Database on radioactive material resulting from historical dumping, accidents and losses at sea

CD-ROM Supporting information for the IAEA-TECDOC-1776,
Inventory of radioactive material resulting from historical dumping, accidents and losses at sea
(for the purposes of the London Convention 1972 and London Protocol 1996)

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1. INTRODUCTION

The International Atomic Energy Agency (IAEA) was requested by the Contracting Parties to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter 1972 (London Convention) and the 1996 Protocol (London Protocol) to develop and maintain an inventory of anthropogenic radioactive materials entering the marine environment from all sources related to the Convention and Protocol [1, 2]. To respond to the request, the IAEA has undertaken the development of such an inventory to include:

(1) radioactive waste resulting from dumping at sea;
(2) accidents and losses which occurred at sea and involved radioactive material.

The 28th Consultative Meeting of the Contracting Parties to the London Convention and Protocol requested the IAEA in 2006 to update any information included in two previously published reports, the IAEA-TECDOC-1105, Inventory of Radioactive Waste Disposals at Sea [3] and IAEA-TECDOC-1242, Inventory of Accidents and Losses at Sea Involving Radioactive Materials [4].

The updating process conducted by IAEA Secretariat, in cooperation with the International Maritime Organization (IMO) Secretariat, started in 2007 and consisted of formal invitations to all IAEA Member States and to the Contracting Parties to the London Convention and Protocol to submit any new or historical information on dumping activities or accidents in the sea involving sources of radiation, resulting in radioactive material entering the oceans (IAEA Note Verbale Ref. 754-J9.14.Circ., 2007-04-17 – IMO Note LC/LC.1/Circ.16, Ref. T5/5.01, 2007-07-20).

The following annexes contain updated detailed information on the inventory of radioactive materials in the worldwide oceans resulting from past dumping activities, accidents and losses at sea, which is presented in support of IAEA-TECDOC-1776 Inventory of radioactive materials resulting from historical dumping, accidents and losses at sea (for the purposes of the London Convention 1972 and Protocol 1996)[1].The information is illustrated with maps and detailed data in the form of tables.

Annex I provides information on waste dumping at sea by the countries which carried out this activity during the period when such practices were permitted and regulated. Annex II and Annex III present data on accidents resulting in actual or potential releases of radioactive material to the marine environment and data on accidents and losses where the radioactive material was recovered intact prior to any release of radionuclides, respectively. Annex IV presents information of losses of industrial sealed sources resulting in actual or potential releases of radioactive material to the marine environment and Annex V presents information on losses of industrial sealed sources where the sources were recovered intact. Annex VI provides information on the amount of radioactivity in submarine nuclear reactors and the shielding assembly of icebreaker Lenin, according to the results of the IAEA's International Arctic Seas Assessment Project (IASAP). Information regarding the process by which the information contained in these annexes was collected and verified, as well a description of the type of information and quality of the data can be found in the main text of IAEA-TECDOC-1776.

[1] The information presented in these annexes is being distributed in electronic format by means of a CD-ROM attached to the IAEA-TECDOC-1776, which must be cited when identifying the source of information.

Most of the data and other information presented in these annexes were already published in Refs. [3] and [4]. However, thanks to the updating process, some countries have provided new information on past dumping operations previously not reported and on accidents occurred after 2001. In some cases obvious mistakes found in the earlier publications have been corrected, notably those regarding the dumping operations of the Russian Federation in 1992, which were recorded twice. Also, corrections have been made to tables of dumping carried out by the Former Soviet Union. Ref. [3] included references to tables that could be found only in the Working Materials of the IAEA's IASAP and were therefore not available in the public domain. The relevant information retrieved from those IASAP tables is presented now as Annex VI of this publication.

The IAEA officer responsible for the preparation of the information on this CD-ROM was D. Telleria of the Division of Radiation, Transport and Waste Safety.

REFERENCES

[1] INTERNATIONAL MARITIME ORGANIZATION, Report of the Third Consultative Meeting of the Contracting Parties to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, LDC III/12, IMO, London (1978).

[2] INTERNATIONAL MARITIME ORGANIZATION, Resolution LDC.21(9): Disposal of Radioactive Waste and Other Radioactive Matter at Sea, Report of the Ninth Consultative Meeting of the Contracting Parties to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, LDC 9/12, IMO, London (1985).

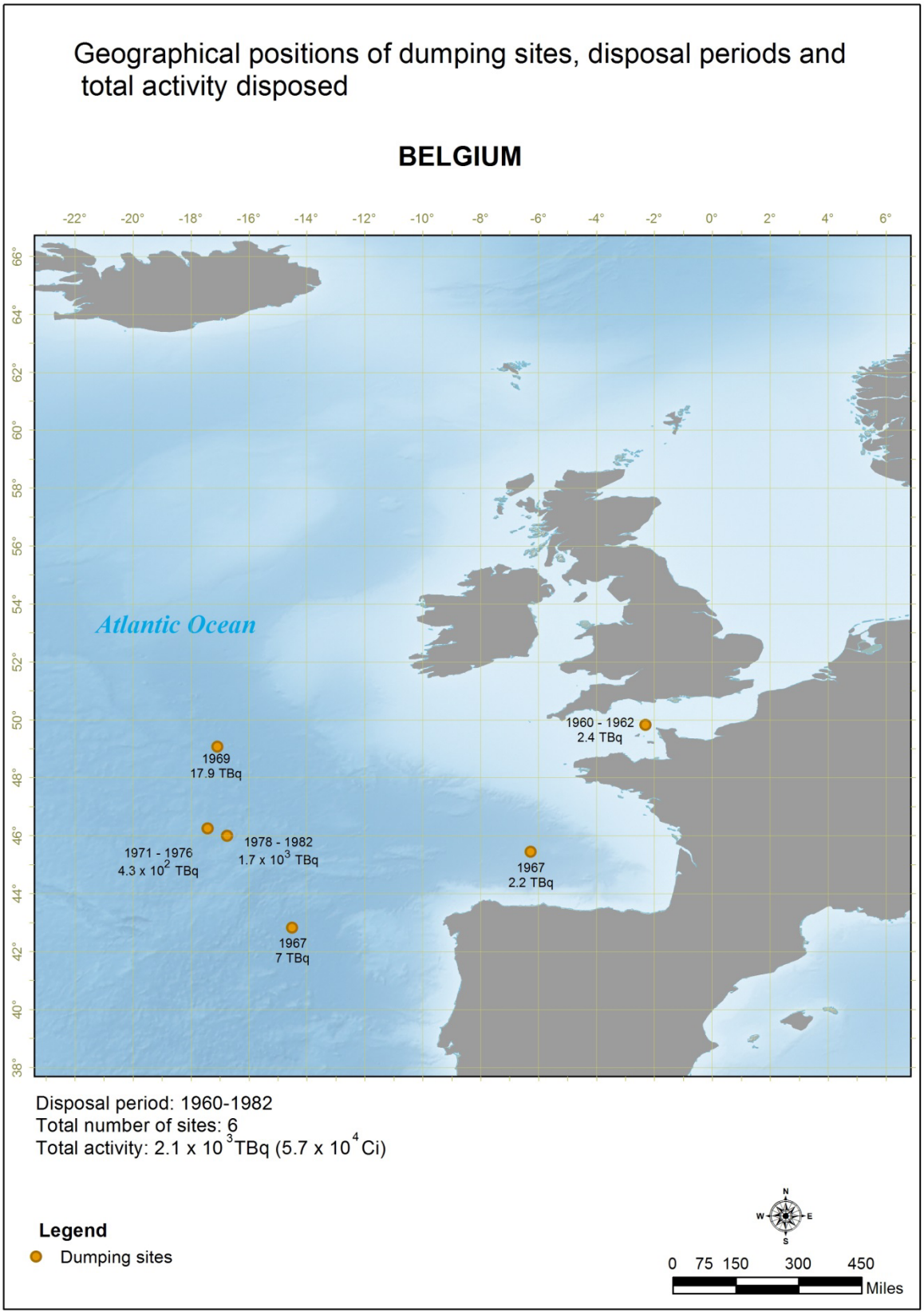
[3] INTERNATIONAL ATOMIC ENERGY AGENCY, Inventory of radioactive waste disposals at sea, IAEA-TECDOC-1105, IAEA, Vienna (1999).

[4] INTERNATIONAL ATOMIC ENERGY AGENCY, Inventory of accidents and losses at sea involving radioactive materials, IAEA-TECDOC-1242, IAEA, Vienna (2001).

ANNEX I.

HISTORICAL RADIOACTIVE WASTE DUMPING AT SEA BY COUNTRY

I-1. BELGIUM


Geographical positions of dumping sites, disposal periods and total activity disposed
BELGIUM
-22° -20° -18° -16° -14° -12° -10° -8° -6° -4° -2° 0° 2° 4° 6°
66° 64° 62° 60° 58° 56° 54° 52° 50° 48° 46° 44° 42° 40° 38°
Atlantic Ocean
1960 - 1962
2.4 TBq
1969
17.9 TBq
1971 - 1976
4.3 x 10^2 TBq
1978 - 1982
1.7 x 10^3 TBq
1967
2.2 TBq
1967
7 TBq
Disposal period: 1960-1982
Total number of sites: 6
Total activity: 2.1 x 10^3 TBq (5.7 x 10^4 Ci)
Legend
Dumping sites
N
W
E
S
0 75 150 300 450
Miles

DATE	CO-ORDINATES		DEPTH	Package	CONTAINER*			Total weight t	ACTIVITY			H-3 GBq
	Latitude	Longitude	m		Number	Type	Matrix		Total GBq	Alpha GBq	Beta-gamma GBq**	
1960	49º 50'N	2º 18'W	65–160	Yes			B/C	284.0	543.9	25.9	518.0	–
1962	49º 50'N	2º 18'W	65–160	Yes			B/C	431.0	1852.2	2.2	1850.0	–
1963	45º 27'N	6º 16'W	4100–4800	Yes			B/C	789.0	2260.0	40.0	2220.0	–
1967	42º 50'N	14º 30'W	5200–5200	Yes	1945	M 220 l	B	599.9	7030.0	37.0	6993.0	–
1969	49º 05'N	17º 05'W	4000–4600	Yes	2222	M 220 l	B	600.4	17945.0	370.0	17575.0	–
1971	46º 15'N	17º 25'W	3600–4750	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	–
Subtotal					**5033**			**1768.4**	**91094.0**	**703.0**	**90391.0**	**66341.0**
1972	46º 15'N	17º 25'W	3600–4750	Yes	2964	M 220 l	B			37.0		–
					98	M 400 l	C					–
Subtotal					**3062**			**1112**	**71447.0**	**37.0**	**71410.0**	**70300.0**
1973	46º 15'N	17º 25'W	3600–4750	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	–
Subtotal					**6177**			**2296**	**66193.0**	**814.0**	**65379.0**	**62419.0**
1975	46º 15'N	17º 25'W	3600–4750	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	–
Subtotal					**6056**			**2001.6**	**121767.0**	**1406.0**	**120361.0**	**111925.0**
1976	46º 15'N	17º 25'W	3600–4750	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	–
Subtotal					**5521**			**2242.7**	**77933.1**	**2701.0**	**75232.1**	**51800.0**

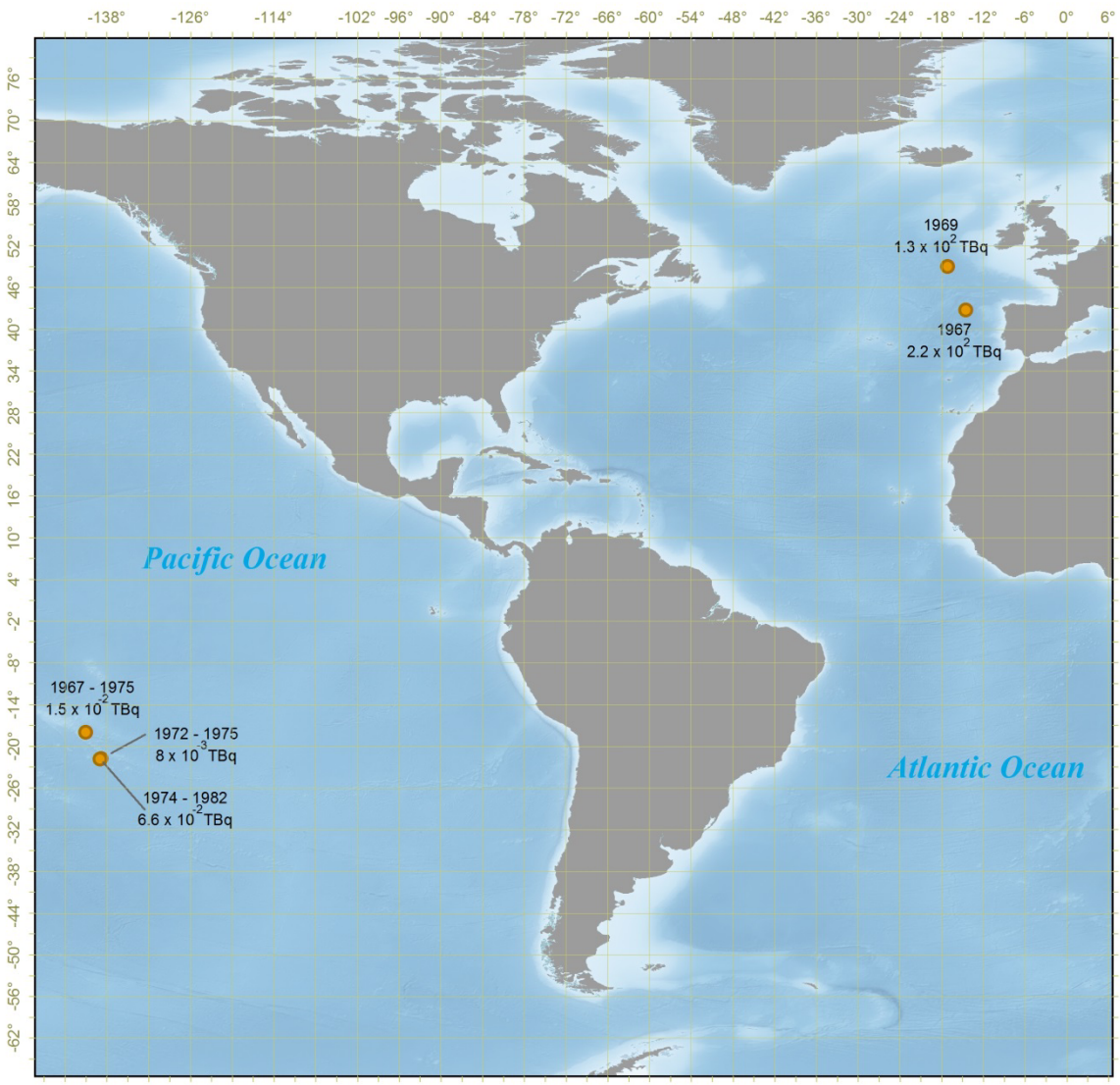
DATE	CO-ORDINATES		DEPTH	Package	CONTAINER*			Total weight t	ACTIVITY			H-3 GBq
	Latitude	Longitude	m		Number	Type	Matrix		Total GBq	Alpha GBq	Beta-gamma GBq**	
1978	46º 00'N	16º 45'W	3900–4750	Yes	3761	M 220 l	B			9435.0	120657.0	112887.0
					1691	M 220 l	C				2960.0	–
					195	M 400 l	C				2405.0	–
					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	–
Subtotal					**6198**			**3671.5**	**169360.1**	**9435.0**	**159925.1**	**112887.0**
1979	46º 00'N	16º 45'W	3900–4750	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	–
Subtotal					**2157**			**872.0**	**41935.8**	**1176.6**	**40759.2**	**34817.0**
1980	46º 00'N	16º 45'W	3900-4750	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	
Subtotal					**5099**			**3512.0**	**858616.2**	**2279.2**	**856337.0**	**264365.0**
1981	46º 00'N	16º 45'W	3900-4750	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	–
Subtotal					**5547**			**4450.0**	**345953.7**	**4576.9**	**341376.8**	**8820.8**

DATE	CO-ORDINATES		DEPTH	Package	CONTAINER*			Total weight t	ACTIVITY			H-3 GBq
	Latitude	Longitude	m		Number	Type	Matrix		Total GBq	Alpha GBq	Beta-gamma GBq**	
1982	46º 00'N	16º 45'W	3900-4750	Yes	2984	M 220 l	B			3296.7	7585	2923
					106	M 220 l	C				3.7	–
					1960	M 400 l	C			2301.4	1036	370
					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	–
Subtotal					**6307**			**5100.0**	**246401.5**	**5638.8**	**240762.7**	**3293.0**
Total					**55324**			**29730.5**	**2120332.5 (5.73×10^4 Ci)**	**29242.6**	**2091089.9**	**786967.8**

* 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.

Geographical positions of dumping sites, disposal periods and total activity disposed

FRANCE



Disposal period: 1967-1982
Total number of sites: 5
Total activity: 3.5 x 10^2 TBq (9.6 x 10^3 Ci)

Legend
Dumping sites

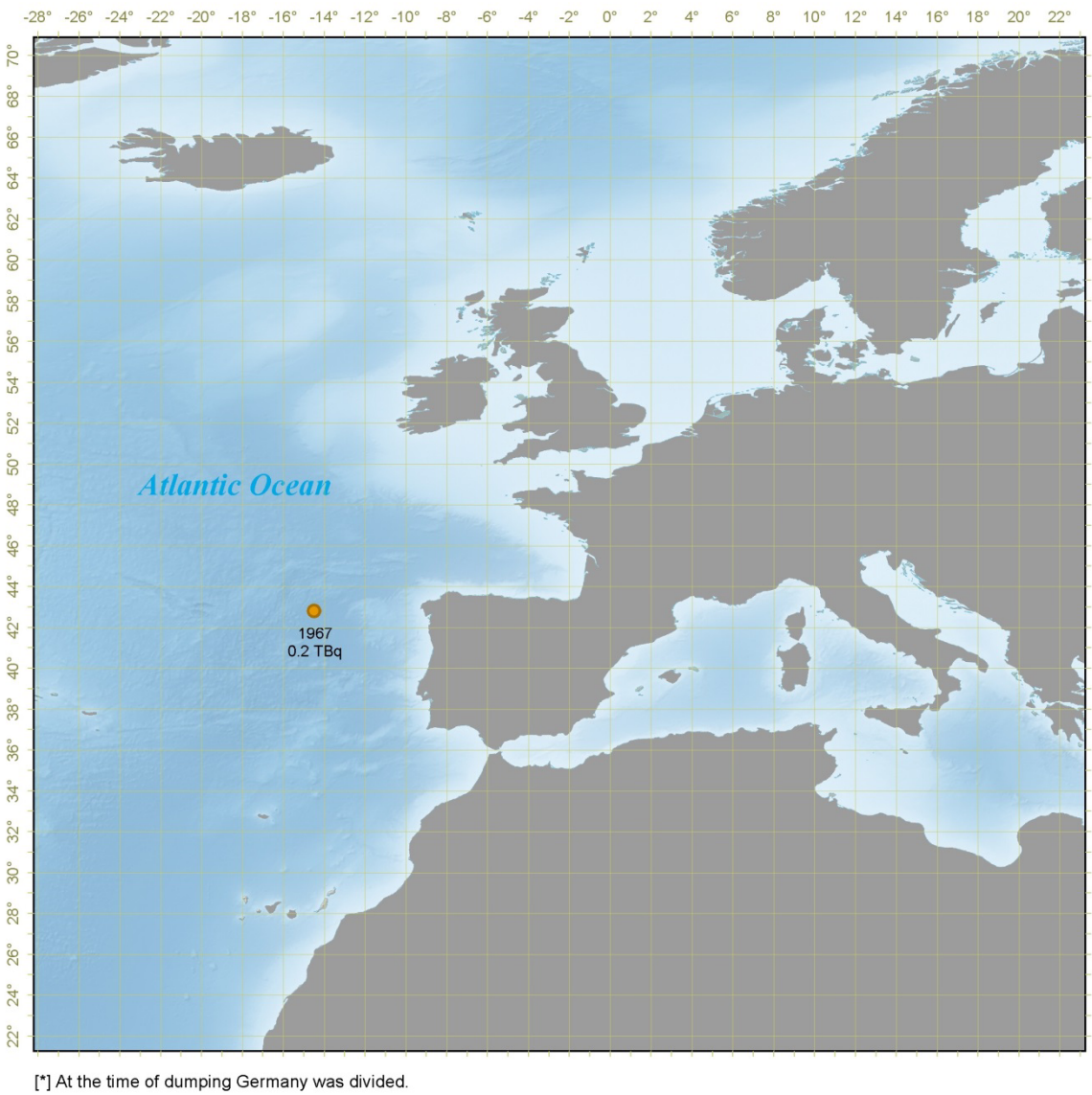
N W E S
0 375 750 1,500 2,250
Miles

DATE	CO-ORDINATES		DEPTH		Package	CONTAINER			Total weight t	ACTIVITY		
	Latitude	Longitude	Min. m	Max. m		Number	Type	Matrix		Total GBq	Alpha GBq	Beta-gamma GBq
1967	42º 50'N	14º 30'W	4590	5310	Yes	30700	Metal		8837.0	218560.0	5920.0	212640.0
						896	Metal	Concrete	347.0	410.0	40.0	370.0
Subtotal						**31596**			**9184**	**218970**	**5960**	**213010**
1967–1975*	17º 57'S	141º 2'W	2500						532	15.03	0.03	15
1972–1975*	21º 43'S	138º 53'W	2000	3000	Yes			Concrete	76	8	7	1
1974–1982*	21º 46'S	139º 0'W	2000	3000	Partly			Concrete	2580	66	60	6
1969	49º 05'N	17º 05'W	4000	4600	Yes	14800			5015.0	134421.0	2516.0	131905.0
Total						**46396**			**17387.0**	**353480.03 (9.55×10^3 Ci)**	**8543.03**	**344937.0**

* Reference [I-1].

I-3. FEDERAL REPUBLIC OF GERMANY

Geographical positions of dumping sites, disposal periods and total activity disposed



[*] At the time of dumping Germany was divided.

Disposal period: 1967
Total number of sites: 1
Total activity: 2.0 x 10^{-1} TBq (5.5 Ci)

Legend

Dumping sites

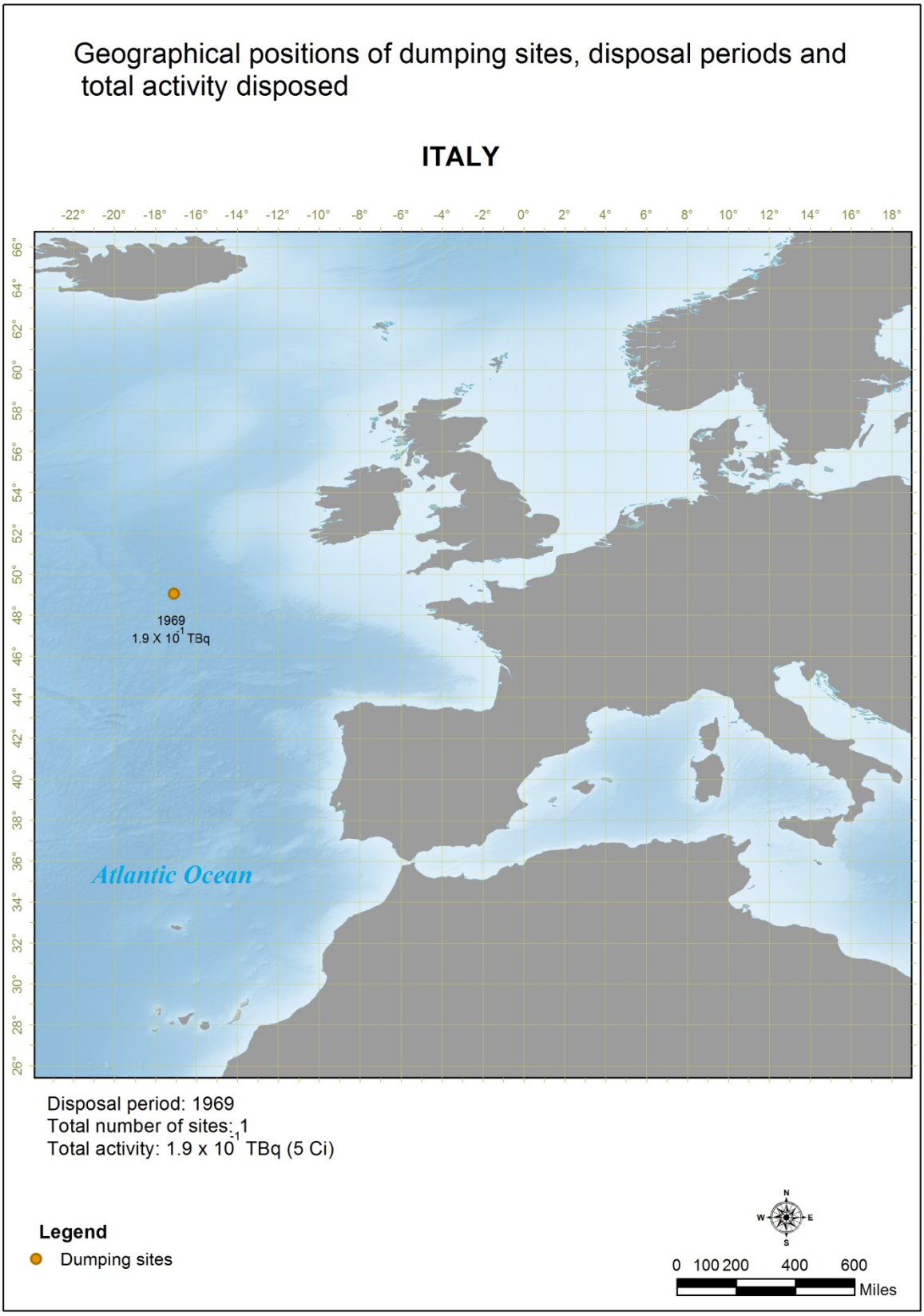
N W E S

0 125 250 500 750 Miles

DATE	CO-ORDINATES		DEPTH	Package	CONTAINER			Total weight t	ACTIVITY		
	Latitude	Longitude	m		Number	Type	Matrix		Total GBq	Alpha GBq	Beta-gamma GBq
1967	42º 50'N	14º 30'W	2500–5200	Yes	480	Barrel*	Concrete	180.5	203.5 (5.5 Ci)	18.5	185.0

* Rolling hoop barrel, DIN-Standards 6635 and 6636.

I-4. ITALY


Geographical positions of dumping sites, disposal periods and total activity disposed
ITALY
-22° -20° -18° -16° -14° -12° -10° -8° -6° -4° -2° 0° 2° 4° 6° 8° 10° 12° 14° 16° 18°
66° 64° 62° 60° 58° 56° 54° 52° 50° 48° 46° 44° 42° 40° 38° 36° 34° 32° 30° 28° 26°
1969
1.9 X 10-1 TBq
Atlantic Ocean
Disposal period: 1969
Total number of sites: 1
Total activity: 1.9 x 10-1 TBq (5 Ci)
Legend
Dumping sites
N
W
E
S
0 100 200 400 600
Miles

DATE	CO-ORDINATES		DEPTH		Package	CONTAINER			Total weight t	ACTIVITY		
	Latitude	Longitude	Min. m	Max. m		Number	Type	Matrix		Total GBq	Alpha GBq	Beta-gamma GBq
1969	49º 05'N	17º 05'W	4000–4600		Yes	100	Metal drum*	Concrete	44.74	185.0 (5 Ci)	74.0	111.0

* Type of container: metal drum lined with concrete.

Geographical positions of dumping sites, disposal periods and total activity disposed



Disposal period: 1955-1969
Total number of sites: 6
Total activity: 1.5×10^{1} TBq (407.5 Ci)

Legend

- Dumping sites

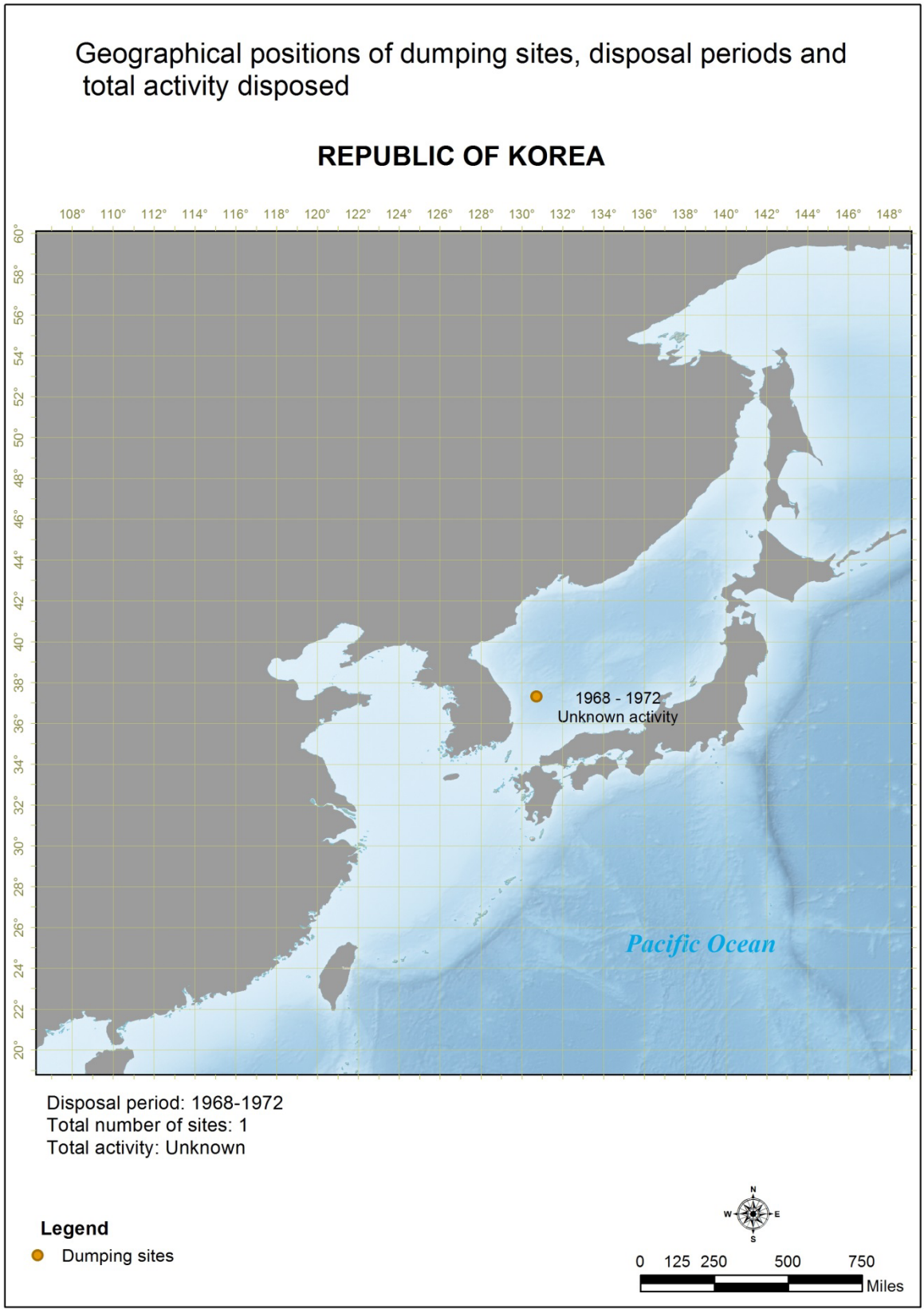
N W E S

0 40 80 160 240 Miles

DATE	CO-ORDINATES		DEPTH	Package	CONTAINER*			ACTIVITY		
	Latitude	Longitude	m		Number	Type	Matrix	Total GBq	Alpha GBq	Beta-gamma GBq**
1955	34º 55'N	139º 25'E	1400–1500	Yes	27	M 200 l	Mortar	7.4	–	7.4
1957	34º 34'N	138º 32'E	2000–2500	Yes	10	M 200 l	Mortar	29.6	–	29.6
1958	34º 42'N	139º 56'E	2400–2800	Yes	11	M 200 l	Mortar	29.6	–	29.6
					54	M 200 l	Mortar	185.0	–	185.0
Subtotal					**65**			**214.6**	–	**214.6**
1959	34º 42'N	139º 56'E	2400–2800	Yes	52	M 200 l	Mortar	222.0	–	222.0
					43	M 200 l	Mortar	185.0	–	185.0
Subtotal					**95**			**407**	–	**407**
1960	34º 42'N	139º 56'E	2400–2800	Yes	40	M 200 l	Mortar	185.0	–	185.0
	34º 34'N	139º 53'E	2400–2800	Yes	70	M 200 l	Mortar	370.0	–	370.0
1962	34º 41'N	139º 53'E	2400–2800	Yes	1523	M 200 l	Mortar	1023.9	6.3	1017.6
1963	34º 42'N	139º 56'E	2400–2800	Yes	165	M 200 l	Mortar	2410.0	5.0	2405.0
1964	34º 42'N	139º 56'E	2400–2800	Yes	135	M 200 l	Mortar	2553.8	0.1	2553.7
1965	34º 42'N	139º 56'E	2600–2600	Yes	201	M 200 l	Mortar	1007.2	0.8	1006.4
1967	34º 41'N	139º 55'E	2600–2600	Yes	225	M 200 l	Mortar	2813.7	0.4	2813.3
1968	34º 42'N	139º 56'E	2600–2600	Yes	230	M 200 l	Mortar	1303.3	0.02	1303.3
1969	34º 42'N	139º 56'E	2600–2600	Yes	245	M 200 l	Mortar	2753.5	0.3	2753.2
Total					**3031**			**15079.0 (407.5 Ci)**	**12.9**	**15066.1**

* Key for the type of container: M: metal.

