underground nuclear test in the Pacific.' Underground tests in French Polynesia set up a signal like a sound wave in the ocean that propagated extremely well to the seismogram station in Rarotonga. 'We realised we had quite a sensitive detector of the French nuclear tests.' Smith would announce the test to the Prime Minister's Office, which would contact other countries' top officials and then release the information to the media. 'It was all cloak and dagger stuff for a while', says Smith. 'Then, in the final stages of testing, the French used to make announcements that in less than an hour they would be doing another test.'[12]

FREN[illegible] UNDERGROUND NUCLEAR TESTS IN THE PACIFIC, 1975–96

YEAR	DATE	LOCATION	ESTIMATED YIELD
1975	5 June	Fangataufa	<20 kt
	26 November	Fangataufa	20–200 kt
1976	3 April	Moruroa	<20 kt
	11 July	Moruroa	20–200 kt
	30 October	Moruroa	<20 kt
	5 December	Moruroa	<20 kt
1977	19 February	Moruroa	20–200 kt
	19 March	Moruroa	200 kt–1 Mt
	2 April	Moruroa	<20 kt
	6 July	Moruroa	20–200 kt
	12 November	Moruroa	<20 kt
	24 November	Moruroa	200 kt–1 Mt
	17 December	Moruroa	<20 kt
1978	27 February	Moruroa	<20 kt
	22 March	Moruroa	<20 kt
	25 March	Moruroa	<20 kt
	1 July	Moruroa	<20 kt
	19 July	Moruroa	20–200 kt
	26 July	Moruroa	<20 kt
	2 November	Moruroa	<20 kt
	30 November	Moruroa	200 kt–1 Mt
	17 December	Moruroa	<20 kt
	19 December	Moruroa	20–200 kt
1979	1 March	Moruroa	20–200 kt
	9 March	Moruroa	20–200 kt
	24 March	Moruroa	20–200 kt
	4 April	Moruroa	20–200 kt
	18 June	Moruroa	20–200 kt
	29 June	Moruroa	200 kt–1 Mt
	25 July	Moruroa	200 kt–1 Mt
	28 July	Moruroa	<20 kt
	19 November	Moruroa	<20 kt
	22 November	Moruroa	<20 kt
1980	23 February	Moruroa	<20 kt
	3 March	Moruroa	<20 kt
	23 March	Moruroa	200 kt–1 Mt
	1 April	Moruroa	20–200 kt
	4 April	Moruroa	20–200 kt
	16 June	Moruroa	200 kt–1 Mt
	21 June	Moruroa	20–200 kt
	6 July	Moruroa	20–200 kt
	19 July	Moruroa	200 kt–1 Mt
	25 November	Moruroa	<20 kt
	3 December	Moruroa	200 kt–1 Mt
1981	27 February	Moruroa	<20 kt
	6 March	Moruroa	<20 kt
	28 March	Moruroa	20–200 kt

YEAR	DATE	LOCATION	ESTIMATED YIELD
1981 (cont.)	10 April	Moru[illegible]	20-200 kt
	8 July	Moruroa	20-200 kt
	11 July	Moruroa	<20 kt
	18 July	Moruroa	<20 kt
	3 August	Moruroa	200 kt-1 Mt
	6 November	Moruroa	<20 kt
	11 November	Moruroa	20-200 kt
	5 December	Moruroa	20-200 kt
	8 December	Moruroa	20-200 kt
1982	20 February	Moruroa	<20 kt
	24 February	Moruroa	<20 kt
	20 March	Moruroa	20-200 kt
	23 March	Moruroa	<20 kt
	27 June	Moruroa	<20 kt
	1 July	Moruroa	200 kt-1 Mt
	21 July	Moruroa	<20 kt
	25 July	Moruroa	200 kt-1 Mt
	27 November	Moruroa	<20 kt
1983	19 April	Moruroa	200 kt-1 Mt
	25 April	Moruroa	<20 kt
	25 May	Moruroa	200 kt-1 Mt
	18 June	Moruroa	<20 kt
	28 June	Moruroa	20-200 kt
	20 July	Moruroa	20-200 kt
	4 August	Moruroa	200 kt-1 Mt
	3 December	Moruroa	<20 kt
	7 December	Moruroa	20-200 kt
1984	8 May	Moruroa	<20 kt
	12 May	Moruroa	200 kt-1 Mt
	12 June	Moruroa	20-200 kt
	16 June	Moruroa	200 kt-1 Mt
	27 October	Moruroa	20-200 kt
	2 November	Moruroa	200 kt-1 Mt
	1 December	Moruroa	<20 kt
	6 December	Moruroa	200 kt-1 Mt
1985	30 April	Moruroa	20-200 kt
	8 May	Moruroa	200 kt-1 Mt
	3 June	Moruroa	20-200 kt
	7 June	Moruroa	20-200 kt
	24 October	Moruroa	<20 kt
	26 October	Moruroa	200 kt-1 Mt
	24 November	Moruroa	20-200 kt
	26 November	Moruroa	200 kt-1 Mt
1986	26 April	Moruroa	20-200 kt
	6 May	Moruroa	<20 kt
	27 May	Moruroa	20-200 kt
	30 May	Moruroa	200 kt-1 Mt
	10 November	Moruroa	<20 kt

