IAEA-TECDOC-588

Inventory of radioactive material entering the marine environment: Sea disposal of radioactive waste

INTERNATIONAL ATOMIC ENERGY AGENCY IAEA

INVENTORY OF RADIOACTIVE MATERIAL ENTERING THE MARINE ENVIRONMENT:
SEA DISPOSAL OF RADIOACTIVE WASTE
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FOREWORD

Contracting Parties to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter have designated the International Atomic Energy Agency as the competent international authority in technical matters related to sea dumping of radioactive wastes and entrusted it with specific responsibilities.

The Contracting Parties to the Convention requested IAEA to develop an inventory of radioactive wastes entering the marine environment from all sources. The rationale for having such an inventory is related to its use as an information base with which the impact of disposal at sea could be more adequately assessed and compared.

Three sources of anthropogenic radionuclides in the marine environment are considered: the controlled release of low level radioactive liquid effluents, the disposal at sea of low level solidified radioactive wastes and accidents at sea involving potential releases of radioactive materials into the marine environment. This report, the first of a series of three, one for each source, concerns the low level solidified radioactive waste disposed of at sea in the past.

Other documents prepared by the IAEA relevant to the subject of the present document are:

Packaging of Radioactive Wastes for Sea Disposal, IAEA-TECDOC-240, IAEA, Vienna (1980).

Environmental Assessment Methodologies for Sea Dumping of Radioactive Wastes, Safety Series No. 65, IAEA, Vienna (1984).

Low Level Radioactive Waste Disposal: An Evaluation of Reports Comparing Ocean and Land Based Disposal Options, IAEA-TECDOC-562, IAEA, Vienna (1990).

The success of this exercise required the full collaboration of the Contracting Parties. The IAEA would like to thank them for providing the necessary information.

This work was co-ordinated in the Waste Management Section of the Division of Nuclear Fuel Cycle and Waste Management and the responsible officer was D. Calmet.

EDITORIAL NOTE

In preparing this material for the press, staff of the International Atomic Energy Agency have mounted and paginated the original manuscripts and given some attention to presentation.

The views expressed do not necessarily reflect those of the governments of the Member States or organizations under whose auspices the manuscripts were produced.

The use in this book of particular designations of countries or territories does not imply any judgement by the publisher, the IAEA, as to the legal status of such countries or territories, of their authorities and institutions or of the delimitation of their boundaries.

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CONTENTS

SUMMARY

Variable amounts of packaged low level radioactive waste have been disposed at more than 50 sites in the northern parts of the Atlantic and Pacific Oceans. In 1946, the first sea disposal operation took place at a site in the North East Pacific Ocean, about 80 km off the coast of California. The last known disposal operation was in 1982, at a site about 550 km off the European continental shelf in the Atlantic Ocean.

Since 1957, the date of the first IAEA meeting to design a methodology to assess the safety of "radioactive waste disposal into the sea" [1], the IAEA has provided specific guidance and recommendations for ensuring that disposal of radioactive wastes into the sea will not result in unacceptable hazards to human health and marine organisms, damage to amenities or interference with other legitimate uses of the sea. In 1972, the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter designated the IAEA as the competent international authority in matters related to sea disposal of radioactive waste and entrusted it with specific responsibilities. Inter alia the Contracting Parties requested the IAEA to develop an inventory of radioactive wastes entering the marine environment from all sources. The rationale for having such an inventory is related to its use as an information base with which the impact of radioactive materials from disposal operations can be more adequately assessed. The continuous compilation of data on waste disposals at sea could also ensure that the IAEA recommendations on the disposal rate in a single basin are not overstepped.

The inventory shows that between 1946 to 1982 an estimated 46 PBq[1] (1.24 MCi) of radioactive waste coming from research, medicine, the nuclear industry and military activities were packaged, usually in metal drums lined with a concrete or bitumen matrix, and disposed of at sea. This inventory includes some unpackaged wastes and liquid wastes which were disposed of from 1950 to 1960. Beta-gamma emitters represent more than 98% of the total radioactivity of the waste and tritium alone represents one third of the total radioactivity disposed at the North East Atlantic sites. The other beta-gamma emitters radionuclides include ^{90}Sr, ^{137}Cs, ^{55}Fe, ^{58}Co, ^{60}Co, ^{125}I and ^{14}C. The wastes also contain low quantities of alpha-emitting nuclides with plutonium and americium isotopes representing 96% of the alpha emitters present.

1 1 PBq = 10^{15} Becquerel, 1 PBq = 27.10^{3} Curie

1. INTRODUCTION

The Report of the United Nations Conference on Human Environment held in Stockholm in 1972 [2] enunciated general principles for environmental protection. One principle specifically addressed the protection of the marine environment in addition of a set of "General Principles for Assessment and Control of Marine Pollution". Pursuant to Recommendation 86 of the Stockholm Conference, these principles were forwarded to an Inter-Governmental Conference held in London in 1972 which adopted the **Convention on the Prevention of Marine Pollution by Dumping[2] of Wastes and Other Matter** (referred as the London Dumping Convention) [3]. The London Dumping Convention (LDC) entered into force on 30 August 1975.

The Contracting Parties to the London Dumping Convention agreed to "promote the effective control of all sources of pollution of the marine environment, and pledge themselves especially to take all practicable steps to prevent the pollution of the sea by the dumping of waste and other matter that is liable to create hazards to human health, to harm living resources and marine life, to damage amenities or to interfere with other legitimate uses of the sea". Contracting Parties to the London Dumping Convention have designated the IAEA as the competent international authority in matters related to sea disposal of radioactive waste and entrusted IAEA with specific responsibilities. These are:

- to define high level radioactive wastes or other high level radioactive matter **unsuitable** for dumping at sea listed in Annex I to the Convention, and
- to recommend a basis for issuing **special permits** for dumping materials listed in Annex II to the Convention.

IAEA was mandated to keep the Definitions and Recommendations to limit the impact of the disposal operation under review. As requested, a provisional definition of high level waste unsuitable for disposal at sea and recommendations were provided in 1974 [4] and successively revised in 1978 [5] and 1986 [6]. The revisions reflect the increasing knowledge of relevant oceanographic behaviour and improving assessment capabilities.

To further discharge its responsibilities, the IAEA, from time to time, issues recommendations and guidance for ensuring that disposal of radioactive wastes into the sea does not result in unacceptable hazards to man and marine organisms (Table I).

Since the entry into force of the London Dumping Convention, States that are Contracting Parties to the London Dumping Convention have conducted the disposal operations in keeping with the relevant IAEA recommendations at a limited number of sites. In 1983, resolution LDC.21(9) of the Contracting

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2 For the purpose of the LDC, "Dumping" means:
(i) any deliberate disposal at sea of wastes and other matter from vessels, aircraft, platforms or other man-made structures at sea;
(ii) any deliberate disposal at sea of vessels, aircraft, platforms or other man-made structure at sea.

Table I: Chronological sequence of major documents published by IAEA in connection with ocean disposal activities.

1946 First Dumping Operations (USA)

1957 Advisory Group Meeting on Radioactive Waste Disposal into the Sea.

1958 First United Nations Conference on the Law of the Sea (UNCLOS I)

1961 Radioactive Waste Disposal into the Sea. IAEA, Safety Series No 5

1965 Methods of Surveying and Monitoring Marine Radioactivity. IAEA, Safety Series No 11

1970 Reference Methods in Marine Radioactivity Studies. IAEA TRS No 18

1972 Terms of the Convention for the Prevention of Marine Pollution by Dumping of Wastes and Other Matter. IAEA INFCIR/205

1974 Provisional definition of high level radioactive waste unsuitable for dumping at sea and recommendations. IAEA INFCIRC/205/add.1

1975 Convention for the Prevention of Marine Pollution by Dumping of Wastes and Other Matter enters into force

1978 Revised Version of the Definition and Recommendation for the Convention for the Prevention of Marine Pollution by Dumping of Wastes and Other Matter. IAEA INFCIRC/205/add.1/rev.1

1980 Packaging of radioactive wastes for sea disposal. IAEA TECDOC No 240

1981 Considerations concerning "de minimis" quantities of radioactive waste suitable for dumping at sea under a suitable permit. IAEA TECDOC No 244

1982 Last Dumping Operation (OECD Countries)

1983 Control of Radioactive Waste Disposal into the Marine Environment IAEA Safety Series No 61 (Revision of the IAEA Safety Series No 5).

1984 Environmental Assessment Methodologies for sea Dumping of Radioactive Wastes. IAEA Safety Series No 65

The oceanographic and radiological Basis for the Definition of High level wastes unsuitable for dumping at sea. IAEA Safety Series No 66

1985 Sediment K_ds and Concentration Factors for Radionuclides in the Marine Environment. IAEA Technical Reports Series No 247

1986 An Oceanographic Model for the Dispersion of Wastes Disposed of in the Deep Sea. IAEA Technical Reports Series No 263

Definition and Recommendations for the Convention for the Prevention of Marine Pollution by Dumping of Wastes and Other Matter. IAEA Safety Series No 78

1988 Assessing the Impact of Deep sea Disposal of Low-level Radioactive waste on Living Marine Resources. IAEA Technical Reports Series No 288

1989 Principles for the Establishment of Upper Bounds to Doses to Individuals from Global and Regional Sources. IAEA Safety Series No 92

1990 Estimation of Radiation Risks at Low Dose. A Report to the Contracting Parties of the Convention for the Prevention of Marine Pollution by Dumping. IAEA TECDOC No 557

Low Level Radioactive Waste Disposal: An Evaluation of Reports Comparing Ocean and Land Based Disposal Options. IAEA TECDOC No 562

Parties to the London Dumping Convention introduced a voluntary moratorium on the disposal of low level radioactive wastes at sea [7]. Since then the IAEA has continued to support the London Dumping Convention by providing scientific advice on issues relevant to the future review of the moratorium.

The proposal to develop an **inventory of radioactive wastes entering the marine environment from all sources** was first raised at the Third Consultative Meeting (1978) [8] of the London Dumping Convention and again in 1985 as part of the studies called for in resolution LDC.21(9) of the Ninth Consultative Meeting. During the Eleventh Consultative Meeting (1988) [9], various Contracting Parties requested the IAEA to work actively towards this objective.

During the twelfth Consultative Meeting (1989) of the London Dumping Convention the working group on "**the implications of accidents to nuclear-powered vessels**" in accordance with Article V of the Convention on notification of dumping of vessel in case of **force majeure** recommended that "Contracting Parties should be requested to provide all relevant information to the IAEA regarding accidents at sea involving releases of radioactive material". The chairman of the Consultative Meeting "encouraged Contracting Parties to submit information for the compilation of the above-mentioned inventory insofar as this was possible" [10]. It was decided that this information was to be incorporated in the inventory.

The rationale for having such a global inventory is related to its use as an information base with which the impact of all disposals at sea could be more adequately assessed and compared. Among the potential sources of anthropogenic radionuclides in the marine environment three main sources were selected: the controlled release of low level radioactive liquid effluent, the disposal at sea of low level solidified radioactive waste and the marine accident involving radioactive materials.

This report, the first of a series which will cover these sources, partially responds to the request of the Contracting Parties and provides the inventory of low level radioactive waste disposed of at sea.

2. SOURCES OF RADIONUCLIDES IN THE MARINE ENVIRONMENT

2.1 INTRODUCTION

The anthropogenic radionuclides found in the marine environment can be associated with various human activities:

- the explosion of nuclear weapons either in the atmosphere or during underwater testing,

- the controlled release of low level radioactive liquid effluents from nuclear power plants, reprocessing plants, industries, hospitals, scientific research centres and nuclear weapons facilities,

- the disposal on the bottom of the ocean of low level radioactive waste, usually packaged, coming from the installations listed above,

- accidents at sea involving potential releases of radioactive materials into the marine environment, for example the loss of a vessel such as a nuclear powered submarine or one carrying nuclear fuel, or nuclear weapons or the re-entry of a satellite containing nuclear materials.

The availability of information on the inputs of radionuclides due to atmospheric and underwater nuclear weapon testing is limited due to the confidentiality of the data. This source of radionuclides is not included in the data base.

The controlled release of low level radioactive liquid effluents from civil installations is well documented in national reports. The United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) periodically reviews the radioactive contamination of the environment due to nuclear power production. UNSCEAR regularly publishes reports on the "Sources and Effects of Ionizing Radiation" where data on liquid effluent releases and dose assessment associated to these practices as well as those connected to nuclear explosions can be found [11, 12, 13]. The UNSCEAR documents can be of direct use for comparison purposes in relation to the various releases from the nuclear fuel cycle.

The two sources "Sea Dumping Operations" and "Accidents" are most closely related to the objectives of the London Dumping Convention and the establishment of data bases on these sources has been considered a priority. This report presents the data collected on low level radioactive waste disposed of at sea by the Member States of the International Atomic Energy Agency.

2.2 RADIOACTIVE WASTE DISPOSAL AT SEA

Commercial nuclear reactors as well as medical, research, industry and military facilities produce radioactive waste. In the past, low level radioactive

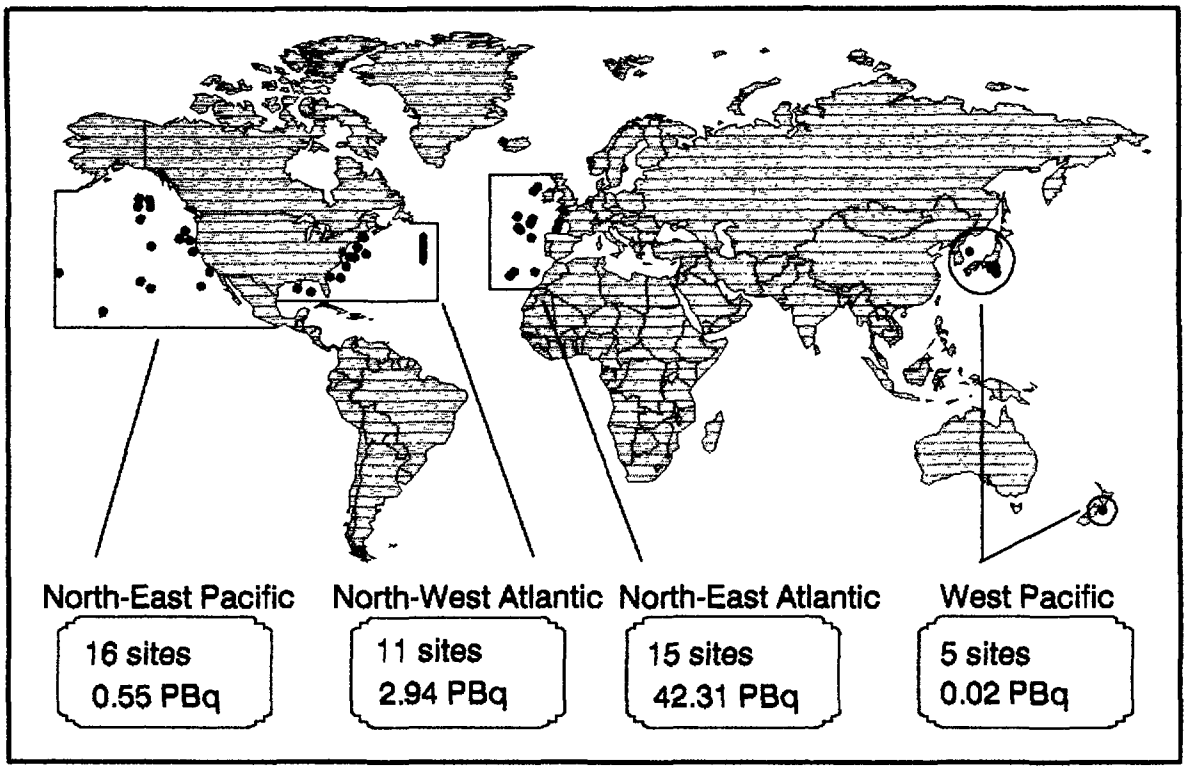


Figure 1: Quantities of low level radioactive wastes disposed of in the Atlantic and Pacific Oceans.

waste, like certain non radioactive wastes produced by human activities, was disposed of into the ocean as an alternative to disposal on land.

In 1946, the first sea disposal operation took place at a site in the North East Pacific Ocean, about 80 km off the coast of California. The last known disposal operation was in 1982, at a site about 550 km off the European continental shelf in the Atlantic Ocean (Figure 1). The main objective of waste disposal in the deep sea is to isolate radioactive waste from man's environment for a period of time long enough in order to allow the physical decay of radionuclides in the waste so that any subsequent release of radionuclides from the disposal site will not result in unacceptable radiological risks, even in the long-term.

Although sea disposal is essentially a dispersal rather than a containment strategy, IAEA recommended that the packages should be designed to ensure containment of the wastes during their descent to and impact on the sea floor and to minimize, to the extent reasonably achievable, subsequent releases of radionuclides to the sea, thereby preventing unnecessary contamination of the marine environment [14]. The IAEA recommendation is intended to delay and slow the leaking process of radionuclides so that radionuclide concentrations in the marine environment will be kept to low levels. In addition, recommendations were provided by IAEA on the environmental assessment methodologies for sea disposal of radioactive wastes [15].

Until 1977 sea disposal operations were performed under national authority. In 1977 the Council of the Organisation for Economic Co-operation and

Development (OECD) decided to established a "Multilateral Consultation and Surveillance Mechanism" to co-ordinate the ocean disposal of its Member States and to set up a Co-ordinated Research and Environmental Surveillance Programme (CRESP) to keep the suitability of the disposal site under review [16]. The NEA keeps records of the disposal operations of low level radioactive waste carried out by its Members States [17].

Since 1977, the North-East Atlantic site used until 1982 has been surveyed on a yearly basis by CRESP. Radiological surveys of the Pacific and North-West Atlantic Ocean sites are carried out from time to time by the US Environmental Protection Agency. So far, samples of sea water, sediments and deep sea organisms collected near to the various sites have not shown any excess in the levels of radionuclides above those due to nuclear weapons fallout, except on certain occasions when caesium and plutonium were detected at higher levels in samples taken close to packages at the disposal site.

3. THE DATA BASE ON RADIOACTIVE MATERIAL DISPOSED OF AT SEA

3.1 INTRODUCTION

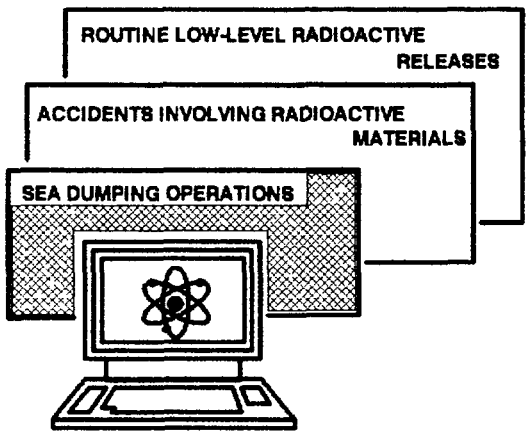
The rationale for having the inventory is related to its use as an information base against which the impact of radionuclides released into the marine environment can be more adequately assessed and compared. Taking into account these objectives, a management system for the inventory has been developed with capacity for:

- storage of information on past practices,

- inclusion of future information, and

- accessibility of the information needed in impact assessment calculations.

A **computerized data base** has been set up with three modules:



- a module on **Controlled Low Level Radioactive Liquid Releases** into coastal waters from nuclear plants,

- a module on **Sea disposal Operations** of packaged low level radioactive wastes,

- a module on **Accidents** which may lead to a direct release of radionuclides into the sea.

Each data base module has been established separately for the storage and rapid retrieval of specific information requested for each source. A system which functions as a memory can be automatically corrected for radioactive decay and used as a source term in calculations such as those on global assessment of the impact of radionuclides released in the marine environment.

3.2 THE COMPUTERIZED DATA BASE

Various types of information and data are required for assessment of a disposal operation. They include: the quantity and composition of the waste, the methods of preparation and packaging of the waste, the characteristics of the proposed disposal site [15].

The data base module on **Sea Disposal Operations** contains information on

- the disposal operation : State responsible for the operation and date,
- the site : geographical coordinates (latitude and longitude) and depth,
- the containers : number, volume and type of containers and total weight,
- the matrix : type (concrete, bituminen, polymer,...)
- the waste : state (solid, solidified or liquid)
- the radionuclides : A value is given of the total quantity disposed of. A value is given for alpha and beta-gamma radionuclides, when the information is available, a detailed inventory for each radionuclide is included in the data base. Where information is available the inventory of tritium is included separately. The quantities are expressed in Giga Becquerel at the date of the disposal operation.

3.3 COLLECTION OF INFORMATION

An extensive literature exists on the disposal of low level radioactive waste at sea. It is however recognized that there are inconsistencies in the different sources of information analysed (reports and unofficial publications).

Pursuant to resolution LDC.28(10) of the tenth Consultative Meeting of the London Dumping Convention a "Questionnaire on Radioactive Waste" was sent to Contracting Parties in 1986 [18]. In 1988 the summary of responses to the questionnaire on radioactive waste disposal had been updated and circulated to the Contracting Parties [19]. In 1988, using the information collected (Table II), IAEA established a provisional data base on **Sea Dumping Operations**. In May 1989, The IAEA in a circular letter requested Member States that have engaged in sea disposal operations to check the information extracted from the IAEA data base and/or to provide information relevant to their past sea disposal activities. In March 1990 a follow-up letter was addressed to Member States that had not answered the first circular letter.

Table II: Summary of responses of Contracting Parties to the London Dumping Convention [19] to a questionnaire on disposal of radioactive waste (Resolution LDC.28(10) [18]. The question No 11 was: "Have you dumped? Are you dumping or are you planning dumping of radioactive material at sea ?"

COUNTRY	HAVING DUMPED ?	PLANNING DUMPING ?	KEEP OPTION OPEN ?	NOTES
Australia	No	No	No	
Belgium	Yes	Not Mentioned	Yes	
Canada	No	No	Yes (*)	for contaminated soils
Chile	No	No	No	
China	No	No	Not Mentioned	
Denmark	No	No	No	
Finland	No	No	Not Mentioned	
France	Yes	No	Yes	for tritium
Germany, FR	Yes	No	Not Mentioned	
Greece	No	No	Not Mentioned	
Ireland	No	No	No	
Italy	Yes	No	Not Mentioned	
Japan	Yes	(**)	Yes	
Mexico	No	No	Not Mentioned	
Nauru	Not Mentioned	Not Mentioned	Not Mentioned	
Netherlands	Yes	No	Not Mentioned	
New Zealand	Yes	No	No	
Norway	No	No	No	
Portugal	No	No	No	
South Africa	No	No	Yes	
Spain	No	No	No	
Sweden	Yes	No	No	
Switzerland	Yes	No	Yes	
USSR	No	No	Not Mentioned	
United Kingdom	Yes	Not Mentioned	Yes	
USA	Yes	No	Not Mentioned	

* Canada has stated it feels it would be improper to preclude the option while an international working group under the LDC is studying the costs, benefits and implications of the option.

** Japan has stated that it has no intention of carrying out disposal at sea in disregard of the concern expressed by some countries.

The new information and corrections sent by Member States were incorporated into the data base. For each State that in the past engaged in sea disposal operations an information excerpt from the data base (updated to April 1990) is provided as an annex to this document.

3.4 FEATURES OF THE DUMPING OPERATIONS

The information received by the IAEA is heterogeneous due to the different ways in which records on disposal operations are kept in different countries. Usually an indication of the date of the disposal operation as well as of the location of the disposal site, in geographical coordinates, is given, except for USA operations which were not reported on a unit basis but in terms of a period of operation for each site. The type, number and weight or volume of the disposed containers is reported. The weight or volume is representative of the disposed containers but not of the radioactive waste itself. The waste is contained in a matrix of concrete or bitumen and the matrix together with the metal or concrete container represent the major part of the weight or volume (up to 99%). The total radioactive content or total alpha and beta-gamma radioactivity disposed are reported. The composition in terms of radionuclide content is not usually recorded with the exception of tritium and ^{226}Ra for the most recent years. Nevertheless some indication of the radionuclide composition, as a percentage, is given in some cases as well as of their origin: research, medical, industry and military activities.

The data base shows that the first disposal operation at sea took place in 1946 in the Pacific Ocean and the last one in 1982 in the North East Atlantic Ocean (see the annex). During these 36 years, 12 States have used 47 sites to dispose of approximatively 46 PBq (1.24 MCi) of mainly solid or solidified low level radioactive waste (Table III).

The radioactive wastes were usually contained in metal drums of 200 litres lined with concrete or bitumen. Some monolithic blocks were also dumped and sometimes a polymer matrix was used. Unpackaged waste and liquid waste are rarely reported (4 times).

Beta-gamma emitters represent more than 98% of the total radioactivity of the waste and tritium alone represents one third of the total radioactive material disposed of at the North-East Atlantic sites. They comprise fission and activation products such as ^{90}Sr, ^{137}Cs, ^{55}Fe, ^{58}Co, ^{60}Co, ^{125}I and ^{14}C. The wastes also contain low quantities of alpha-emitting nuclides with plutonium and americium isotopes representing 96% of the alpha emitters present.

Of the total amount of radioactive material, more than 98% has been disposed of in the North Atlantic Ocean, 92% thereof in the eastern basin. The quantities of waste disposed of by each States involved in disposal at sea indicates that some States used this waste management option for only a small quantity of waste and during exceptional operations: three States conducted only one operation and one State two. In contrast the contrary three states used the sea disposal option regularly for the disposal of larger quantities of waste (Figure 2).

Table III: Quantities of alpha, beta-gamma emitters and tritium disposed of in the Atlantic and Pacific Oceans by the countries involved in sea disposal operations between 1949 to 1982.

	Alpha GBq	Beta/Gamma* GBq	Tritium GBq	Totals GBq	Percent of the total quantity %
+ ATLANTIC SITES					
Belgium	29243	2091090	786968	2120333	4.63
France	8476	344915	-	353391	0.77
Germany, FR	20	180	-	200	0.0004
Italy	74	111	-	185	0.0004
The Netherlands	1113	334940	99430	336053	0.73
Sweden	938	2305	-	3243	0.01
Switzerland	4318	4415025	3902242	4419343	9.64
United Kingdom	626269	34451318	10781207	35077587	76.55
United States	-	-	-	2942165	6.42
Subtotals	670451	41639884	15569847	45252500	98.75
+ PACIFIC SITES					
Japan	252	15189	-	15442	0.03
Korea	-	-	-	-	-
New Zealand	1039	-	-	1039	0.002
United States	-	-	-	554247	1.21
Subtotals	1291	15189	-	570728	1.25
+ FOR ALL SITES					
Totals	671742	41655074	15569847	45823228	100

* Tritium activities are included in the beta-gamma figures.

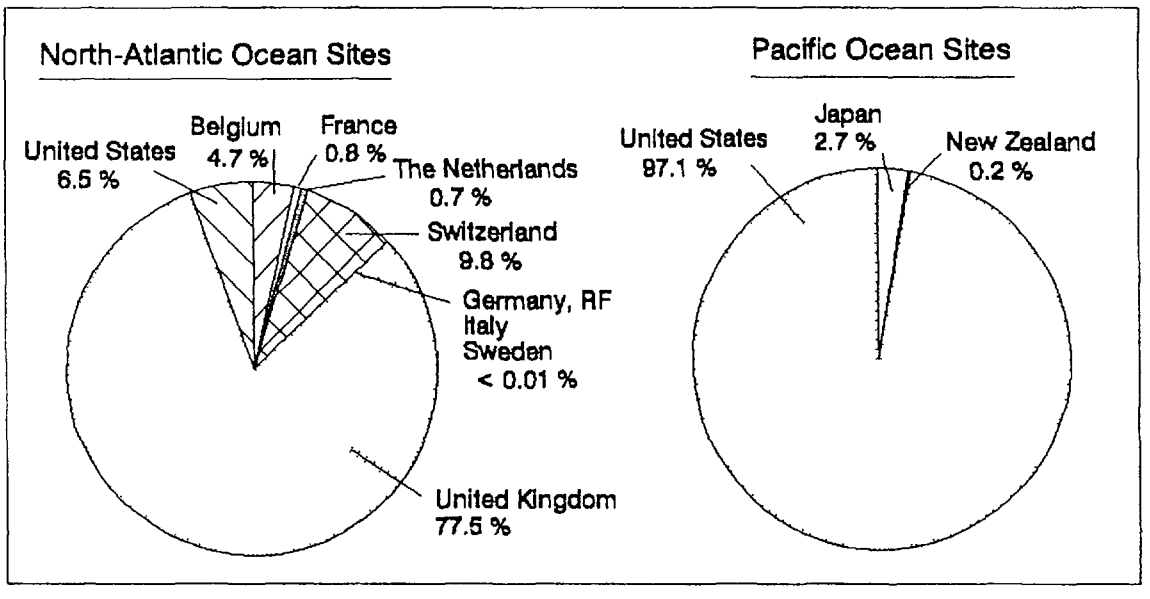


Figure 2: Percentage of the total amount of radioactive material disposed of by country in the Atlantic and Pacific Oceans.

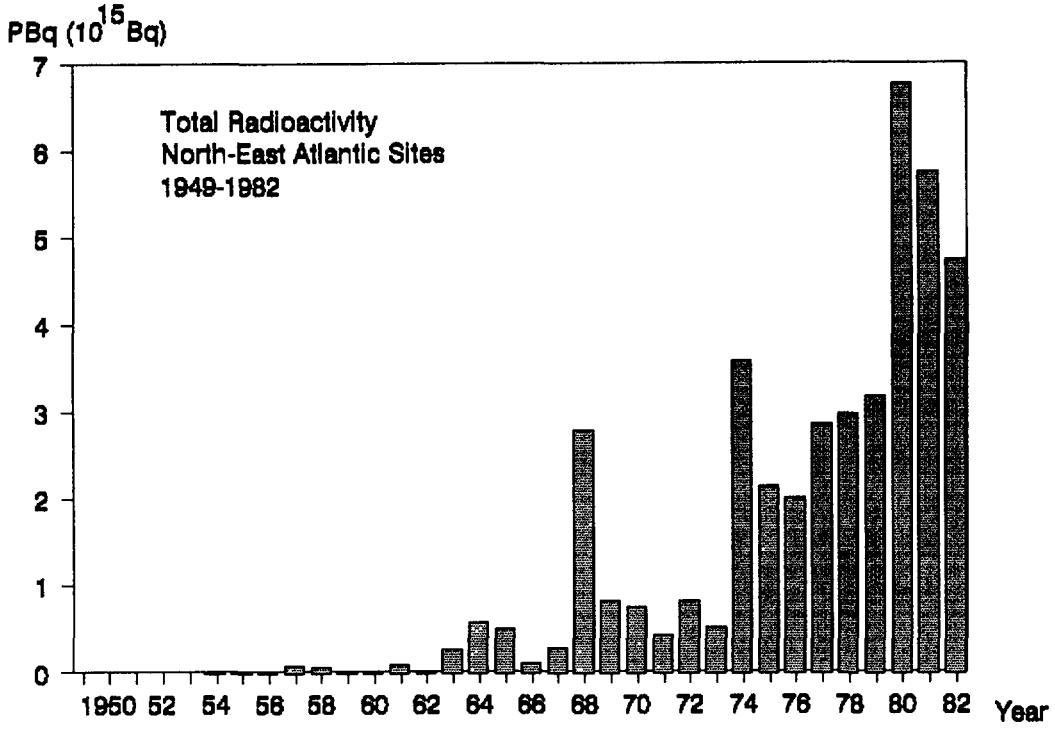


Figure 3: Total radioactive material disposed of annually between 1949 and 1982 at the North-East Atlantic Ocean sites.

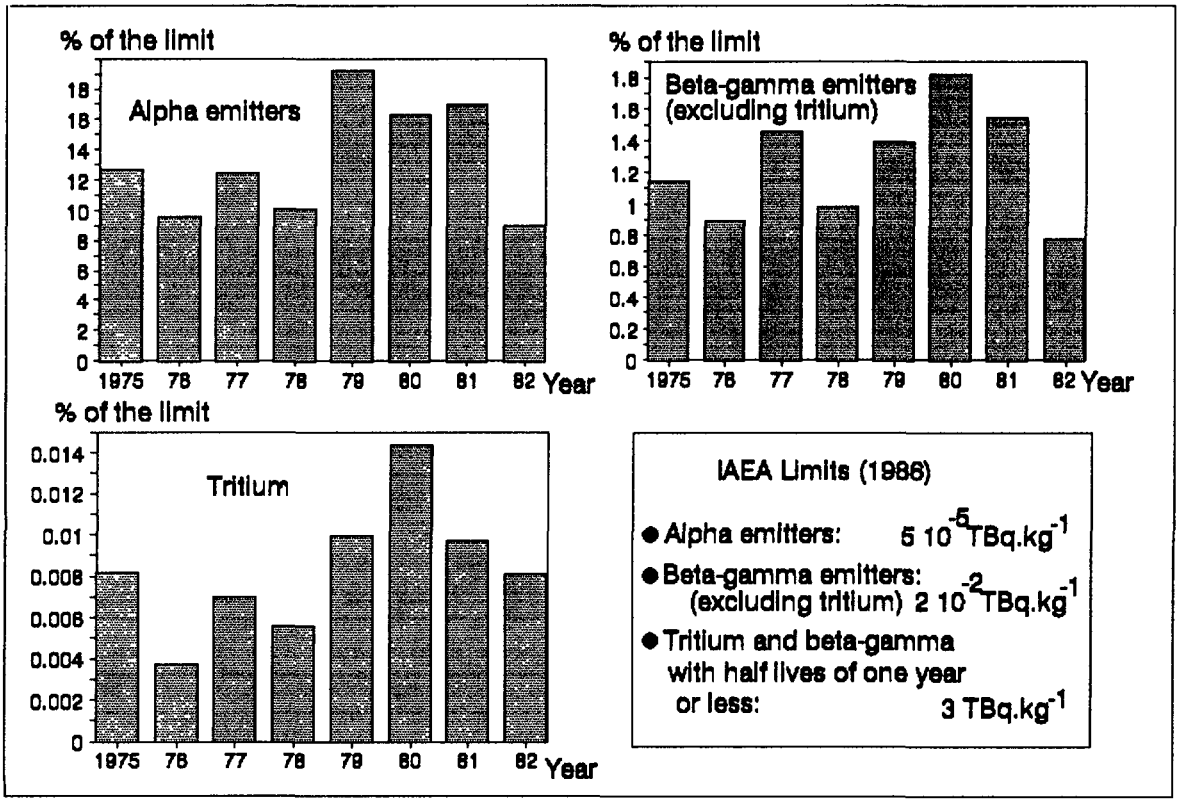


Figure 4: Quantities of alpha, beta/gamma emitters and tritium disposed of annually since 1975 at the North-East Atlantic Ocean sites, expressed as a percentage of the recommended IAEA limits [5].

Considering the evolution with time of the sea disposal practice, whereas the last operation was performed in 1972 in the Pacific Ocean, the evolution in the North-East Atlantic Ocean shows an increase by a factor of 3 of the annual quantities disposed of from 1974 onwards (Figure 3).

Figures 4 show the yearly concentrations of alpha emitters, beta-gamma emitters (excluding tritium) and tritium in wastes disposed of at the NEA North-East Atlantic sites since 1975 when tritium data were available. These quantities are expressed as the percentage of the concentration limits set up by IAEA in the Definition and Recommendations for the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter in 1986 [6]. The concentrations of the radionuclides disposed of each year were always at least one order of magnitude lower than the recommended limits.

ANNEX

THE INVENTORY OF SEA DISPOSAL OF RADIOACTIVE WASTE

A.1 State: **Belgium**

Disposal period: **1960-1982**

Total number of years of disposal operations: **15**

Total number of sites: **6**

Total number of containers dumped: **55324**

Total weight of containers dumped: **$2.31\ 10^4$ tons**

Total radioactivity: **$2.12\ 10^6$ GBq**

Information provided to IAEA on: **14 November 1989**

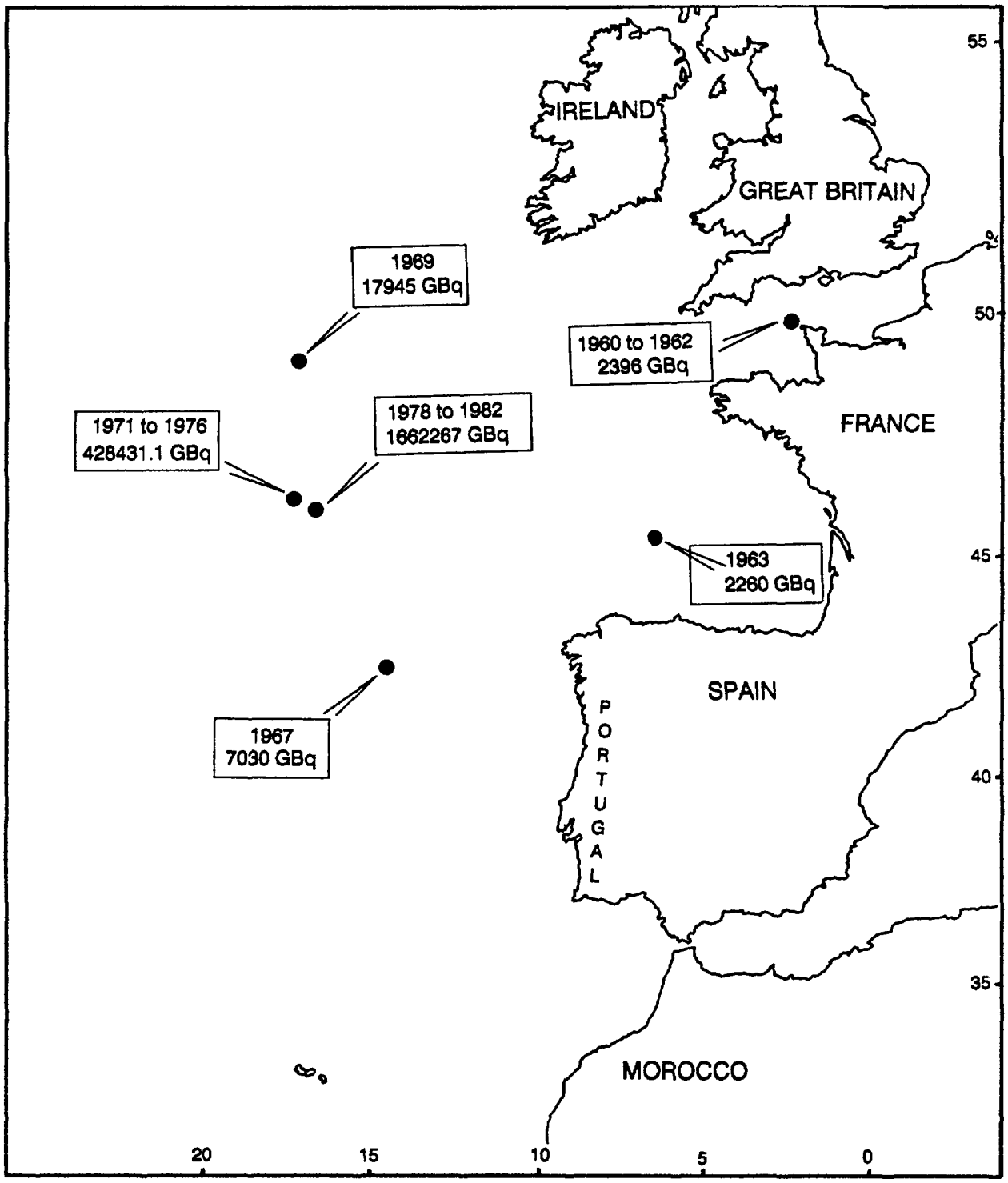


Figure A.1: Geographical positions, disposal periods and total quantities disposed.

Date	Coordinates Latitude	Longitude	Depth Min. m	Max. m	Country Package	CONTAINER * Number	Type	Matrix	Total Weight t	RADIOACTIVITY Total GBq	Alpha GBq	BetaGamma GBq**	H-3 GBq
1960	49°50'N	2°18'W	65	160	Belgium Yes			B/C	284	543.9	25.9	518.0	-
1962	49°50'N	2°18'W	65	160	Belgium Yes			B/C	431	1852.2	2.2	1850.0	-
1963	45°27'N	6°16'W	4100	4800	Belgium Yes			B/C	789	2260.0	40.0	2220.0	-
1967	42°50'N	14°30'W	5200	5200	Belgium Yes	1945 M	220 l	B	599.9	7030.0	37.0	6993.0	-
1969	49°05'N	17°05'W	4000	4600	Belgium Yes	2222 M	220 l	B	600.4	17945.0	370.0	17575.0	-
1971	46°15'N	17°25'W	3600	4750	Belgium Yes	2861 M	220 l	B			703.0	54501.0	33226.0
						1968 M	220 l	C				31709.0	30229.0
						42 M	400 l	B				1073.0	1036.0
						146 M	400 l	C				1924.0	1850.0
						16 C	1000 l	C				1184.0	
					Subtotals :	5033			1768.4	91094.0	703.0	90391.0	66341.0
1972	46°15'N	17°25'W	3600	4750	Belgium Yes	2964 M	220 l	B			37.0		-
						98 M	400 l	C					-
					Subtotals :	3062			1112.0	71447.0	37.0	71410.0	70300.0
1973	46°15'N	17°25'W	3600	4750	Belgium Yes	2083 M	220 l	B			814.0	62189.6	59296.2
						3791 M	220 l	C				55.5	-
						156 M	400 l	C				0.4	-
						145 M	600 l	C				3129.8	3122.8
						2 M	1000 l	C				3.7	-
					Subtotals :	6177			2296.0	66193.0	814.0	65379.0	62419.0
1975	46°15'N	17°25'W	3600	4750	Belgium Yes	5920 M	220 l	B			296.0	120039.1	111925.0
						127 M	400 l	C				321.9	-
						9 M	400 l	B			1110.0	0.0	-
					Subtotals :	6056			2001.6	121767.0	1406.0	120361.0	111925.0
1976	46°15'N	17°25'W	3600	4750	Belgium Yes	2887 M	220 l	B			2590.0	47989.0	37555.0
						2196 M	220 l	C				16942.3	14245.0
						138 M	400 l	C				40.7	-
						300 M	600 l	C			111.0	10260.1	-
					Subtotals :	5521			2242.7	77933.1	2701.0	75232.1	51800.0
1978	46°00'N	16°45'W	3900	4750	Belgium Yes	3761 M	220 l	B			9435.0	120657.0	112887.0
						1691 M	220 l	C				2960.0	-
						195 M	400 l	C				2405.0	-
						45 M	400 l	Cm				555.0	-
						48 M	600 l	C				740.0	-
						28 C	1000 l	Cm				2220.0	-
						302 C	1500 l	Cm				10237.9	-
						128 C	1500 l	P				20150.2	-
					Subtotals :	6198			3671.5	169360.1	9435.0	159925.1	112887.0
1979	46°00'N	16°45'W	3900	4750	Belgium Yes	1465 M	220 l	B			1084.1	36940.8	34817.0
						343 M	220 l	C			85.1	595.7	-
						144 M	220 l	Cm				717.8	-
						70 M	400 l	C			7.4	876.9	-
						135 M	400 l	Cm				1628.0	-
					Subtotals :	2157			872.0	41935.8	1176.6	40759.2	34817.0

Date	Coordinates Latitude	Longitude	Depth Min. m	Max. m	Country Package	CONTAINER * Number	Type	Matrix	Total Weight t	RADIOACTIVITY Total GBq	Alpha GBq	BetaGamma GBq**	H-3 GBq
1980	46°00'N	16°45'W	3900	4750	Belgium Yes	3438	M 220 l	B			1868.5	240093.0	235098.0
						322	M 220 l	C			55.5	490.0	-
						57	M 220 l	Cm				185.0	-
						513	M 400 l	C			347.8	10804.0	10027.0
						264	M 400 l	Cm				2664.0	-
						105	M 600 l	C				3404.0	-
						152	C 1000 l	Cm			7.4	583564.0	19240.0
						71	C 1500 l	Cm				4329.0	-
						177	C 1500 l	P				10804.0	-
					Subtotals :	5099			3512.0	858616.2	2279.2	856337.0	264365.0
1981	46°00'N	16°45'W	3900	4750	Belgium Yes	3102	M 220 l	B			2586.3	14204.3	8284.3
						51	M 220 l	C			22.2	0.0	-
						1716	M 400 l	C			1968.4	710.4	340.4
						207	M 400 l	Cm				1147.0	-
						40	M 600 l	C				677.1	196.1
						56	M 1200 l	C				333.0	-
						25	C 1000 l	Cm				275761.0	-
						234	C 1500 l	Cm				16169.0	-
						116	C 1500 l	P				32375.0	-
					Subtotals :	5547			4450.0	345953.7	4576.9	341376.8	8820.8
1982	46°00'N	16°45'W	3900	4750	Belgium Yes	2984	M 220 l	B			3296.7	7585.0	2923.0
						106	M 220 l	C				3.7	-
						1960	M 400 l	C			2301.4	1036.0	370.0
						591	M 400 l	Cm				3404.0	-
						209	M 600 l	C			40.7	925.0	-
						2	M 600 l	Cm				111.0	-
						34	M 1200 l	C				925.0	-
						255	C 1500 l	Cm				95349.0	-
						166	C 1500 l	P				131424.0	-
					Subtotals :	6307			5100.0	246401.5	5638.8	240762.7	3293.0
					Totals :	55324			29016	2120333	29243	2091090	786968

* Key for the type of containers and matrix:

B: Bitumen
C: Concrete
Cm: Cement
M: Metallic
P: Polymers

** Tritium activities are included in the beta-gamma figures.

A.2 State: **France**

Disposal period: **1967-1969**

Total number of years of disposal operations: **2**

Total number of sites: **2**

Total number of containers dumped: **46396**

Total weight of containers dumped: **14299 tons**

Total radioactivity: **3.53 10^5 GBq**

Information provided to IAEA on: **1 June 1989**

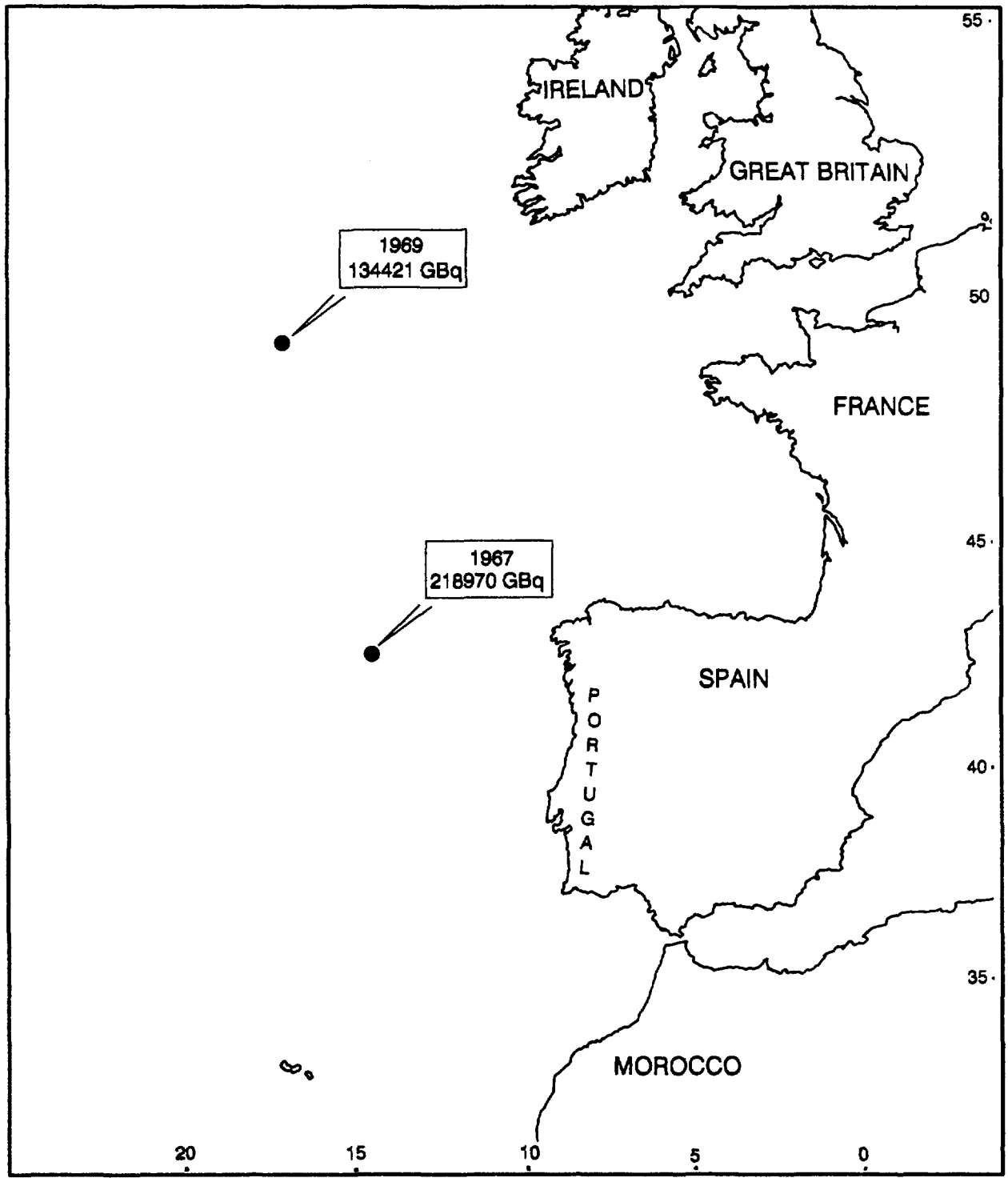


Figure A.2: Geographical positions, disposal periods and total quantities disposed.

Date	Coordinates Latitude	Longitude	Depth Min. m	Depth Max. m	Country	Package	CONTAINER Number	Type	Matrix	Total Weight t	RADIOACTIVITY Total GBq	Alpha GBq	BetaGamma GBq
1967	42°50'N	14°30'W	4590	5310	France	Yes	30700	Metal	-	8837	218560	5920	212640
							896	Metal	Concrete	347	410	40	370
						Subtotals	31596			9184	218970	5960	213010
1969	49°05'N	17°05'W	4000	4600	France	Yes	14800	-	-	5015	134421	2516	131905
						Total:	46396			14199	353391	8476	344915

A.3 State: **Germany, Federal Republic of**

Disposal period: **1967**

Total number of years of disposal operations: **1**

Total number of sites: **1**

Total number of containers dumped: **480**

Total weight of containers dumped: **185 tons**

Total radioactivity: **2.03 10^2 GBq**

Information provided to IAEA on: **26 Septembre 1990**

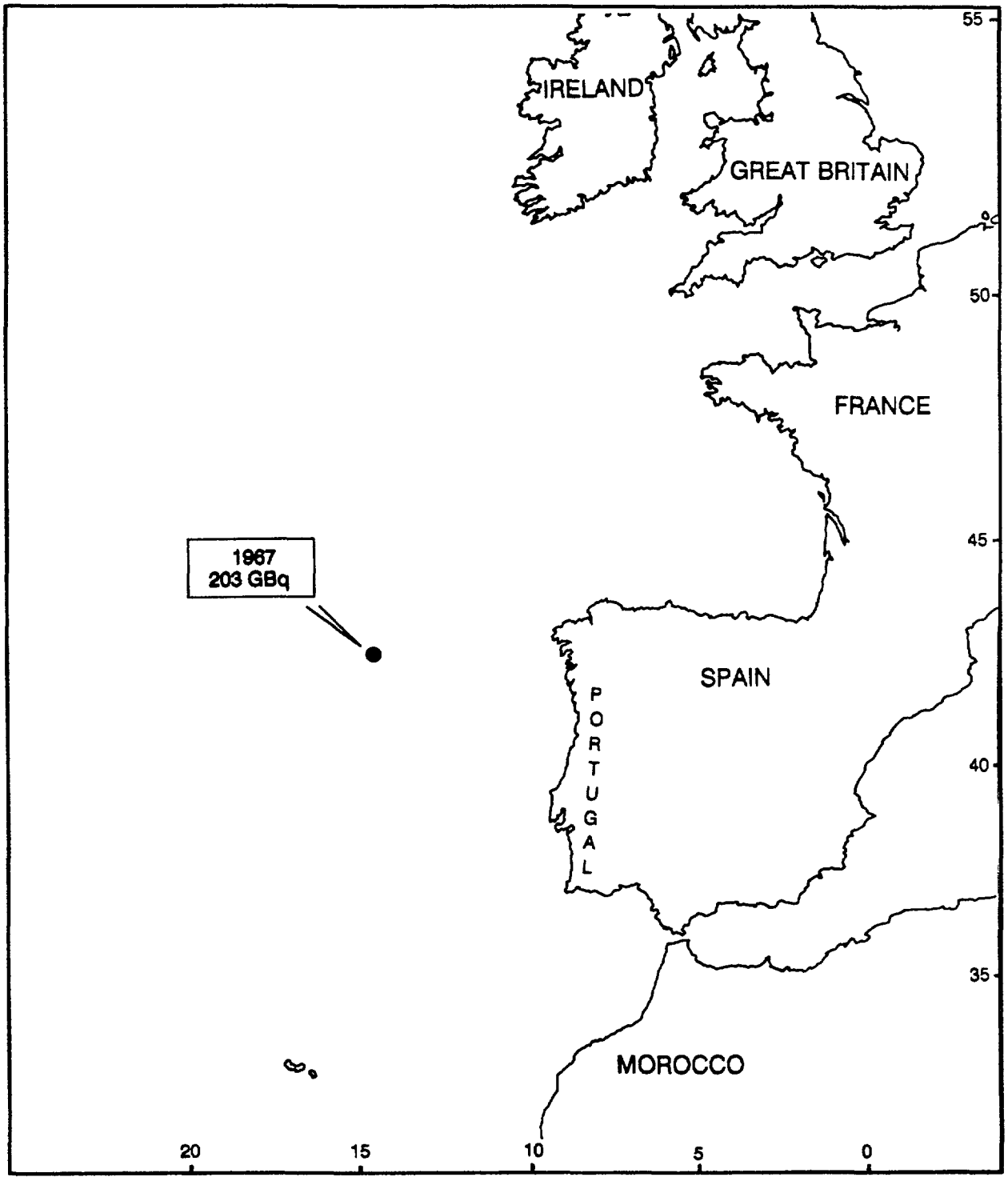


Figure A.3: Geographical position, disposal period and total quantity disposed.

Date	Coordinates Latitude ø	Longitude G	Depth Min. m	Max. m	Country Package	CONTAINER Number	Type	Matrix	Total Weight t	RADIOACTIVITY Total GBq	Alpha GBq	BetaGamma GBq
1967	42°50'N	14°30'E	2500	5200	FRG* Yes	480	Barrel**	concrete	180.5	203.5	18.5	185

*: This report was compiled before the recent reunification of Germany.

**: Key for the type of container: Rolling Hoop Barrel, DIN-Standards 6635 and 6636.

A.4 State: **Italy**

Disposal period: **1969**

Total number of years of disposal operations: **1**

Total number of sites: **1**

Total number of containers dumped: **100**

Total weight of containers dumped: **44.745 tons**

Total radioactivity: **1.85 10^2 GBq**

Information provided to IAEA on: **18 May 1990**

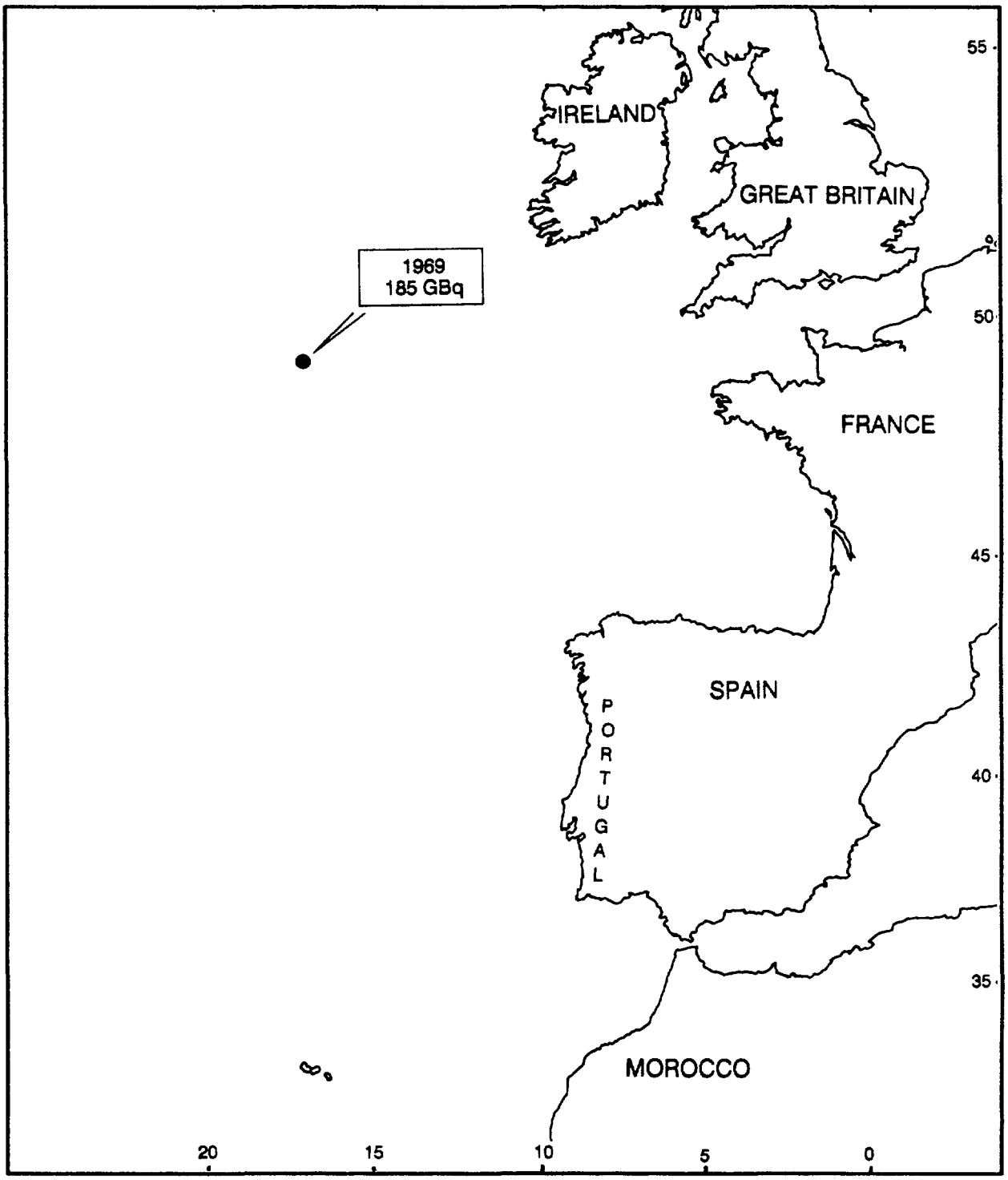


Figure A.4: Geographical position, disposal period and total quantity disposed.

Date	Coordinates Latitude	Longitude	Depth Min. m	Depth Max. m	Country Package	CONTAINER Number	Type *	Matrix	Total Weight t	RADIOACTIVITY Total GBq	Alpha GBq	BetaGamma GBq
1969	49°05'N	17°05'E	4000	4600	Italy Yes	100	Metal D.	Concrete	44.74	185	74	111

* Type of container: metal drum lined with concrete.

A.5 State: **Japan**

Disposal period: **1955-1969**

Total number of years of disposal operations: **12**

Total number of sites: **6**

Total number of containers dumped: **3031**

Total volume of containers dumped: **606.2 10^3 m^3**

Total radioactivity: **1.54 10^4 GBq**

Information provided to IAEA on: **30 May 1989**

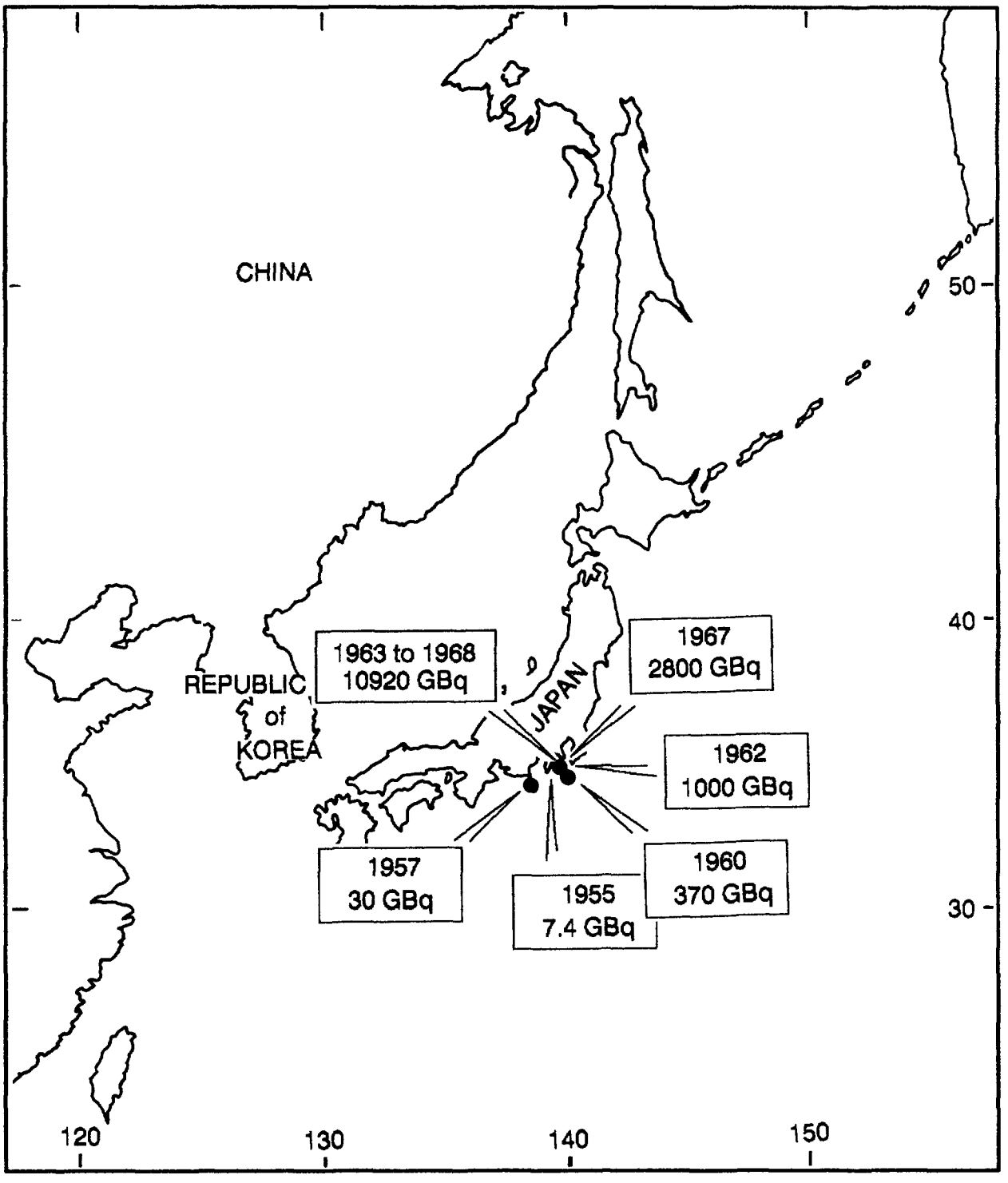


Figure A.5: Geographical positions, disposal periods and total quantities disposed.

Date	Coordinates Latitude	Longitude	Depth Min. m	Max. m	Country	Package	CONTAINER Number	Type *	Matrix	RADIOACTIVITY Total GBq	Alpha GBq	BetaGamma GBq
1955	34°55'N	139°25'E	1400	1500	Japan	Yes	27	M 200 l	Mortar	7.4	-	7.4
1957	34°34 N	138°32'E	2000	2500	Japan	Yes	10	M 200 l	Mortar	30	-	30
1958	34°42'N	139°56'E	2400	2800	Japan	Yes	11	M 200 l	Mortar	30	-	30
							54	M 200 l	Mortar	190	-	190
1959	34°42'N	139°56'E	2400	2800	Japan	Yes	52	M 200 l	Mortar	222	-	222
							43	M 200 l	Mortar	190	-	190
1960	34°42'N	139°56'E	2400	2800	Japan	Yes	40	M 200 l	Mortar	190	-	190
	34°34'N	139°53'E	2400	2800	Japan	Yes	70	M 200 l	Mortar	370	-	370
1962	34°41'N	139°53'E	2400	2800	Japan	Yes	1523	M 200 l	Mortar	1026.3	6.3	1020
1963	34°42'N	139°56'E	2400	2800	Japan	Yes	165	M 200 l	Mortar	2415	5	2410
1964	34°42'N	139°56'E	2400	2800	Japan	Yes	135	M 200 l	Mortar	2600.05	0.05	2600
1965	34°42'N	139°56'E	2600	2600	Japan	Yes	201	M 200 l	Mortar	1010.81	0.81	1010
1967	34°41'N	139°55'E	2600	2600	Japan	Yes	225	M 200 l	Mortar	2855	40	2815
1968	34°42'N	139°56'E	2600	2600	Japan	Yes	230	M 200 l	Mortar	1505	200	1305
1969	34°42'N	139°56'E	2600	2600	Japan	Yes	245	M 200 l	Mortar	2800.3	0.3	2800
						Total:	3031	606200		15441.86	252.46	15189.4

Key for the type of container: M: Metal

A.6 State: **Korea, Republic of**

Disposal period: **1968-1972**

Total number of years of disposal operations: **5**

Total number of sites: **1**

Total number of containers dumped: **115**

Total weight of containers dumped: **45 tons**

Total radioactivity: **? GBq**

Information provided to IAEA on: **11 August 1989**

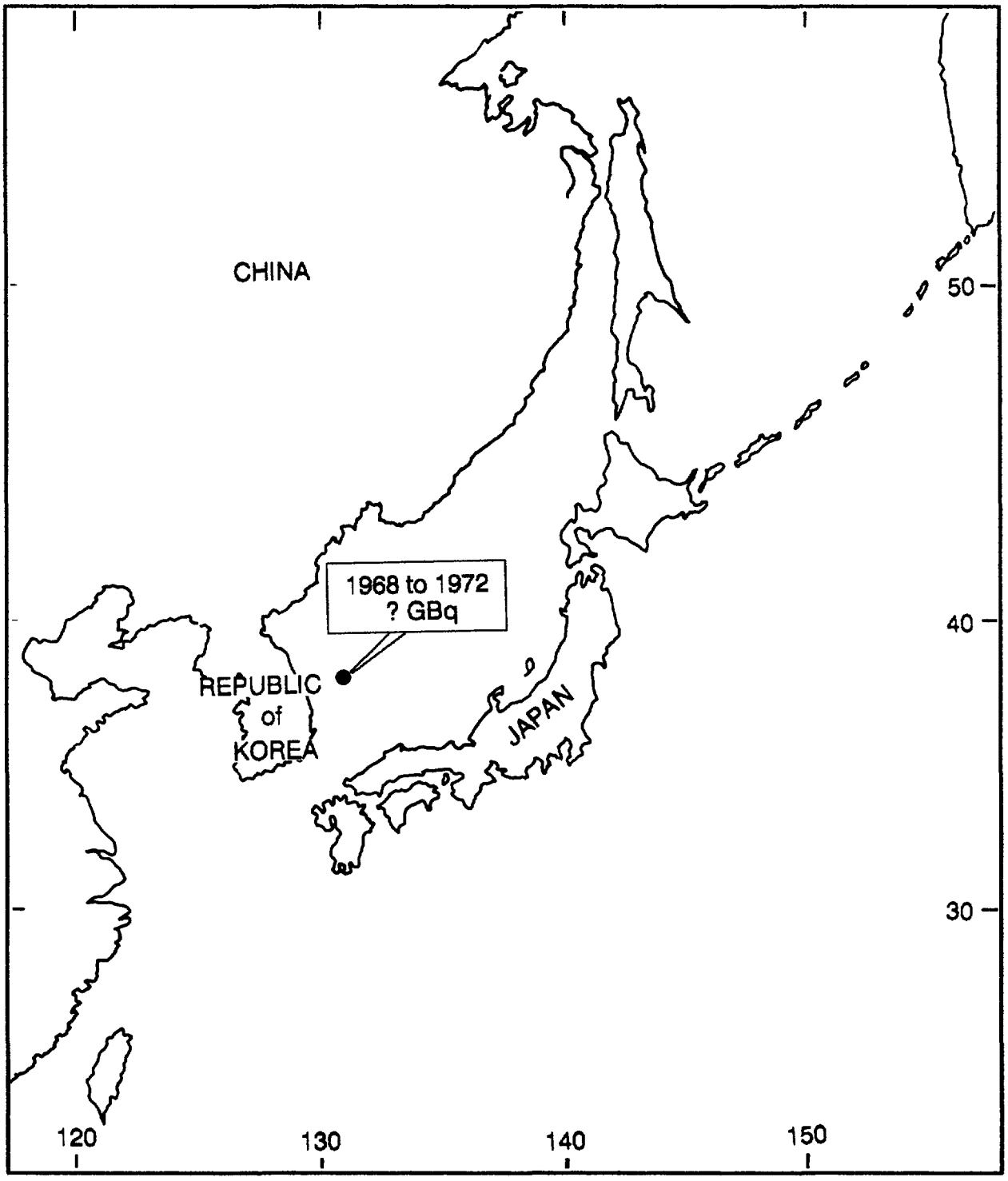


Figure A.6: Geographical position and disposal period.

Date	Coordinates Latitue	Longitude	Depth Min. m	Max. m	Country	Package	CONTAINER Number	Type	Matrix	Total Weight t	RADIOACTIVITY Total GBq	Alpha GBq	BetaGamma GBq
1968	37°20'N	130°44'E	2192	2192	Korea,R	Yes	21	C.L.D.	Concrete	8	?	?	?
1969	37°20'N	130°44'E	2192	2192	Korea,R	Yes	21	C.L.D.	Concrete	8	?	?	?
1970	37°20'N	130°44'E	2192	2192	Korea,R	Yes	23	C.L.D.	Concrete	9	?	?	?
1971	37°20'N	130°44'E	2192	2192	Korea,R	Yes	25	C.L.D.	Concrete	10	?	?	?
1972	37°20'N	130°44'E	2192	2192	Korea,R	Yes	25	C.L.D.	Concrete	10	?	?	?
						Total:	115			45			

Key for the type of container:

- C.L.D.: metal drum lined with concrete (200 l)

A.7 State: **Netherlands**

Disposal period: **1967-1982**

Total number of years of disposal operations: **14**

Total number of sites: **4**

Total number of containers dumped: **28428**

Total weight of containers dumped: **19162 tons**

Total radioactivity: **3.36 10^5 GBq**

Information provided to IAEA on: **22 june 1989**

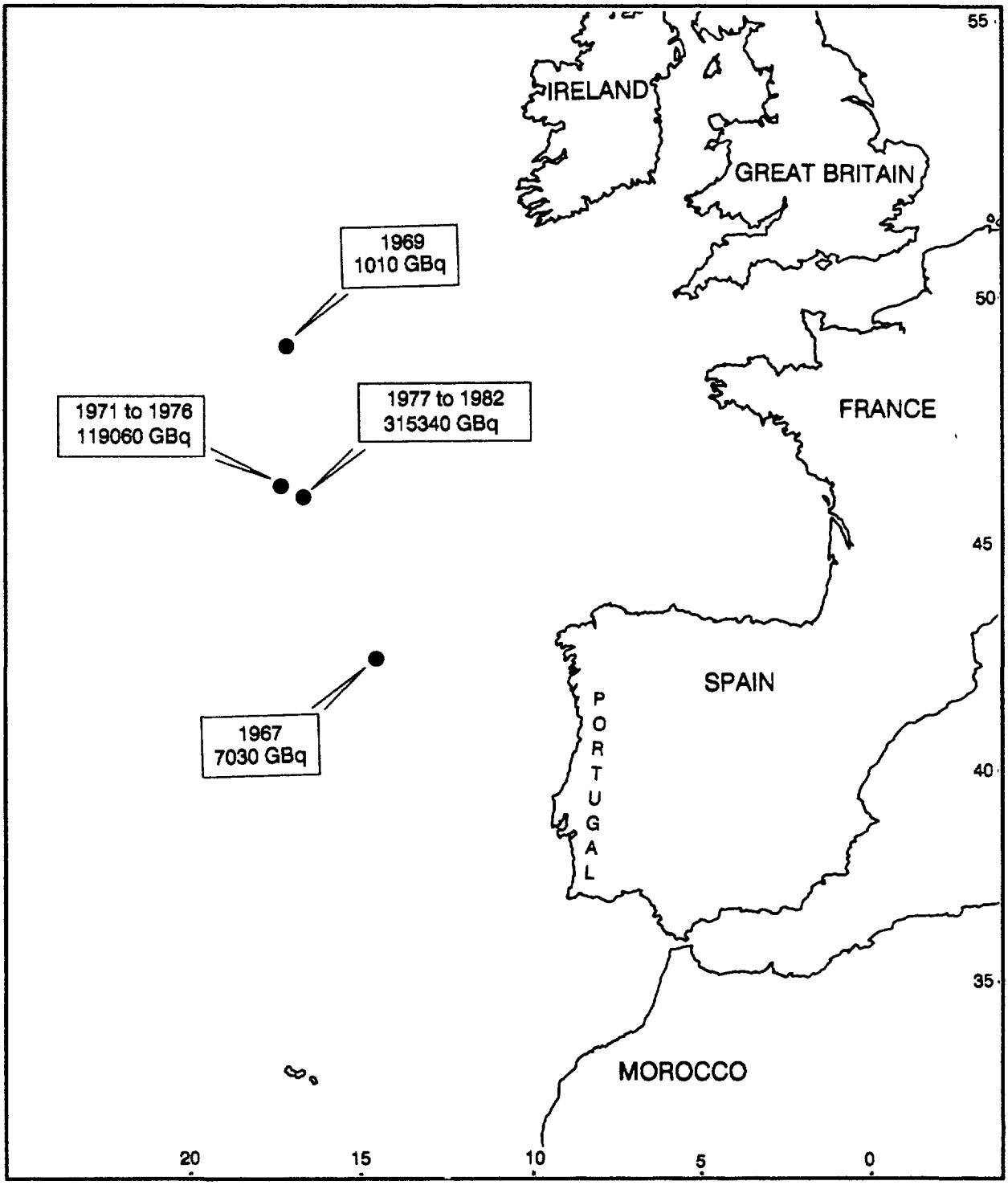


Figure A.7: Geographical positions, disposal periods and total quantities disposed.

Date	Coordinates Latitude	Longitude	Depth Min. m	Max. m	Country Package	CONTAINER Number	Type*	Matrix	Total Weight t	RADIOACTIVITY Total GBq	Alpha GBq	BetaGamma GBq**	H-3 GBq
1967	42°50'N	14°30'E	5200	5200	Netherlands Yes	-	MLC/MCB	C	207	73	3	70	-
1969	49°05'N	17°05'E	4000	4600	Netherlands Yes	-	MLC/MCB	C	303	1010	10	1000	-
1971	46°15'N	17°25'E	3200	4100	Netherlands Yes	-	MLC/MCB	C	360	750	10	740	-
1972	46°15'N	17°25'E	3200	4100	Netherlands Yes	-	MLC/MCB	C	626	2030	-	2030	-
1973	46°15'N	17°25'E	3200	4100	Netherlands Yes	-	MLC/MCB	C	657	1850	-	1850	-
1974	46°15'N	17°25'E	3200	4100	Netherlands Yes	1189	MLC/MCB	C	501	21020	40	20980	20350
1975	46°15'N	17°25'E	3200	4100	Netherlands Yes	2162	MLC/MCB	C	901	18190	60	18130	14800
1976	46°15'N	17°25'E	3200	4100	Netherlands Yes	4496	MLC/MCB	C	1911	36370	40	36330	3700
1977	46°00'N	16°45'E	3200	4750	Netherlands Yes	3812	MLC/MCB	C	3015	22190	330	21860	7100
1978	46°00'N	16°45'E	3200	4750	Netherlands Yes	2946	MLC/MCB	C	1562	57060	190	56870	17460
1979	46°00'N	16°45'E	3200	4750	Netherlands Yes	3393	MLC/MCB	C	2122	31310	50	31260	11400
1980	46°00'N	16°45'E	3200	4750	Netherlands Yes	2960	MLC/MCB	C	1885	19960	20	19940	3850
1981	46°00'N	16°45'E	3200	4750	Netherlands Yes	3015	MLC/MCB	C	2063	68840	240	68600	3070
1982	46°00'N	16°45'E	3200	4750	Netherlands Yes	4455	MLC/MCB	C	3049	55400	120	55280	17700
					Total	28428			19162	336053	1113	334940	99430

* Key for the type of containers and matrix:

- MLC: Metal drum lined with concrete
- MCB: Monolithic concrete block
- C: Concrete

** Tritium activities are included in the beta-gamma figures.

A.8 State: **New Zealand**

Disposal period: **1954-1976**

Total number of years of disposal operations: **11**

Total number of sites: **4**

Total number of containers dumped: **39**

Total volume of containers dumped: **0.62 m^3 approx.**

Total radioactivity: **1.04 10^3 GBq approx.**

Information provided to IAEA on: **23 March 1990**

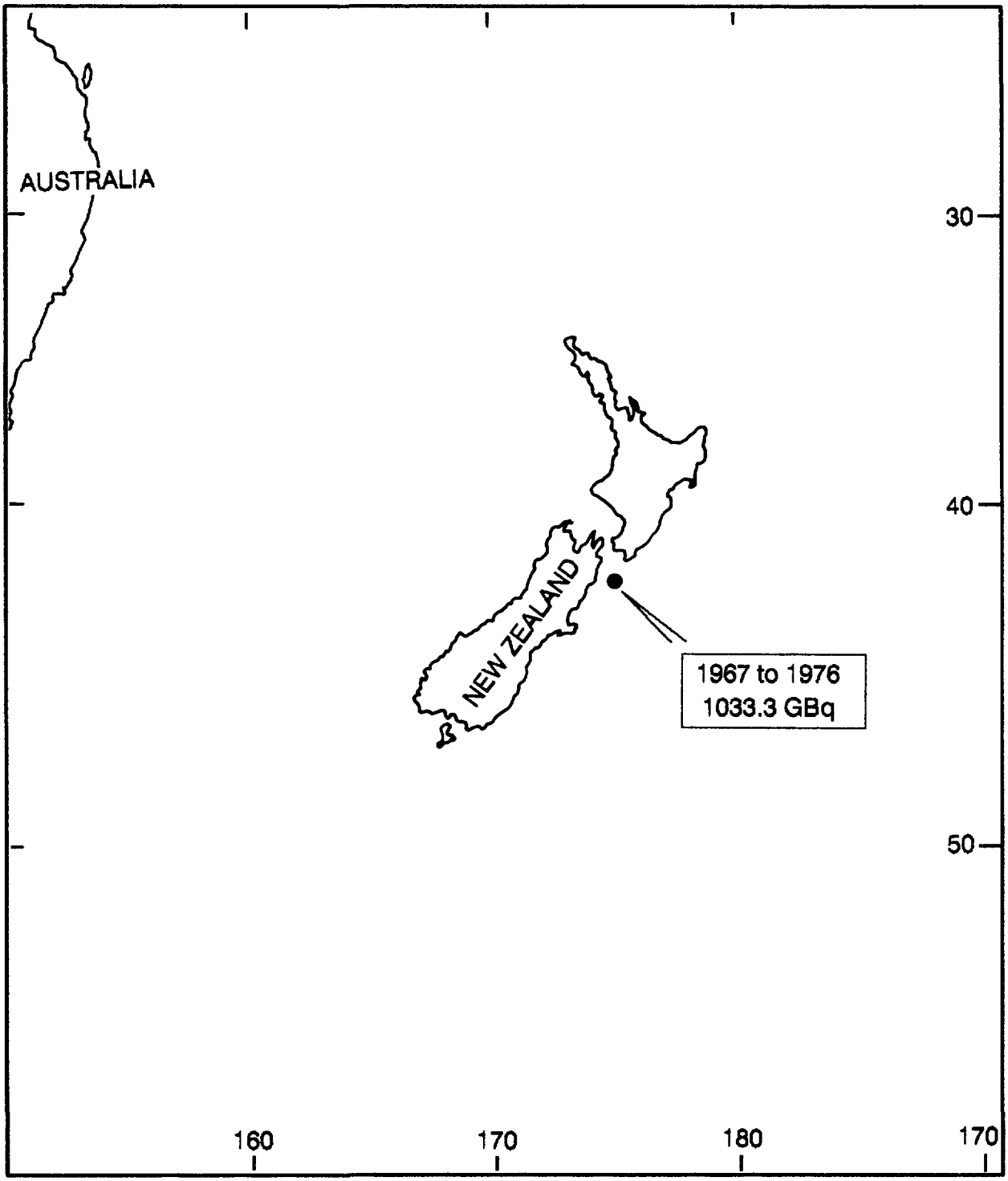


Figure A.8: Geographical position, disposal period and total quantity disposed.

Date	Coordinates Latitude	Longitude	Depth Min. m	Country Package	CONTAINER Number	Type	Matrix	Total Volume l	RADIOACTIVITY Total GBq	Alpha GBq	Beta Gamma GBq	Ra-226 GBq
1954	(1)*		18	New Zealand Yes	4	Drum	-	-	-	-	-	-
1955	(1)*		18	New Zealand Yes	1	Barrel	-	-	-	-	-	-
1956	(1)*		18	New Zealand Yes	1	Barrel	-	-	-	-	-	-
1956	(1)*		18	New Zealand Yes	1	Barrel	-	-	-	-	-	-
1961	(1)*		18	New Zealand Yes	2	Drum	-	199.8	-	-	-	5 mg
					2	Drum	-	90.8	-	-	-	-
					1	Wooden Box	-		-	-	-	-
1962	(2)*		549	New Zealand Yes	2	Drum	-	199.8	0.74	-	-	0.74
					1	Drum	-	-	-	-	-	_
1965	42°13'S	176°10'E(3)*	2600	New Zealand No	4	Block	Concrete	-	-	-	-	4 mg
1967	42°15'S	175°00'E	2834	New Zealand Yes	1	Drum	Concrete	56.8	-	-	-	11 mg
				No	1	Block	Concrete					
1972	42°15'S	175°00'E	2834	New Zealand Yes	9	Drum	Concrete	22.7	116.96	-	-	2.22
1973	42°15'S	175°00'E	2834	New Zealand Yes	2	Drum	Concrete	22.7	444.00	-	-	-
1976	42°15'S	175°00'E	2834	New Zealand Yes	7	Drum	Concrete	22.7	477.30	-	-	-
				Totals	39			615.2	1039.00			

Key for coordinates:

- (1)*: 3 miles North-North West Lytteldon Heads.
- (2)*: 6 miles South of baring Heads.
- (3)*: at a bearing 135°, at a distance of 50 miles from Cap Pallister, disposal from an aircraft.

A.9 State: **Sweden**

Disposal period: **1969**

Total number of years of disposal operations: 1

Total number of sites: **1**

Total number of containers dumped: **2895**

Total weight of containers dumped: **1080.3 tons**

Total radioactivity: **3.24 10^3 GBq**

Information provided to IAEA on: **11 April 1990**

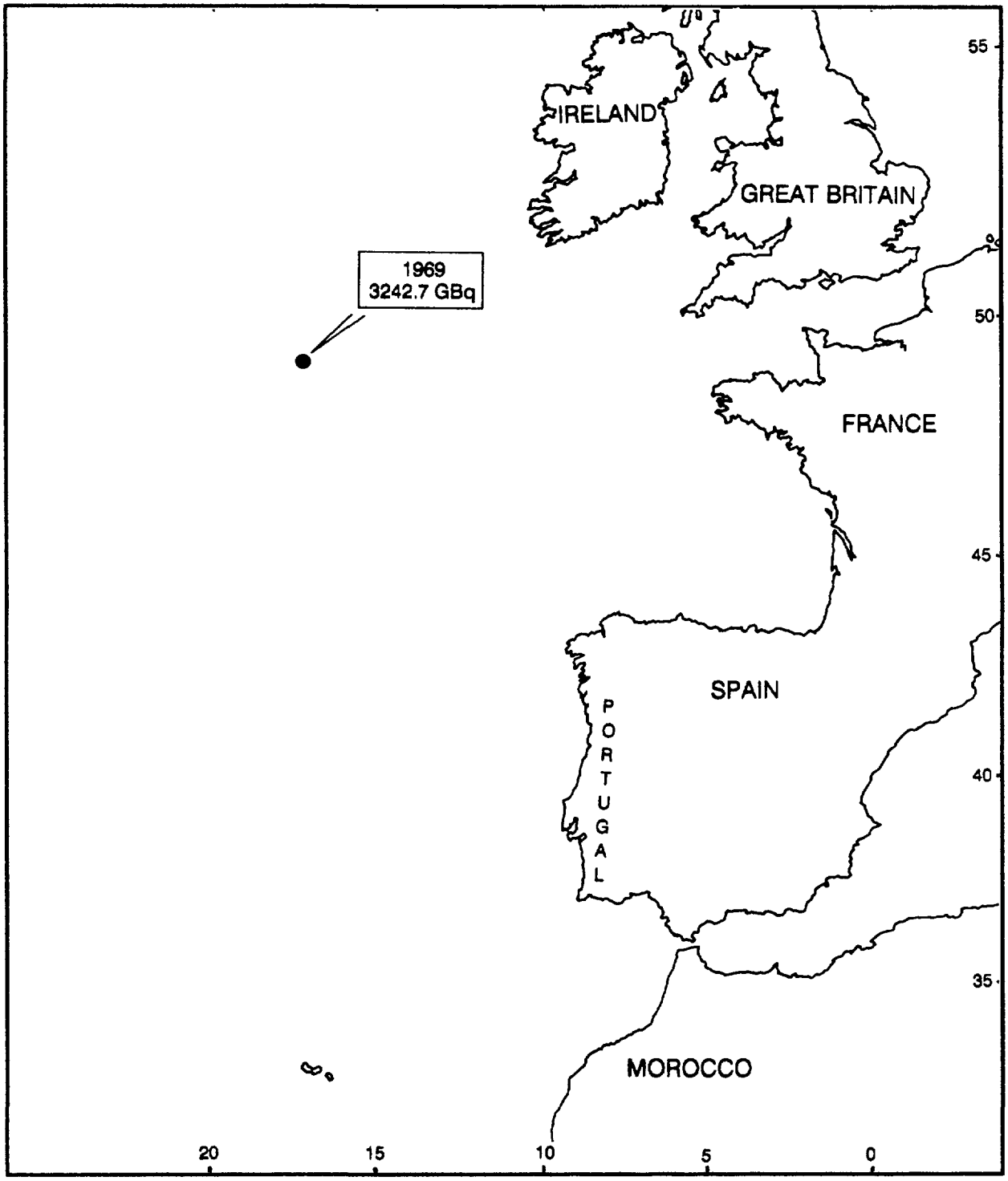


Figure A.9: Geographical position, disposal period and total quantity disposed.

Date	Coordinates Latitude	Longitude	Depth Min. m	Max. m	Country	Package	CONTAINER Number	Type *	Matrix	Total Weight t	RADIOACTIVITY Total GBq	Alpha GBq	BetaGamma GBq
1969	49°05'N	17°05'E	4000	4600	Sweden	Yes	220	M 200 l	Concrete	82.0	259.0	74.0	185.0
						Yes	2645	M 200 l	Concrete	982.0	2701.0	851.0	1850.0
						Yes	3	M 200 l	Concrete	1.9	26.3	0.4	25.9
						Yes	14	M 200 l	Concrete	7.4	99.9	11.1	88.8
						Yes	13	M 200 l	Concrete	7.0	156.5	1.1	155.4
						Totals :	2895			1080.3	3242.7	937.6	2305.1

* Key for the type of containers:

- M: Metal drum

A.10 State: **Switzerland**

Disposal period: **1969-1982**

Total number of years of disposal operations: **12**

Total number of sites: **3**

Total number of containers dumped: **7420**

Total weight of containers dumped: **5321 tons**

Total radioactivity: **4.42 10^6 GBq**

Information provided to IAEA on: **7 July 1989**

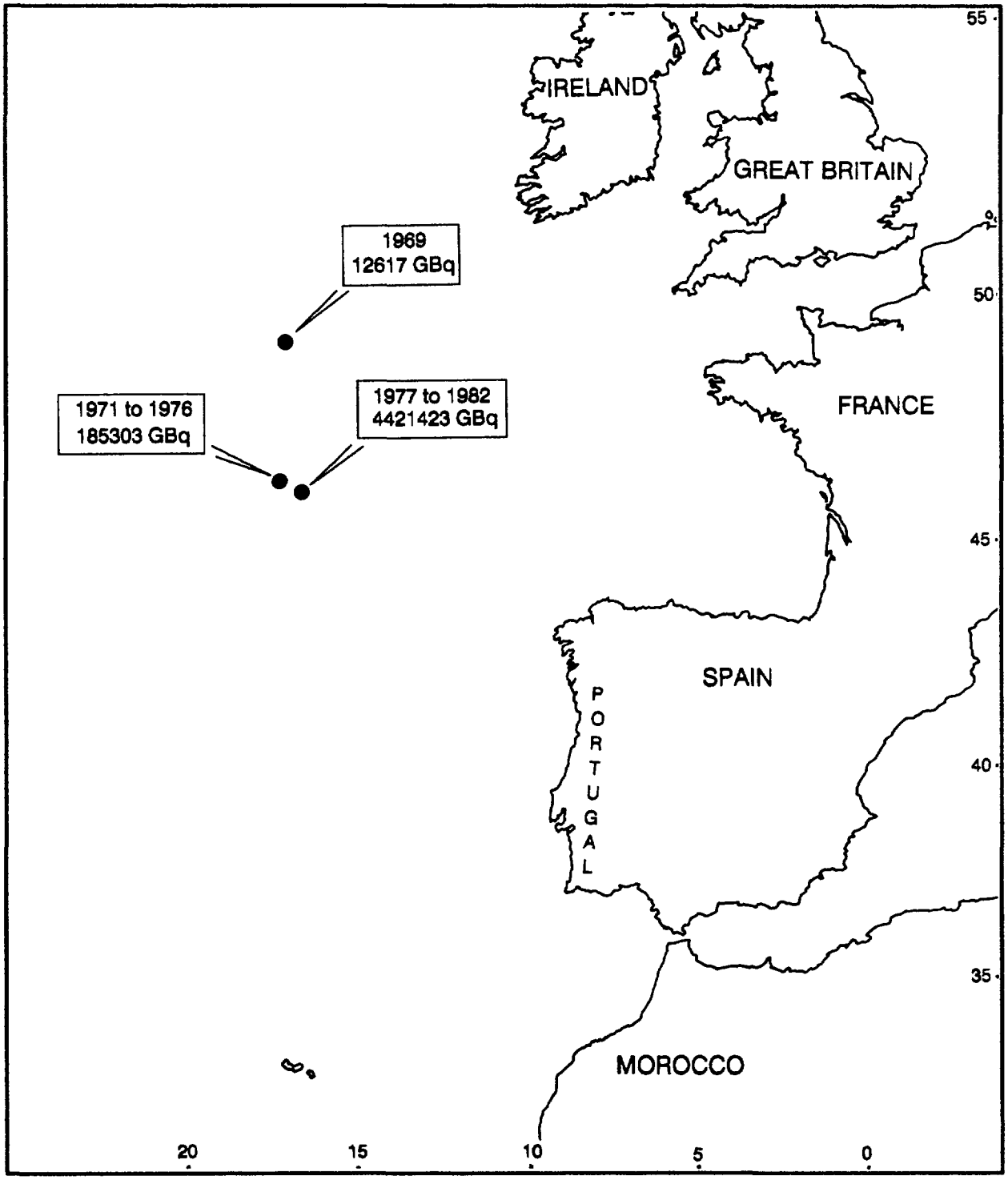


Figure A.10: Geographical positions, disposal periods and total quantities disposed.

Date	Coordinates Latitude	Longitude	Depth Min. m	Max. m	Country Package	CONTAINER Number	Type*	Matrix	Total Weight t	RADIOACTIVITY Total GBq	Alpha GBq	BetaGamma GBq**	H-3 GBq
1969	49°05'N	17°25'E	4000	4600	Switzerland Yes	100	MDLC	C	224	12617		12617	
1971	46°15'N	17°25'E	3600	4750	Switzerland Yes	150	MD	C					
						128	MDLC	C					
					Subtotals :	278			376	13242.3	70.3	13172	
1972	46°15'N	17°25'E	3600	4750	Switzerland Yes	1075	MD	C					
						45	MDLC	C					
					Subtotals :	1120			509	22237	259	21978	7104
1974	46°15'N	17°25'E	3600	4750	Switzerland Yes	587	MD	C					
						121	MDLC	C					
					Subtotals :	708			509	79043.1	603.1	78440	67414
1975	46°15'N	17°25'E	3600	4750	Switzerland Yes	200	MD	C					
						55	MDLC	C					
					Subtotals :	255			203	43356.6	806.6	42550	15725
1976	46°15'N	17°25'E	3600	4750	Switzerland Yes	541	MD	C					
						59	MDLC	C					
					Subtotals :	600			349	27424.4	562.4	26862	17501
1977	46°00'N	16°45'E	3900	4750	Switzerland Yes	630	MD	C					
						82	MDLC	C					
					Subtotals :	712			457	35268.4	303.4	34965	13542
1978	46°00'N	16°45'E	3900	4750	Switzerland Yes	801	MD	C					
						165	MDLC	C					
					Subtotals :	966			733	166111.	1017.5	165094	14430
1979	46°00'N	16°45'E	3900	4750	Switzerland Yes	378	MD	C					
						4	MDLC	C					
					Subtotals :	382			409	63717.7	3.7	63714	58682
1980	46°00'N	16°45'E	3900	4750	Switzerland Yes	594	MD	C					
						10	MDLC	C					
					Subtotals :	604			301	1903960	14.8	1903946	1876307
1981	46°00'N	16°45'E	3900	4750	Switzerland Yes	671	MD	C					
						39	MDLC	C					
					Subtotals :	710			404	1405556	407	1405149	1332111
1982	46°00'N	16°45'E	3900	4750	Switzerland Yes	883	MD	C					
						152	MDLC	C					
					Subtotals :	1035			847	646808.	270.1	646538	499426
					Totals :	7470			5321	4419343	4317.9	4415025	3902242

Keys:

- * Type of containers and matrix: MD: metal drum, MDLC: metal drum lined with concrete, C: Concre
- ** Tritium activities are included in the beta-gamma figures.

A.11 State: **United Kingdom**

Disposal period: **1949-1982**

Total number of years of disposal operations: **34**

Total number of sites: **15**

Total number of containers dumped: **?**

Total weight of containers dumped: **74052 tons**

Total radioactivity: **3.51 10^7 GBq**

Information provided to IAEA on: **5 December 1989**

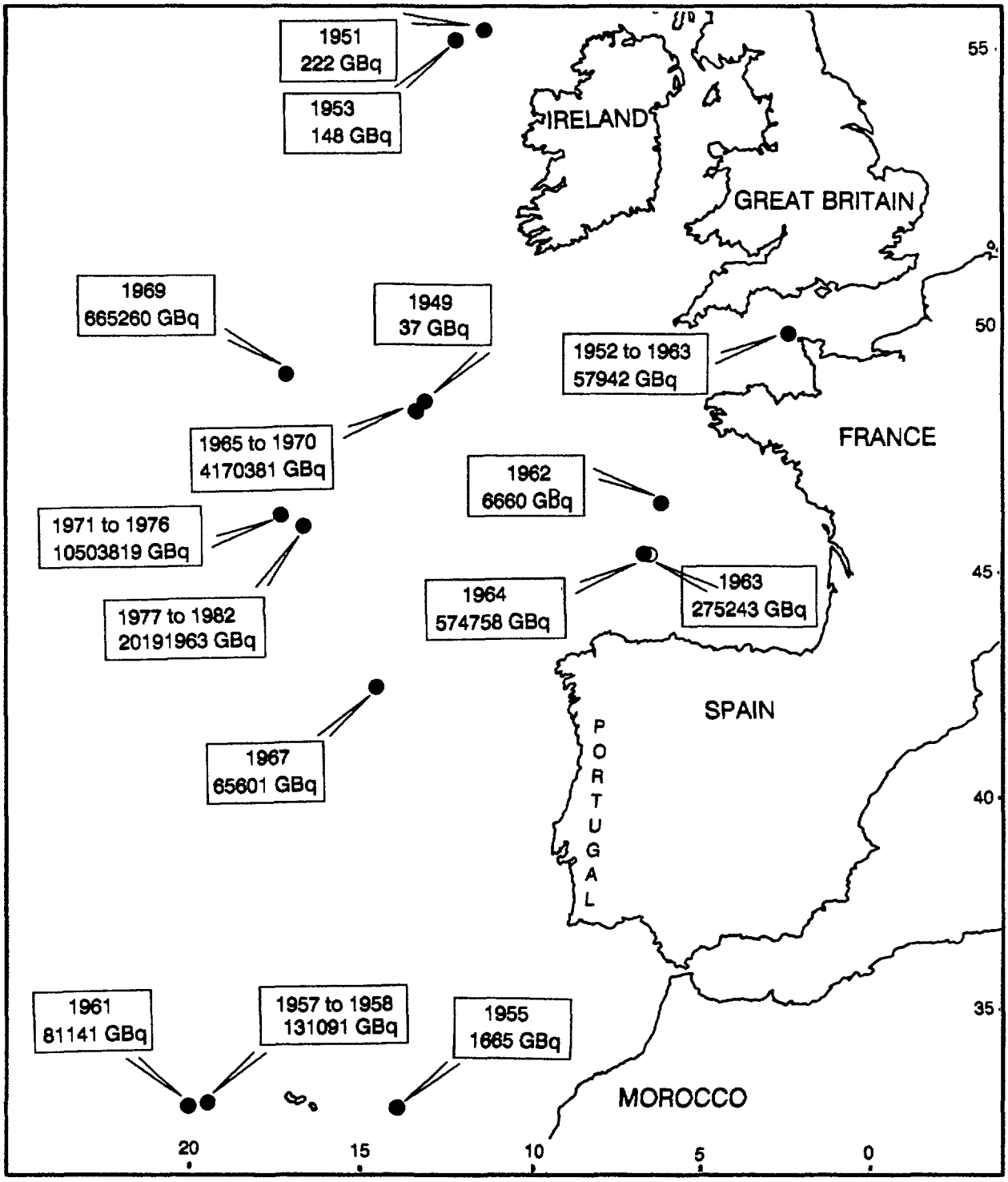


Figure A.11: Geographical positions, disposal periods and total quantities disposed.

Date	Coordinates Latitude	Longitude	Depth Min. m	Max. m	Country	Package *	Total Weight t	RADIOACTIVITY Total GBq	Alpha GBq	BetaGamma GBq**	H-3 GBq
1949	48°30'N	13°00'W	3600	4000	UK	Yes	9	37	-	37	-
1950	49°50'N	2°18'W	65	160	UK	Yes	350	814	74	740	-
1951	49°50'N	2°18'W	65	160	UK	Yes	319	703	37	666	-
	55.20 N	11°20'W	2700	2700	UK	Yes	33	222	37	185	-
1952	49°50'N	2°18'W	65	160	UK	Yes	534	1147	74	1073	-
1953	55°08'N	12°10'W	2800	2800	UK	Yes	57	148	74	74	-
	49°50'N	2°18'W	65	160	UK	Yes	758	1813	370	1443	-
1954	49°50'N	2°18'W	65	160	UK	Yes	1145	2886	851	2035	-
1955	49°50'N	2°18'W	65	160	UK	Yes	1164	2923	1295	1628	-
	32°37'N	14°05'W	4000	4200	UK	Yes	1453	1665	444	1221	-
1956	49°50'N	2°18'W	65	160	UK	Yes	1038	2849	1628	1221	-
1957	49°50'N	2°18'W	65	160	UK	Yes	1537	9990	4033	5957	-
	32°42'N	19°30'W	3600	4100	UK	Yes	4404	65231	35335	29896	-
1958	32°42'N	19°30'W	3600	4100	UK	Yes	2694	65860	25715	40145	-
	49°50'N	2°18'W	65	160	UK	Yes	1011	4255	2146	2109	-
1959	49°50'N	2°18'W	65	160	UK	Yes	1198	2886	148	2738	-
1960	49°50'N	2°18'W	65	160	UK/B	Yes	2551	10804	2738	8066	-
1961	49°50'N	2°18'W	65	160	UK	Yes	1967	12136	740	11396	-
	32°38'N	20°05'W	2100	4800	UK	Yes	4360	81141	20831	60310	-
1962	46°27'N	6°10'W	4200	4600	UK	Yes	253	6660	629	6031	-
	49°50'N	2°18'W	65	160	UK/B	Yes	1444	2997	185	2812	-
1963	49°50'N	2°18'W	65	160	UK	Yes	1543	1739	111	1628	-
	45°27'N	6°16'W	4100	4800	UK/B	Yes	5809	275243	13616	261627	-
1964	45°27'N	6°36'W	4100	4800	UK	Yes	4392	574758	16428	558330	-
1965	48°20'N	13°16'W	1900	4500	UK	Yes	1759	513116	4218	508898	-
1966	48°20'N	13°16'W	1900	4500	UK	Yes	1044	104340	2886	101454	-
1967	42°50'N	14°30'W	2500	5200	UK	Yes	722	65601	3367	62234	-
1968	48°20'N	13°16'W	1900	4500	UK	Yes	3164	2796016	27047	2768969	-
1969	49°05'N	17°05'W	4000	4600	UK	Yes	1878	665260	14430	650830	-
1970	48°20'N	13°16'W	1900	4500	UK	Yes	1674	756909	8621	748288	-
1971	46°15'N	17°25'W	3200	4100	UK	Yes	1434	330785	12030	318755	-
1972	46°15'N	17°25'W	3200	4100	UK	Yes	1885	729751	24938	704813	-

Date	Coordinates Latitude	Longitude	Depth Min. m	Max. m	Country	Package *	Total Weight t	RADIOACTIVITY Total GBq	Alpha GBq	BetaGamma GBq**	H-3 GBq
1973	46°15'N	17°25'W	3200	4100	UK	Yes	1453	458763	27343	431420	-
1974	46°15'N	17°25'W	3200	4100	UK	Yes	1256	3497425	14763	3482662	-
1975	46°15'N	17°25'W	3200	4100	UK	Yes	1350	1967808	26048	1941760	956080
1976	46°15'N	17°25'W	3200	4100	UK	Yes	2269	1870943	29193	1841750	693010
1977	46°00'N	16°45'W	3200	4750	UK	Yes	2140	2803116	34410	2768706	1159136
1978	46°00'N	16°45'W	3200	4750	UK	Yes	2080	2594478	30118	2564360	1209900
1979	46°00'N	16°45'W	3200	4750	UK	Yes	2014	3051054	51097	2999957	1516667
1980	46°00'N	16°45'W	3200	4750	UK	Yes	2693	3991190	66267	3924923	1486253
1981	46°00'N	16°45'W	3200	4750	UK	Yes	2517	3949415	75184	3874231	1414991
1982	46°00'N	16°45'W	3200	4750	UK	Yes	2697	3802710	46770	3755940	2345170
						Total:	74052	35077587	626269	34451318	10781207

Keys:
- * Type of containers: most of the packages had an outer shell of steel, a small minority have been monolithic blocks.
- * Type of matrix: most of the packages were lined with concrete.
- ** Tritium activities are included in the beta-gamma figures.

A.12 State: **United States of America - Atlantic Ocean**

Disposal period: **1949-1967**

Total number of years of disposal operations: **?**

Total number of sites: **11**

Total number of containers dumped: **34282**

Total weight of containers dumped: **?**

Total radioactivity: **2.94 10^6 GBq**

Information provided to IAEA on: **27 October 1989**

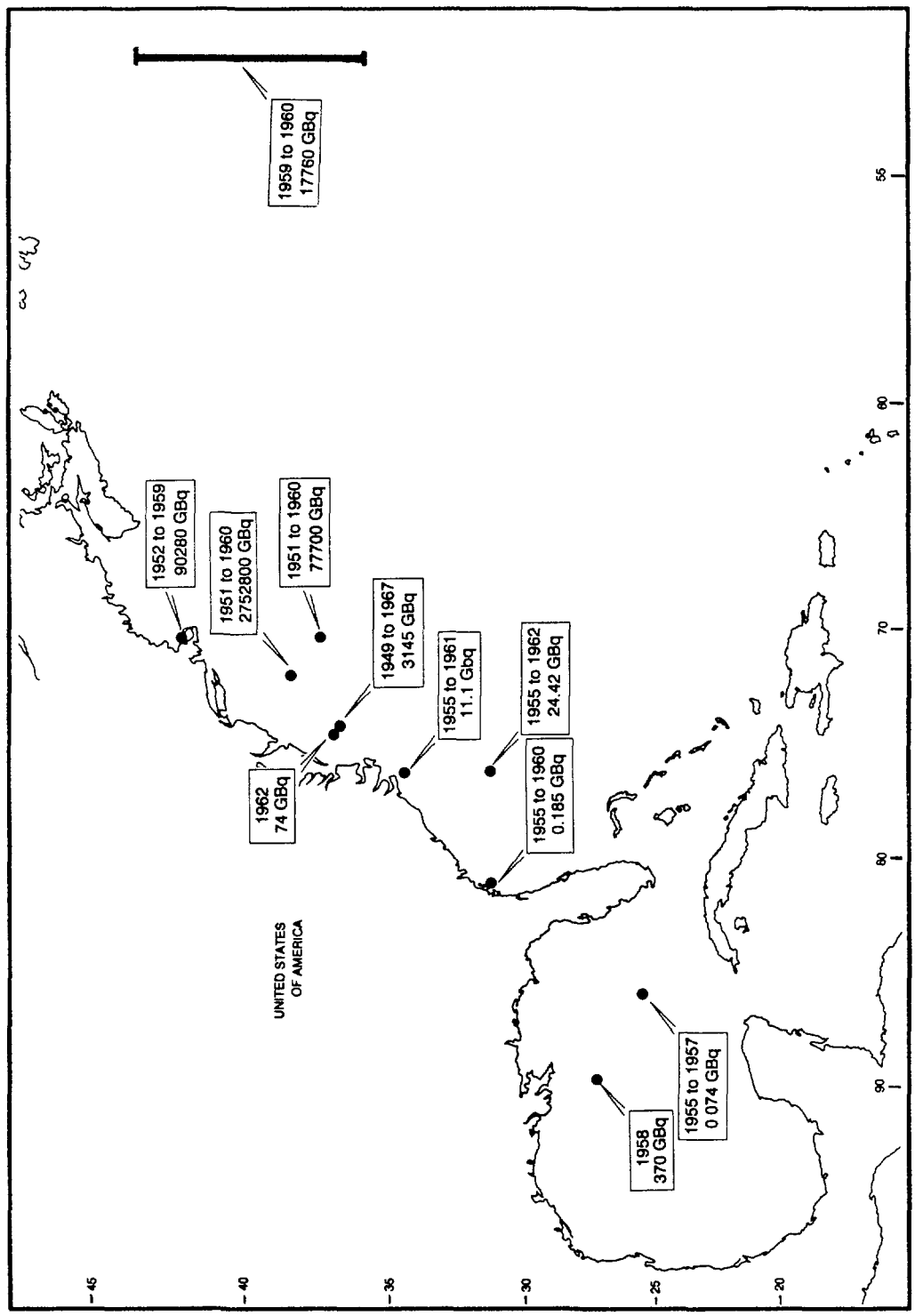


Figure A.12: Geographical positions in the Atlantic Ocean, disposal periods and total quantities disposed.

Date		Coordinates		Depth		Country		CONTAINER	NATURE OF WASTE*			RADIOACTIVITY
		Latitude	Longitude	Min.	Max.		Package					TOTAL
Start	End			m	m			Number	BPM	SM	SNM	GBq
ATLANTIC OCEAN SITES												
1949	1967	36°56'N	74°23'W	1829	1967	USA	Yes	834	Yes			3145.00
1951	1960	38°30'N	72°06'W	1829	2800	USA	Yes	14301	Yes**			2752800.00
		37°50'N	70°35'W	1829	3800	USA	Yes	14500	Yes			77700.00
1952	1959	42°25.5N	70°35'W	92		USA	Yes	4008	Yes	Yes		90280.00
1955	1957	25°40'N	85°17'W	3110	<	USA	Yes	78	Yes			0.07
1955	1960	off Sapelo Island		11		USA	No-liquid		Yes			0.19
1955	1961	34°32'N	76°40'W	19		USA	No		Yes			11.10
1955	1962	31°32'N	76°30'W	915	3660	USA	Yes	119	Yes			24.42
1958	1958	27°14'N	89°33'W	1829	<	USA	Yes	1	Yes			370.00
1959	1960	36°20'N	45°00'W	3660	5289	USA	Yes	432	Yes			17760.00
		to										
		43°49'N	45°00'W									
1962		37°00'N	74°37'W	421		USA	Yes	9	Yes			74.00
							Subtotals :	34282				2942164.78
							Totals (Atlantic+Pacific) :	90543				3496411.83

Keys to table:

* = BPM: By-product materials; SM: Source materials;
SNM: Special nuclear materials.

** = includes the Submarine Seawolf Reactor Shell, dumped in 1959,
estimated radioactivity: 1000.000 GBq.

NB: Radioactivity is the estimated activity at time of packaging.

A.13 State: **United States of America - Pacific Ocean**

Disposal period: **1946-1970**

Total number of years of disposal operations: **?**

Total number of sites: **18**

Total number of containers dumped: **56261**

Total weight of containers dumped: **?**

Total radioactivity: **5.54 10^5 GBq**

Information provided to IAEA on: **27 October 1989**

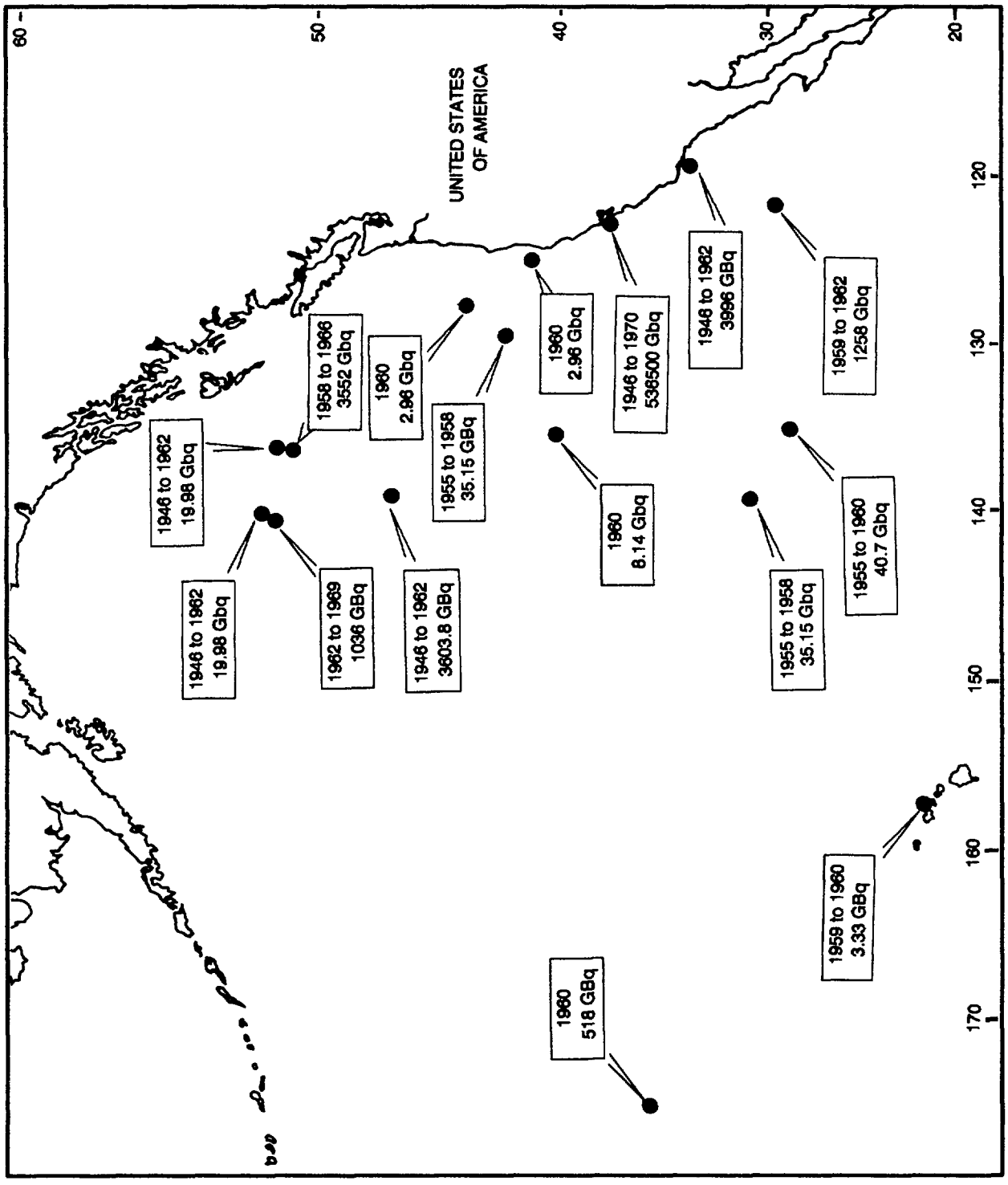


Figure A.13: Geographical positions in the Pacific Ocean, disposal periods and total quantities disposed.

Date		Coordinates		Depth		Country		CONTAINER	NATURE OF WASTE*			RADIOACTIVITY
		Latitude	Longitude	Min.	Max.		Package					TOTAL
Start	End			m	m			Number	BPM	SM	SNM	GBq
PACIFIC OCEAN SITES												
1946	1962	33°40'N	119°35'W	1829	1940	USA	Yes	3114	Yes	Yes		3996.00
	1962	51°30'N	136°10'W	-	-	USA	Yes	38	-	-	-	19.98
	1962	52°05'N	140°00'W	-	-	USA	Yes	41	-	-	-	19.98
	1962	47°00'N	138°54'W	-	-	USA	Yes	361	-	-	-	3603.80
	1962	-	-		1830	USA	Yes	37	-	-	-	44.40
	1962	-	-	-	-	USA	Yes	231	-	-	-	3570.50
1946	1970	37°27'N	123°37'W	896	1700	USA	Yes	47500	Yes	Yes	Yes	536500.00
1955	1958	42°12'N	129°31'W	3292	<	USA	Yes	26	Yes			35.15
1955	1958	30°43'N	139°05'W	3658	4560	USA	Yes	26	Yes			35.15
1955	1960	28°47'N	135°00'W	3477	<	USA	Yes	29	Yes			40.70
1958	1966	50°56'N	136°03'W	3292	<	USA	Yes	197	Yes	Yes		3552.00
1959	1960	21°28'N	157°25'W	3456	<	USA	Yes	39	Yes			3.33
1959	1962	32°00'N	121°30'W	2210	3658	USA	Yes	4415	Yes	Yes	Yes	1258.00
1960		34°58'N	174°52'W	5487	<	USA	Yes	7	Yes			518.00
		43°52'N	127°44'W	2926	<	USA	Yes	4	Yes			2.96
		42°04'N	125°01'W	1000	? 4097	USA	Yes	4	Yes			2.96
		40°07'N	135°24'W	1829	1990	USA	Yes	29	Yes	Yes		8.14
1962	1969	52°25'N	140°20'W	3294	<	USA	Yes	163	Yes	Yes		1036.00
							Subtotals :	56261				554247.05
							Totals (Atlantic+Pacific) :	90543				3496411.83

Keys to table:

* = BPM: By-product materials; SM: Source materials;
SNM: Special nuclear materials.
- = No data available.

NB: Radioactivity is the estimated activity at time of packaging.

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