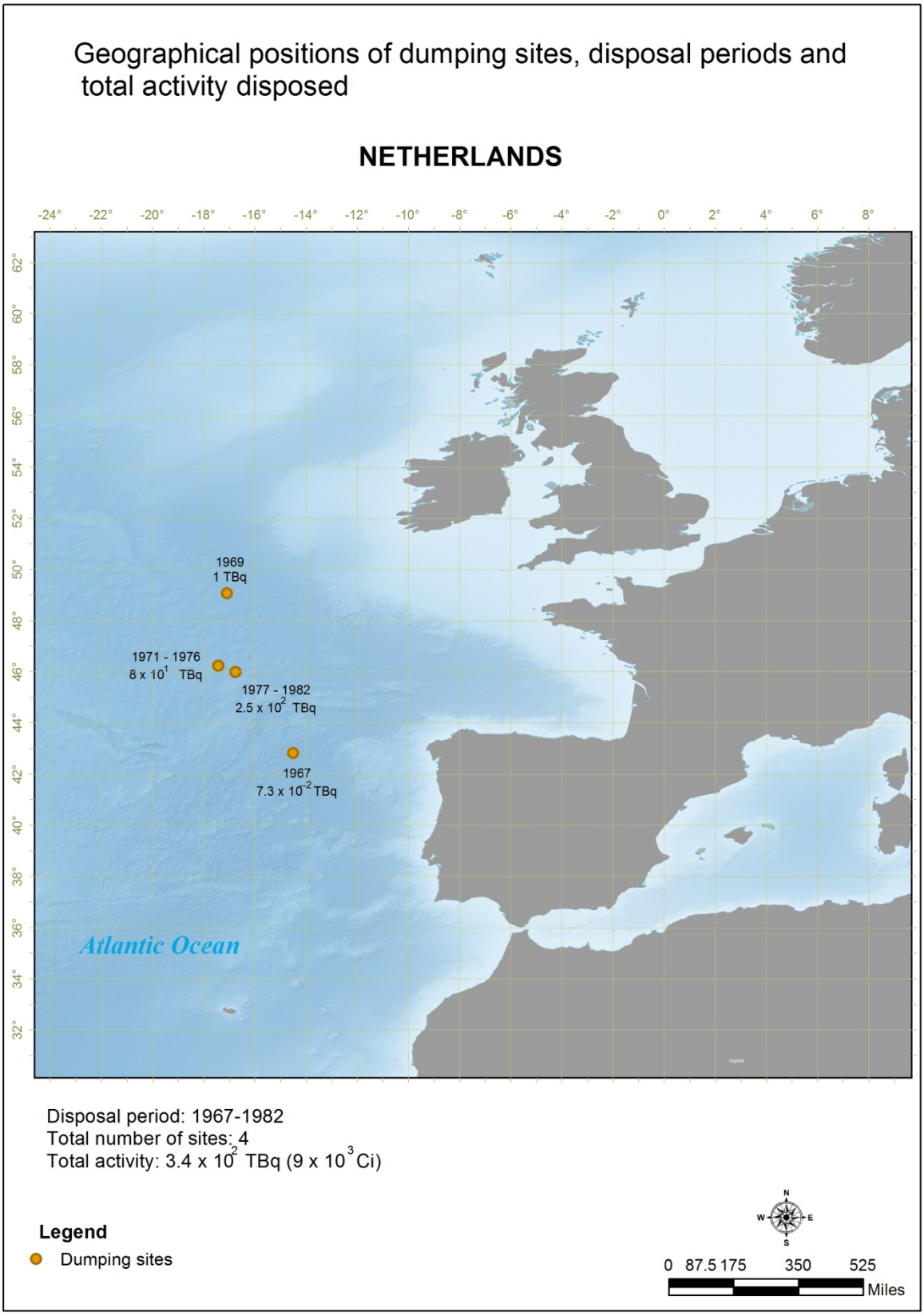
I-6. REPUBLIC OF KOREA



DATE	CO-ORDINATES		DEPTH	Package	CONTAINER			Total weight t	ACTIVITY		
	Latitude	Longitude	m		Number	Type*	Matrix		Total GBq	Alpha GBq	Beta-gamma GBq
1968	37º 20'N	130º 44'E	2192	Yes	21	C.L.D.	Concrete	8	-	-	-
1969	37º 20'N	130º 44'E	2192	Yes	21	C.L.D.	Concrete	8	-	-	-
1970	37º 20'N	130º 44'E	2192	Yes	23	C.L.D.	Concrete	9	-	-	-
1971	37º 20'N	130º 44'E	2192	Yes	25	C.L.D.	Concrete	10	-	-	-
1972	37º 20'N	130º 44'E	2192	Yes	25	C.L.D.	Concrete	10	-	-	-
Total					**115**			**45**			

* Key for the type of container: C.L.D.: metal drum lined with concrete (200l).

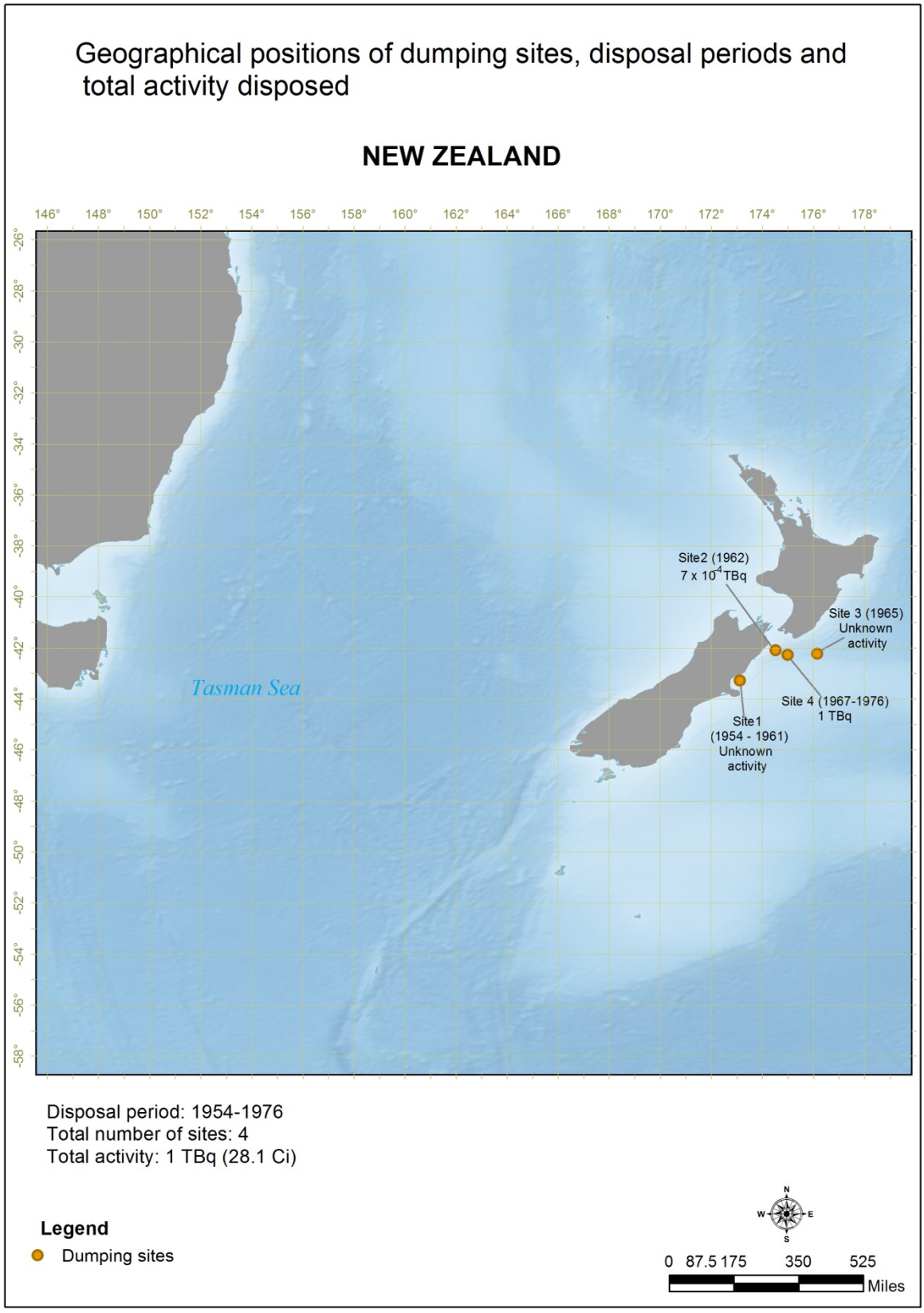
I-7. NETHERLANDS



DATE	CO-ORDINATES		DEPTH	Package	CONTAINER			Total weight t	ACTIVITY			H-3 GBq
	Latitude	Longitude	m		Number	Type*	Matrix		Total GBq	Alpha GBq	Beta-gamma GBq**	
1967	42º 50'N	14º 30'W	5200	Yes	–	MLC/MCB	C	207.0	73.0	3.0	70.0	–
1969	49º 05'N	17º 05'W	4000–4600	Yes	–	MLC/MCB	C	303.0	1010.0	10.0	1000.0	–
1971	46º 15'N	17º 25'W	3200–4100	Yes	–	MLC/MCB	C	360.0	750.0	10.0	740.0	–
1972	46º 15'N	17º 25'W	3200–4100	Yes	–	MLC/MCB	C	626.0	2030.0	–	2030.0	–
1973	46º 15'N	17º 25'W	3200–4100	Yes	–	MLC/MCB	C	657.0	1850.0	–	1850.0	–
1974	46º 15'N	17º 25'W	3200–4100	Yes	1189	MLC/MCB	C	501.0	21020.0	40.0	20980.0	20350.0
1975	46º 15'N	17º 25'W	3200–4100	Yes	2162	MLC/MCB	C	901.0	18190.0	60.0	18130.0	14800.0
1976	46º 15'N	17º 25'W	3200–4100	Yes	4496	MLC/MCB	C	1911.0	36370.0	40.0	36330.0	3700.0
1977	46º 00'N	16º 45'W	3200–4750	Yes	3812	MLC/MCB	C	3015.0	22190.0	330.0	21860.0	7100.0
1978	46º 00'N	16º 45'W	3200–4750	Yes	2946	MLC/MCB	C	1562.0	57060.0	190.0	56870.0	17460.0
1979	46º 00'N	16º 45'W	3200–4750	Yes	3393	MLC/MCB	C	2122.0	31310.0	50.0	31260.0	11400.0
1980	46º 00'N	16º 45'W	3200–4750	Yes	2960	MLC/MCB	C	1885.0	19960.0	20.0	19940.0	3850.0
1981	46º 00'N	16º 45'W	3200–4750	Yes	3015	MLC/MCB	C	2063.0	68840.0	240.0	68600.0	3070.0
1982	46º 00'N	16º 45'W	3200–4750	Yes	4455	MLC/MCB	C	3049.0	55400.0	120.0	55280.0	17700.0
Total					**28428**			**19162.0**	**336053.0 (9×10^3 Ci)**	**1113.0**	**334940.0**	**99430.0**

* 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.

I-8. NEW ZEALAND



DATE	CO-ORDINATES		DEPTH	Package	CONTAINER			Total volume l	ACTIVITY			Ra-226 GBq [or mg]
	Latitude	Longitude	m		Number	Type	Matrix		Total GBq	Alpha GBq	Beta-gamma GBq	
1954	Site 1		18	Yes	4	Drum	–	–	–	–	–	–
1955	Site 1		18	Yes	1	Barrel	–	–	–	–	–	–
1956	Site 1		18	Yes	1	Barrel	–	–	–	–	–	–
1956	Site 1		18	Yes	1	Barrel	–	–	–	–	–	–
1961	Site 1		18	Yes	2	Drum	–	396	0.93	–	–	25 mg
					2	Drum	–	180	–	–	–	–
					1	Wooden Box	–	–	–	–	–	–
Subtotal					**5**			**576**	**0.93**			
1962	Site 2		549	Yes	2	Drum	–	396	0.74	–	–	0.74
					1	Drum	–	–	–	–	–	–
1965	Site 3											
	42º 13'S	176º 10'E	2600	No	4	Block	Concrete	–	0.15	–	–	4 mg
1967	Site 4 (area A)											
	42º 15'S	175º 0'E	2834	Yes	1	Drum	Concrete	56.8	0.4	–	–	11 mg
				No	1	Block	Concrete	–	–	–	–	–
1972	42º 15'S	175º 0'E	2834	Yes	9	Drum	Concrete	205	117.0	–	–	2.22
1973	42º 15'S	175º 0'E	2834	Yes	2	Drum	Concrete	45.5	444.0	–	–	–
1976	42º 15'S	175º 0'E	2834	Yes	7	Drum	Concrete	159	477.3	–	–	8.14
Total					**39**			**1438.3**	**1040.5 (28.1 Ci)**			

Keys for co-ordinates: Site 1: Three miles north-north west of Lyttelton Heads; Site 2: Six miles south of Baring Heads; Site 3: At a bearing of 135º, at a distance of 50 miles from Cape Palliser; dumping from an aircraft.

I-9. SWEDEN

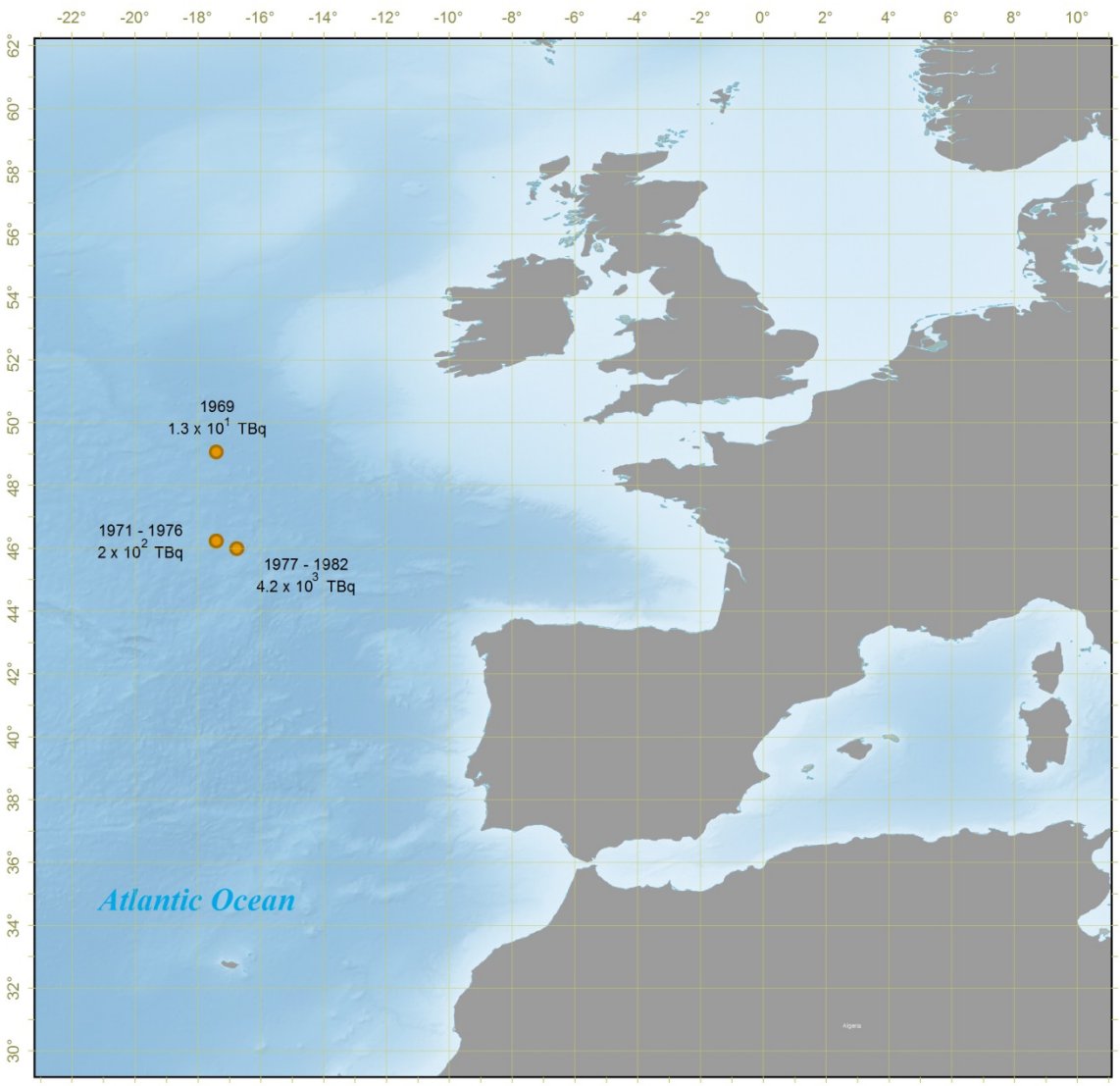

Geographical positions of dumping sites, disposal periods and total activity disposed
1959 -1961
1.5 x 10² TBq
1969
3.2 TBq
Atlantic Ocean
Disposal period: 1959, 1961 and 1969
Total number of sites: 2
Total activity: 3.3 TBq (88 Ci)
Legend
Dumping sites
N
W
E
S
0 125 250 500 750
Miles

DATE	CO-ORDINATES		DEPTH	Package	CONTAINER			Total weight t	Total Volume m^3	ACTIVITY		
	Latitude	Longitude	m		Number	Type*	Matrix			Total GBq	Alpha GBq	Beta-gamma GBq
1959	Baltic Sea, about 30 km south east of Landsort		About 400	Yes	200	M 200 l		60	40.000	4.4		
1961	Baltic Sea, about 30 km south east of Landsort			Yes	30	M 200 l		4	3.750	10.4		
Subtotal					**230**			**64**	**43.750**	**14.8**		
1969	49º 05'N	17º 05'W	4000–4600	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
Subtotal					**2895**			**1080.3**		**3242.7**	**937.6**	**2305.1**
Total					**3125**			**1144.3**		**3257.5 (88.04 Ci)**		

* Key for the type of containers: M: metal drum.

I-10. SWITZERLAND

Geographical positions of dumping sites, disposal periods and total activity disposed



Disposal period: 1969-1982
Total number of sites: 3
Total activity: 4.4×10^3 TBq (11.9×10^4 Ci)

Legend

- Dumping sites

N W E S

0 87.5 175 350 525

Miles

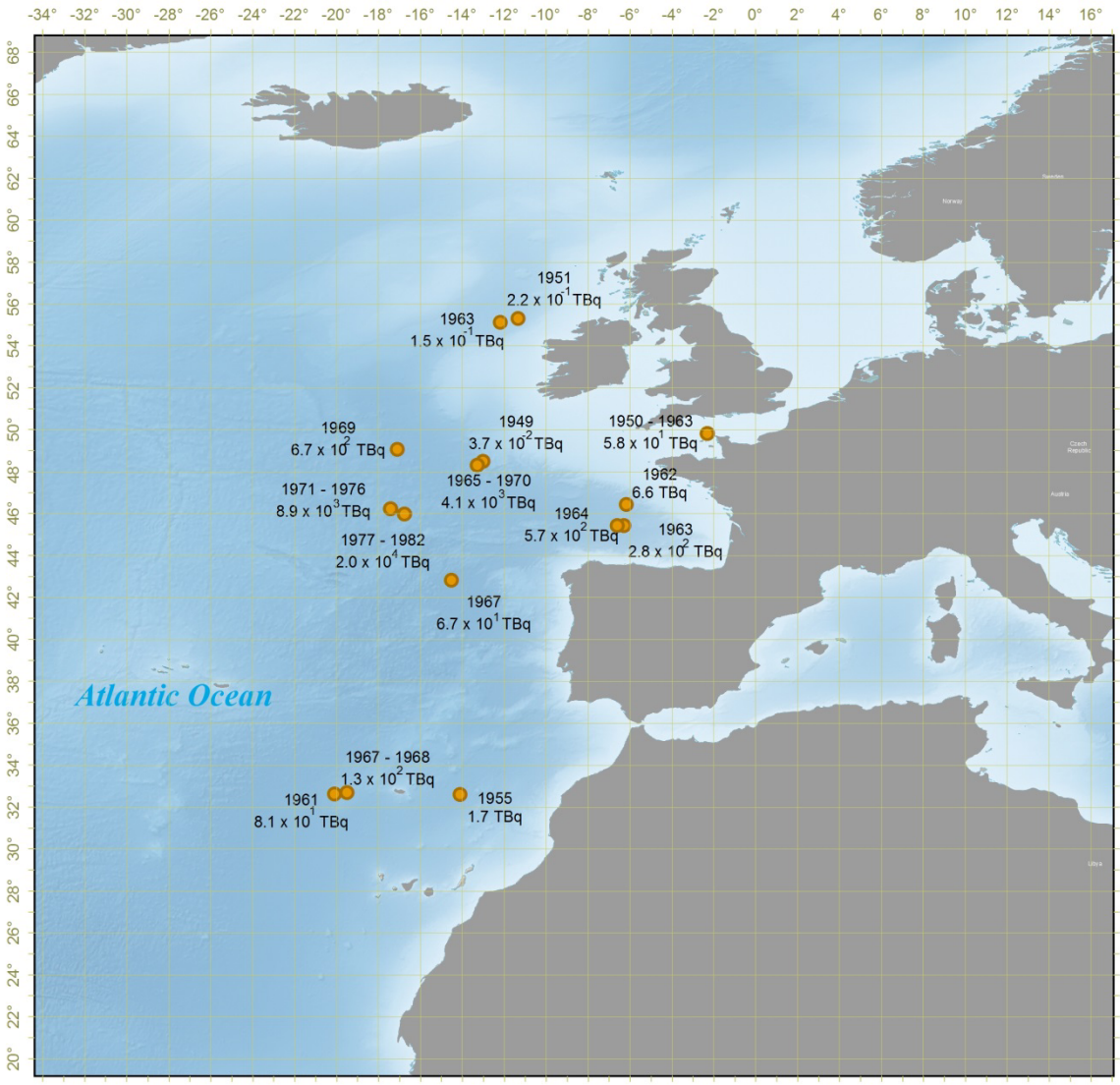
DATE	CO-ORDINATES		DEPTH	Package	CONTAINER			Total weight t	ACTIVITY			H-3 GBq
	Latitude	Longitude	m		Number	Type*	Matrix		Total GBq	Alpha GBq	Beta-gamma GBq**	
1969	49º 05'N	17º 25'W	4000–4600	Yes	100	MDLC	C	224	12617.0		12617.0	
1971	46º 15'N	17º 25'W	3600–4750	Yes	150	MD	C					
					128	MDLC	C					
Subtotal					**278**			**376**	**13242.3**	**70.3**	**13172.0**	
1972	46º 15'N	17º 25'W	3600–4750	Yes	1075	MD	C					
					45	MDLC	C					
Subtotal					**1120**			**509**	**22237.0**	**259.0**	**21978.0**	**7104.0**
1974	46º 15'N	17º 25'W	3600–4750	Yes	587	MD	C					
					121	MDLC	C					
Subtotal					**708**			**509**	**79043.1**	**603.1**	**78440.0**	**67414.0**
1975	46º 15'N	17º 25'W	3600–4750	Yes	200	MD	C					
					55	MDLC	C					
Subtotal					**255**			**203**	**43356.6**	**806.6**	**42550.0**	**15725.0**
1976	46º 15'N	17º 25'W	3600–4750	Yes	541	MD	C					
					59	**MDLC**	**C**					
Subtotal					**600**			**349**	**27424.4**	**562.4**	**26862.0**	**17501.0**
1977	46º 00'N	16º 45'W	3900–4750	Yes	630	MD	C					
					82	MDLC	C					
Subtotal					**712**			**457**	**35268.4**	**303.4**	**34965.0**	**13542.0**
1978	46º 00'N	16º 45'W	3900–4750	Yes	801	MD	C					
					165	MDLC	C					
Subtotal					**966**			**733**	**166111.5**	**1017.5**	**165094.0**	**14430.0**
1979	46º 0'N	16º 45'W	3900–4750	Yes	378	MD	C					
					4	MDLC	C					
Subtotal					**382**			**409**	**63717.7**	**3.7**	**63714.0**	**58682.0**
1980	46º 0'N	16º 45'W	3900–4750	Yes	594	MD	C					
					10	MDLC	C					
Subtotal					**604**			**301**	**1903961.0**	**14.8**	**1903946.0**	**1876307.0**

DATE	CO-ORDINATES		DEPTH	Package	CONTAINER			Total weight t	ACTIVITY			H-3 GBq
	Latitude	Longitude	m		Number	Type*	Matrix		Total GBq	Alpha GBq	Beta-gamma GBq**	
1981	46º 0'N	16º 45'W	3900–4750	Yes	671	MD	C					
					39	MDLC	C					
Subtotal					**710**			**404**	**1405556.0**	**407.0**	**1405149.0**	**1332111.0**
1982	46º 0'N	16º 45'W	3900–4750	Yes	883	MD	C					
					152	MDLC	C					
Subtotal					**1035**			**847**	**646808.1**	**270.1**	**646538.0**	**499426.0**
Total					**7470**			**5321**	**4419342.9 (11.94×10^4 Ci)**	**4317.9**	**4415025.0**	**3902242.0**

* Key for the type of containers and matrix: MD: metal drum; MDLC: metal drum lined with concrete; C: concrete.
** Tritium activities are included in the beta-gamma figures.

Geographical positions of dumping sites, disposal periods and total activity disposed

UNITED KINGDOM



Disposal period: 1949-1982
Total number of sites: 15
Total activity: 3.5 x 10^4 TBq (9.5 x 10^5 Ci)

Legend

- Dumping sites

0 125 250 500 750 Miles

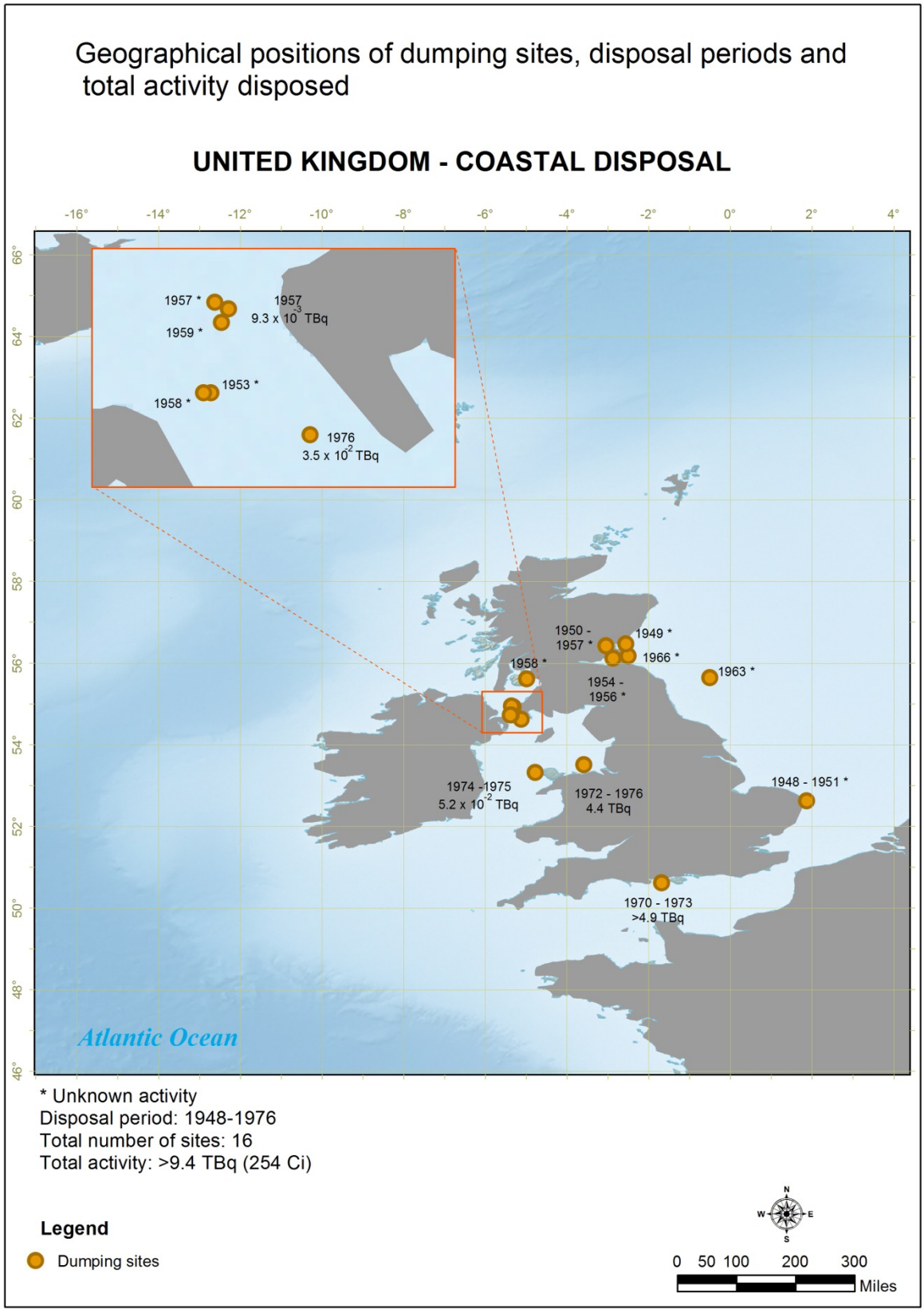
DATE	CO-ORDINATES		DEPTH	Package*	Total weight t	ACTIVITY			H-3 GBq
	Latitude	Longitude	m			Total GBq	Alpha GBq	Beta-gamma GBq**	
1949	48º 30'N	13º 00'W	3600–4000	Yes	9	37.0	–	37.0	–
1950	49º 50'N	2º 18'W	65–160	Yes	350	814.0	74.0	740.0	–
1951	49º 50'N	2º 18'W	65–160	Yes	319	703.0	37.0	666.0	–
	55º 20'N	11º 20'W	2700–2700	Yes	33	222.0	37.0	185.0	–
1952	49º 50'N	2º 18'W	65–160	Yes	534	1147.0	74.0	1073.0	–
1953	55º 08'N	12º 10'W	2800–2800	Yes	57	148.0	74.0	74.0	–
	49º 50'N	2º 18'W	65–160	Yes	758	1813.0	370.0	1443.0	–
1954	49º 50'N	2º 18'W	65–160	Yes	1145	2886.0	851.0	2035.0	–
1955	49º 50'N	2º 18'W	65–160	Yes	1164	2923.0	1295.0	1628.0	–
	32º 37'N	14º 05'W	4000–4200	Yes	1453	1665.0	444.0	1221.0	–
1956	49º 50'N	2º 18'W	65–160	Yes	1038	2849.0	1628.0	1221.0	–
1957	49º 50'N	2º 18'W	65–160	Yes	1537	9990.0	4033.0	5957.0	–
	32º 42'N	19º 30'W	3600–4100	Yes	4404	65231.0	35335.0	29896.0	–
1958	32º 42'N	19º 30'W	3600–4100	Yes	2694	65860.0	25715.0	40145.0	–
	49º 50'N	2º 18'W	65–160	Yes	1011	4255.0	2146.0	2109.0	–
1959	49º 50'N	2º 18'W	65–160	Yes	1198	2886.0	148.0	2738.0	–
1960	49º 50'N	2º 18'W	65–160	Yes	2551	10804.0	2738.0	8066.0	–
1961	49º 50'N	2º 18'W	65–160	Yes	1967	12136.0	740.0	11396.0	–
	32º 38'N	20º 05'W	2100–4800	Yes	4360	81141.0	20831.0	60310.0	–
1962	46º 27'N	6º 10'W	4200–4600	Yes	253	6660.0	629.0	6031.0	–
	49º 50'N	2º 18'W	65–160	Yes	1444	2997.0	185.0	2812.0	–
1963	49º 50'N	2º 18'W	65–160	Yes	1543	1739.0	111.0	1628.0	–
	45º 27'N	6º 16'W	4100–4800	Yes	5809	275243.0	13616.0	261627.0	–
1964	45º 27'N	6º 36'W	4100–4800	Yes	4392	574758.0	16428.0	558330.0	–

DATE	CO-ORDINATES		DEPTH	Package*	Total weight t	ACTIVITY			H-3 GBq
	Latitude	Longitude	m			Total GBq	Alpha GBq	Beta-gamma GBq**	
1965	48º 20'N	13º 16'W	1900–4500	Yes	1759	513116.0	4218.0	508898.0	–
1966	48º 20'N	13º 16'W	1900–4500	Yes	1044	104340.0	2886.0	101454.0	–
1967	42º 50'N	14º 30'W	2500–5200	Yes	722	65601.0	3367.0	62234.0	–
1968	48º 20'N	13º 16'W	1900–4500	Yes	3164	2796016.0	27047.0	2768969.0	–
1969	49º 05'N	17º 05'W	4000–4600	Yes	1878	665260.0	14430.0	650830.0	–
1970	48º 20'N	13º 16'W	1900–4500	Yes	1674	756909.0	8621.0	748288.0	–
1971	46º 15'N	17º 25'W	3200–4100	Yes	1434	330785.0	12030.0	318755.0	–
1972	46º 15'N	17º 25'W	3200–4100	Yes	1885	729751.0	24938.0	704813.0	–
1973	46º 15'N	17º 25'W	3200–4100	Yes	1453	458763.0	27343.0	431420.0	–
1974	46º 15'N	17º 25'W	3200–4100	Yes	1256	3497425.0	14763.0	3482662.0	–
1975	46º 15'N	17º 25'W	3200–4100	Yes	1350	1967808.0	26048.0	1941760.0	956080.0
1976	46º 15'N	17º 25'W	3200–4100	Yes	2269	1870943.0	29193.0	1841750.0	693010.0
1977	46º 0`N	16º 45'W	3200–4750	Yes	2140	2803116.0	34410.0	2768706.0	1159136.0
1978	46º 0`N	16º 45'W	3200–4750	Yes	2080	2594478.0	30118.0	2564360.0	1209900.0
1979	46º 0`N	16º 45'W	3200–4750	Yes	2014	3051054.0	51097.0	2999957.0	1516667.0
1980	46º 0`N	16º 45'W	3200–4750	Yes	2693	3991190.0	66267.0	3924923.0	1486253.0
1981	46º 0`N	16º 45'W	3200–4750	Yes	2517	3949415.0	75184.0	3874231.0	1414991.0
1982	46º 0`N	16º 45'W	3200–4750	Yes	2697	3802710.0	46770.0	3755940.0	2345170.0
Subtotal Marine					**74052**	**35077587.0 (9.5×10^5 Ci)**	**626269.0**	**34451318.0**	**10781207.0**

* Key for the type of containers and matrix: most of the packages had an outer shell of steel, a small minority were monolithic blocks, most of the packages were lined with concrete.

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

I-12. UNITED KINGDOM (COASTAL DUMPING)



DATE	CO-ORDINATES		DEPTH		Package*	Total weight t	ACTIVITY			H-3 GBq
	Latitude	Longitude	Min. m	Max. m			Total GBq	Alpha GBq	Beta-gamma GBq**	
1948–1951	Off Lowestoft (Outside herring fishing area)		25	40	Liquid waste from fish tolerance experiments. Poured from drums	7.3 maximum per disposal (exact number of disposals not known)	Not known	Not known	Not known	Not known
1949	Not known whether sea dumping actually took place. Advice was to dump at least 5 miles offshore (probably from the Tay Estuary) or to landfill.		Not known	If dumped at sea, probably less than 60 metres	35,000 faulty luminized dials possibly sealed in a drum or drums	Not known	Not known	Between 0.93 and 1.9 of Ra-226 and progeny	Not known	Not known
1950–1957	Unknown - described as "well out to sea", probably from the Tay Estuary		Not known	Probably less than 60 metres	Considerable quantity of scrap radium luminized dials — type of packaging unknown	Not known	Not known	Ra-226 and progeny	Not known	Not known
1953– (number of disposals uncertain)	Beaufort's Dyke (exact dumpsite unknown)		Probably around 80 metres	Around 300 metres	1953 operation comprised two bins containing rubber gloves and broken glassware	Not known	Not known	Not known	Not certain but may have included Ca-45	Not known
1954–1956	Not known for certain. Thought to be in deep water close to Forth Rail Bridge at North Queensferry, Firth of Forth		Not known	Probably less than 40 metres	Scrap radio valves believed to be in perforated drums	Not known	Not known	Ra-226 and. progeny Estimated to be around 0.16 in the form of $RaBr_2$ every 6 months	Not known	Not known
1959	54º 54'N	05º 20'W	200		7 containers of waste from Scottish universities	0.5	Not known	Not known	Not known	Not known
1957	54º 56'N	05º 19'W	110		5 bins of waste from Edinburgh University	0.4	Not known	Not known	Not known	Not known

DATE	CO-ORDINATES		DEPTH		Package*	Total weight t	ACTIVITY			H-3 GBq
	Latitude	Longitude	Min. m	Max. m			Total GBq	Alpha GBq	Beta-gamma GBq**	
1957	54º 56'N	05º 19'W	110		Caesium contaminated solids and liquids in 4 steel containers	0.3	9,32	Not known	9.32	Not known
1957	54º 56'N	05º 19'W	110		Two galvanized cylinders containing luminized and other material	0.1	Not known	Not known	Not known	Not known
1957	54º 57'N	05º 21'W	192		1 large container of scrap radio valves	0.1	Not known	May have been $RaBr_2$	Not known	Not known
1958	Beaufort's Dyke (exact dumpsite unknown)		Probably around 80 metres	Around 300 metres	Unknown. Presumed to be a batch of faulty luminized watch dials	Not known	Not known	Not known	Not known	Not known
1958	55º 37'N	04º 59'W	44	172	Unknown — 2 small antistatic devices thought to have been dumped in a container with other waste	Not known, but likely to have been fairly light (foil bonded to plastic)	Not known	Not known	Sr- 90	Not known
1963	55º 39'N	05º 0'W	Not known	Around 80	Loose rubble and soil	638	Not known	7.4 of Ra-226	Not known	Not known
1966	Boundary 56º 10'N 56º 11'N	Boundary 02º 29'W 02º 31'W	54	69	Liquids and sludges	Not known	Not known	Not known	Cr-51, Fe-55, Fe--59, Co-60	Not known
1970–1973	Boundary 51º 43'N 51º 42'N 51º 33'N 51º 31'N	Boundary 01º 48'W 01º 56'W 01º 43'W 01º 52'W	25	45	Liquid effluent poured into vessel wake	Not known	Up to 4900	0.0	Up to 4900	0.0

DATE	CO-ORDINATES		DEPTH		Package*	Total weight t	ACTIVITY			H-3 GBq
	Latitude	Longitude	Min. m	Max. m			Total GBq	Alpha GBq	Beta-gamma GBq**	
1972–1976	53º 31'N It is also possible that small amount of this material could have been disposed of in the Morecambe Bay area	03º 35'W	20	30	Sludges poured direct into the sea from vessels	Up to 2240 (this is the maximum weight authorized for disposal, actual amount dumped unknown)	Up to 4400	Up to 4400	0.0	0.0
1974–1975	Boundary 53º 23'N 53º 23'N 53º 19'N 53º 16'N	Boundary 04º 48'W 04º 45'W 04º 45'W 04º 48'W	50	70	Co-60 in the form of a soluble salt contained in phials with soluble plugs	Not known	52	0.0	52	0.0
1976	Boundary 54º 35'N 54º 40'N	Boundary 05º 04'W 05º 10'W	160	200	Rubble and soil deposited from vessel	Around 9600	35.5	35.5	0.0	0.0
Subtotal Coastal							**>9.397×10^3 (253.97 Ci)**			
Total (Marine and Coastal)						**>80000**	**3.51×10^7 (9.5×10^5 Ci)**			

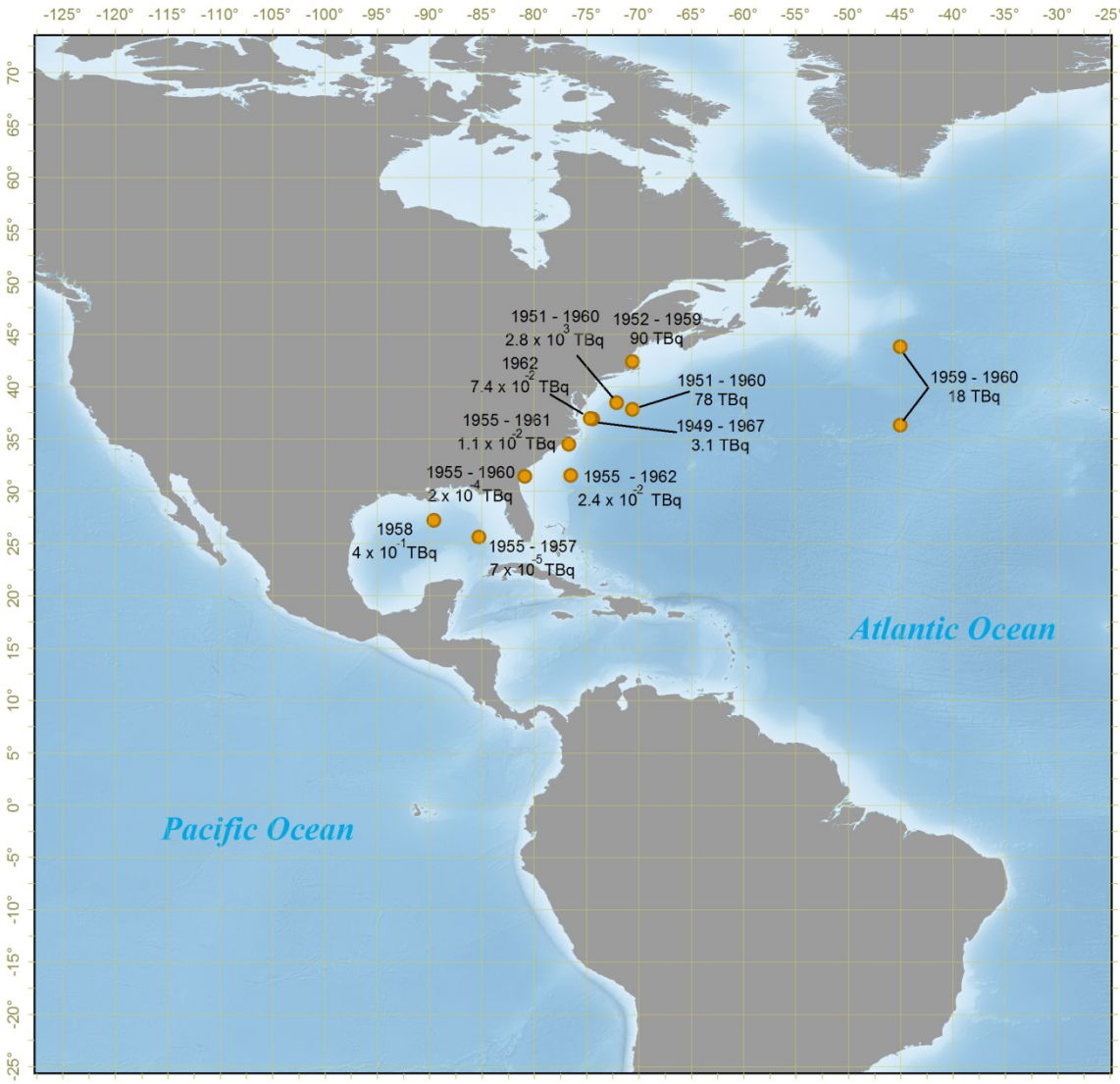
* Most of the packages had an outer shell of steel, small minorities were monolithic blocks; most of the packages were lined with concrete.

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

I-13. UNITED STATES OF AMERICA (ATLANTIC OCEAN)

Geographical positions of dumping sites, disposal periods and total activity disposed

UNITED STATES OF AMERICA
ATLANTIC OCEAN



Disposal period: 1949-1967
Total number of sites: 12
Total activity: 3 x 10^3 TBq (8 x 10^4 Ci)

Legend
- Dumping sites

N W E S
0 250 500 1,000 1,500
Miles

DATE	CO-ORDINATES		DEPTH	Package	CONTAINER	NATURE OF WASTE*			ACTIVITY
	Latitude	Longitude	m		Number	BPM	SM	SNM	Total GBq
1949–1967	36º 56'N	74º 23'W	1829–1967	Yes	834	Yes			3145.00
1951–1960	38º 30'N	72º 06'W	1829–2800	Yes	14301	Yes**			2752800.00
1951–1960	37º 50'N	70º 35'W	1829–3800	Yes	14500	Yes			77700.00
1952–1959	42º 25.5'N	70º 35'W	92	Yes	4008	Yes	Yes		90280.00
1955–1957	25º 40'N	85º 17'W	3110	Yes	78	Yes			0.07
1955–1960	off Sapelo Island		11	No-liquid		Yes			0.19
1955 -1961	34º 32'N	76º 40'W	19	No		Yes			11.10
1955–1962	31º 32'N	76º 30'W	915–3660	Yes	119	Yes			24.42
1958–1958	27º 14'N	89º 33'W	1829	Yes	1	Yes			370.00
1959–1960	36º 20'N 43º 49'N	45º 00'W 45º 00'W	3660–5289	Yes	432	Yes			17760.00
1962	37º 00'N	74º 37'W	421	Yes	9	Yes			74.00
Subtotal Atlantic					**34282**				**2942164.8 (7.95×10^4 Ci)**
Totals (Atlantic + Pacific)					**92740**				**3496411.8 (9.45×10^4 Ci)**

Keys to table:

*BPM = byproduct materials; SM = source materials; SNM = special nuclear materials.

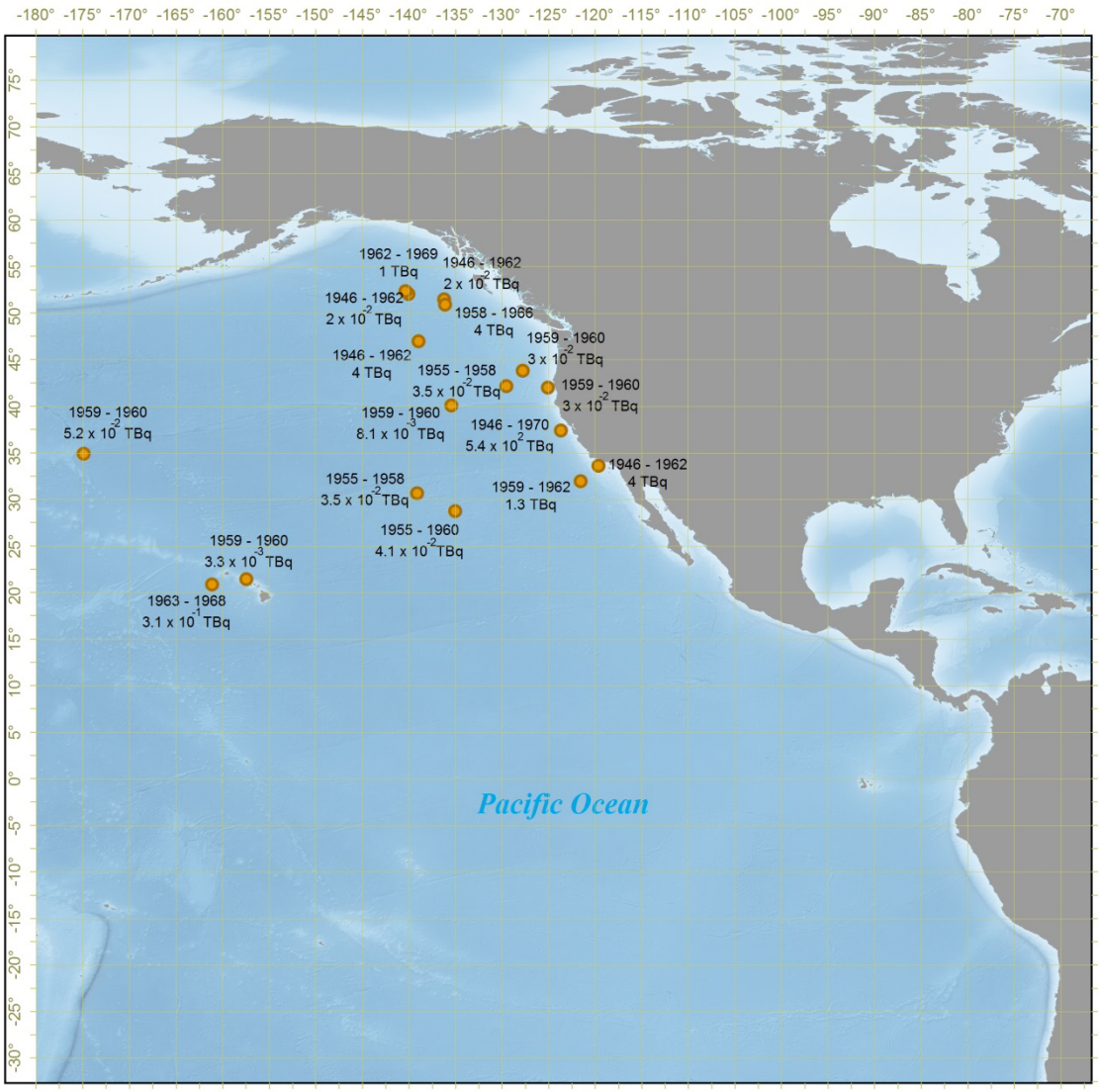
** = includes the Seawolf submarine reactor shell (without nuclear fuel), dumped in 1959; estimated activity 1221 TBq (33000 Ci).

N.B.: Radioactivity is the estimated activity at the time of packaging.

I-14. UNITED STATES OF AMERICA (PACIFIC OCEAN)

Geographical positions of dumping sites, disposal periods and total activity disposed

UNITED STATES OF AMERICA
PACIFIC OCEAN



Disposal period: 1946-1970
Total number of sites: 19 (Two sites coordinates are unknown)
Total activity: 5.5 x 10^2 TBq (1.5 x 10^4 Ci)

Legend
- Dumping sites

N W E S

0 250500 1,000 1,500
Miles

DATE	CO-ORDINATES		DEPTH			Package	CONTAINER	NATURE OF WASTE*			ACTIVITY
	Latitude	Longitude	m				Number	BPM	SM	SNM	Total GBq
1946–1962	33º 40'N	119º 35'W	1829	–	1940	Yes	3114	Yes	Yes		3996.00
1946–1962	51º 30'N	136º 10'W	–		–	Yes	38	–	–	–	19.98
1946–1962	52º 05'N	140º 00'W	–		–	Yes	41	–	–	–	19.98
1946–1962	47º 00'N	138º 54'W	–		–	Yes	361	–	–	–	3603.80
1946–1962	Unknown				1830	Yes	37	–	–	–	44.40
1946–1962	Unknown		–		–	Yes	231	–	–	–	3570.50
1946–1970	37º 27'N	123º 37'W	896	–	1700	Yes	47500	Yes	Yes	Yes	536500.00
1955–1958	42º 12'N	129º 31'W	3292	<		Yes	26	Yes			35.15
1955–1958	30º 43'N	139º 05'W	3658	–	4560	Yes	26	Yes			35.15
1955–1960	28º 47'N	135º 00'W	3477	<		Yes	29	Yes			40.70
1958–1966	50º 56'N	136º 03'W	3292	<		Yes	197	Yes	Yes		3552.00
1959–1960	21º 28'N	157º 25'W	3456	<		Yes	39	Yes			3.33
1959–1962	32º 00'N	121º 30'W	2210	–	3658	Yes	4415	Yes	Yes	Yes	1258.00
1959–1960	34º 58'N	174º 52'W	5487	<		Yes	7	Yes			518.00
1959–1960	43º 52'N	127º 44'W	2926	<		Yes	4	Yes			2.96
1959–1960	42º 04'N	125º 01'W	1000	–	4097	Yes	4	Yes			2.96
1959–1960	40º 07'N	135º 24'W	1829	–	1990	Yes	29	Yes	Yes		8.14
1962–1969	52º 25'N	140º 20'W	3294	<		Yes	163	Yes	Yes		1036.00
1963-1968**	20º 54'N	161º 06'W	4600	–		Yes	2197	Yes	No	No	310
Subtotal Pacific							**58458**				**554557.1 (1.50×10^4 Ci)**
Total (Atlantic + Pacific)							**92740**				**3496721.8 (9.45×10^4 Ci)**

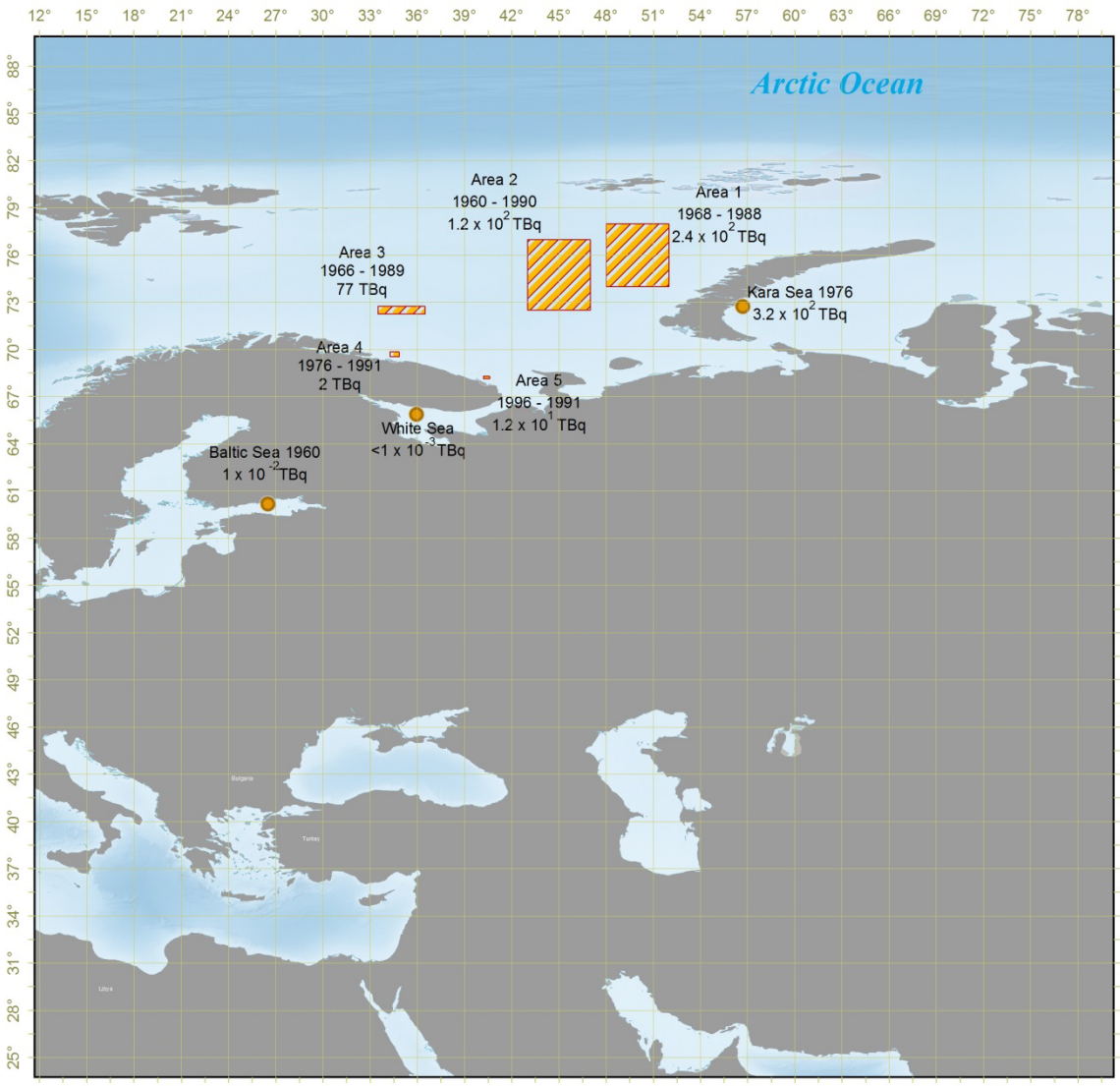
Keys: *BPM = by product materials; SM = source materials; SNM = special nuclear materials.
– = no data available

N.B.: Total activity is the estimated activity at the time of packaging.

**Ref [I-2]

I-15. FORMER SOVIET UNION (LIQUID RADIOACTIVE WASTE IN THE ARCTIC SEAS)

Geographical positions of dumping sites, disposal periods and total activity disposed



Disposal period: 1959-1991
Total number of sites: 8
Total activity: 764 TBq (2.0 x 10^4 Ci)

Legend
Dumping sites
Dumping areas

0 250 500 1,000 1,500
Miles

SUMMARY

AREA	CO-ORDINATES		DEPTH	ACTIVITY	GEOGRAPHICAL LOCATION
	Latitude	Longitude	m	TBq	
1	78º 0'N	48º 0'E	180–300	235.2	Barents Sea (open sea)
	78º 0'N	52º 0'E			
	74º 0'N	48º 0'E			
	74º 0'N	52º 0'E			
2	77º 0'N	43º 0'E	200–300	123.6	Barents Sea (open sea)
	77º 0'N	47º 0'E			
	72º 30'N	43º 0'E			
	72º 30'N	47º 0'E			
3	72º 45'N	33º 30'E	200–300	77.0	Barents Sea (open sea)
	72º 45'N	36º 30'E			
	72º 15'N	33º 30'E			
	72º 15'N	36º 30'E			
4	69º 51'N	34º 15'E	100–200	2.0	Barents Sea (coastal)
	69º 51'N	34º 51'E			
	69º 34'N	34º 15'E			
	69º 34'N	34º 51'E			
5	68º 18'N	40º 13'E	50–100	11.8	Barents Sea (coastal)
	68º 18'N	40º 36'E			
	68º 10'N	40º 13'E			
	68º 10'N	40º 36'E			
Subtotal Areas 1–5				**449.6**	
Subtotal Outside Areas 1–5				**314.5**	Baltic Sea; Kara Sea; White Sea
Total				**764.1 (20651 Ci)**	

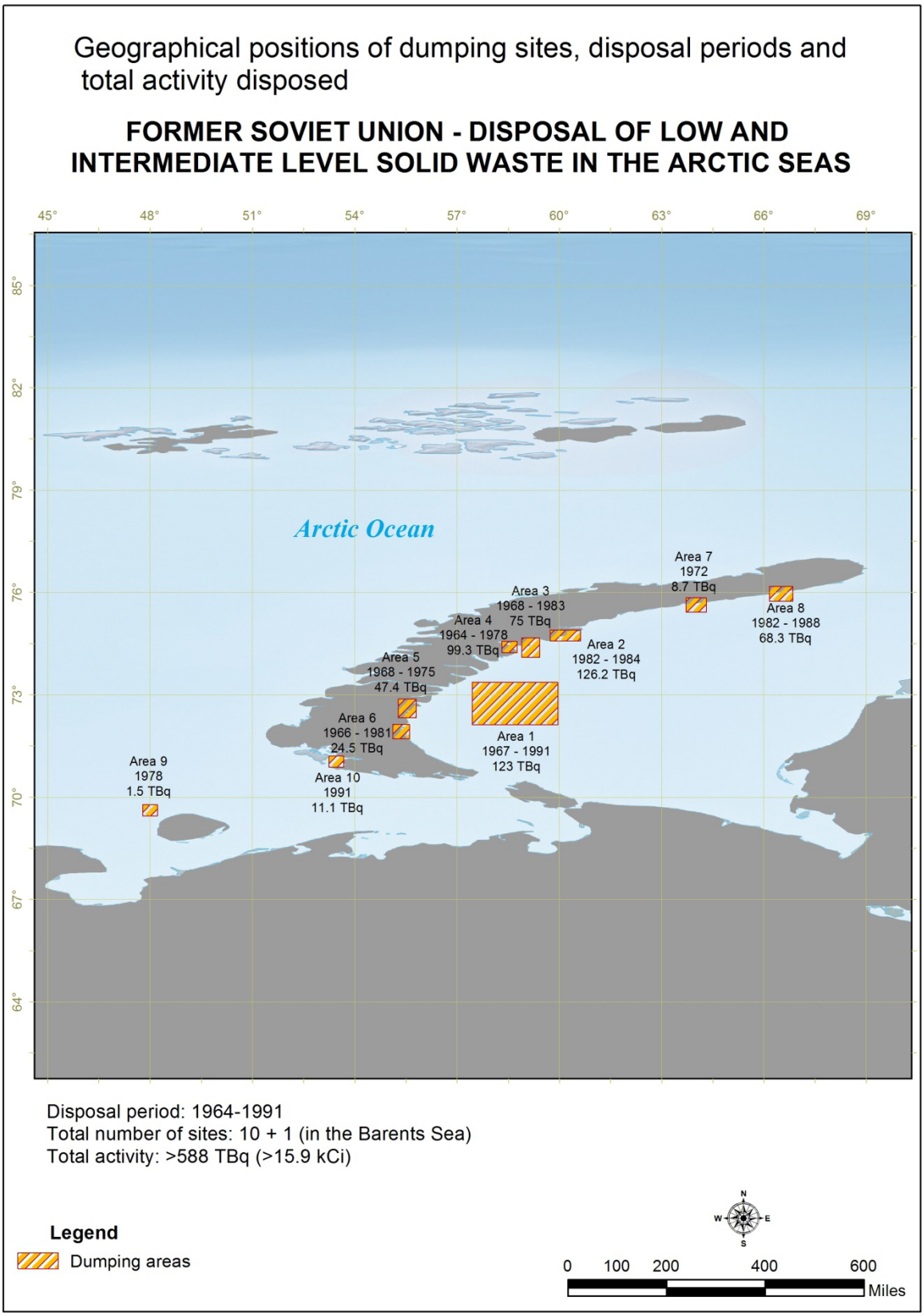
DATE	CO-ORDINATES		DEPTH	VOLUME	ACTIVITY
	Latitude	Longitude	m	m^3	TBq
Area 1	78º 0'N	48º 0'E	180–300		
	78º 0'N	52º 0'E			
	74º 0'N	48º 0'E			
	74º 0'N	52º 0'E			
	Barents Sea (open sea)				
1968				353.0	0.10
1969				316.0	4.05
1970				2703.0	2.42
1972				850.0	0.22
1973				882.0	0.81
1975				1947.0	15.91
1976				1800.0	2.33
1977				1500.0	2.53
1978				340.0	1.12
1979				604.0	0.44
1980				650.0	1.00
1982				1250.0	6.25
1983				685.0	2.68
1988				364.5	195.30
Subtotal Area 1				**14244.5**	**235.2**
Area 2	77º 0'N	43º 0'E	200–300		
	77º 0'N	47º 0'E			
	72º 30'N	43º 0'E			
	72º 30'N	47º 0'E			
	Barents Sea (open sea)				
1960				760.0	0.01
1961				930.0	0.61
1962				850.0	0.17
1963				1054.0	13.25
1964				910.0	5.67
1965				6520.0	35.65
1966				3540.0	13.57
1967				144.0	1.12
1969				3416.0	1.92
1971				2371.0	0.76
1972				930.0	0.72
1973				4057.0	2.83
1974				8645.0	9.83
1975				4720.0	2.04
1976				6229.0	2.81

DATE	CO-ORDINATES		DEPTH	VOLUME	ACTIVITY
	Latitude	Longitude	m	m^3	TBq
1977				4150.0	1.75
1980				3405.0	0.83
1981				2146.0	9.93
1982				1745.4	0.41
1983				1772.1	9.82
1984				5125.4	8.22
1986				900.0	0.39
1987				1740.0	1.29
1990				751.0	0.03
Subtotal Area 2				**66810.9**	**123.6**
Area 3	72º 45'N	33º 30'E	200–300		
	72º 45'N	36º 30'E			
	72º 15'N	33º 30'E			
	72º 15'N	36º 30'E			
	Barents Sea (open sea)				
1966				1220.0	0.22
1967				530.0	0.08
1968				1357.0	0.02
1969				1290.0	0.01
1970				4370.0	3.56
1971				1096.0	0.13
1972				4101.0	3.75
1973				3872.0	4.79
1974				3155.0	11.89
1975				851.0	0.57
1976				2788.0	30.01
1977				860.0	0.06
1978				5170.0	3.34
1979				7286.0	2.90
1980				3957.0	1.39
1981				2130.0	7.44
1982				1476.6	0.69
1983				472.0	0.41
1984				820.0	0.22
1985				2376.6	2.44
1986				870.0	1.09
1987				780.0	0.54
1989				2472.0	1.47
Subtotal Area 3				**53300.2**	**77.0**

DATE	CO-ORDINATES		DEPTH	VOLUME	ACTIVITY
	Latitude	Longitude	m	m^3	TBq
Area 4	69º 51'N	34º 15'E	100–200		
	69º 51'N	34º 51'E			
	69º 34'N	34º 15'E			
	69º 34'N	34º 51'E			
	Barents Sea (coastal)				
1975				835.0	0.23
1981				906.0	0.15
1984				740.0	0.10
1986				1410.0	0.21
1987				2211.0	0.83
1989				875.0	0.05
1990				1267.0	0.26
1991				263.2	0.15
Subtotal Area 4				**8507.2**	**2.0**
Area 5	68º 18'N	40º 13'E	50–100		
	68º 18'N	40º 36'E			
	68º 10'N	40º 13'E			
	68º 10'N	40º 36'E			
	Barents Sea (coastal)				
1966				449.0	0.04
1967				2000.0	0.10
1968				1400.0	0.06
1969				750.0	0.02
1970				2257.0	0.02
1971				1549.0	0.05
1972				2560.0	0.31
1973				885.0	0.15
1974				838.0	0.03
1975				1610.0	0.30
1976				830.0	0.41
1977				870.0	0.32
1980				800.0	0.30
1981				2755.0	0.78
1982				1855.0	0.36
1983				3247.0	0.83
1984				1614.8	1.90
1985				3980.5	0.81
1986				3410.0	0.88
1987				2063.0	0.76
1989				2752.0	0.41

DATE	CO-ORDINATES		DEPTH	VOLUME	ACTIVITY
	Latitude	Longitude	m	m^3	TBq
1990				5913.6	2.18
1991				2382.8	0.73
Subtotal Area 5				**46771.7**	**11.8**
Subtotal Areas 1–5				**189634.5**	**449.6**
Discharge outside Areas 1–5					
1959	65º 44'N	35º 54'E		600.0	0.001
1960	Near Gogland Island, Baltic Sea			100.0	0.01
1976	Kara Sea, LRW from nuclear icebreaker Lenin			–	314.50
Subtotal outside Areas 1-5				**700.0**	**314.5**
Total				**190334.6**	**764.1 (20651 Ci)**

I-16. FORMER SOVIET UNION (SOLID RADIOACTIVE WASTE IN THE ARCTIC SEAS)



SUMMARY

AREA	CO-ORDINATES		DEPTH	ACTIVITY	GEOGRAPHICAL LOCATION
	Latitude	Longitude	m	TBq	
1	72º 5'N 73º 17'N	57º 30'E 60º 0'E	380	122.817	Kara Sea Novaya Zemlya Depression
2	74º 40'N 74º 42'N	59º 53'E 60º 17'E	13–33	126.172	Sedov Inlet east coast of Novaya Zemlya
3	74º 35'N 74º 7'N	59º 18'E 59º 12'E	24	75.000	Oga Inlet east coast of Novaya Zemlya
4	74º 22'N 74º 22'N	58º 42'E 58º 41'E	56–135	99.302	Tsivolka Inlet east coast of Novaya Zemlya
5	72º 33'N 72º 32'N	55º 34'E 55º 23'E	25–27	47.361	Stepovoy Inlet east coast of Novaya Zemlya
6	71º 56'N 71º 56'N	55º 22'E 55º 19'E	12–20	24.467	Abrosimov Inlet east coast of Novaya Zemlya
7	75º 40'N	63º 59'E	13–16	8.689	Blagopoluchiye Inlet east coast of Novaya Zemlya
8	75º 58'N 75º 59'N	66º 20'E 66º 18'E	Up to 50	68.249	Techeniye Inlet east coast of Novaya Zemlya
9	69º 34'2N	47º 56'E		1.480	20 miles to north-west of Kolguvev Island
10				11.100	Chernaya Bay south coast of Novaya Zemlya
Subtotal Areas 1–10				**> 584.6**	
Outside Areas 1–10		**–**	**–**	**>3.7**	**Barents Sea**
Total				**>588.3 (>15901 Ci))**	

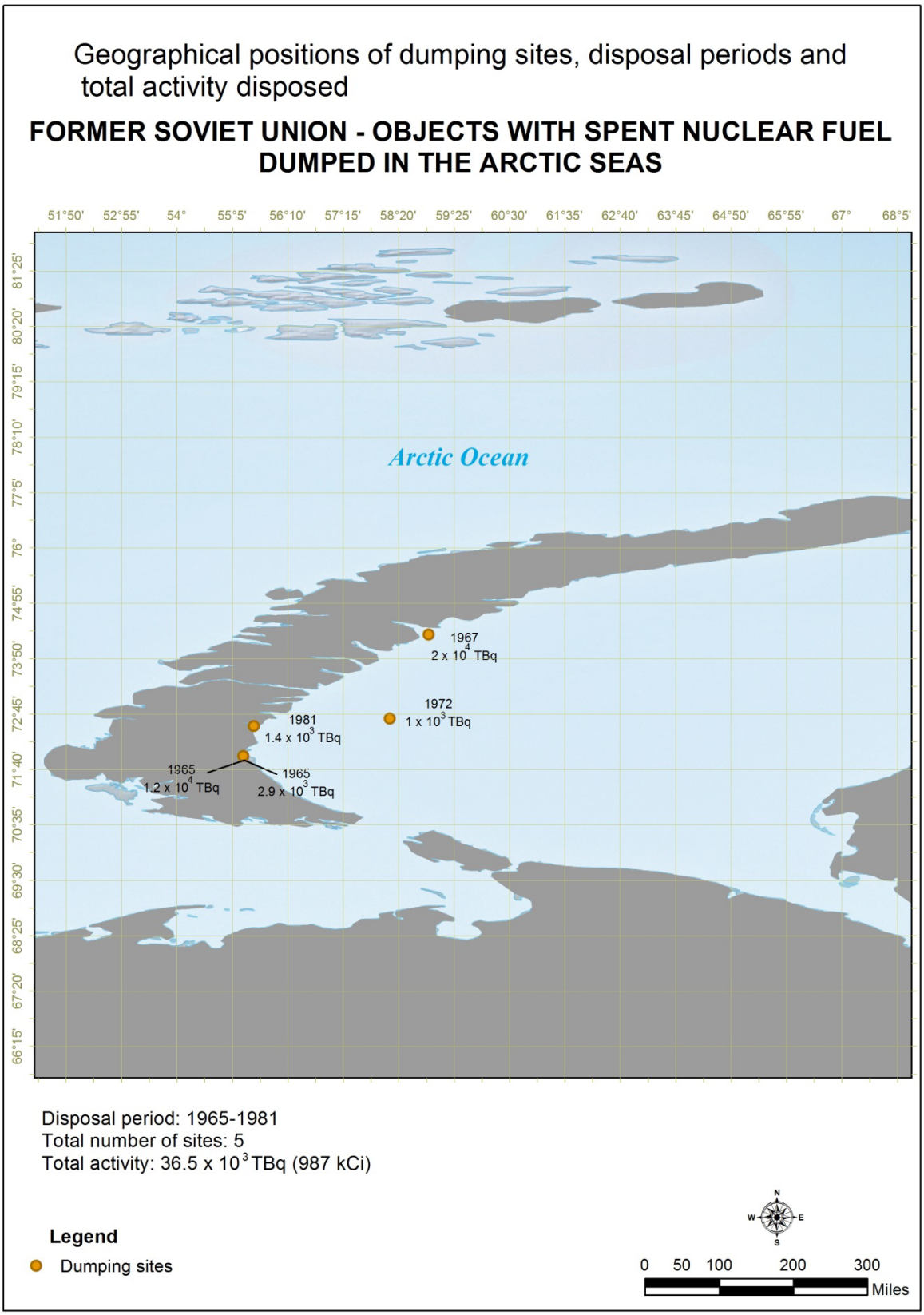
DATE	CO-ORDINATES		DEPTH	VOLUME	ACTIVITY	FORM OF DISPOSAL		
	Latitude	Longitude	m	m^3	TBq	Containers	Ships	Unpackaged
Area 1, Kara Sea (Novaya Zemlya Depression)			380					
1967	73º 17'N	59º 54'E		212.00	1.306			3 pumps of icebreaker Lenin
1967	72º 21'N	57º 50'E		910.00	13.283		m/v Diaz	
1968	73º 06'N	59º 10'E		150.00	0.207		Barge No. 3	
1969				144.80	5.890	–	-	–
1970	73º 11'N	59º 54'E		144.00	0.207	–	-	–
1972	72º 24'N	57º 55'E		–	5.920		Lighter Sayany	
1973	72º 23'N	58º 0'E		–			Tanker TNT15	
1974	72º 11'N	57º 40'E		–			Tanker Goryn	
1975	72º 38'N	58º 20'E		5000.00	1.110		Lighter Oma	
1977	72º 19'N	57º 46'E		600.00	0.022		Lighter L-3	
1980	72º 18'N	57º 36'E		243.00	4.381		m/v-801250	
1980	72º 15'N	57º 35'E		–		–	–	–
1984	72 º15'N	57 º30'E		295.10	9.176		Containers (V*+)	
1984	72 º15'N	57 º30'E		4.00	0.215			Class III furfurol — acetone resin (V+)
1984	72 º15'N	57 º30'E		3.00	0.548			Primary loop circulating pump
1985	72 º21'N	57 º50'E		5182.10	27.315	1027		1 large object
1985	73 º06'N	59 º10'E		693.26	18.759	535		
1986	72 º21'N	57 º50'E		419.40	5.803	321		
1987	73 º07'N	59 º10'E		1302.30	23.241	847		Steam generator, primary loop circulating pump
1989	73 º 06'N	59 º 10'E		370.26	3.223	256		
1989	72 º 21'N	57 º 50'E		142.00	0.895	57		
1991	73 º 17'N	59 º 54'E		264.40	0.764	131		1 large object
1991	73 º17'N	59 º 54'E		54.50	0.552			
Subtotal Area 1				**16134**	**122.8**	**3174**	**8**	**9**
Area 2, Sedov Inlet (east coast of Novaya Zemlya)			13–33					
1982	74º 40'N	59º 55'E		–	3.700			
1982	74º 40'N	59º 55'E		2357.6	63.573	298		91 4K-650 B bundles
1982	74º 42'N	69º 56'E		218.4	2.353	182		
1982	74º 41'N	59º 53'E		276.0	4.378	230		
1983	74º 40'N	59º 56'E		280.5	41.493	231		
1984	74º 41'N	60º 17'E		136.5	6.394	108		
1984	74º 41'N	60º 17'E		3.0	0.222			6 filters
1984	74º 41'N	60º 17'E		10.5	1.943			7 pcs. primary loop circulating pumps
1984	74º 41'N	60º 17'E		150.9	2.117	59		1 steam generator
Subtotal Area 2				**3433**	**126. 2**	**1108**	**–**	**106**

DATE	CO-ORDINATES		DEPTH	VOLUME	ACTIVITY	FORM OF DISPOSAL		
	Latitude	Longitude	m	m^3	TBq	Containers	Ships	Unpackaged
Area 3, Oga Inlet (east cost of Novaya Zemlya)			24					
1968	74º 07'N	59º 12'E		400.0	0.148		Barge SB-5	1 large object
1976	74º 35'N	59º 15'E		560.0	34.373			
1978	74º 17'N	58º 18'E		170.0	0.574			1 large object
1980	74º 35'N	59º 14'E		287.0	10.151			1 large object
1980	74º 35'N	59º 14'E		500.0	2.191			
1981				-	12.915	Containers,		1 large object
1983	74º 35'N	59º 13'E		540.0	7.597	212		
1983	74º 35'N	59º 13'E		580.0	7.052	260		
Subtotal Area 3				**3037**	**75.0**	**472**	**1**	**4**
Area 4, Tsivolka Inlet (east coast of Novaya Zemlya)			56–135					
1964	74º 22'N	58º 41'E		640.0	36.163	1600	Lighter N. Bauman	1 large object
1965	74º 22'N	58º 41'E		266.0	16.612			1 large object
1966	74º 22'N	58º 41'E		446.0	19.764			1 large object
1967	74º 22'N	58º 42'E		240.0	13.874			1 large object
1967	74º 22'N	58º 41'E		25.2	1.060			1 large object
1967	74º 23'N	58º 42'E		72.2	2.856			1 large object
1976	74º 22'N	58º 42'E		1233.0	0.444		Lighter Kolezhma	
1978	74º 22'N	58º 41'E		438.0	8.529	–		
Subtotal Area 4				**3360**	**99.3**	**1600**	**2**	**6**
Area 5, Stepovoy Inlet (east coast of Novaya Zemlya)			25–27					
1968	72º 32'N	55º 33'E		185.2	6.837			1 large object from icebreaker Lenin
1970	72º 33'N	55º 29'E		243.0	13.727			1 large object
1972	72º 33'N	55º 26'E		242.0	7.844			1 large object
1973	72º 33'N	55º 23'E		532.0	12.034			1 large object
1975	72º 33'N	55º 24'E		445.0	6.919			1 large object
Subtotal Area 5				**1647**	**47.4**	**–**	**–**	**5**
Area 6, Abrosimov Inlet (east coast of Novaya Zemlya)			12–20					
1966	71º 56'N	55º 19'E		–	–		Barge	
1967	71º 56'N	55º 21'E		–	0.010		Barge MNN 231500	
1967	71º 56'N	55º 21'E		–	1.110		Barge MSN-378250	1 large object
1974	71º 56'N	55º 21'E		520.0	8.473			
1977	71º 55'N	55º 22'E		254.0	14.319	8		
1980	71º 56'N	55º 21'E		750.0	0.370		Lighter L-8711	5 steam generators 1 large object
1981	71º 56'N	55º 21'E		392.0	0.185	–		
Subtotal Area 6				**1916**	**24.5**	**8**	**4**	**7**

DATE	CO-ORDINATES		DEPTH	VOLUME	ACTIVITY		FORM OF DISPOSAL	
	Latitude	Longitude	m	m^3	TBq	Containers	Ships	Unpackaged
Area 7, Blagopoluchiye Inlet (east coast of Novaya Zemlya)			13–16					
1972	75º 40'N	63º 39'E		331.0	8.689			1 large object from icebreaker Lenin
Subtotal Area 7				**331**	**8.7**	**–**	**–**	**1**
Area 8, Techeniye Inlet (east coast of Novaya Zemlya)			Up to 50					
1982	76º 58'N	66º 20'E		91.2	1.086	76		
1982	76º 58'N	66º 20'E		84.0	0.148	70		
1988	73º 59'N	66º 18'E		229.0	67.015		Lighter No. 4	
Subtotal Area 8				**404**	**68.3**	**146**	**1**	
Area 9, Kolguvev Island								
1978	69º 34'2"N (20 miles to north-west of Kolguyev Island)	47º 56'5"E		1100.0	1.480		Lighter Nikel	7 leads of reactor, 5 steam generators, 2 steam reductors
Subtotal Area 9				**1100**	**1.5**	**–**	**1**	**14**
Area 10,Chernaya bay (south of Novaya Zemlya)								1 steam tube
1991				–	11.100 (30 Ci)		1 LO (Ship)	
Subtotal Area 10					**11.100**		**1**	**1**
Subtotal Areas 1–10				**31363**	**584.6**	**6508**	**18**	
Outside Areas 1–10	Barents Sea			–	> 3.7			Barge with solid RW in welded hold
Total				**31363**	**> 588.3 (>15901 Ci)**	**6508**	**18**	**153**

* V is designated as vessel.

I-17. FORMER SOVIET UNION (OBJECTS WITH SPENT NUCLEAR FUEL DUMPED IN THE ARCTIC SEAS)



Object	Co-ordinates (1) and year	Depth (metres)	Total activity (PBq)	Radionuclide content	Reference (2)
Compartment of NS Number 285 with 2 reactors, (one reactor containing SNF)	71°56'2" N, 55°18'5" E, Abrosimov Fjord, 1965	20	11.610 (313.8 kCi)	Fission products, activation products and actinides	[I-3]
Compartment of NS Number 901 (with 2 reactors containing SNF	71°56'2" N, 55°18'9" E, Abrosimov Fjord, 1965	20	2.946 (79.6 kCi)	Fission products, activation products and actinides	[I-3]
Shielding assembly of reactor from nuclear icebreaker Lenin with residual SNF (60% of original UO, fuel charge)	74"22'1" N, 58°42'2" E, Tsivolka Fjord, 1967	49	19.552 (528.4 kCi)	Fission products, activation products and actinides	[I-4]
Reactors of NS Number 421 (containing SNF)	72°40' N, 58°10' E, Novaya Zemlya Trough, 1972	300	1.048 (28.3 kCi)	Fission products, activation products and actinides	[I-3]
NS Number 601 (with 2 reactors containing SNF)	72°31'1" N, 55°30'15" E, Stepovoy Fjord, 1981	50	1.36 (37.0 kCi)	Fission products, activation products and actinides	[I-5]
Total: 5 objects (6 reactors and special container with SNF)	1965-1981		36.516 (986.9 kCi)		

(1) These are the co-ordinates given in the official information provided by the Russian Federation (e.g in the report referred to as the"White Book") [I-6]. The joint Norwegian-Russian investigations in the dumping areas [I-7] showed that a number of the coordinates of dumped objects cited in the White Book are inaccurate. Thus in Abrosimov Fjord, two reactor compartments were discovered at point 71°56'44"N 55°18'81"E; one reactor compartment at point 71°56'50"N 55°18'71"E; a submarine in Stepovoy Fjord was found at 72°31'33"N 55°33'50"E. Work on establishing which nuclear submarines (factory numbers) these reactor compartments belong to is yet to be completed.

(2) Relevant information is taken from Tables 9, 12 and 18 of Reference [I-3], Table 4 of Reference [I-4] and Table 13 of Reference [I-5] and are summarized in AnnexVI.

NS = nuclear submarine.
SNF = spent nuclear fuel

I-18. FORMER SOVIET UNION (RADIOACTIVE OBJECTS WITHOUT SPENT NUCLEAR FUEL DUMPED IN THE ARCTIC SEAS)



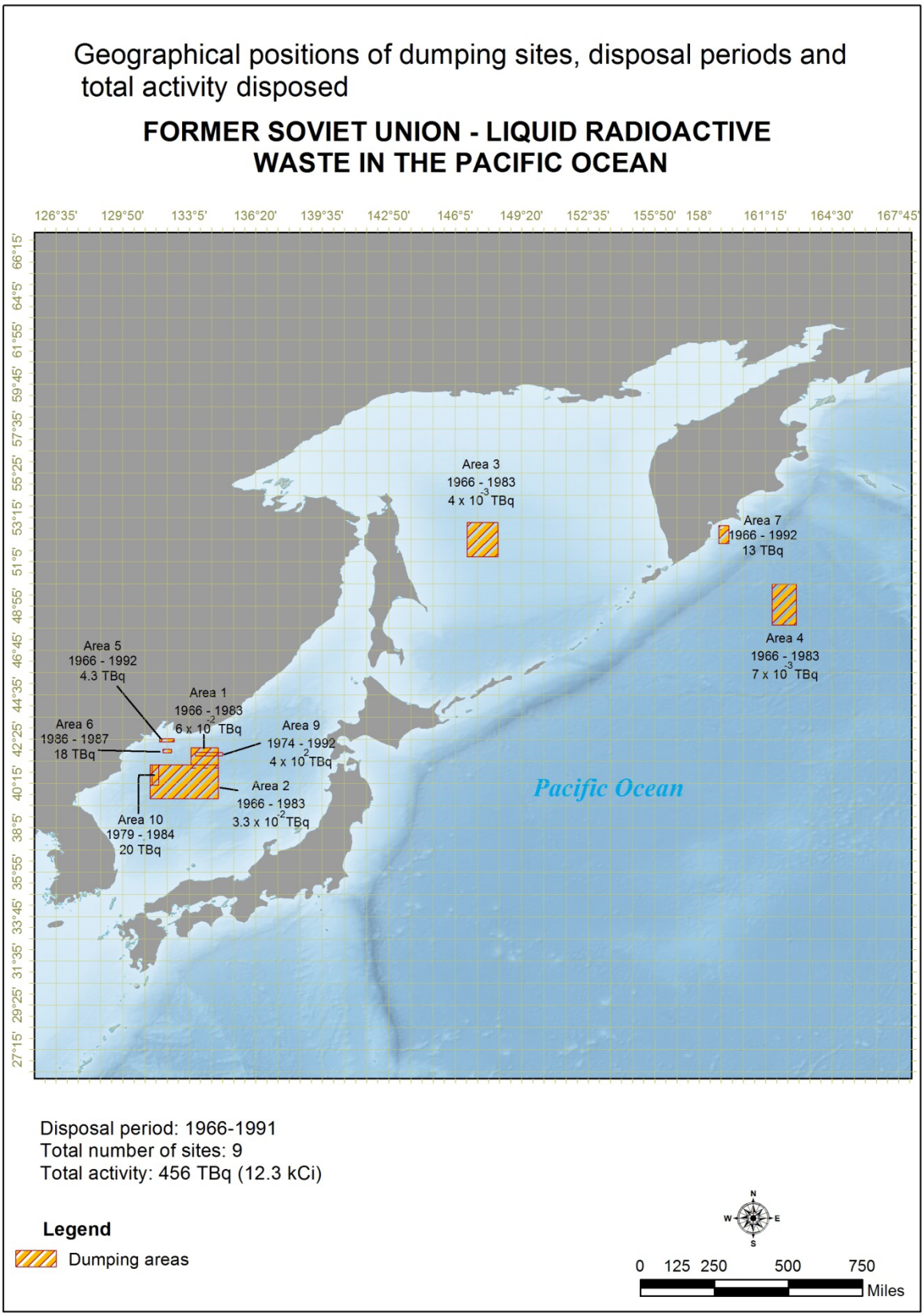
Object	Co-ordinates (1) and year	Depth (metres)	Total activity (PBq)	Radionuclide content	Reference (2)
Reactor compartment of NS Number 285 with 2 reactors (one reactor without SNF)	71°56'2" N, 55°18'5" E, Abrosimov Fjord, 1965	20	Included in NS 285 in the table of Annex I-17	Activation products	[I-3]
Reactor compartment of NS Number 254 (with 2 reactors without SNF)	71°55'13" N, 55°32'32" E, Abrosimov Fjord, 1965	20	0.093 (2.5 kCi)	Activation products	[I-3]
Reactor compartment of NS Number 260 (with 2 reactors without SNF)	72"56'2" N, 55°18'5" E, Abrosimov Fjord, 1966	20	0.044 (1.2 kCi)	Activation products	[I-3]
Steam generating installation OK- 150 of icebreaker Lenin (comprising 3 reactors without SNF and with primary loop pipelines and water tight stock equipment)	74°26'4" N, 58°37'3" E, Tsivolka Fjord, 1967	50	Included in OK-150 in the table of Annex I-17	Activation products	[I-4]
Reactor compartment of NS Number 538 (with 2 reactors without SNF)	75°55' N 66°24' E, Techeniye Fjord, 1988	35-40	0.006 (0.2 kCi)	Activation products	[I-3]
Total 5 objects with 10 reactors without SNF	1965–1988		0.143 (3.9.kCi)		

(1) These are the co-ordinates given in the official information provided by the Russian Federation (e.g in the report refered to as the "White Book") [I-6]. The joint Russian-Norwegian investigations in the dumping areas [I-7] showed that a number of the coordinates of dumped objects cited in the White Book are inaccurate Thus in Abrosimove Fjord, two reactor compartments were discovered at point 71°56'44"N 55°18'81 "E, one reactor compartment at point 71°56'50"N 55°18'7"E, a submarine in Stepovoy Fjord was found at 72°31'33"N 55°33'50"E. Work on establishing which nuclear submarines (factory numbers) these reactor compartments belong to is yet to be completed. Approximate co-ordinates of the dumping site Techeniye Fjord are 75°59' N, 66°18' E.

(2) Relevant information is taken from Table 4 of Reference [I-4] and Tables 3, 6 and 15 of Reference [I-3] and are summarized in Annex VI.

NS = nuclear submarine
SNF = spent nuclear fuel

I-19. FORMER SOVIET UNION (LIQUID RADIOACTIVE WASTE IN THE PACIFIC OCEAN)



SUMMARY

AREA	CO-ORDINATES		DEPTH	ACTIVITY	GEOGRAPHICAL LOCATION
	Latitude	Longitude	m	TBq	
1	42º 0'N	133º 10'E	3250–3700	0.056	Sea of Japan*
	42º 0'N	134º 30'E			
	41º 0'N	133º 10'E			
	41º 0'N	134º 30'E			
2	41º 10'N	131º 10'E	2900–3300	0.033	Sea of Japan*
	41º 10'N	134º 30'E			
	39º 30'N	131º 10'E			
	39º 30'N	134º 30'E			
3	53º 0'N	148º 10'E	-	0.004	Pacific Ocean
	53º 0'N	146º 40'E			(east coast of Kamchatka)
	51º 20'N	148º 10'E			
	51º 20'N	146º 40'E			
4	50º 0'N	162º 45'E	-	0.007	Pacific Ocean
	50º 0'N	161º 35'E			(east coast of Kamchatka)
	48º 0'N	162º 40'E			
	48º 0'N	161º 35'E			
5	42º 26'N	131º 37'E	1100–1500	4.325	Sea of Japan*
	42º 26'N	132º 20'E			
	42º 17'N	131º 37'E			
	42º 17'N	132º 20'E			
6	41º 55'N	131º 47'E	1900–3300	18.084	Sea of Japan*
	41º 55'N	132º 13'E			
	41º 45'N	131º 47'E			
	41º 45'N	132º 13'E			
7	52º 28'N	159º 02'E	1400–1500	13.007	Pacific Ocean
	52º 28'N	159º 12'E			(east coast of Kamchatka)
	52º 40'N	159º 02'E			
	52º 40'N	159º 12'E			

* The practice of the UN Secretariat is to use, in the absence of an internationally agreed standard, the most widespread and generally recognized denomination. This practice is without any prejudice to the position of any Member State of the United Nations on a particular appellation and does not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations. The use of an appellation by the Secretariat based on the practice is without prejudice to any negotiations or agreements between the interested parties and should not be interpreted as advocating or endorsing any party's position, and can in no way be invoked by any party in support of a particular position in the matter.

AREA	CO-ORDINATES		DEPTH	ACTIVITY	GEOGRAPHICAL LOCATION
	Latitude	Longitude	m	TBq	
9	41º 36'N	133º 22'E	3250–3700	401.087	Sea of Japan*
	41º 36'N	134º 42'E			
	41º 46'N	133º 22'E			
	41º 46'N	134º 42'E			
10	40º 10'N	131º 15'E	2900–3300	19.816	Sea of Japan*
	41º 10'N	131º 15'E			
	40º 10'N	131º 35'E			
	41º 10'N	131º 35'E			
Total				**456.42 (12335.6 Ci)**	

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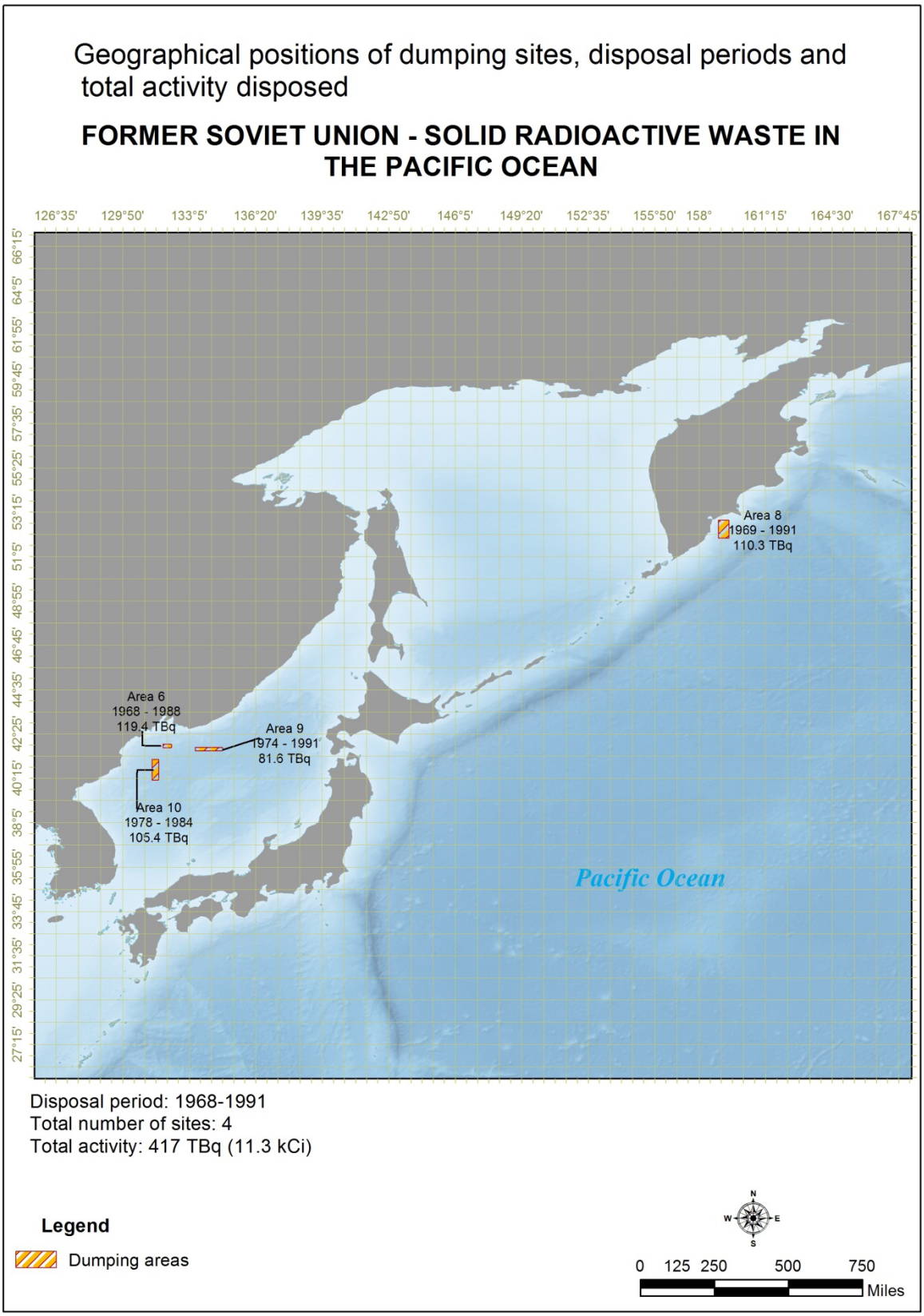
DATE	CO-ORDINATES		DEPTH	VOLUME	ACTIVITY
	Latitude	Longitude	m	m^3	TBq
		Area 1	3250–3700		
1966-1983*	42º 0'N	133º 10'E		16250.00	0.056
	42º 0'N	134º 30'E			
	41º 0'N	133º 10'E			
	41º 0'N	134º 30'E			
		Area 2	2900–3300		
1966-1983*	41º 10'N	133º 10'E		3156.00	0.033
	41º 10'N	134º 30'E			
	39º 30'N	133º 10'E			
	39º 30'N	134º 30'E			
		Area 3	–		
1966-1983*	53º 0'N	148º 10'E		1513.00	0.004
	53º 0'N	146º 40'E			
	51º 20'N	148º 10'E			
	51º 20'N	146º 40'E			
		Area 4	–		
1966-1983*	48º 0'N	161º 35'E		4803.00	0.007
	50º 0'N	162º 45'E			
		Area 5	1100–1500		
	42º 26'N	131º 37'E			
	42º 26'N	132º 20'E			
	42º 17'N	131º 37'E			
	42º 17'N	132º 20'E			
1966				–	0.005
1967				–	0.006
1968				–	0.115
1969				–	0.033
1970				–	0.067
1971				–	0.057
1972				–	1.197
1973				2930.00	0.867
1974				900.00	1.036
1986				33.00	0.006
1986				223.00	–
1988				1808.00	0.692
1990				133.00	–
1991				900.00	0.196
1992				906.00	0.048
Subtotal Area 5				**7833.00**	**4.325**

DATE	CO-ORDINATES		DEPTH	VOLUME	ACTIVITY
	Latitude	Longitude	m	m^3	TBq
	Area 6		1900–3300		
	41º 55'N	131º 47'E			
	41º 55'N	132º 13'E			
	41º 45'N	131º 47'E			
	41º 45'N	132º 13'E			
1986				824.00	11.772
1987				872.00	2.072
1987				904.00	1.765
1987				664.00	1.865
1987				904.00	0.514
1987				904.00	0.096
Subtotal Area 6				**5072.00**	**18.084**
	Area 7		1400–1500		
	52º 28'N	159º 02'E			
	52º 28'N	159º 12'E			
	52º 40'N	159º 02'E			
	52º 40'N	159º 12'E			
1966				800.00	0.004
1967				900.00	0.001
1968				900.00	0.002
1969				1200.00	0.008
1970				–	0.009
1971				–	0.044
1972				2100.00	0.006
1973				3700.00	0.189
1974				–	0.002
1975				856.00	–
1977				1517.00	0.035
1978				2334.00	0.196
1980				2335.00	0.011
1981				3530.00	0.103
1982				2960.00	5.546
1983				1730.00	1.056
1984				526.00	0.708
1985				305.00	0.474
1986				2550.00	0.979
1987				780.00	1.180
1988				1230.00	1.587
1989				1660.00	0.402

DATE	CO-ORDINATES		DEPTH	VOLUME	ACTIVITY
	Latitude	Longitude	m	m^3	TBq
1990				890.00	0.048
1991				580.00	0.369
1992				906.00	0.048
Subtotal Area 7				**34289.00**	**13.007**
	Area 9		3250–3700		
	41º 36'N	133º 22'E			
	41º 36'N	134º 42'E			
	41º 46'N	133º 22'E			
	41º 46'N	134º 42'E			
1974				2835.00	0.822
1975				2028.00	0.128
1976				3630.00	0.483
1977				2210.00	0.014
1978				4124.00	0.739
1984				1500.00	0.121
1985				2997.50	7.048
1986				3698.74	379.264
1987				2710.00	8.044
1988				720.00	0.387
1989				1807.00	3.289
1990				902.00	0.312
1991				2034.00	0.155
1992				1774.00	0.281
Subtotal Area 9				**32970.2**	**401.087**
	Area 10		2900–3300		
	40º 10'N	131º 15'E			
	41º 10'N	131º 15'E			
	40º 10'N	131º 35'E			
	41º 10'N	131º 35'E			
1979				3140.0	15.208
1980				3545.0	1.926
1981				929.0	0.148
1982				2840.0	0.502
1983				3553.6	0.754
1984				3600.0	1.278
Subtotal Area 10				**17607.6**	**19.816**
Total Areas (1–7, 9–10)				**97771.8**	**456.419 (12335.6 Ci)**

* For areas 1–4, year by year breakdown not available.

I-20. FORMER SOVIET UNION (SOLID RADIOACTIVE WASTE IN THE PACIFIC OCEAN)



SUMMARY

AREA	CO-ORDINATES		DEPTH	ACTIVITY	GEOGRAPHICAL LOCATION
	Latitude	Longitude	m	TBq	
6	41º 55'N	131º 47'E	1900–3300	119.399	Sea of Japan*
	41º 55'N	132º 13'E			
	41º 45'N	131º 47'E			
	41º 45'N	132º 13'E			
8	52º 28'N	159º 06'E	2000–2570	110.692	Pacific Ocean
	52º 28'N	159º 11'E			(east coast of Kamchatka)
	52º 34'N	159º 02'E			
	52º 34'N	159º 11'E			
9	41º 36'N	133º 22'E	3250–3700	82.143	Sea of Japan*
	41º 36'N	134º 42'E			
	41º 46'N	133º 22'E			
	41º 46'N	134º 42'E			
10	40º 10'N	131º 15'E	2900–3300	105.385	Sea of Japan*
	41º 10'N	131º 15'E			
	40º 10'N	131º 35'E			
	41º 10'N	131º 35'E			
Total				**417.619 (11287Ci)**	

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DATE	CO-ORDINATES		DEPTH	VOLUME	ACTIVITY	FORM OF DISPOSAL		
	Latitude	Longitude	m	m^3	TBq	Containers	Ships	Unpackaged
	Area 6		1900–3300					
1968	No data			136.0	0.777	136		
1969	No data			1145.0	7.733	1145		
1970	No data			693.0	0.814	693		
1971	41° 55'N	131° 47'E	2000		43.309			NS No. 143 RB and NS No. 143 LB
					43.941			Nuclear submarine reactors without SNF *
1971	No data			481.0	4.107	481		
1973	No data			241.0	4.514	241		
1973	No data			550.0	2.146		m/v Litiy	
1973	No data			70.0	0.111		Floating crane	
1986	41° 50'N	131° 30'E		59.0	2.664	52		
1986	41° 50'N	131° 30'E		40.0	0.148	40		
1986	41° 50'N	132° 0'E		371.0	0.407		Fishing vessel Indra	
1986	41° 51'N	132° 0'E		180.0	4.255		f/v Kapitan Aron	
1987	41° 50'N	132° 0'E		21.0	1.591			Part of a crane
1987	41° 50'N	132° 0'E		200.0	0.629		Barge	
1987	41° 50'N	132° 0'E		95.0	0.518	44		
1987	41° 50'N	132° 0'E		16.0	0.037			Metal
1987	41° 50'N	132° 0'E		37.0	1.258	37		
1987	41° 50'N	132° 0'E		48.0	0.185	32		
1988	41° 50'N	132° 0'E		26.0	0.255	14		
Subtotal Area 6				**4409.0**	**119.399**	**2915**	**5**	**4**
	Area 8		2000–2570					
1969	No data			61.0	4.921	61		
1970	No data			20.0	0.518	20		
1970	52° 28'N	159° 6'E		16.0	0.518	16		
1970	52° 28'N	159° 11'E		4.0	0.222	4		
1970	52° 34'N	159° 2'E		4.0	0.189	4		
1970	52° 34'N	159° 11'E		16.0	0.592	18		
1970	No data			16.0	2.331	16		
1971	No data			20.0	0.333	20		
1971	No data			5.0	2.590	5		
1972	No data			300.0	0.141		m/v Sungay	
1972	No data			14.0	0.118	14		
1973	No data			60.0	0.962	60		
1974	No data			56.0	0.178	56		
1975	No data			64.0	1.739	64		
1976	No data			27.0	0.629	27		
1977	No data			25.0	1.517	25		
1978	No data			50.0	1.332	50		
1980	54° 34'N	159° 2'E		94.0	0.999	94		
1981	52° 28'N	159° 11'E		48.0	0.999	48		

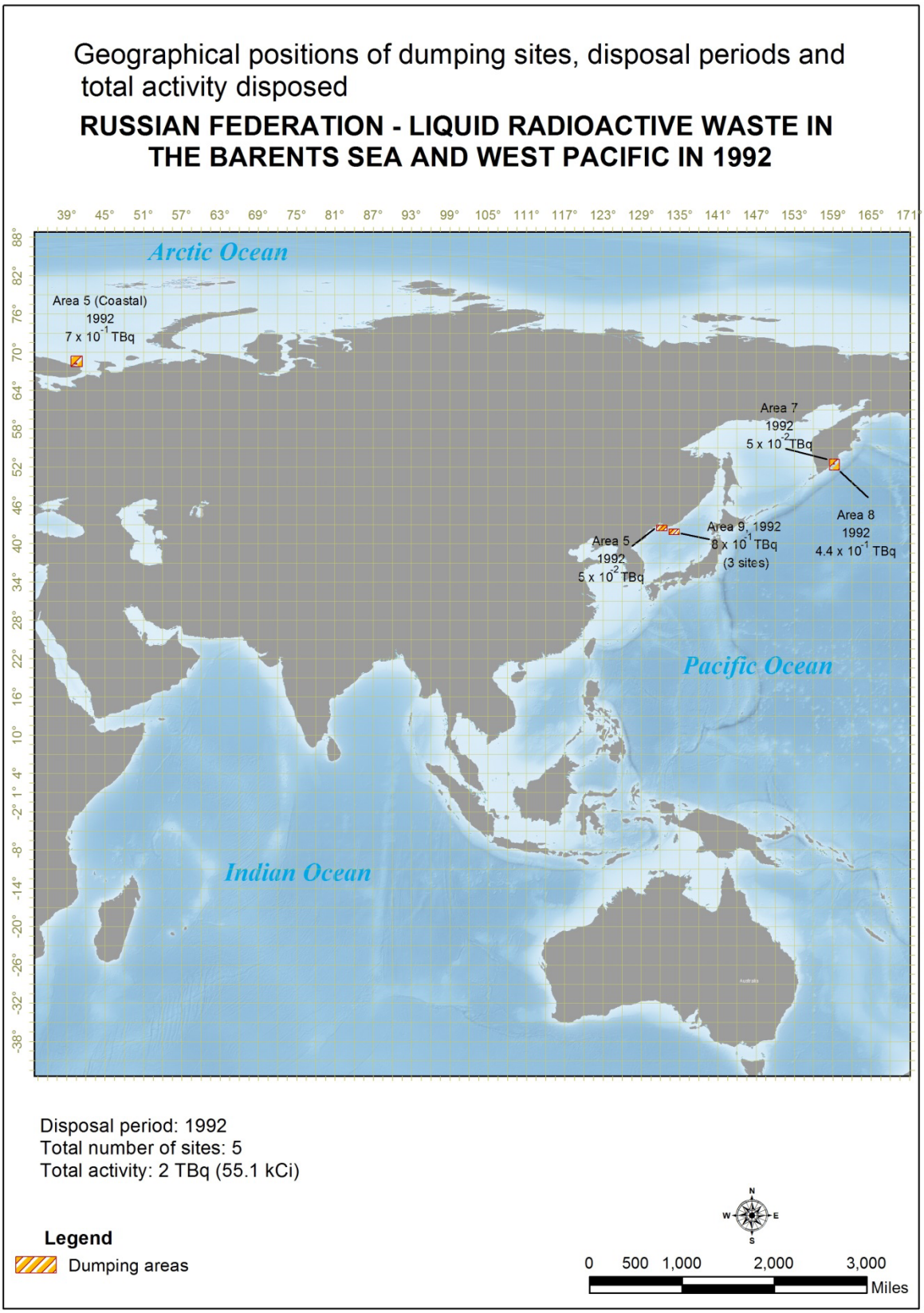
DATE	CO-ORDINATES		DEPTH	VOLUME	ACTIVITY	FORM OF DISPOSAL		
	Latitude	Longitude	m	m^3	TBq	Containers	Ships	Unpackaged
1982	54º 34'N	159º 11'E		95.0	8.954	95		
1983	52º 28'N	159º 2'E		60.0	1.628	60		
1985	52º 30'N	159º 4'E		82.0	56.869	51		
1986	52º 31'N	159º 9'E		47.0	0.407	41		
1986	52º 30'N	159º 8'E		15.0	0.296	15		
1986	52º 31'N	159º 8'E		8.0	1.443			50 pumps
1986	52º 31'N	159º 8'E		105.0	1.665	105		
1987	52º 31'N	159º 8'E		50.0	1.517	50		
1987	52º 32'N	159º 8'E		51.0	1.480	50		
1988	52º 30'N	159º 8'E		2.7	0.296			1 pump
1988	52º 30'N	159º 9'E		70.0	2.183			10 steam generators
1988	52º 30'N	159º 9'E		97.0	1.369	97		
1989	52º 30'N	159º 9'E		46.0	0.481	46		
1989	52º 30'N	159º 9'E		7.0	2.590			1 protective screen
1989	52º 30'N	159º 9'E		3.7	0.031			1 pump
1989	52º 30'N	159º 9'E		30.0	0.629	30		
1989	52º 30'N	159º 9'E		14.0	0.130			Gas bags
1989	52º 30'N	159º 9'E		56.0	0.311	56		
1990	52º 30'N	159º 9'E		72.0	0.481	72		
1990	52º 30'N	159º 9'E		600.0	5.106		Barge	
1990	52º 30'N	159º 9'E		55.0	1.073	50		
1991	52º 30'N	159º 9'E		41.0	0.481	41		
1992	52º 30'N	159º 9'E		46.0	0.444	41		
Subtotal Area 8				**2553.4**	**110.692**	**1502**	**2**	**63+**
	Area 9		3250–3700					
1974	41º 40'N	133º 30'E		14	0.222	14		
1974	41º 45'N	134º 41'E		32	0.629	32		
1974	41º 44'N	134º 2'E		28	0.074	28		
1974	41º 36'N	133º 22'E		132	1.221		Seiner No. 100	
1975	41º 41'N	133º 40'E		40	1.332	40		
1975	41º 40'N	134º 1'E		4	0.814	4		
1975	41º 40'N	134º 1'E		40	10.952	40		
1975	41º 39'N	134º 10'E		18	1.036	18		
1975	41º 40'N	133º 30'E		22	0.311	22		
1975	41º 40'N	133º 30'E		20	0.962	20		
1975	41º 36'N	132º 22'E		130	0.592		Seiner No. 5	
1975	41º 36'N	132º 22'E		63	0.148	63		
1975	41º 36'N	132º 22'E		230	0.740		Seiner No. 6	
1975	41º 36'N	132º 22'E		204	0.703		Seiner No. 4	
1975	41º 41'N	134º 41'E		196	0.962		Seiner No. 2	
1975	41º 41'N	134º 41'E		154	0.592		Seiner No. 3	
1975	41º 41'N	134º 41'E		36	0.133	36		

DATE	CO-ORDINATES		DEPTH	VOLUME	ACTIVITY	FORM OF DISPOSAL		
	Latitude	Longitude	m	m^3	TBq	Containers	Ships	Unpackaged
1976	41° 41'N	133° 30'E		40.0	0.592	40		
1977	41° 42'N	133° 30'E		46.0	6.068	46		
1977	41° 41'N	133° 22'E		62.0	0.111	38		
1977	41° 37'N	133° 42'E		174.0	0.222		Seiner	
1977	41° 37'N	133° 42'E		160.0	0.222		Seiner	
1978	41° 40'N	133° 40'E		29.0	0.407	29		
1978	41° 40'N	133° 40'E		13.0	0.666	13		
1978	41° 40'N	133° 40'E		23.0	0.126	23		
1978	41° 43'N	133° 35'E		28.0	0.091	28		
1978	41° 41'N	133° 31'E		39.0	2.516	39		
1978	41° 40'N	133° 31'E		36.0	0.278	36		
1978	41° 38'N	133° 41'E		33.0	0.185	33		
1978	41° 37'N	133° 42'E		235.0	0.555		Seiner	
1978	41° 37'N	133° 42'E		178.0	0.407		Seiner	
1978	41° 44'N	133° 26'E		29.0	0.074	27		
1978	41° 44'N	133° 26'E		321.0	0.185	321		
1984	41° 41'N	134° 2'E		34.0	8.732	34		
1984	41° 39'N	133° 30'E		29.0	0.315	29		
1985	41° 38'N	133° 30'E		36.0	0.307	31		
1985	41° 39'N	133° 30'E		60.0	0.359	60		
1985	41° 40'N	133° 23'E		201.0	0.518		m/v Ungur	
1985	41° 37'N	134° 0'E		80.0	0.796	80		
1985	41° 41'N	134° 1'E		50.0	3.330	50		
1985	41° 38'N	133° 25'E		58.0	0.122	58		
1986	41° 40'N	134° 10'E		38.0	2.590	37		
1986	41° 40'N	134° 18'E		31.0	0.555	31		
1986	41° 46'N	134° 10'E		20.0	0.185	18		
1987	41° 40'N	134° 20'E		31.0	0.962	34		
1987	41° 46'N	134° 30'E		41.0	3.145	28		
1987	41° 36'N	133° 22'E		474.0	0.499		Seiner	
1987	41° 36'N	134° 30'E		42.0	0.296	28		
1988	41° 36'N	134° 30'E		208.0	0.296			
1988	41° 46'N	134° 30'E		50.0		34		
1988	41° 40'N	134° 30'E		1665.0	0.629		Tanker-4	
1988	41° 40'N	134° 18'E		362.0	1.332		f/v-8	
1988	41° 42'N	134° 30'E		56.0	2.294	56		
1988	41° 40'N	134° 18'E		110.0	0.303		f/v-427	
1989	41° 40'N	134° 0'E		35.0	0.518	35		
1989	41° 40'N	134° 0'E		360.0	13.801		Barge	
1990	41° 40'N	134° 0'E		114.0	3.811		SeinerTaezhny	
1991	41° 40'N	134° 0'E		18.0	0.052	14		
1991	41° 40'N	134° 0'E		15.0	0.241			5 steam generators

DATE	CO-ORDINATES		DEPTH	VOLUME	ACTIVITY	FORM OF DISPOSAL		
	Latitude	Longitude	m	m^3	TBq	Containers	Ships	Unpackaged
1991	41° 40′N	134° 0′E						21 pumps
1991	41° 40′N	133° 30′E		124.0	1.461		f/s Otvazhny	
1992	41° 40′N	133° 30′E		2640.0	0.537			
1992	41° 40′N	133° 30′E		55.0	0.029	41		
Subtotal Area 9				**9846**	**82.143**	**1688**	**18**	**26**
	Area 10		2900–3300					
1978	40° 10′N	131° 15′E		31	1.702			Submarine reactor tanks (2 pcs.)
1979	40° 10′N	131° 15′E	3000		37.622			NS No. 172 RB and NS No. 172 LB
					41.100			Nuclear submarine reactors without SNF *
1979	41° 30′N	131° 35′E		60	4.625			Tanks of reservoir for spent process channels (2 pcs.)
1979	40° 10′N	131° 15′E		162	0.340		Fishing ship	
1979	41° 23′N	131° 25′E		50	0.155	42		
1979	40° 10′N	131° 15′E		800	0.766	21		
1980	41° 05′N	131° 30′E		68	2.689	68		
1980	41° 25′N	131° 20′E		65	0.035	53		
1980	40° 10′N	131° 15′E		200	0.081		Fishing ship Tedzhem	
1980	40° 10′N	131° 15′E		240	0.111		Fishing ship Tauz	
1980	41° 29′N	131° 18′E		34	0.007	34		
1980	40° 10′N	131° 18′E		284	0.133		RS-309	
1981	40° 10′N	131° 18′E		165	0.093		Fishing ship Tekeli	
1981	41° 20′N	131° 26′E		183	5.347	188		
1981	41° 00′N	131° 26′E		74	0.019	48		
1981	40° 00′N	131° 15′E		472	0.280	–	Seiner Tagil	
1981	40° 10′N	131° 15′E		217	0.104	–	fs-300	
1982	41° 20′N	131° 26′E		40	1.421	40		
1982	41° 05′N	131° 30′E		36	0.866	36		
1982	40° 10′N	131° 15′E		255	0.263		Fishing ship Troitsk	
1982	41° 29′N	131° 26′E		31	0.004	31		
1982	41° 25′N	131° 21′E		42	0.013	38		
1982	40° 10′N	131° 15′E		450	0.407		Fishing ship Kosmonavt Yegorov	
1983	41° 20′N	131° 26′E		107	3.415	83		Reactor lids (8 pcs.)
1983	41° 25′N	131° 25′E		47	0.087	47		
1983	41° 25′N	131° 25′E		405	0.392		Medium fishing trawler/refrigerator ship	
1983	40° 30′N	131° 35′E		436	0.459		Seiner Izvolta	
1984	40° 20′N	131° 20′E		118	2.849	119		
Subtotal Area 10				**5072**	**105.385**	**848**	**12**	**14**
Total				**21880.4**	**417.619 (11287 Ci)**	**6953**	**37**	**107+**

* Reference [I-8].

I-21. RUSSIAN FEDERATION (LIQUID RADIOACTIVE WASTE IN THE BARENTS SEA AND WEST PACIFIC IN 1992)



Disposal area (co-ordinates)	Type of dumping	Activity TBq
Barents Sea		
Area 5 (coastal) (1)	3066 m^3 LRW	0.666
West Pacific		
Area 5, Sea of Japan* (2)	906 m^3 LRW	0.048
Area 7, east coast of Kamchatka (2)	906 m^3 LRW	0.048
Area 9, Sea of Japan* (2)	1774 m^3 LRW	0.281
Area 8, 52º30'N 159º9'E, east coast of Kamchatka (3)	46 m^3 SRW, 41 containers	0.444
Area 9, 41º40'N 133º30'E, Sea of Japan* (2)	2640 m^3 SRW, tanker TNT-11	0.534
Area 9, 41º40'N 133º30'E, Sea of Japan* (2)	55 m^3 SRW, 41 containers	0.019
Total by type	**6652 m^3 LRW** **2741 m^3 SRW** **1 vessel**	**1.043** **0.997**
Total activity		**2.040** **(55.135 Ci)**

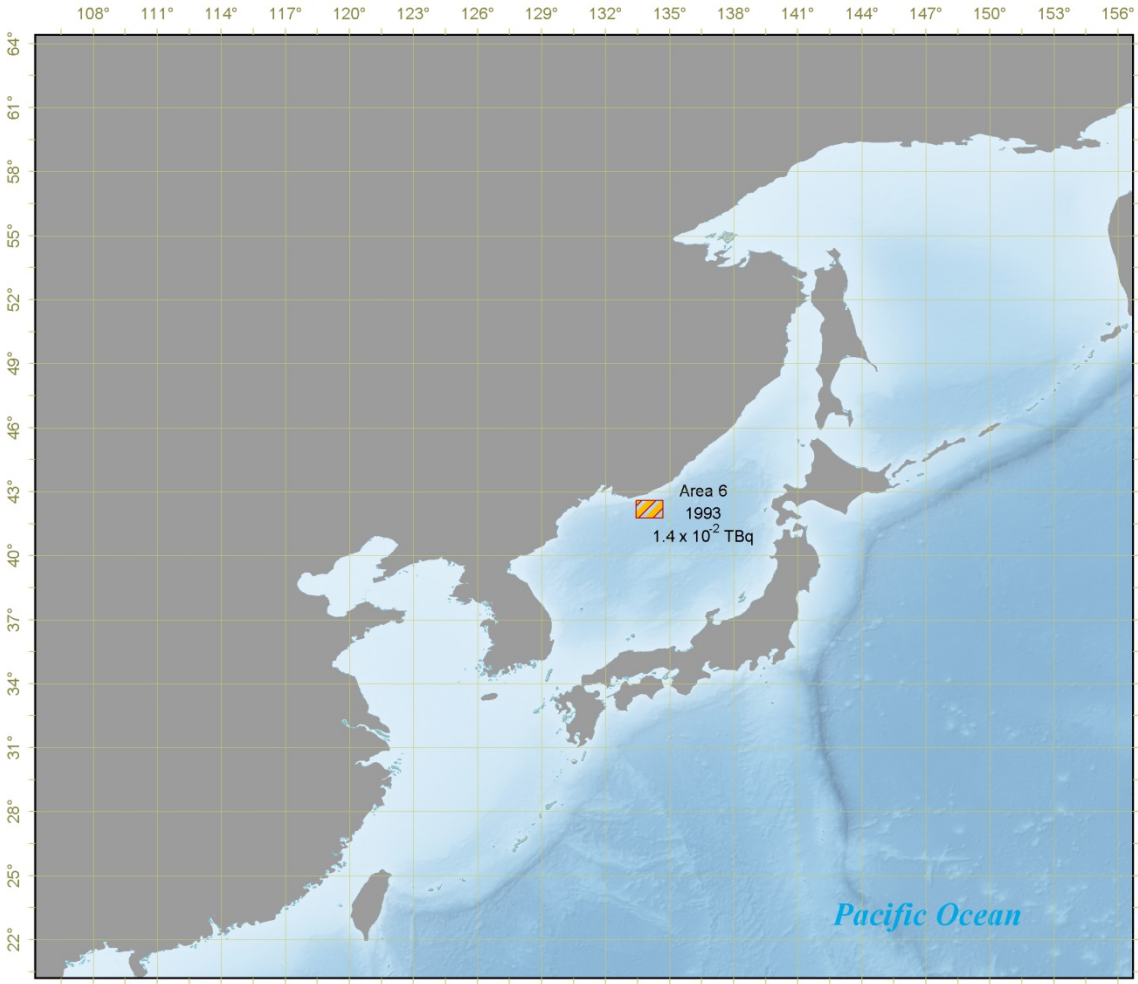
(1) See the table of Annex I-15, Area 5 (coastal).
(2) See the table of Annex I-19, Areas 7 and 9.
(3) See the table of Annex I-20, Area 8.

* The practice of the UN Secretariat is to use, in the absence of an internationally agreed standard, the most widespread and generally recognized denomination. This practice is without any prejudice to the position of any Member State of the United Nations on a particular appellation and does not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations. The use of an appellation by the Secretariat based on the practice is without prejudice to any negotiations or agreements between the interested parties and should not be interpreted as advocating or endorsing any party's position, and can in no way be invoked by any party in support of a particular position in the matter.

I-22. RUSSIAN FEDERATION (LIQUID RADIOACTIVE WASTE IN THE SEA OF JAPAN* IN 1993)

Geographical positions of dumping sites, disposal periods and total activity disposed

RUSSIAN FEDERATION - LIQUID RADIOACTIVE WASTE IN THE SEA OF JAPAN* IN 1993



[*] The practice of the UN Secretariat is to use, in the absence of an internationally agreed standard, the most widespread and generally recognized denomination. This practice is without any prejudice to the position of any Member State of the United Nations on a particular appellation and does not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations. The use of an appellation by the Secretariat based on the practice is without prejudice to any negotiations or agreements between the interested parties and should not be interpreted as advocating or endorsing any party's position, and can in no way be invoked by any party in support of a particular position in the matter.

Disposal period: 1993
Total number of sites: 1
Total activity: 1.4 x 10^{-2} TBq (0.4 Ci)

Legend

Dumping areas

N W E S

0 200 400 800 1,200
Miles

Disposal area (co-ordinates)	Type of dumping	Radionuclides*	Concentration	Total activity
			Bq/L	GBq
Area 6 41°46' – 42°36'N, 133°26' – 134°42'E	Discharge of liquid radioactive waste	Cs-137 Sr-90 Co-60	12029 3318 83	10.73 2.96 0.074
Total activity				**13.764 GBq (0.372 Ci)**

*Information is based on Reference [I-9], the radionuclide distribution from Reference [I-10].

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[I-9] LC 16/J/4 statement made on 10 November 1993 by Mr. V.I. Danilov-Danilyan, Minister of Environmental Protection and National Resources, Russian Federation, at the 16th Consultative Meeting of the London Convention 1972.

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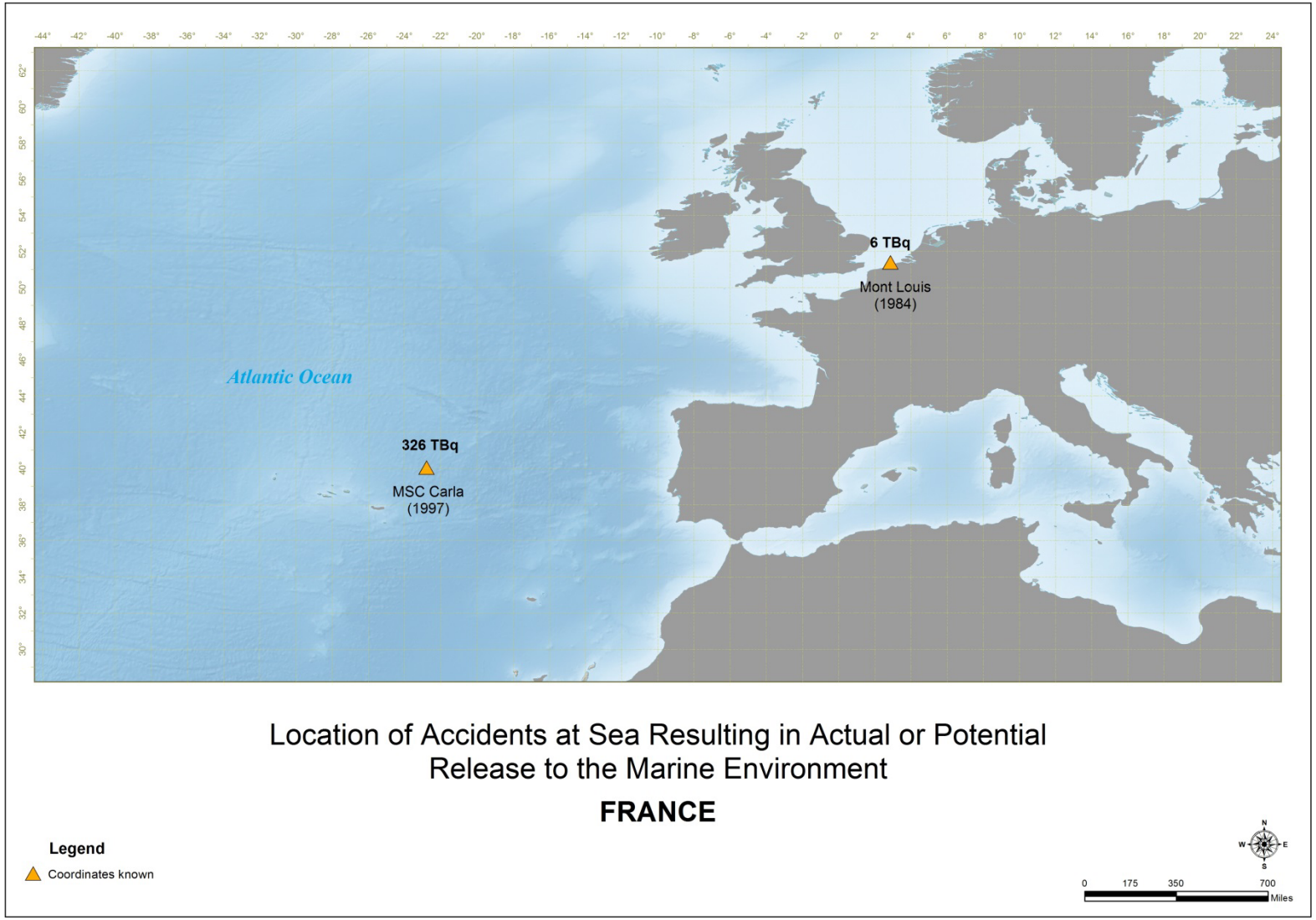
ANNEX II.

ACCIDENTS RESULTING IN ACTUAL OR POTENTIAL RELEASE OF RADIOACTIVE MATERIAL TO THE MARINE ENVIRONMENT BY COUNTRY

II-1. FRANCE


Atlantic Ocean
6 TBq
Mont Louis
(1984)
326 TBq
MSC Carla
(1997)
Location of Accidents at Sea Resulting in Actual or Potential Release to the Marine Environment
FRANCE
Legend
Coordinates known
0 175 350 700
Miles

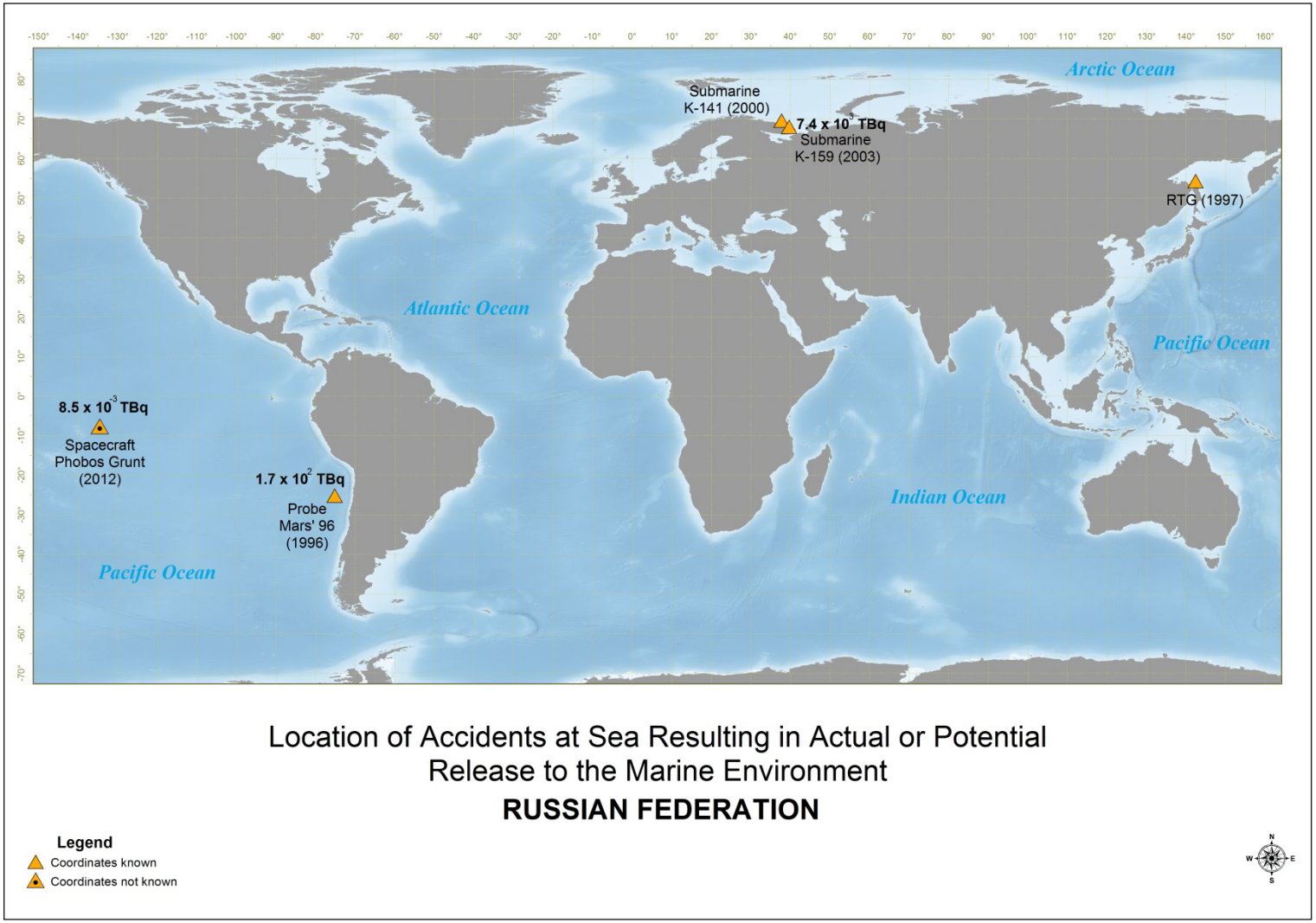
Date	Vessel involved	Geographical area	Latitude	Longitude	Depth (m)	Radioactive material	Recovered	Marine monitoring	Release occurred	Estimated activity released	Total activity
1984	Mont Louis, surface vessel (a)	North Sea 20 km off Zeebrugge	51º 24' 12" N	2º 50' E	25	Containers of uranium hexafluoride	Yes	Yes	No		6 TBq*
1997	MSC Carla (b)	Atlantic Ocean, 70 nautical miles off the Azores	40º 3' N	22º 50' W		3 packages containing Cs-137 sealed sources	No	–	No		326 TBq

*Original activity involved. The object is recovered without leakages

(a) **Surface vessel Mont Louis** — On 25 August 1984, the cargo carrier Mont Louis collided with the car ferry Olau Britannia, 20 km off Zeebrugge and sank in shallow waters. Among the cargo, 30 containers of less than 1% enriched uranium hexafluoride were present. The type 48Y containers were cylindrical and weighed 15 tons each. By 4 October 1984 all the containers had been recovered. One container showed signs of being breached. Between 25 August and 11 October 1984, more than 200 samples of seawater, sand, organisms, air filters and swabs were analyzed and 150 measurements of dose rates were performed by French authorities. None of the analyses revealed any release of radionuclides to have occurred. In addition, no significant radiation dose was registered through different control measurements performed on the crew members of the Mont Louis and workers involved in the container recovery [II-1].

(b) **Surface vessel MSC Carla** — In the accident on 24 November 1997 involving the Panamanian-flag ship MSC Carla, 70 nautical miles off the Azores, north San Miguel Island, Atlantic Ocean involving 3 type B packages containing cesium chloride ^{137}Cs sealed sources (total activity: 326 TBq), no release of activity was reported [II-2].

II-2. RUSSIAN FEDERATION



Date	Vessel/carrier involved	Geographical area	Latitude	Longitude	Depth (m)	Radioactive material	Recovered	Marine monitoring	Release occurred	Estimated activity released	Total activity
1996	Mars'96 Probe (a)	South Pacific Ocean, near West of Chile	25º 6' S	75º 24' W		RTG. Pu-238 sealed source	No	–	–	–	174 TBq
1997	Helicopter (b)	Sea of Okhotsk off Sakhalin island	54º 19' N	142º 15' E		RTG power supply. Sr-90 sealed source	Yes	Yes	No	–	1.3 PBq*
2000	Submarine K-141 Kursk (c)	Barents Sea, off Kola Peninsula	69" 37' N	37' 35' E	116	2 nuclear reactors	Yes	Yes	No	–	–**
2003	Nuclear submarine K-159 (d)	Barents Sea, off Kola Peninsula	68º 3' N	39º 30' E	238	2 nuclear reactors	No	Yes	No	–	7.4 PBq
2012	Spacecraft Phobos-Grunt (e)	Southern Pacific Ocean	7º 34' 40" S	134º 53' 3" E		Co-57 sources	No	No	–	–	8.5 GBq

*Original activity involved. The object is recovered without leakages.
** The nuclear submarine was recovered in 2001 without leakages.

(a) **Interplanetary station Mars' 96** — The automatic Interplanetary Station Mars' 96 was launched on 16 November 1996 but as a result of an unsuccessful burn of the booster block entered the earth's atmosphere and fell into the Pacific Ocean to the West of Chile. The Mars' 96 probe contained 18 Radionuclide Thermoelectric Generator (RTG) containing ^{238}Pu with a total activity 174 TBq (4.7 kCi). Potential local radioactive contamination of the marine environment cannot be excluded [II-3]. The location of Mars'96 Interplanetary Station fell into South Pacific Ocean is a 800 × 200 km area with the centre at 25° 6' S, 75° 24' W.

(b) **Helicopter** — On 8 August 1997 there was an emergency disposal by helicopter of a RTG containing 35 kCi (1.3 PBq) of ^{90}Sr in the Sea of Okhotsk near Maria cape on the Sakhalin Island. The Russian Government launched a search for the lost RTG. In 2007, the RTG was found by the Ministry of the Russian Federation for Civil Defence, Emergences and Elimination of Consequences of Natural Disasters and the Pacific Ocean Fleet and was raised to the surface anf sent for subsequence recovery. [II-4, II-5].

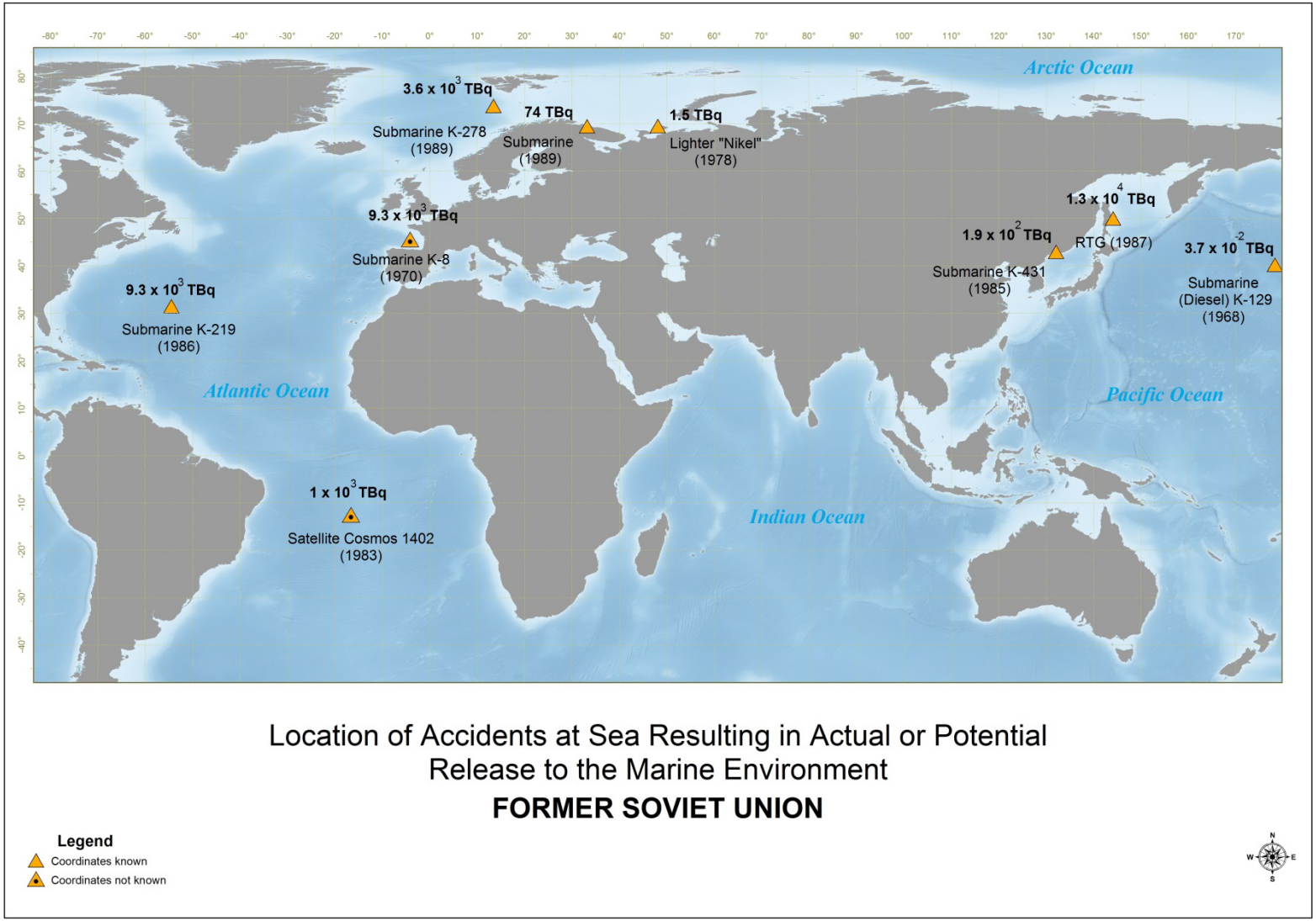
(c) **Nuclear submarine K-141Kursk** — On 12 August 2000 the Russian nuclear submarine K-141 Kursk sank in the waters of the Barents sea about 140 km off the town of Severomorsk in the Kola Peninsula. The submarine was an Oscar class II attack submarine powered by two 190 MW pressurised water reactors. The official reason for the accident was said to be torpedo explosion. In October 2001, The K-141, Kursk was raised to the surface and towed away for subsequent recovery. The results of radiation monitoring in the area where the submarine was wrecked revealed no change in the radiation situation relative to the background values.[II-5].

(d) **Nuclear submarine K-159** — On 30 August 2003 the K-159 submarine, decommissioned in 1989, sank in the Barents Sea while being towed to the Nerpa ship repair plant, located in Snezhnogorsk at the Murmansk region, for unloading the spent nuclear fuel. The two reactors

in the submarine were brough to a safe nuclear state, at the time of decomisioning in 1989, by lowering and welding the control rods. The primary circuit systems of both reactors were left in a sealed state. The last time the cores of the reactors were reloaded was, 1970 for the aft and 1972 for the fore. The activity remaining in the nuclear reactors at the time of the accident was estimated in 7.4 PBq. After the accident the are was visually inspected and the radiation situation was measured. The measurement results showed tha the gamma radiation levels at the location of the wreck were within natural backgorund. A programme of further measurements was announcedm in 2003 by the Russian federation Ministry of Atomic Energy and the Kurchatov Institute Russian Scientific Centre [II-6].

(e) **Phobos-Grunt spacecraft** — On 15 January 2012 the Phobos-Grunt spacecraft fell back to the earth carrying recoilless gamma-ray sources based on short living ^{57}Co. It ended up probably into the Southern Pacific. The activity of the sources was extremely low (0.0085 TBq). [II-5].

II-3. FORMER SOVIET UNION



Date	Vessel/carrier involved	Geographical area	Latitude	Longitude	Depth (m)	Radioactive material	Recovered	Marine monitoring	Release occurred	Estimated activity released	Total activity
1968	Diesel submarine K-129 (a)	Pacific, 1230 miles from Kamchatka	40º 6' N	179º 57' E	6000	2 nuclear warheads	Yes	–	–	–	37 GBq*
1970	Submarine K-8 (b)	Northeast Atlantic, Bay of Biscay	45º 37' 7" N**	4º 23' 43" W**	4000	2 nuclear reactors. Nuclear warheads	No	–	–	–	9.25 PBq 30 GBq
1978	Lighter Nikel (c)	Off Kolguyev Island Southeastern Barents Sea	69º 31' N	47º 56' 2" E		Unenclosed solid LLW and ILW	No				1.5 TBq
1983	Satellite COSMOS 1402 (d)	South Atlantic, 1600 km East of Brazil	12º 29' 48" S**	16º 51' 22" W**		Nuclear reactor core U-235, Sr-90,Cs-137	No				1 PBq
1985	Submarine K-431 (e)	Soviet Pacific Coast, Chazhma Bay, Shkotovo-22	43º N	132º E		Nuclear reactor core	Yes	Yes	Yes		185 TBq
1986	Submarine K-219 (f)	Atlantic Bermudas	31º 29' N	54º 42' W	5500	2 nuclear reactors	No				9.25 PBq
1987	Helicopter (g)	Sea of Okhotsk off Sakhalin island	50º 02' N***	144º E***	30	RTG power supply. Sr-90 sealed source	No	–	–	–	12.65 PBq****
1989	Submarine K-278 Komsomolets (h)	Norwegian Sea, 180 km SW Bear Island	73º 46' 18" N	13º 15' 54" E	1680	Nuclear reactor core	No	Yes	Yes	< 370 GBq	3.59 PBq
1989	Submarine (i)	Barents Sea, Ara Bay Kola peninsula	69º 30 N	33º E		Liquid radioactive waste	No		Yes		74 TBq

*Original activity involved. The object is recovered without leakages

**Coordinates estimated by the IAEA.

*** Estimated. The area where the RTG sank is between latitudes 49° 59’ N and 50° 5’ 5” N, and between longitude 144° 3’ 6” E and the coastline.

****Original activity as of day of manufacture. The calculated maximum activity as of 2004 is 8150 TBq.

(a) **Diesel submarine K-129** — On 6 March 1968 the diesel submarine K-129, which carried two torpedoes with nuclear warheads and three ICBM Rockets, was lost in Pacific Ocean approximately 1230 miles from Kamchatka, near the Hawaiian Islands. In August 1974 the bow part (three compartments of this submarine with nuclear warheads) were raised by RV Glomar Explorer [II-7, II-8].

(b) **Nuclear submarine K-8** — On 8 April 1970 in Biscay Bay, 300 miles north-west of Spain on board the nuclear submarine K-8, a fire started as a result of oil coming into contact with the air regeneration system. During the fire both nuclear reactors were shutdown. As a result of the fire, the rubber seals in the hull failed and sea water began to enter inside the submarine. It sank during a storm on 11 April 1970 [II-7, II-9].

(c) **Lighter Nikel** — During transportation of encapsulated solid low and medium level radioactive waste (5 steam generators, 7 compensating grids, 4 make-up units, 2 electric transformers) with a total activity of 40 Ci ^{90}Sr equivalent[2], the lighter Nikel was lost in 1978 in a storm, 20 miles north-west of Kolguyev Island in the south-eastern Barents Sea [II-7]. No attempt has been made to recover the lighter.

(d) **Satellite Cosmos 1402** — After completion of its mission in late December 1982, the USSR radar imaging satellite Cosmos 1402 failed to boost its nuclear reactor into a higher orbit. The spacecraft was split into three parts one of which re-entered and burnt up in the atmosphere on 30 December 1982. The second part re-entered on 23 January 1983 over the Indian Ocean and the third part containing the reactor core (fission products estimated to be up to 1 PBq) re-entered and broke up over the South Atlantic on 7 February 1983 about 1600 km east of Brazil. It is not known to what extent the reactor core was vaporized during re-entry [II-10, II-11].

(e) N**uclear submarine K-431** — On 10 August 1985 during the refueling work on the nuclear submarine K-431 at a pier in the Navy Shipyard of Chazhma Bay (Russian Far East) a prompt explosive criticality accident occurred in the reactor compartment. As a result, radionuclides with an activity of about 185 TBq (mainly short-lived radionuclides) were released into the atmosphere. A fraction of these radionuclides was deposited in the waters of the Bay in an area of approximately 0.1 km^2. The total activity of ^{60}Co in bottom sediments of the radioactive contaminated part of the bay was estimated at 185 GBq [II-12, II-13].

(f) **Nuclear submarine K-219** — In October 1986, the nuclear submarine K-219 sank about 1000 km northeast of Bermuda in the Atlantic Ocean. The submarine was submerged when a fire started. An explosion then occurred in the rocket compartment damaging the hull. During the fire, both reactors were shut down (one by the hand drive of the control grid). After attempting for three days to reach port under its own power the submarine was towed by a Soviet merchant ship before it sank at a depth of 6000 m. No attempt has been made to recover the submarine [II-9, II-15].

(g) **Helicopter** — On 20 August 1987 a Radionuclide Thermoelectric Generator (RTG No. 26) accidentally sank as a result of an incident with the carrying helicopter in the Sea of Okhotsk in the vicinity of Mys Nitskiy near the east coast of Sakhalin island. The RTG weighed 2.3 tons and was equipped with a ^{90}Sr source with an activity of 350 kCi (12.95 PBq) . The activity of the radioisotope thermoelectric generator is given as of the date of manufacture. The calculated maximum activity as of 2004 is 8150 TBq. Reconnaissance work in 1987, 1988, 1992, 2009 and 2010 did not locate the radioisotope thermoelectric generator. The region where the disposal took place has a surface area of 21 sq. miles and an average depth of 30 m. The RTG has a pressure hull made of stainless steel with thick walls, behind which the source is arranged in the internal tight-proof cavity inside the biological shielding unit [II-5, II-16].

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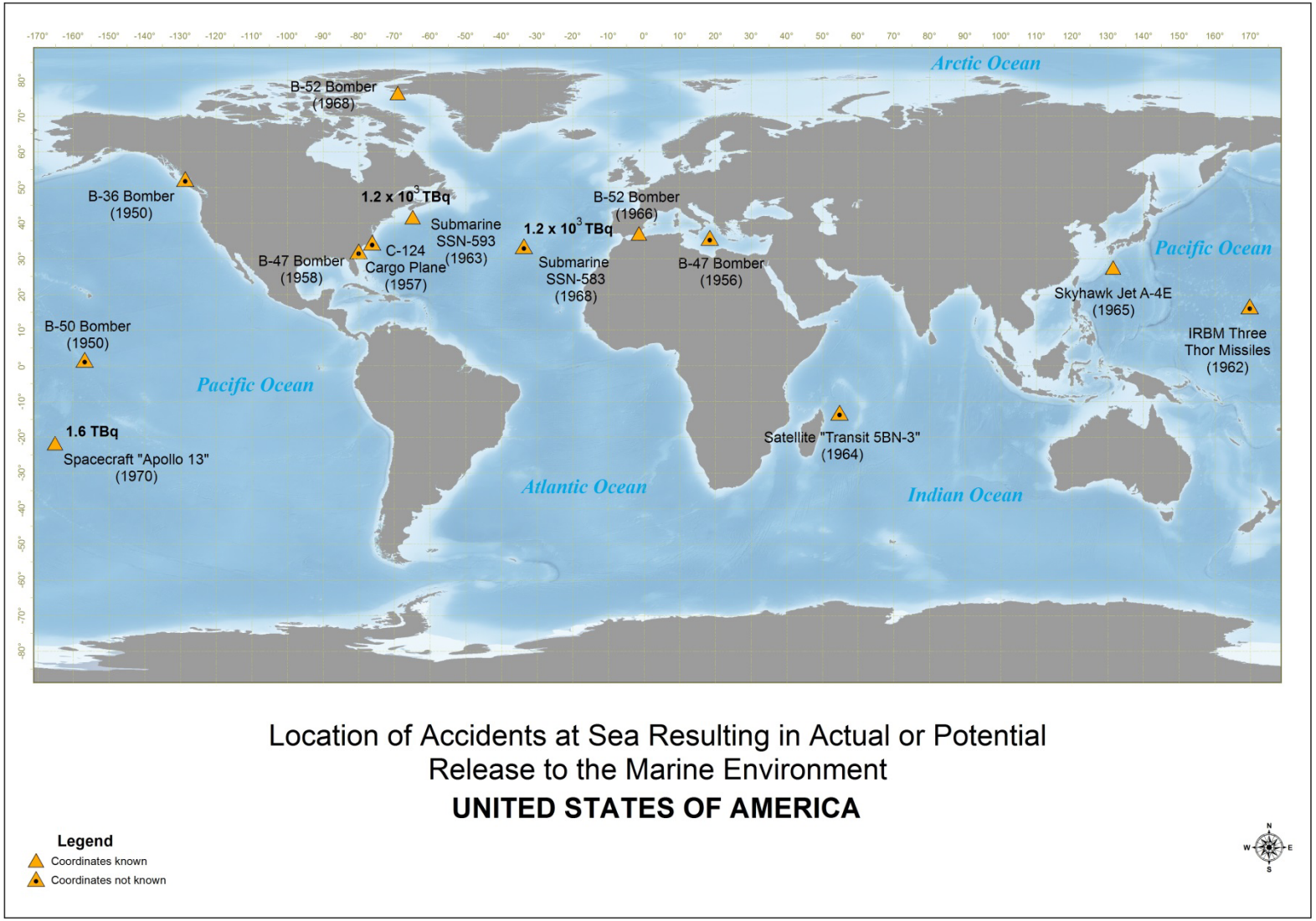
[2] ^{90}Sr equivalent activities are calculated by converting the gamma radiation dose rate of each waste package using an empirical relationship which is based on the radionuclide content of a standard package and the ratios of the maximum permissible concentration of different radionuclides in drinking water to the maximum permissible concentration of ^{90}Sr [II-14].

(h) **Nuclear submarine K-278 Komsomolets** — On 7 April 1989 in the Norwegian Sea, 180 km south-east of the island of Bear Island, the nuclear submarine "Komsomolets" had an accident and sank. The accident was caused by a fire which started in the stern compartment when the submarine was in a submerged position. When the fire started the automatic protection system of the submarine was triggered. Subsequently the crew shut down the reactor completely. In May 1989 Soviet hydrographic ships completed a preliminary survey of the site of the accident. Russian, Norwegian and British surveys were carried out that showed that the radiation levels at various depths and in sediment samples did not exceed the background level. The radionuclide release rate from Komsomolets was estimated as no more than 37 GBq per year [II-17, II-18, II-19].

(i) **Nuclear submarine** (name not notified) — The largest reported accidental release of liquid radioactive waste (74 TBq) occurred in 1989 during the anchorage of a submarine of the North Fleet in the Ara Bay. The accident led to the radioactive contamination of a sea area of about 1 km^2 [II-7, II-12].

II-4. UNITED STATES OF AMERICA



Date	Vessel/carrier involved	Geographical area	Latitude	Longitude	Depth (m)	Radioactive material	Recovered	Marine monitoring	Release occurred	Estimated activity released	Total activity
1950	B-36 Bomber (a)	Pacific Ocean, off British Columbia, Canada	52º 27' 11" N*	128º 58' 58"W*	–	No capsule, only uranium**	No	No	Yes	–	–
1950	B-50 Bomber (b)	Over water, outside USA	1º 45' 15" N*	157º 10' 51"W*		No capsule, only uranium**	No	No	Yes	–	–
1956	B-47 Bomber (c)	Mediterranean Sea	35º 57' 52" N*	18º 7' 2" E*		Two capsules, no weapon**	No	No	Yes	–	–
1957	Cargo Plane C-124 (d)	Atlantic Ocean, off New Jersey and Delaware	34º 35' 7" N*	76º 31' 59" W*		No capsule, only uranium**	No	No	Yes	–	–
1958	B-47 Bomber (e)	Atlantic Ocean, off Georgia	32º 10' 2" N*	80º 19' 48" W*		No capsule, only uranium**	No	No	Yes	–	–
1962	IRBM Thor Missile (f)	Pacific Ocean, Johnston Island	16º 44' N	169º 30' E		Nuclear test device	No	No	Yes	–	–
1962	IRBM Thor Missile (g)	Pacific Ocean, Johnston Island	16º 44' N	169º 30' E		Nuclear test device	No	No	Yes	–	–
1962	IRBM Thor Missile (h)	Pacific Ocean, Johnston Island	16º 44' N	169º 30' E		Nuclear test device	No	No	Yes	–	–
1963	Nuclear submarine SSN-593 Thresher (i)	Atlantic Ocean, 100 miles east of Cape Cod	41º 46' N*	65º 3' W*	2590	Nuclear reactor	No	Yes	Yes	0.04 GBq	1.15 PBq***
1964	Satellite Transit 5BN-3 (j)	West Indian Ocean, North of Madagascar	13º 2' 47" S*	54º 29' 18" E*		SNAP-9A generator	No	Yes	Yes	630 TBq****	630 TBq
1965	Skyhawk Jet A-4E (k)	Pacific Ocean, 250 miles South of Kyushu, 70 miles east of Okinawa	27º 35' N	131º 19' E	4800	1 nuclear weapon	No	Yes	–	–	
1966	B-52 Bomber (l)	Mediterranean Sea, 5 miles off Palomares Spain	37º 12' N	1º 41' 0" W	914	4 nuclear weapons	Yes	Yes	Yes	1.37 TBq	
1968	B-52 Bomber (m)	Arctic Ocean, Thule, Greenland	76º 32' N	69º 17' W	247	4 nuclear weapons	Partial	Yes	Yes	5 TBq	
1968	Nuclear submarine SSN-583 Scorpion (n)	Atlantic Ocean, 400 miles southwest of Azores	33º 38' 2" N*	34º 1' 7" W*	>3000	Nuclear reactor, 2 nuclear warheads	No	Yes	Yes	0.04 GBq	1.15 PBq ***
1970	Spacecraft Apollo 13 (o)	South Pacific Ocean, Tonga Trench south of Fiji	21º 38' S	165º 22' W	6000	SNAP-27 generator	No	–	–	–	1.63 TBq

* Coordinates estimated by the IAEA.
** With some early models of nuclear weapons, it was standard procedure during most operations to keep the capsule of nuclear material separate from the weapon for safety purposes. While the weapon with the capsule removed did contain a quantity of natural (not enriched) uranium accidental detonation of the high explosives element would not cause a nuclear detonation or contamination.
*** Estimates as of 1984.
**** The nuclear fuel was vaporized during re-entry and was dispersed worldwide.

(a) **B-36 Bomber** — On 13 February 1950, the B-36 Bomber was en route from Eielson Air Force Base (Alaska U.S.) to Carswell Air Force Base (Texas U.S.) on simulated combat profile mission. The weapon aboard the aircraft had a dummy capsule installed. After six hours of flight, the aircraft developed seriuos mechanical difficulties, making it necessary to shut down three engines.The aircraft was at 12 000 feet altitude. Icing conditions complicated the emergency and level flight could not be maintained. The aircraft headed out over the Pacific Ocean and dropped the weapon from 8000 feet. A brief flash occurred on impact, followed by a sound an shock wave. Only the weapon's high explosive material detonated. The aircraft was then flown over Prince Royal Island (British Columbia, Canada) where the crew bailed out [II-20].

(b) **B-50 Bomber** — On 10 November, because of an in-flight emergency, a weapon containing no capsule of nuclear material was jettisoned over water from an altitude of 10 500 feet. A high explosive detonation was observed [II-20].

(c) **B-47 Bomber** — On 10 March 1956, the aircraft was one of four scheduled for non-stop deployment frm MsDill Air Force Base (Florida U.S.) to an overseas air base. Take-off from McDill and the first refuelling were normal.The second refuelling point was over the Mediterranean Sea. In preparation for this, the flight penetrated a solis cloud formation to descend to the refuelling level of 14,000 feet. Base on the clouds was 14,500 feet and visibility was poor. The aircraft, carrying two nuclear capsules in carrying cases, never made contact with the tanker. An extensive search failed to locate any traces of the missing aircraft or crew. No waepons were aboard the aircraft, only two capsules of nuclear weapons material in carrying cases. A nuclear detonation was not possible [II-20].

(d) **C-124 Cargo Plane** — On 28 July 1957, two weapons were jettisoned from a C-124 aircraft off the east coast of the USA. There were three weapons and one nuclear capsule aboard the aircraft at the time. Nuclear components were not installed in the weapons. The C-124 aircraft was en route from Dower Air Base (Delaware U.S.), when a loss of power from number one and two engines were experienced. Maximum power was applied to the remaining engines; however, level flight could not be maintained. At this point, the decision was made to jettison cargo in the interest of safety of the aircraft and crew. The first weapon was jettisoned at 4500 feet altitude. The second weapon was jettisoned at approximately 2500 feet altitude. No detonation occurred from either weapon. Both weapons are presumed to have been damaged from impact with the ocean surface. Both weapons are presumed to have submerged almost instantly. The ocean varies in depth in the area of the jettisons. The C-124 landed at an airfield in the vicinity of Atlantic City, New Jersey, U.S. with the remaining weapon and nuclear capsule aboard. A search for the weapon or debris had negative results [II-20].

(e) **B-47 Bomber** — On 5 February 1958, the B-47 was on a simulated combat mission that originated at Homestead Air Force Base (Florida, U.S.). While near Savannah, Georgia, the B-47 had a mid-air collision at 3:30 a.m., with an F-86 aircraft. Following the collision, the B-47 attempted three times to land at Hunter Air Force Base, Georgia, with a weapon aboard. Because of the condition of the aircraft its airspeed could not be reduced enough to ensure a safe landing. Therefore, the decision was made to jettison the Mark 15, Mod 0 weapon rather than expose Hunter Air Force Base to the possibility of a high explosive detonation. A nuclear detonation was not possible since the nuclear capsule was not the aboard the aircraft. The weapon was jettisoned into the water several miles from the mouth of the Savannah River

(Georgia) in Wassaw Sound of Tybee Beach. The presice weapon impact point is unknown. The weapon was dropped from an altitude of approximately 7200 feet at an aicraft speed of 180-190 knots. No detonation occurred. After jettison, the B-47 landed safely. A three-square-mile area was searched using a ship with divers and underwater demolition team technicians using galvanic drag and hand-held sonar devises. The weapon was not found. The weapon was considered to be irretrievably lost [II-20].

(f) **IRBM Thor Missile —** On 2 June 1962, a Thor missile with a nuclear test device was launched from Johnston Island shortly after midnight. The missile apparently flew a normal trajectory; however, the tracking system lost it. As there were ships and aircraft in the vicinity and no way to predict whether the trajectory was safe, the missile with its warhead was destroyed. No nuclear detonation occurred [II-21, II-22].

(g) **IRBM Thor Missile —** A Thor missile with a nuclear test devise was launched just before midnight on 19 June 1962 from Johnston Island. The Thor missile with two experimental reentry vehicles replacing two of the three instrument pods flew a normal course for about 59 seconds after liftoff. At that time the rocket motor stopped and the Range Safety Officer ordered the missile and warhead destroyed. The missile was between 30 000 and 35 000 feet (9100 and 10 700 m) when it was destroyed. One of the re-entry vehicles, the instrument pod and missile parts fell on Johnston Island. A substantial amount of debris fell on and in the water around Johnston Island. Navy Explosive Ordinance Disposal and Underwater Demolition Team Swimmers spent two weeks recovering debris from the lagoon waters around the island. They recovered approximately 250 pieces of the system, some of which were contaminated with plutonium [II-21, II-22].

(h) **IRBM Thor Missile —** A Thor missile with a nuclear test devise was launched just before midnight on 15 October 1962 from Johnston Island. The missile malfunctioned shortly after launch, requiring Range Safety Officerto to order the destruction of the warhead after 95 seconds after launch [II-22].

(i) **Nuclear Submarine SSN-593 Thresher —** USS nuclear submarine Thresher was lost at sea on 10 April 1963. Several monitoring surveys have been conducted at the Thresher site. Only small concentrations of ^{60}Co from heat transfer systems were detected in sediment samples from the site. No ^{60}Co was found in samples of water, marine life, or debris. The estimated total amount of radioactivity released from the submarine was less than 0.04 GBq. The total amount of radioactivity listed for this submarine, 1.15 PBq, is corrected for radioactive decay as of 1984 [II-23– II-25].

(j) **Satellite Transit 5BN-3** — On 21 April 1964 the United States navigational satellite Transit 5BN-3 with a SNAP-9A radioisotope generator containing 630 TBq of ^{238}Pu metal failed to achieve orbit and re-entered the atmosphere at 120 km altitude and burned up over the West Indian Ocean north of Madagascar. The nuclear fuel was vaporized during re-entry and was dispersed worldwide [II-10, II-26, II-27].

(k) **Skyhawk Jet A-4E** — On 5 December 1965 an A-4 aircraft loaded with one nuclear weapon rolled off the elevator of the United States aircraft carrier Ticonderoga and fell into the open sea in the vicinity of the island of Okinawa, Japan sinking to a depth of 16000 feet. The pilot, aircraft and weapon were lost [II-20, II-21]. A radiological survey of the area where the aircraft sunk did not show any increase in the levels of plutonium in seawater.

(l) **B-52 Bomber** — On 17 January 1966 a B-52 bomber and a KC-135 refuelling tanker collided in mid-air near the village of Palomares in Spain. The B-52 crashed. Of the four thermonuclear weapons carried by the aircraft, one fell into the ocean and was retrieved on 7 April 1966, another was recovered intact from the fields where it had landed, while the remaining two were destroyed on impact. The pyrophoric plutonium metal was ignited, creating a cloud of oxide fume that contaminated an area of 2.26 km^2. The top 10 cm of soil was removed immediately after the accident but some areas remained partially contaminated by plutonium and americium. Heavy rains in the region followed by floods washed a fraction of the contaminated soil into the Mediterranean continental shelf. Analyses of sediment cores collected in the period 1985 to 1991 in the marine area near Palomares show enhanced levels of transuranics derived from the accident. The input of the Palomares accident into the Mediterranean has been estimated to be a maximum of 1.37 TBq of plutonium [II-21, II-28, II-29].

(m) **B-52 Bomber** — On 21 January 1968 a B-52 bomber crashed on the ice near the Thule airbase in northern Greenland. The bomber carried four nuclear weapons which were destroyed, spreading plutonium over a large area of the ice. The contamination was mainly confined to the marine environment. The monitoring survey carried out during four expeditions between 1968 and 1979 showed that most of the activity released as, including ^{241}Am, is confined to the sediments and the benthic environment within a distance of 50 km of the crash site. The total inventory estimated by these surveys was 3.1 TBq ($^{239/240}Pu$: 1 TBq; ^{238}Pu: 17 GBq; ^{241}Pu: 2 TBq; ^{241}Am: 0.1 TBq) [II-30, II-31]. More recent investigations of plutonium in the sediments carried out during 2003-2006 and taking account of hot particles have raised the estimated inventory of $^{239/240}Pu$ to 2.9 TBq with an approximate 95% confidence interval from 1.6 TBq to 6 TBq [II-32]. Consequently the total inventory estimated currently is 5 TBq.

(n) **Nuclear submarine SSN-583 Scorpion —** USS nuclear submarine SSN-583 Scorpion was lost at sea on 22 May 1968. Several monitoring surveys have been conducted at the Scorpion site. Only small concentrations of ^{60}Co from coolant systems were detected in sediment samples from the site. No plutonium from the two nuclear weapons was detected in any of the water, sediment and marine life samples. No ^{60}Co was detected in samples of water, marine life or debris. No plutonium from the two nuclear weapons was detected in any of the water, sediment and marine life samples. No ^{60}Co was detected in samples of water,marine life or debris. The estimated total amount of radioactivity released from the submarine was less than 0.04 GBq. The total radioactivity inventory listed for this submarine is corrected for radioactivity decay as of 1984 [II-23, II-33].

(o) **Spacecraft Apollo 13** — After a successful launch on 11 April 1970 a malfunction occurred in the oxygen supply on board the manned spacecraft Apollo 13 on its way to the moon. The astronauts had to use the lunar landing module as a survival facility during a flight around the moon and returned to earth with the lunar landing module attached. The landing module, with a SNAP-27 radioisotope generator containing 1.63 PBq of ^{238}Pu, re-entered the atmosphere over the South Pacific Ocean on 17 April 1970. The generator entered intact, as designed, and landed in the deep ocean south of the Fiji Islands in the vicinity of the Tonga Trench. Atmospheric samples showed no evidence of release of ^{238}Pu into the atmosphere. No attempt has been made to recover the generator from the 6000 m depth since the exact location is unknown [II-10, II-27].

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ANNEX III.

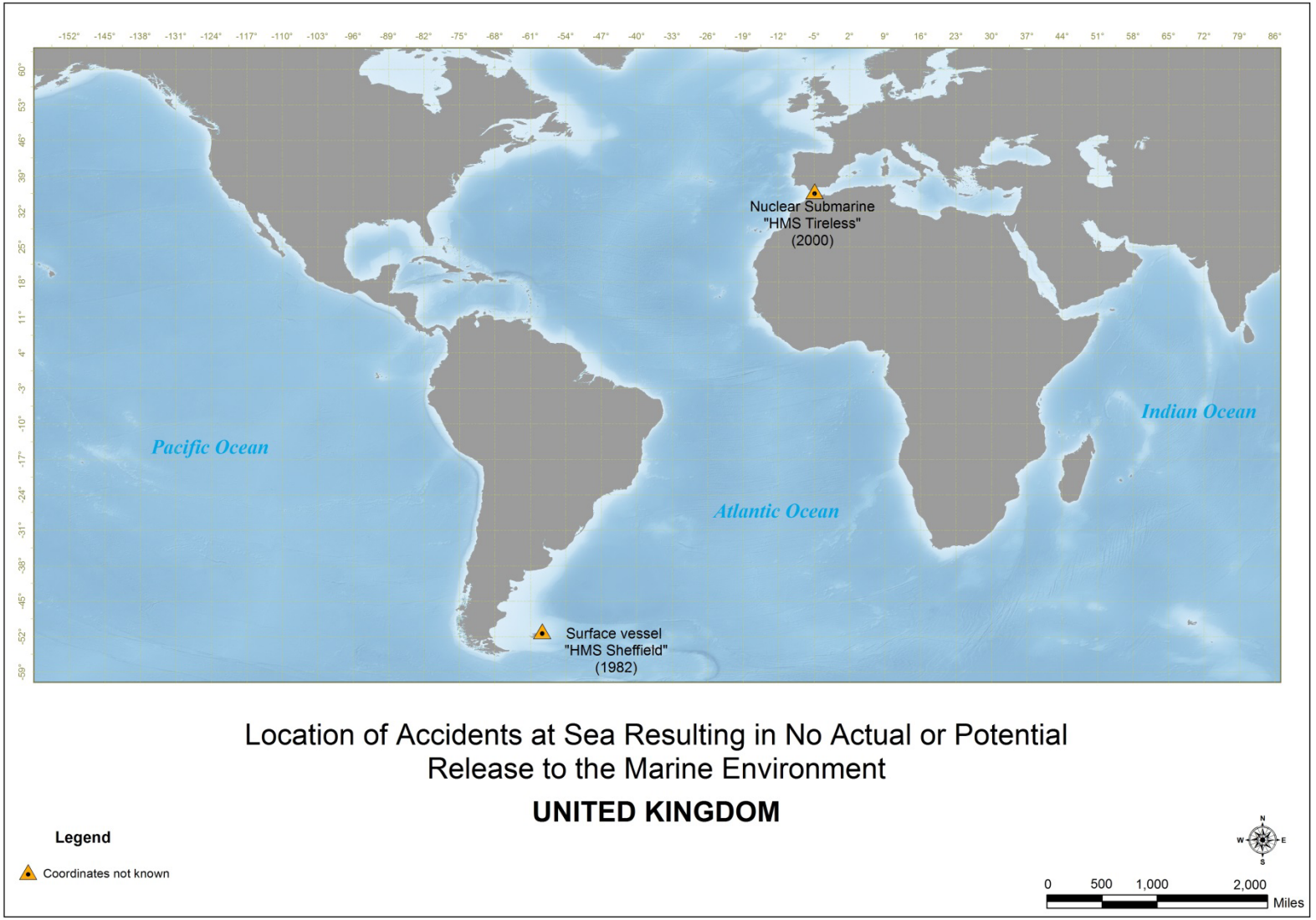
ACCIDENTS AND LOSSES AT SEA WHERE THE RADIOACTIVE MATERIAL HAS BEEN RECOVERED INTACT BY COUNTRY


Arctic Ocean
Submarine K-19
(1961)
Pacific Ocean
Indian Ocean
Atlantic Ocean
Location of Accidents at Sea Resulting in No Actual or Potential
Release to the Marine Environment
FORMER SOVIET UNION
Legend
Coordinates not known
N
W
E
S
0
500
1,000
2,000
Miles

Date	Vessel involved	Geographical area	Latitude	Longitude	Depth (m)	Radioactive material	Recovered	Marine monitoring	Release occurred	Estimated activity released	Total activity
1961	Nuclear submarine K-19 (a)	North-West Atlantic	55º 36'N	38º 13' W		Reactor core	Yes				

(a) **Nuclear submarine K-19** — On 4 July 1961 in the North-West Atlantic on board of the Soviet nuclear submarine K-19, a serious radiation accident occurred. During routine work, members of crew did not notice the leakage from the first heat-transfer circuit of one of the two reactors. The nuclear fuel was overheated. In an attempt to arrange the pipeline for fuel cooling, a part of the crew was overexposed to radiation and the commander asked for assistance. The submarine was towed to base. The overexposed men were evacuated to a special hospital. No radioactive contamination of sea water occurred. As the submarine could not be repaired because of high radiation fields, the reactor compartments along with two reactors were subsequently cut out and dumped in the Abrosimov Bay of Novaya Zemlya [III-1].

III-2. UNITED KINGDOM



Date	Vessel involved	Geographical area	Latitude	Longitude	Depth (m)	Radioactive material	Recovered	Marine monitoring	Release occurred	Estimated activity released	Total activity
1982	Surface vessel HMS Sheffield (a)	South Atlantic Ocean Falkland Islands (Malvinas)*	50º 53' 50" S**	58º 50' 12" W**							
2000	Nuclear submarine HMS Tireless (b)	Mediterranean Sea, off Gibraltar	35º 57' 34" N**	5º 3' 57" W**							

* A dispute exists between the Governments of Argentina and the United Kingdom of Great Britain and Northern Ireland concerning sovereignty over the Falkland Islands (Malvinas).

**Estimated by the IAEA.

(a) **Surface vessel HMS Sheffield** — On 4 May 1982, during the conflict between the United Kingdom and Argentina over the sovereignty of the Falkland Islands (Malvinas)*, the Type 42 destroyer HMS Sheffield of the UK Royal Navy was hit by an Exocet missile fired from an Argentine Super Etendard aircraft. Twenty members of her crew were killed and the ship abandoned. It has been suggested that the ship had nuclear weapons on board when she sank [III-2]. In response to questions raised in the British Parliament in July 1982, a Minister of the Crown assured Parliament, in the context of the sinking of "HMS Sheffield" in May 1982, that "there has never been any incident involving a British nuclear weapon leading to its loss or to the dispersal of radioactive contamination" [III-3].

(b) **Nuclear submarine HMS Tireless** — On 19 May 2000, following a leak of coolant water from pipework in the reactor compartment, the nuclear powered submarine HMS Tireless went into Gibraltar for repair assessment. According to information provided by the United Kingdom's Ministry of Defence, although some coolant was discharged into the Mediterranean Sea, no contaminated water leaked from the submarine. The United Kingdom's Government decided that the safest option was to carry out the repair in Gibraltar. All other options considered (towing, the use of a heavy lift ship or barge, return to the UK using the submarine's secondary diesel engines) involve additional risks and were rejected. In October 2000 it became clear that the fault on HMS Tireless might have been a generic one. All other submarines of a similar design were inspected and the flaw has been found in six other submarines, which are under inspection [III-4].


1.3 x 10^3 TBq
Spacecraft
"Nimbus B-1"
(1968)
Atlantic Ocean
Pacific Ocean
Location of Accidents at Sea Resulting in No Actual or Potential Release to the Marine Environment
UNITED STATES OF AMERICA
Legend
Coordinates known
0 150 300 600 900
Miles

Date	Carrier involved	Geographical area	Latitude	Longitude	Depth (m)	Radioactive material	Recovered	Marine monitoring	Release occurred	Estimated activity released	Total activity
1968	Spacecraft Nimbus B-1 (a)	Pacific Ocean, Santa Barbara Channel	34º 7' N	120º 20' W	100	2 SNAP-19 generators	Yes	No			1.26 PBq

SNAP = System of Nuclear Auxiliary Power.

(a) **Spacecraft Nimbus B-1** — On 18 May 1968 the United States spacecraft Nimbus B-1 containing two SNAP-19 radioisotope generators did not reach orbit due to a booster failure at launch. The booster was destroyed at an altitude of 30 km and the spacecraft fell with the generator into the Santa Barbara Channel off the coast of California. The two fuel capsules containing a total of 1265 TBq of ^{238}Pu were recovered intact (as designed) from a depth of 100 m. There was no release of fuel [III-5, III-6].

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ANNEX IV.

EXAMPLES OF LOSSES OF INDUSTRIAL SEALED SOURCES RESULTING IN ACTUAL OR POTENTIAL RELEASE TO THE MARINE ENVIRONMENT BY COUNTRY

Country	Date	Geographical area	Latitude	Longitude	Depth (m)	Radioactive material	Total Activity (TBq)	Remarks	Exact location
Belgium	1986				3 or 4	Cs-137	1.85E-05		Unknown
Brazil	1985	Itaorna Bay, located at Angra dos Reis, Rio de Janeiro	23° 14' 17.00" S	44° 13' 10.86" W		Cs-137	3.18E-03		Estimated by IAEA
	1988	Atlantic Ocean, about 100 miles from Campos Bay (Offshore PARGO-1 A) drilling station				Ir-192	1.17E+00		Unknown
India	1992	Bombay Offshore, 30 km from the shore	19° 21' 6.57" N	72° 26' 52.01" E	2185	Cs-137 Am-241/Be	5.55E-02 5.92E-02	The well with the abandoned source was plugged with 100 m of concrete and no activity was released	Estimated by IAEA
	1992	Bombay High North	20° 25' 17.48" N	72° 9' 21.76" E	100	Cs-137	5.55E-02	The well with the abandoned source was plugged with 100 m of concrete and no activity was released	Estimated by IAEA
	1992	Bombay Offshore Rig	19° 21' 6.57" N	72° 26' 52.01" E	100	Cs-137 Am-241/Be	5.55E-02 7.03E-01	The well with the abandoned source was plugged with 100 m of concrete and no activity was released	Estimated by IAEA
Indonesia		Handil, East Kalimantan	1° 51' 49" S	117° 15' 49" E	2548	Am-241/Be Cs-137	6.66E-01 5.55E-02	Abandoned by cementing	Known
		Java Sea Offshore	5° 56' 28" S	107° 26' 2" E	2367	Am-241/Be Cs-137	7.40E-01 7.40E-02	Abandoned by cementing	Known
		Handil, Kaltinen	0° 46' 18" S	117° 48' 6" E	300	Am-241/Be Am-241/Be Cs-137	6.66E-01 1.85E-02 5.55E-02	Abandoned by cementing	Known
		West Java, Offshore	5° 46' 4" S	107° 35' 75" E	4058	Am-241 Cs-137	5.92E-01 5.55E-02	Abandoned by cementing	Known
		Natuna Sea, Ribu	5° 13' 52" S	105° 35' 39" E	1726	Am-241/Be Cs-137	2.78E-01 6.29E-02	Abandoned by cementing	Known
		Natuna Sea, Ribu	5° 15' 47.16" S	105° 58' 25.30" E	1468.5	Am-241/Be Cs-137	7.40E-01 7.40E-02	Abandoned by cementing	Estimated by IAEA
Malaysia	1990	South China Sea, offshore Sabah (Offshore Bongawan No. 1)	5° 0' 6.43" N	114° 24' 20.63" E	1800	Cs-137	7.40E-02	The well was abandoned by cementing with 500 ft. of cement on top of the source four days after the incident	Estimated by IAEA
	1991	South China Sea, offshore Sarawak (Bunga Orkid No. 1)	3° 54' 43.01" N	112° 38' 30.48" E	3685	Cs-137	7.40E-02	The well was abandoned by cementing with 100 ft. of cement on top of the source three days after the incident	Estimated by IAEA
	1995	South China Sea, offshore Terengganu (Guntong D13)	5° 27' 5.99" N	103° 56' 34.84" E	3132	Cs-137 Am-241/Be	7.40E-02 1.11E-01	The well was abandoned by cementing. Length of abandoned drillstring located above abandoned sources is 66 metres	Estimated by IAEA

Country	Date	Geographical area	Latitude	Longitude	Depth (m)	Radioactive material	Total Activity (TBq)	Remarks	Exact location
Mexico	1983	Campeche Sound	19° 27' 13.91" N	91° 41' 16.01" W		Ir-192	3.70E+00		Estimated
	1985	Campeche Sound, 80 km from the coast	19° 27' 13.91" N	91° 41' 16.01" W		Ir-192	3.89E+00		Estimated
	1993	Campeche Sound, 80 km from the coast (AKAL-H Marine Platform)	19° 24' 52" N	91° 46' 8" W	40	Ir-192	3.15E-03	No radioactive contamination	Known
	1995	Campeche Sound, 35 km from the coast (ABKATUM-D Marine Platform)	18° 57' 45" N	92° 24' 71" W	40	Ir-192	2.44E-01	No radioactive contamination	Known
	1995	Campeche Sound, 105 km from the coast (Barge 269)	19° 44' 69" N	91° 32' 7" W	40	Ir-192 Ir-192	1.31E+00 5.22E-01	No radioactive contamination	Known
Norway	1972	Block 2/7	58° 51' 11.51" N	5° 7' 56.16" E		Cs-137 Am-241/Be Ra-226 Co-60	5.55E-02 1.85E-01 3.70E-06 1.48E-05	Sources lost when the supply boat sank. All sources shielded and inside a transport container	Estimated by IAEA
	1974	Stavangerhorden	67° 32' 5.58" N	9° 35' 34.88" E		Ir-192	1.50E+00	Industrial radiography container lost into the sea from an oil rig	Estimated by IAEA
	1978	Boss Rig	64° 56' 12.39" N	8° 26' 37.89" E		Ra-226	3.70E-06	Probably lost overboard.	Estimated by IAEA
	1985	Odin	62° 32' 18.66" N	5° 14' 46.27" E	2235	H-3	3.70E-01		Estimated by IAEA
	1985	Nortrym	65° 44' 10.29" N	9° 59' 33.83" E		Th-232	5.90E-08	Calibration source, probably blown into the sea	Estimated by IAEA
	1988	Eldfisk	67° 8' 6.63" N	12° 3' 58.41" E		Cs-137	5.55E-01		Estimated by IAEA
	1989	–	67° 32' 5.58" N	9° 35' 34.88" E	4742	Cs-137 Am-241/Be	3.50E-01 1.00E-01		Estimated by IAEA
	1990	Statfjord	64° 11' 14.35" N	6° 52' 12.01" E	3423 3425	Cs-137 Am-241/Be	5.55E-0 1.11E-01		Estimated by IAEA
	1990	Gullfaks	62° 15' 49.38" N	4° 47' 47.44" E	3751	Cs-137	3.70E-03		Estimated by IAEA
	1990	Eldfisk	67° 8' 6.63" N	12° 3' 58.41" E	4090	Am-241/Be	6.66E-01		Estimated by IAEA
	1990	Statfyord	64° 11' 14.35" N	6° 52' 12.01" E	4212	Am-241	1.67E-03		Estimated by IAEA

Country	Date	Geographical area	Latitude	Longitude	Depth (m)	Radioactive material	Total Activity (TBq)	Remarks	Exact location
Norway (continued)	1991	Byford Dolphin	61° 57' 50.17" N	4° 14' 48.88" E	1920	Am-241	1.67E-07		Estimated by IAEA
	1992	Oseberg	60° 14' 24.68" N	4° 14' 48.88" E	4870 4872	Cs-137 Am-241/Be	7.40E-02 1.85E-01		Estimated by IAEA
	1992	Vildkat Explorer	69° 54' 29.37" N	16° 54' 45.72" E	4377	Am-241	1.67E-07		Estimated by IAEA
	1993	Treasure Saga	70° 19' 58.26" N	17° 47' 13.43" E	622	Am-241	1.67E-07		Estimated by IAEA
	1998	Veslefrikk				Am-241/Be	3.7E-03		Estimated by IAEA
	1999	Veslefrikk				Cs-137 Am-241/Be	7.4-E02 6.66-E01		Estimated by IAEA
	1999	Statfjord				Cs-137 Am-241/Be	7.4-E02 1.85E-1		Estimated by IAEA
	1999	Oseberg Oest				Cs-137 Am-241/Be	7.4-E-02 1.85E-01		Estimated by IAEA
	2000	Troll Vest				Cs-137 Am-241/Be	7.4-E-02 1.85E-01	Position: 6745690 mN, 534086 mE Position: 6745691 mN, 534085 mE	Known
	2000	Snorre				Cs-137 Am-241/Be	6.3E-02 3.7.E-01		Estimated by IAEA
	2000	Sygna				Cs-137 Am-241/Be	6.3E-02 3.7.E-01		Estimated by IAEA
	2000	Norne				Cs-137 Am-241/Be	7.4-E-02 1.48E-01		Estimated by IAEA
	2001	Gullfaks				Cs-137 Am-241/Be	7.4-E-02 1.85E-01		Estimated by IAEA
	2001	Vigdis				Cs-137 Am-241/Be	7.4-E-02 1.48E-01		Estimated by IAEA
	2002	Gullfaks				Cs-137 Am-241/Be	6.3E-02 3.7.E-01		Estimated by IAEA
	2002	Heidrun Nordflanken				Cs-137 Am-241/Be	7.4-E-02 1.85E-01		Estimated by IAEA
	2002	Vigdis				Cs-137 Am-241/Be	7.4-E-02 1.48E-01		Estimated by IAEA

Country	Date	Geographical area	Latitude	Longitude	Depth (m)	Radioactive material	Total Activity (TBq)	Remarks	Exact location
Norway (continued)	2002	Troll Vest				Cs-137 Am-241/Be	7.4-E-02 1.85E-01		Estimated by IAEA
	2002	Snorre				Cs-137 Am-241/Be	6.3E-02 3.7.E-01		Estimated by IAEA
	2002	Statfjord				Cs-137 Am-241/Be	7.4-E-02 1.48E-01		Estimated by IAEA
	2002	Norne				Cs-137 Am-241/Be	7.4-E-02 1.48E-01		Estimated by IAEA
	2002	Gullfaks				Cs-137 Am-241/Be	6.3E-02 3.7.E-01		Estimated by IAEA
	2002	Gullfaks				Cs-137 Am-241/Be	7.4-E-02 1.85E-01		Estimated by IAEA
	2002	Snorre				Cs-137 Am-241/Be	7.4-E-02 1.85E-01		Estimated by IAEA
	2002	Snorre				Cs-137 Am-241/Be	7.4-E-02 1.85E-01		Estimated by IAEA
	2002	Oseberg				Cs-137 Am-241/Be	7.4-E-02 1.85E-01		Estimated by IAEA
	2004	Heidrun				Cs-137 Am-241/Be	7.4-E-02 1.85E-01		Estimated by IAEA
	2004	Heidrun				Cs-137 Am-241/Be	6.3E-02 3.7.E-01		Estimated by IAEA
	2004	Valhall				Cs-137 Am-241/Be	7.4-E-02 1.48E-01		Estimated by IAEA
	2004	Ringhorne				Cs-137 Am-241/Be	7.4-E-02 1.85E-01		Estimated by IAEA
	2004	Varg				Cs-137	7.4-E-02		Estimated by IAEA
	2004	Varg				Cs-137 Am-241/Be	7.4-E-02 7.03E-01		Estimated by IAEA
	2004	Veslefrikk				H-3	5.5E-02		Estimated by IAEA
	2004	Troll Vest				Cs-137 Am-241/Be	7.4-E-02 1.85E-01		Estimated by IAEA

Country	Date	Geographical area	Latitude	Longitude	Depth (m)	Radioactive material	Total Activity (TBq)	Remarks	Exact location
Norway (continued)	2005	Tune fase 2				Cs-137	6.3E-02		Estimated by IAEA
	2005	Vale				Cs-137 Am-241/Be	7.4-E-02 1.85E-01		Estimated by IAEA
	2005	Valhall				Cs-137 Am-241/Be	7.4-E-02 1.85E-01		Estimated by IAEA
	2006	Grane				Cs-137 Am-241/Be	9.25E-02 1.85E-01		Estimated by IAEA
	2006	Oseberg				Cs-137 Am-241/Be	7.4-E-02 2.96E-01		Estimated by IAEA
	2007	Visund				Cs-137	6.0E-02		Estimated by IAEA
	2007	Oseberg				Cs-137 Am-241/Be	7.4E-02 7.03E-01		Estimated by IAEA
	2007	Grane				Cs-137	7.4E-02		Estimated by IAEA
	2007	Snorre	61° 30' 41.756" N 61° 30' 41.756" N	2° 15' 51.937" E 2° 15' 51.937" E		Cs-137 Cs-137 H-3	1.8E-09 3.7E-08 5.92E-02	Known Known	
	2008	Visund	61° 21' 52.851" N	2° 27' 28.920" E		Cs-137 H-3	6.3E-02 5.92E-02	Known	
	2008	Vigdis Ext.	61° 21' 48.294" N	2° 2' 48.723" E		Cs-137 H-3	6.3E-02 5.92E-02	Known	
	2008	Dagny				Cs-137 Am-241/Be	6.3E-02 5.92E-01		Estimated by IAEA
	2008	Valhall				Cs-137 Am-241/Be	9.25E-02 1.85E-01		Estimated by IAEA
	2008	Visund	61° 18' 43" N	8° 20' 32" E		Cs-137 H-3	6.3E-02 5.92E-02	Known	
	2009	Tone Soer				Cs-137 Am-241/Be	9.25E-02 1.85E-01		Estimated by IAEA
	2009	Kvitebjoern	61° 6' 5.964" N	2° 34' 23.881" E		Cs-137	6.3E-02	Known	
	2010	Oseberg				Am-241/Be Cs-137 Am-241/Be	7.03E-01 7.4E-02 5.92E-01		Estimated by IAEA

Country	Date	Geographical area	Latitude	Longitude	Depth (m)	Radioactive material	Total Activity (TBq)	Remarks	Exact location
Norway (continued)	2010	Gullfaks				Cs-137 Cs-137 Cs-137 H-3	6.3E-02 1.8E-09 3.7E-08 5.55E-02		Estimated by IAEA
	2010	Norne	66° 0' 56.413" N	8° 4' 12.763" E		Cs-137 Am-241/Be Cs-137 Cs-137	6.3E-02 3.7E-01 1.85E-09 3.33E-08		Known
	2010	Norne	65° 59' 46.986" N	8° 1' 55.857" E		Cs-137 H-3 Cs-137	6.3E-02 5.9E-02 3.7E-08		Known
	2011	Gjoa	61° 19' 29.3566" N	3° 58' 6.884" E		Cs-137 H-3 Cs-137	6.3E-02 5.92E-02 3.7E-08		Known
	2011	Sleipner west	58° 24' 4.034" N	1° 38' 53.189" E		Cs-137 H-3 Cs-137	6.3E-02 5.92E-02 3.7E-08		Known
	2011	Ekofisk				Am-241	3.7E-03		Estimated by IAEA
	2011	Theta NE				Cs-137 Am-241/Be	6.3E-02 5.92E-01	stabilization sources	Estimated by IAEA
	2011	Ringthorn				Cs-137 Am-241/Be	9.25E-02 1.85E-01		Estimated by IAEA
United Kingdom	1967	Liverpool docks	53° 35' 0.17" N	3° 24' 22.54" W		Cs-137	3.60E-02	No release detected	Estimated by IAEA
	1972	50 km off Dutch coast	51° 23' 29.22" N	1° 55' 15.48" E		Am-241/Be	5.90E-01	No release detected	Estimated by IAEA
	1973	40 miles 162 degrees from Nine Head Eire	52° 3' 26.47" N	11° 13' 50.25" W		Cs-137	5.60E-02	No release detected	Estimated by IAEA
	1974	North Sea, 120 miles east of Aberdeen	57° 36' 23.57" N	0° 20' 22.00" E		Gauges for industrial use	6.50E-01	No release detected	Estimated by IAEA
	1984	North Sea, East of Aberdeen	58° 54' 38.19" N	0° 46' 13.42" W		Encapsulated sources: Cs-137, Am-241	7.21E-01	No release detected	Estimated by IAEA
	1988	North Sea	58° 28' N	0° 15' E	134		1.67E-01	Monitoring may have been conducted	Known

Country	Date	Geographical area	Latitude	Longitude	Depth (m)	Radioactive material	Total Activity (TBq)	Remarks	Exact location
UK (continued)	1988	Irish Sea, 24 km north of Great Orme	53° 35' N	3° 50' W		Cf-252	5.00E-05	No release detected	Known
	1989	North Sea	53° 29' N	3° 17' E			7.30E-01	Monitoring may have been conducted	Known
USA	1981	Gulf of Mexico, near Louisiana	28° 19' 13.13" N	91° 49' 27.98" W		Am-241 Cs-137	6.66E-01 7.40E-02	Two sources	Estimated by IAEA
	1981	Gulf of Mexico, near Louisiana	28° 33' 37.13" N	90° 41' 10.96" W		H-3	2.22E-01	Well logging	Estimated by IAEA
	1981	Gulf of Mexico, near Louisiana	28° 33' 37.13" N	90° 41' 10.96" W		Am-241 Cs-137	5.92E-01 5.55E-02	Two sources	Estimated by IAEA
	1981	Gulf of Mexico, near Texas	27° 53' 15.57" N	94° 41' 4.62" W		Am-241 Cs-137	5.92E-01 5.55E-02	Two sources	Estimated by IAEA
	1981	Gulf of Mexico, near Texas	28° 3' 10.63" N	96° 2' 53.88" W		Cs-137	3.70E-03	Well logging (Activity estimated <3.7 GBq)	Estimated by IAEA
	1982	Gulf of Mexico, near Louisiana	28° 52' 39.83" N	91° 22' 59.34" W		Cs-137	7.40E-02	Well logging	Estimated by IAEA
	1982	Pacific Ocean, near Alaska	56° 24' 25.12" N	148° 6' 58.61" W		Ra-226	9.25E-06	Calibration source	Estimated by IAEA
	1982	Gulf of Mexico, near Louisiana	28° 33' 37.13" N	90° 41' 10.96" W		Am-241 Cs-137	5.92E-01 5.55E-02	Two sources	Estimated by IAEA
	1982	Gulf of Mexico, near Louisiana	28° 33' 37.13" N	90° 41' 10.96" W		Am-241	6.66E-01	Well logging	Estimated by IAEA
	1982	Gulf of Mexico, near Louisiana	28° 22' 28.22" N	91° 26' 42.31" W		Cs-137	3.70E-01	Well logging (Activity estimated <370 GBq)	Estimated by IAEA
	1983	Gulf of Mexico, near Texas	28° 40' 22.11" N	95° 5' 52.27" W		Am-241	5.92E-01	Two sources	Estimated by IAEA
	1983	Gulf of Mexico, near Texas	27° 38' 22.97" N	95° 0' 54.74" W		Cs-137	5.55E-02	Two sources	Estimated by IAEA
	1983	Pacific Ocean, near California	35° 27' 1.80" N	122° 14' 2.43" W		Am-241 Cs-137	5.92E-01 5.55E-02	Two sources	Estimated by IAEA
	1983	Gulf of Mexico, near Louisiana	28° 44' 46.03" N	91° 0' 13.67" W		Cs-137	7.40E-02	Well logging	Estimated by IAEA
	1983	Gulf of Mexico, near Louisiana	28° 41' 30.93" N	91° 13' 14.05" W		Am-241 Cs-137	5.92E-01 5.55E-02	Two sources	Estimated by IAEA
	1983	Gulf of Mexico, near Louisiana	28° 33' 37.13" N	90° 41' 10.96" W		Am-241 Cs-137	5.92E-01 5.55E-02	Two sources	Estimated by IAEA

Country	Date	Geographical area	Latitude	Longitude	Depth (m)	Radioactive material	Total Activity (TBq)	Remarks	Exact location
USA (continued)	1983	Gulf of Mexico, near Louisiana	28° 34' 4.99" N	91° 35' 31.86" W		Cs-137	5.55E-02	Well logging	Estimated by IAEA
	1984	Unknown (probably Gulf of Mexico)	24° 46' 5.88" N	87° 41' 41.97" W		Am-241 Cs-137	5.92E-01 5.55E-02	Two sources	Estimated by IAEA
	1984	Gulf of Mexico	26° 14' 4.94" N	92° 37' 6.33" W		Am-241 Cs-137	7.40E-01 7.40E-02	Two sources	Estimated by IAEA
	1984	Gulf of Mexico, near Texas	27° 45' 49.27" N	95° 13' 18.57" W		H-3	3.70E-01	Two sources	Estimated by IAEA
	1984	Unknown (probably Gulf of Mexico)	24° 46' 5.88" N	87° 41' 41.97" W		Am-241 Cs-137	5.92E-01 5.55E-02	Two sources	Estimated by IAEA
	1984	Gulf of Mexico, near Louisiana	28° 33' 37.13" N	90° 41' 10.96" W		Am-241 Cs-137	5.92E-01 5.55E-02	Two sources	Estimated by IAEA
	1984	Gulf of Mexico, near Louisiana	28° 33' 37.13" N	90° 41' 10.96" W		Am-241 Cs-137	5.92E-01 5.55E-02	Two sources	Estimated by IAEA
	1985	Gulf of Mexico	27° 16' 4.08" N	93° 21' 44.12" W		Am-241 Cs-137	5.92E-01 5.55E-02	Two sources	Estimated by IAEA
	1985	Gulf of Mexico, near Louisiana	28° 33' 37.13" N	90° 41' 10.96" W		Am-241 Cs-137	5.92E-01 5.55E-02	Two sources	Estimated by IAEA
	1985	Gulf of Mexico	26° 26' 28.77" N	91° 59' 54.85" W		Am-241	7.40E-01	Well logging	Estimated by IAEA
	1985	Gulf of Mexico, Mustang Island	24° 10' 27.91" N	93° 37' 40.47" W		Am-241 Cs-137	5.92E-01 5.55E-02	Two sources	Estimated by IAEA
	1985	Gulf of Mexico, near Texas	27° 38' 22.97" N	95° 0' 54.74" W		Am-241 Cs-137	6.66E-01 7.40E-02	Two sources	Estimated by IAEA
	1985	Gulf of Mexico	26° 38' 52.59" N	91° 10' 19.54" W		Cs-137	3.70E-03	Well logging	Estimated by IAEA
	1985	Gulf of Mexico, near Louisiana	28° 46' 37.51" N	90° 49' 32.64" W		Cs-137	3.70E-02	Well logging (Activity estimated <37 GBq)	Estimated by IAEA
	1985	Gulf of Mexico, near Louisiana	28° 33' 37.13" N	90° 41' 10.96" W		Am-241 Cs-137	5.92E-01 5.55E-02	Two sources	Estimated by IAEA
	1985	Gulf of Mexico, near Louisiana	28° 33' 37.13" N	90° 41' 10.96" W		Cs-137	5.55E-02	Well logging	Estimated by IAEA
	1985	Gulf of Mexico, near Texas	27° 21' 1.61" N	95° 13' 18.57" W		Am-241 Cs-137	6.66E-01 7.40E-02	Two sources	Estimated by IAEA

Country	Date	Geographical area	Latitude	Longitude	Depth (m)	Radioactive material	Total Activity (TBq)	Remarks	Exact location
USA (continued)	1985	Gulf of Mexico, near Louisiana	28° 33' 37.13" N	90° 41' 10.96" W		Cs-137	7.40E-02	Well logging	Estimated by IAEA
	1985	Gulf of Mexico, near Louisiana	28° 44' 20.09" N	93° 8' 2.86" W		Am-241 Cs-137	7.40E-01 7.40E-02	Two sources	Estimated by IAEA
	1985	Gulf of Mexico, near Texas	27° 30' 56.67" N	96° 2' 53.88" W		Am-241 Cs-137	5.92E-01 5.55E-02	Two sources	Estimated by IAEA
	1986	Gulf of Mexico, near Texas	27° 38' 22.97" N	95° 0' 54.74" W		Am-241	5.92E-01	Well logging	Estimated by IAEA
	1986	Gulf of Mexico, near Louisiana	28° 5' 44.87" N	91° 32' 44.63" W		Am-241 Cs-137	5.92E-01 5.55E-02	Two sources	Estimated by IAEA
	1986	Gulf of Mexico	27° 3' 40.25" N	92° 44' 32.63" W		Am-241 Cs-137	7.40E-01 7.40E-02	Well logging (Activity estimated <740 GBq)	Estimated by IAEA
	1986	Gulf of Mexico, near Louisiana	28° 33' 37.13" N	90° 41' 10.96" W		H-3	3.70E-02	Well logging (Activity estimated <37 GBq)	Estimated by IAEA
	1986	Gulf of Mexico, near Louisiana	28° 33' 37.13" N	90° 41' 10.96" W		Cs-137	5.55E-02	Well logging	Estimated by IAEA
	1986	Gulf of Mexico	27° 18' 32.85" N	92° 12' 18.68" W		Am-241	1.11E-01	Well logging	Estimated by IAEA
	1987	Gulf of Mexico, near Louisiana	28° 33' 37.13" N	90° 41' 10.96" W		Unknown	5.55E-02	Well logging	Estimated by IAEA
	1987	Gulf of Mexico, near Louisiana	28° 35' 21.99" N	92° 23' 12.35" W		Am-241 Cs-137	5.92E-01 5.55E-02	Two sources	Estimated by IAEA
	1987	Gulf of Mexico	26° 11' 36.17" N	91° 27' 40.90" W		Am-241	3.70E+00	Well logging. (Activity estimated 370 GBq – 3.7 TBq)	Estimated by IAEA
	1987	Gulf of Mexico, near Louisiana	28° 33' 37.13" N	90° 41' 10.96" W		Am-241 Cs-137	6.85E-01 5.55E-02	Two sources	Estimated by IAEA
	1987	Gulf of Mexico, near Louisiana	28° 41' 30.93" N	91° 29' 1.66" W		Am-241 Cs-137	7.40E-01 7.40E-02	Two sources	Estimated by IAEA
	1987	Gulf of Mexico, near Texas	27° 38' 22.97" N	95° 0' 54.74" W		Am-241 Cs-137	5.92E-01 5.55E-02	Two sources	Estimated by IAEA
	1987	Pacific Ocean, near California	35° 4' 11.04" N	121° 49' 40.27" W		Am-241 Cs-137	5.92E-01 5.55E-02	Two sources	Estimated by IAEA
	1988	Gulf of Mexico, near Texas	27° 38' 22.97" N	95° 0' 54.74" W		Am-241 Cs-137	5.92E-01 5.55E-02	Two sources	Estimated by IAEA

Country	Date	Geographical area	Latitude	Longitude	Depth (m)	Radioactive material	Total Activity (TBq)	Remarks	Exact location
USA (continued)	1988	Gulf of Mexico, near Louisiana	28° 33' 37.13" N	90° 41' 10.96" W		H-3	7.40E-01	Well logging	Estimated by IAEA
	1988	Gulf of Mexico, near Louisiana	29° 10' 18.93" N	91° 31' 21.02" W		Am-241 Cs-137	5.92E-01 5.55E-02	Two sources	Estimated by IAEA
	1988	Gulf of Mexico, near Texas	27° 48' 18.03" N	95° 45' 32.52" W		Am-241 Cs-137	5.92E-01 5.55E-02	Two sources	Estimated by IAEA
	1988	Gulf of Mexico, near Louisiana	28° 33' 37.13" N	90° 41' 10.96" W		Am-241 Cs-137	5.92E-01 5.55E-02	Two sources	Estimated by IAEA
	1988	Offshore Australia	17° 16' 2.79" S	152° 43' 15.35" E		Am-241 Cs-137	5.92E-01 5.55E-02	Two sources	Estimated by IAEA
	1988	Gulf of Mexico, near Louisiana	29° 0' 33.64" N	91° 41' 6.31" W		Am-241 Cs-137	6.85E-01 5.55E-02	Two sources	Estimated by IAEA
	1988	Gulf of Mexico, near Louisiana	28° 33' 37.13" N	90° 41' 10.96" W		Am-241 Cs-137	5.92E-01 5.55E-02	Two sources	Estimated by IAEA
	1988	Gulf of Mexico, near Louisiana	28° 33' 37.13" N	90° 41' 10.96" W		Cs-137	5.55E-02	Well logging	Estimated by IAEA
	1989	Gulf of Mexico, near Louisiana	28° 29' 23.25" N	91° 17' 26.27" W		H-3	3.70E-02	Well logging	Estimated by IAEA
	1989	Gulf of Mexico, near Louisiana	28° 33' 37.13" N	90° 41' 10.96" W		Am-241 Cs-137	5.92E-01 5.55E-02	Well logging	Estimated by IAEA
	1989	Gulf of Mexico, near Louisiana	28° 33' 37.13" N	91° 53' 38.82" W		Am-241 Cs-137	5.92E-01 5.55E-02	Well logging	Estimated by IAEA
	1989	Gulf of Mexico, near Louisiana	28° 53' 7.70" N	92° 29' 24.88" W		H-3	7.40E-02	Well logging	Estimated by IAEA
	1989	Gulf of Mexico, near Louisiana	28° 33' 37.13" N	90° 41' 10.96" W		Cs-137	7.40E-02	Well logging	Estimated by IAEA
	1989	Gulf of Mexico, near Louisiana	28° 33' 37.13" N	90° 41' 10.96" W		H-3	3.70E-02	Well logging	Estimated by IAEA
	1989	Gulf of Mexico, near Louisiana	28° 22' 28.22" N	90° 50' 0.51" W		Am-241 Cs-137	1.11E-01 5.55E-02	Well logging	Estimated by IAEA
	1989	Gulf of Mexico, near Louisiana	28° 33' 37.13" N	90° 41' 10.96" W		Am-241 Cs-137	5.92E-01 5.55E-02	Well logging	Estimated by IAEA
	1989	Gulf of Mexico, near Louisiana	28° 15' 58.03" N	91° 10' 26.83" W		Am-241 Cs-137	5.92E-01 5.55E-02	Three sources	Estimated by IAEA

Country	Date	Geographical area	Latitude	Longitude	Depth (m)	Radioactive material	Total Activity (TBq)	Remarks	Exact location
USA (continued)	1989	Gulf of Mexico, near Louisiana	28° 33' 37.13" N	90° 41' 10.96" W		H-3	7.40E-02	Well logging	Estimated by IAEA
	1989	Gulf of Mexico, near Louisiana	28° 57' 46.41" N	91° 29' 1.66" W		Cs-137	7.40E-02	Well logging	Estimated by IAEA
	1989	Gulf of Mexico, near Texas	27° 38' 22.97" N	95° 0' 54.74" W		Am-241 Cs-137	1.11E-01 3.70E-02	Two sources	Estimated by IAEA
	1989	Gulf of Mexico, near Louisiana	28° 33' 37.13" N	90° 41' 10.96" W		Am-241	1.11E-01	Well logging	Estimated by IAEA
	1990	Gulf of Mexico, near Louisiana	28° 33' 37.13" N	90° 41' 10.96" W		H-3	3.70E-01	Well logging (Activity estimated <370 GBq)	Estimated by IAEA
	1990	Gulf of Mexico, near Louisiana	28° 33' 37.13" N	90° 41' 10.96" W		Am-241	1.11E-01	Well logging	Estimated by IAEA
	1990	Gulf of Mexico, near Louisiana	27° 58' 18.94" N	90° 59' 17.92" W		H-3	5.92E-02	Well logging	Estimated by IAEA
	1990	Unknown (probably Gulf of Mexico)	24° 46' 5.88" N	87° 41' 41.97" W		Am-241	1.11E-01	Well logging	Estimated by IAEA
	1990	Gulf of Mexico, near Louisiana	28° 33' 37.13" N	90° 41' 10.96" W		Am-241	1.11E-01	Well logging	Estimated by IAEA
	1990	Gulf of Mexico, near Louisiana	28° 33' 37.13" N	90° 41' 10.96" W		Am-241	1.11E-01	Well logging	Estimated by IAEA
	1990	Gulf of Mexico, near Louisiana	28° 33' 37.13" N	90° 41' 10.96" W		Am-241	3.70E-05	Well logging (Activity estimated <0.037 GBq)	Estimated by IAEA
	1990	Unknown (probably Gulf of Mexico)	24° 46' 5.88" N	87° 41' 41.97" W		Am-241	1.11E-01	Well logging	Estimated by IAEA
	1990	Gulf of Mexico, near Louisiana	28° 33' 37.13" N	90° 41' 10.96" W		Am-241	1.11E-01	Well logging	Estimated by IAEA
	1990	Gulf of Mexico, near Louisiana	28° 33' 37.13" N	90° 41' 10.96" W		Am-241	1.11E-01	Well logging	Estimated by IAEA
	1990	Unknown (probably Gulf of Mexico)	24° 46' 5.88" N	87° 41' 41.97" W		Am-241	1.11E-01	Well logging	Estimated by IAEA
	1990	Gulf of Mexico, near Louisiana	28° 33' 37.13" N	90° 41' 10.96" W		Am-241 Cs-137	6.85E-01 5.55E-02	Well logging	Estimated by IAEA
	1990	Unknown (probably Gulf of Mexico)	24° 46' 5.88" N	87° 41' 41.97" W		Am-241 Cs-137	6.85E-01 5.55E-02	Well logging	Estimated by IAEA

Country	Date	Geographical area	Latitude	Longitude	Depth (m)	Radioactive material	Total Activity (TBq)	Remarks	Exact location
USA (continued)	1990	Gulf of Mexico, near Louisiana	28° 33' 37.13" N	90° 41' 10.96" W		Am-241	3.70E-03	Well logging (Activity estimated <3.7 GBq)	Estimated by IAEA
	1990	Unknown (probably Gulf of Mexico)	24° 46' 5.88" N	87° 41' 41.97" W		Am-241	7.40E-02	Well logging	Estimated by IAEA
	1990	Gulf of Mexico, near Louisiana	28° 33' 37.13" N	90° 41' 10.96" W		Am-241 Cs-137	2.04E-06 3.33E-08	Well logging	Estimated by IAEA
	1990	Gulf of Mexico, near Louisiana	28° 33' 37.13" N	90° 41' 10.96" W		Cs-137	7.40E-02	Well logging	Estimated by IAEA
	1990	Unknown (probably Gulf of Mexico)	24° 46' 5.88" N	87° 41' 41.97" W		H-3	1.11E-01	Well logging	Estimated by IAEA
	1990	Unknown (probably Gulf of Mexico)	24° 46' 5.88" N	87° 41' 41.97" W		H-3	2.22E-01	Well logging	Estimated by IAEA
	1991	Gulf of Mexico, near Louisiana	28° 33' 37.13" N	90° 41' 10.96" W		Am-241 Cs-137	6.66E-01 7.40E-02	Well logging	Estimated by IAEA
	1991	Gulf of Mexico, near Louisiana	28° 33' 37.13" N	90° 41' 10.96" W		Cs-137	3.70E-02	Well logging (Activity estimated <37 GBq)	Estimated by IAEA
	1991	Gulf of Mexico, near Louisiana	28° 33' 37.13" N	90° 41' 10.96" W		Am-241	3.70E-02	Well logging (Activity estimated <37 GBq)	Estimated by IAEA
	1991	Gulf of Mexico, near Louisiana	27° 59' 29.58" N	91° 8' 28.17" W		Co-60	3.70E-03	Well logging (Activity estimated <3.7 GBq)	Estimated by IAEA
	1991	Gulf of Mexico, near Louisiana	28° 33' 37.13" N	90° 41' 10.96" W		Am-241	3.70E-02	Well logging (Activity estimated <37 GBq)	Estimated by IAEA
	1991	Gulf of Mexico, near Louisiana	28° 33' 37.13" N	90° 41' 10.96" W		Am-241	1.00E-01	Well logging	Estimated by IAEA
	1991	Gulf of Mexico, near Texas	28° 10' 36.92" N	95° 33' 8.70" W		Am-241	3.70E+00	Well logging. (Activity estimated 370 GBq – 3.7 TBq)	Estimated by IAEA
	1991	Gulf of Mexico, near Texas	28° 23' 0.75" N	95° 33' 8.70" W		Am-241	3.70E-02	Well logging (Activity estimated <37 GBq)	Estimated by IAEA
	1991	Gulf of Mexico, near Louisiana	28° 33' 37.13" N	90° 41' 10.96" W		Am-241	3.70E+00	Well logging. (Activity estimated 370 GBq – 3.7 TBq)	Estimated by IAEA
	1992	Gulf of Mexico, near Louisiana	28° 33' 37.13" N	90° 41' 10.96" W		Am-241	3.70E+00	Well logging. (Activity estimated 370 GBq – 3.7 TBq)	Estimated by IAEA
	1992	Gulf of Mexico, near Louisiana	28° 33' 37.13" N	90° 41' 10.96" W		Am-241 Cs-137	6.85E-01 5.55E-02	Well logging	Estimated by IAEA

Country	Date	Geographical area	Latitude	Longitude	Depth (m)	Radioactive material	Total Activity (TBq)	Remarks	Exact location
USA (continued)	1992	Gulf of Mexico, near Louisiana	28° 6' 12.74" N	90° 56' 2.83" W		Cs-137	7.40E-02	Well logging	Estimated by IAEA
	1992	Gulf of Mexico, near Louisiana	28° 52' 11.96" N 28° 33' 37.13" N	92° 5' 43.46" W 90° 41' 10.96" W		Am-241 Cs-137	5.92E-01 5.44E-02	Two sources	Estimated by IAEA
	1992	Gulf of Mexico, near Louisiana	28° 33' 37.13" N	90° 41' 10.96" W		Am-241	2.05E-06	Three sources	Estimated by IAEA
	1992	Gulf of Mexico, near Louisiana	28° 33' 37.13" N	90° 41' 10.96" W		Am-241	3.70E-06	Well logging (Activity estimated <37 MBq)	Estimated by IAEA
	1992	Gulf of Mexico, near Louisiana	28° 33' 37.13" N	90° 41' 10.96" W		Cs-137	3.70E-01	Well logging (Activity estimated <370 GBq)	Estimated by IAEA

(1) A radioactive source designed in such a form that the probability of dispersion of its radioactive contents is extremely low. Sealed sources may be used, for example in teletherapy and brachytherapy and in scientific devices, as well as in a number of industrial and other medical applications. In the context of this report most of the sealed sources have been used in offshore drilling and logging.

(2) For USA, data for NRC licensees only. May not include data from some other Agreement States.

ANNEX V.

EXAMPLES OF LOSSES OF INDUSTRIAL SEALED SOURCES AT SEA LATER RECOVERED INTACT BY COUNTRY

Country	Date	Geographical area	Latitude	Longitude	Depth (m)	Radioactive material	Total Activity (TBq)	Exact location
Bangladesh	1997							Unknown
India	1993	Bombay High, Oil Well No. LA-6(H)	18° 42' 18.44" N	72° 20' 14.02" E		Cs-137	5.55E-02	Estimated by IAEA
Malaysia	1986	South China Sea, Offshore Terengganu	5° 40' 59.33" N	103° 6' 11.84" E	2650	Cs-137 Am-241/Be	7.40E-02 6.66E-01	Estimated by IAEA
	1989	South China Sea, Offshore Terengganu	5° 40' 59.33" N	103° 6' 11.84" E	2740	Cs-137 Am-241/Be	7.40E-02 7.40E-01	Estimated by IAEA
	1991	South China Sea, Offshore Sarawak (Malatut-1)	4° 10' 48.57" N	112° 26' 2.91" E	3223	Cs-137 Am-241/Be	5.55E-02 5.92E-01	Estimated by IAEA
	1991	South China Sea, Offshore Trengganu (Abu-2)	5° 40' 59.33" N	103° 6' 11.84" E	1060	Cs-137 Am-241/Be	5.55E-02 5.92E-01	Estimated by IAEA
	1991	South China Sea, Offshore Sarawak (Mengira-1)	4° 10' 48.57" N	112° 26' 2.91" E	3751	Cs-137 Am-241/Be	5.55E-02 5.92E-01	Estimated by IAEA
Mexico	1991	Campeche Sound, 40 km from coast	19° N	91° 46' 8"	12	Ir-192	2.99E+00	Known
	1991	Campeche Sound, 40 km from coast	19° N	91° 46' 8"	15	Ir-192	2.28E+00	Known
	1995	Campeche Sound, 35 km from coast	19° N	92° W	12	Ir-192	3.11E+00	Known
United Kingdom	1990	North Sea	53° 3' N	3° 2' E	27	Cs-137, Am-241/Be	7.94E-01	Known

ANNEX VI.

AMOUNT OF RADIOACTIVITY IN SUBMARINE NUCLEAR REACTORS AND THE SHIELDING ASSEMBLY OF ICEBREAKER LENIN

Table VI-1. Amount of radionuclides in the shielding assembly of the reactor from the icebreaker Lenin (OK-150) at the time of dumping in 1966 (according to Table 4 of [VI-1]).

Type of radionuclides	**Activity TBq**
Fission products	17410
Activation products	1873
Actinides	269
Total	**19552**

Table VI-2. Amount of radionuclides in the reactor compartment of NS No. 285 at the time of dumping in 1965 (according to Table 9 of [VI-2]).

Type of radionuclides	**Activity TBq**
Fission products	11500
Activation products	113
Actinides	27.2
Total	**11610**

Table VI-3. Amount of radionuclides in the reactor compartment of NS No. 421 at the time of dumping in 1972 (according to Table 18 of the IAEA Working Material IASAP-5).

Type of radionuclides	**Activity TBq**
Fission products	1021
Activation products	19.95
Actinides	7.3
Total	**1048**

Table VI-4. Amount of radionuclides in the reactor compartment of NS No. 901 at the time of dumping in 1965 (according to Table 18 of the IAEA Working Material IASAP-5).

Type of radionuclides	**Activity TBq**
Fission products	2882
Activation products	53.7
Actinides	10.7
Total	**2946.4**

Table VI-5. Amount of radionuclides in the reactor compartment of NS No. 601 at the time of dumping in 1981 (according to Table 13 of the [VI-3]).

Type of radionuclides	**Activity TBq**
Fission products	635
Activation products	1.27
Actinides	731
Total	**1366**

Table VI-6. Amount of long-lived activation products in the reactor compartments of NS 254, 260, 285, 538 and OK-150 at the time of dumping.

Object	**Activation products Activity TBq**	**Year of dumping**	**According to:**
NS 254	93.16	1965	IASAP-5, Table 3
NS 260	43.69	1966	IASAP-5, Table 6
NS 285	Included in Table VI-2	1965	IASAP-9 Table 9
NS 538	5.59	1988	IASAP-5, Table 3
OK-150	Included in Table VI-1	1967	IASAP-1, Table 4

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