YEAR	DATE	LOCATION	ESTIMATED YIELD
1986 (cont	12 November	Moruroa	20-200 kt
	6 December	Moruroa	<20 kt
	10 December	Moruroa	200 kt-1 Mt
1987	5 May	Moruroa	20-200 kt
	20 May	Moruroa	200 kt-1 Mt
	6 June	Moruroa	20-200 kt
	21 June	Moruroa	200 kt-1 Mt
	23 October	Moruroa	200 kt-1 Mt
	5 November	Moruroa	20-200 kt
1988	11 May	Moruroa	200 kt-1 Mt
	25 May	Moruroa	200 kt-1 Mt
	16 June	Moruroa	<20 kt
	23 June	Moruroa	20-200 kt
	25 October	Moruroa	<20 kt
	5 November	Moruroa	200 kt-1 Mt
	23 November	Moruroa	200 kt-1 Mt
	30 November	Fangataufa	200 kt-1 Mt
1989	11 May	Moruroa	20-200 kt
	20 May	Moruroa	<20 kt
	3 June	Moruroa	200 kt-1 Mt
	10 June	Moruroa	200 kt-1 Mt
	24 October	Moruroa	200 kt-1 Mt
	31 October	Moruroa	20-200 kt
	20 November	Moruroa	20-200 kt
	27 November	Moruroa	200 kt-1 Mt
1990	2 June	Moruroa	20-200 kt
	7 June	Moruroa	20-200 kt
	26 June	Fangataufa	200 kt-1 Mt
	4 July	Moruroa	20-200 kt
	14 November	Fangataufa	200 kt-1 Mt
	22 November	Moruroa	200 kt-1 Mt
1991	7 May	Moruroa	<20 kt
	18 May	Moruroa	200 kt-1 Mt
	29 May	Fangataufa	200 kt-1 Mt
	16 June	Moruroa	200 kt-1 Mt
	5 July	Moruroa	<20 kt
	15 July	Moruroa	200 kt-1 Mt
1995	5 September	Moruroa	~20 kt
	1 October	Fangataufa	~150 kt
	27 October	Moruroa	~60 kt
	21 November	Moruroa	~60 kt
	27 December	Moruroa	~30 kt
1996	27 January	Fangataufa	<120 kt

Note: kt = kiloton and Mt = megaton: units of explosive force equivalent to 1000 and 1 million tons of TNT, respectively.

Source: Adapted from *New Zealand at the International Court of Justice: French Nuclear Testing in the Pacific*, New Zealand Ministry of Foreign Affairs and Trade, Wellington, 1996, pp. 48–9, with 1995–96 data from www.ratical.org/ratville/nukes/testChrono95-8.html and http://nuclearweaponarchive.org.

hemisphere war was unlikely to result from fallout or other weapons effects but from the loss of trading part s. ey recommended that, rather than continuing to 'ignore the possibility of nuclear war', New Zealand should be planning to survive one.[37] The report was not well received by the National Government, with several Cabinet ministers describing it as 'vague' and 'emotive'. Just two months later, the Government abolished the New Zealand Commission for the Future, saying 'recent publications show that the Commission's work was no longer relevant to the issues facing New Zealand'.[38]

While New Zealand's Ministry of Civil Defence was set up in 1960 specifically to deal with the threat of nuclear war, by the 1980s it dealt almost exclusively with the threat of natural disasters, especially floods. In a 1983 interview with the *New Zealand Listener*, George Preddey, one of the authors of the Commission for the Future's report and now assistant director-general of the Ministry of Civil Defence, said the British attitude to nuclear civil defence — with its little pamphlets suggesting people put brown paper over their windows in the event of a nuclear disaster — might encourage morale, but it wasn't realistic. 'Our attitude here,' he said, 'is that it is quite misleading to suggest that there is any effective response to nuclear attack. We believe there is no effective civil defence response, that it is unrealistic to plan for a direct nuclear attack on this country.'[39]

While he continued to query whether or not there was a credible civil defence response to a nuclear attack, Preddey did have suggestions on how New Zealand could prepare for a northern hemisphere nuclear war, or an attack on Australia. In his 1985 book, *Nuclear Disaster: A New Way of Thinking Down Under*, Preddey suggested that civil defence preparations for a nuclear disaster could include:

> An infrastructure to co-ordinate the mobilisation of every element of New Zealand society and the economy in the event of a nuclear disaster;
> Deployment of emergency monitoring equipment (for fallout, ultraviolet light, acid rain, and other contingencies of nuclear war) and the training of personnel to use this;
> Distribution of appropriate emergency medical supplies, perhaps including potassium iodate tablets (to block iodine-131 uptake in the event of major attacks on Australia), sun filtering creams (to block ultraviolet light), eye protection, etc;

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after a nuclear war — from burning cities, croplands and forest, and sto
fossil fuels — would produce a thick layer of smoke that would 'drastic
reduce the amount of sunlight reaching the earth's surface'.[41] This wo
almost totally eliminate agricultural production in the northern hemisph
meaning that no food would be available for any survivors of a nuc
war. A subsequent study, the first to use the phrase 'nuclear winter', fo
that a global nuclear war could lead to sub-freezing land temperature
continental areas — down to minus 15–25°C — for many months.[42] Furt
studies supported the idea of a nuclear winter; as it would affect the south
as well as the northern hemisphere, the matter caught the attention of
New Zealand media and public, and on 21 October 1984 a group of scient
took part in a nuclear winter debate on TV1's *Sunday* programme. In
1987 book *Beyond Darkness*, climate scientist Barrie Pittock warned t
a northern hemisphere war could leave temperatures in New Zealand a
Australia 5–10°C cooler, with rainfall reduced to less than 50 per cent
normal. Conditions would be worse in the northern hemisphere, thou
with the cold, dry conditions having a devasting impact on agriculture a
leading to 'mass starvation' in the most affected countries and an influx
'nuclear refugees' to New Zealand and Australia.[43]

Other individuals and organisations issued their own books and pamphl
about nuclear safety. Brian Hildreth's *A Nuclear Survival Manual for N
Zealanders*, published in 1986, outlined preparation and protection measu
for surviving in the aftermath of a nuclear war, including survival first a
energy and self-reliance. It wasn't a pleasant world that was envisaged: