Dumping of radioactive waste

4.0 Dumping

Radioactive waste has been dumped in the ocean ever since the Soviet Union started testing their first nuclear-powered submarine at the shipyard of Severodvinsk in 1959. The dumped waste arises from operation of both nuclear-powered submarines and civil nuclear icebreakers. In all, the former Soviet Union, now Russia, has dumped more than twice as much radioactivity as other countries having dumped radioactive waste at sea. [] The 12 other nations having dumped radioactive waste into the ocean are: Belgium, France, Germany, Italy, Japan, South-Korea, the Netherlands, New Zealand, Switzerland, Sweden, Great Britain, and USA. [] The Soviet/Russian dumping has, as opposed to that of other nations, taken place in shallow waters, north of the 50th latitude, and on the continental shelf.

4.1 Rules and conventions

Dumping of radioactive waste into the ocean is regulated by international conventions (The London Convention). Furthermore, a number of Soviet (presently Russian) laws and rules from different ministries and the Naval Command have been passed. The Soviet/Russian Northern Fleet has broken the country's own set of regulations for dumping radioactive waste, as well as acted in defiance of international regulations a number of times. In addition, the Soviet Union has given erroneous information on the country's dumping of radioactive waste into the ocean to the International Atomic Energy Association (INEA), whose task is to control whether the countries having signed the London Convention observe the regulations. Bellona has put together the following chronological survey of the development of the different national regulations and international conventions limiting dumping:

1960

The first document permitting dumping of liquid radioactive waste containing long-life isotopes is written by *The Soviet Ministry of Medium Machine Construction in co-operation with the third main directorate in The Soviet Ministry of Health Care.[]*

1962

A new version of the 1960-permission becomes operational. [] This regulates the dumping of liquid radioactive waste by prohibiting dumping of more than 1,000 cubic metres, and specifies that the radioactivity may not exceed 1,850 kBq/l for short-life isotopes, and 370 kBq/l for long-life isotopes. The total level of radioactivity may not exceed 370 GBq (10 Ci). Dumping directly from nuclear-powered vessels is only permitted in emergencies.

1966

The regulation of 1962 is replaced by the more detailed *VSTZ-66-regulation drawn up by the Navy and The Soviet Ministry for Health Care. The regulation establishes that dumping is to take place in certain areas, and that the radioactivity level is to be regularly*

monitored in these areas. During 1966-67, the Northern Fleet determines that solid radioactive waste is to be dumped in bays on the eastern coast of Novaja Zemlja, and liquid radioactive waste in limited areas of the Barents Sea.

1972

The London Convention limiting the dumping of radioactive waste at sea from ships is signed by a number of nations, among them the Soviet Union. The convention becomes operational in 1975, and bans dumping of high level radioactive waste, among other things. Furthermore, it limits the dumping of low- and medium level radioactive waste. Dumping of such waste is limited by the IAEA's demands, stating that dumping is to take place outside the continental shelf, on waters deeper than 4,000 metres, and between latitudes of 50° S and 50° N.[]

1975

The Soviet Union ratifies the London Convention, which becomes operational on the 29th of January 1976. In spite of signing the agreement, the Soviet Union continues dumping of solid and liquid radioactive waste. Furthermore, reactors containing fuel are dumped in the Kara Sea in both 1981 and 1988.

1979

The Soviet Union draws up a plan concerning the limitation of dumping of radioactive waste, in order to comply with the London Convention. [] A new law, PS-82, prohibiting regular dumping of radioactive waste from ships, aircrafts and platforms is formulated, and becomes operational in 1983. The prohibition is based on the negative effects the dumping in the sea might have on the environment. The prohibition is drawn up in co-operation with *The Soviet Ministry for Fisheries. At the same time, the Navy draws up regulations for dumping of radioactive waste in the sea.*

1983

The London Convention carries a temporary prohibition on all dumping of radioactive waste. The Soviet Union waives its vote. *The Soviet State Committee for Hydrometrology refuses to approve of the Northern Fleet's further plans for dumping in the Kara Sea.*

1987

PS-82 is withdrawn the 1st of December 1987, and further regulations for dumping is established by the Navy.

1988

The 21st of July 1988, the Soviet delegates at the London Convention claim that dumping of radioactive waste in the sea is prohibited by Soviet law. Furthermore, they claim the Soviet Union has never dumped radioactive waste in the sea, and does not intend to do so in the future. [] Only a few weeks later, the Northern Fleet dumps two submarine reactors containing fuel in the Kara Sea.

1992

The 24th of October, president Boris Yeltsin signs a decree, appointing a commission to investigate the information concerning dumping of radioactive waste at sea. The commission is presided by the president's environmental councillor Alexei Jablokov.[]

1993

In November 1993, the London Convention agrees on making the temporary dumping prohibition a permanent prohibition. England, France, Belgium, China, and Russia waive their votes.

4.2 Dumping performed by the Northern Fleet and the Murmansk Shipping Company

The Russian Northern Fleet (formerly the Soviet) has since 1960 dumped radioactive waste in the Barents Sea and Kara Sea on a regular basis. This comprises solid radioactive waste, liquid radioactive waste, and nuclear reactors with and without fuel. Furthermore, radioactive waste has been dumped in the Barents Sea and Kara Sea from the civil state-run Murmansk Shipping Company's fleet of nuclear icebreakers. The navy has also dumped radioactive waste in the Japan Sea, Pacific Ocean, and Baltic Sea. In all, Russia (former Soviet Union) has dumped between 115,000 TBq (3,1 million Ci) and 333,000 TBq (9 million Ci) at sea. [] In comparison, all other countries put together have dumped 46,000 Tbq (1,24 million Ci) during the period of 1946-1982.[]

4.2.1 Liquid radioactive waste

Liquid radioactive cooling water from the ship reactors and storage tanks for used fuel assemblies has since 1959 been dumped at sea. The last dumping of liquid radioactive waste took place November 1991, and this practice may be resumed if no alternative solutions are found. According to regulations set forth by the Soviet Navy in 1968, the liquid radioactive waste should have a maximal concentration of radioactivity of 370 Bq/l of long-life radioactive isotopes, and 1850 kBq/l of short-life isotopes. [] Whether these regulations are observed, is not known.

The liquid waste of the highest radioactive concentration has been dumped in the three dumping fields furthest to the north in the Barents Sea, while the less radioactive waste is dumped outside the shore of the Kola Peninsula.

gif, 6K
Map: *Dumping areas for liquid radioactive waste*

From 1959 up to 1991, 3.7 Tbq (100 Ci) liquid radioactive waste has been dumped in the White Sea, 451 Tbq (12,171 Ci) in the Barents Sea, and 315 TBq (8,500 Ci) in the Kara Sea. [] 430 TBq (11,600 Ci) radioactive water has leaked out in the sea following accidents concerning storage of fuel assemblies, submarines, and the civil nuclear icebreaker *Lenin. The radioactivity of the liquid waste dumped in the Barents Sea, Kara Sea, and White Sea totals 880 TBq (23,771 Ci).*

The amount of radioactivity in the liquid waste dumped at different points of time, varies considerably.

The tanker Amur is a radiological auxiliary vessel put into use by the Northern Fleet in 1987. The Amur has cleansing facilities for radioactive cooling water from submarine reactors. The cooling water is then dumped in the ocean. After the Amur was put into operation, it has cleansed and 975 tons of radioactive cooling water. []

gif, 105K,
Photo: *The tanker"Amur" dumping liquid radioactive waste in the Barents sea*

The Amur is at present at the Northern Fleet's naval shipyard Nr. 10 Shkval in the Pala Bay for rebuilding. Another tanker similar to the Amur will be delivered to the Northern Fleet in 1994. At the new tanker, evaporation as opposed to filter- cleansing will be used to lower the level of radioactivity of the cooling water prior to its dumping in the ocean. Liquid radioactive waste has also been dumped from vessels of the 1783A-type (Vala design).

4.2.2 Solid radioactive waste

The Northern Fleet has sunk a total of 17 ships and lighters containing radioactive waste in the Barents- and Kara Sea. Aboard the ships there are different types of radioactive waste of varying levels of radioactivity, made up mainly of containers with radioactive waste, reactor parts, and other contaminated equipment. The dumped containers are mostly filled with low- and medium radioactive waste, such as contaminated metal parts from the submarines' reactor sections, clothes, and equipment used for work at the reactors. Major items that have been dumped, are cooling water pumps from reactors, generators, and varying reactor parts. Some of these are placed aboard ships and lighters before these were sunk.

Of special interest is the fact that Cargo boat no. 4, sunken in the Techeniya Bay in 1988, has the same position as reactor section no. 538, also sunk in 1988. This may indicate that the reactor section was aboard the cargo boat when it was sunk.

Solid radioactive waste in and without containers has since 1965 to 1991 been dumped in 8 different bays off the eastern coast of Novaya Zemlya, and in the Kara Sea. Both the Northern Fleet and the civil fleet of nuclear icebreakers in Murmansk have dumped radioactive waste in these areas.

According to the Jablokov Report, a total of 6,508 containers of radioactive waste has been dumped directly in the Kara Sea. [] The Northern Fleet has dumped 4,641 of these. [] In archives of the Murmansk Shipping Company, dumping of 11,090 containers into the sea has been recorded. This implies the company has dumped 1,867 individual containers, while the remaining 9,223 containers are placed aboard lighters and ships before they were sunk.

During the first dumping missions in the 60's, many containers did not sink, but remained floating at the surface. The crew aboard the boats carrying out the dumping solved the problem by shooting at the containers with machine guns, causing water to seep in, and the containers to sink. [] This took place in Abrosimova Bay on the south-eastern coast of Novaya Zemlya. Furthermore, reports have been made concerning repeated finds of containers of radioactive waste floating in the Kara Sea. One container was found ashore on Novaya Zemlya. [] At later

dumping missions the problem has been solved by placing rocks along with the radioactive waste in the containers to make them sink.

Moreover, 155 major radioactive items have been dumped. Some of the containers and items were aboard the lighters and cargo boats with radioactive waste dumped in the same areas. The containers hold 0.5 to 1 cubic metre waste, and are made of plain iron. Some of the containers are lined with concrete.

In addition to radioactive waste dumped in bays on the eastern coast of Novaya Zemlya, the ship *Nikel was sunk by the island of Kolgoyev in the Barents Sea (69:34'1 N 47:56'3 E) The ship was loaded with 18 radioactive items corresponding to 1,100 cubic metres of a radioactivity of 1.5 TBq (40 Ci).*

A total of 31,534 cubic metres solid radioactive waste of a radioactivity of 574 TBq (15,502 Ci) is dumped, made up of 6,508 containers, 17 ships, and 155 major items.

4.2.3 Dumped nuclear reactors

13 nuclear reactors from submarines have been dumped in the Kara Sea. Six of the submarine reactors have been dumped with used fuel aboard. All reactors come from nuclear submarines having had serious accidents where the reactors have been a radiation problem. The reactors were so wrecked, and the radiation so strong that the nuclear fuel was impossible to remove. This is the reason why the fuel is not removed before the reactors are dumped. In addition to the submarine reactors, three reactors from the nuclear icebreaker *Lenin have been dumped.[]*

gif, 5K
Photo: *Comparition of dumped radioactive waste. From left to rigth: liquid/solid watste, with/without fuel*

The dumped reactors had been stored for from one to fifteen years from the date of the accident to when they were dumped in the Kara Sea. 5 of the submarine reactors were filled with protective material of steel, cement, and polyester to prevent radioactivity to seep out into the marine environment. According to Russian reactor constructors, this protection may last for up to 500 years. As very little technical data on the different nuclear reactors is available, the amount of radioactivity represented by the nuclear reactors is hard to calculate. Very rough calculations made by Russian experts based on the information available in the Jablakov Commission's report estimate the total radioactivity to be 85 PBq (2,300 kCi) for the submarine reactors containing fuel and the 3 reactors from Lenin.[]

Calculations made by the *Lawrence Livermore National Laboratory in the USA conclude, however, that the amount of radioactivity dumped in the Kara Sea may be higher than what is stated in the Jablokov Commission' s report. The laboratory has made calculations based on available information on the reactor's power production, assumed running time, and assumed isotope composition of the used fuel. The results of the American calculations indicate that the radioactivity of the reactors dumped with used fuel and the 3 reactors from Lenin might have been 178 PBq (4,800 kCi) at the time of the dumping. The radioactivity of the submarine reactors without fuel is estimated to about 3,7 PBq (100 kCi) per reactor.[]*

As shown in the survey of dumped, nuclear reactors, dumped ships, items, and containers with radioactive waste, plus the survey of dumped liquid radioactive waste, the variations in amount of radioactivity at the different dumping fields are considerable. If it's assumed that a reactor

without fuel represent a radioactivity of 3,7 PBq (100 kCi), then more than 80 per cent of the total radioactivity is dumped at the Abrosimova Bay (52 per cent) and at the dumping fields in the Kara Sea (30 per cent). At the Blagopoluchy Bay, Oga Bay, and Sedovo Bay, on the other hand, only minor amounts of radioactivity have been dumped.

Source	Activity (Ci/TBq)
Fallout following the Chernobyl accident and nuclear testings.	**6,300 TBq**
Eroding from the rivers Ob and Jenitsej[]	Some millions Ci.
The Golf Stream, mainly from Sellafield.	7,400 TBq
Dumping in the Barents- and Kara Sea.	Between 3 and 9 millions Ci
Under water nuclear testings.	No available information
Possible leakages from underground nuclear testings at the two testing sites at Novaja Zemlja.	No available information
Total	**Between 5 and 15 millions Ci**

Table: *Different sources of radioactive pollution of Arctic waters*

4.3 Measurements of radioactivity in the Barents- and Kara Seas

Examinations of the radioactivity have been made in areas where waste has been dumped, but the analyses are executed by military laboratories, and the results have never been released. [] Examinations by Russian institutes have been performed by *The Maritime Department of the Soviet Ministry of Defence's 12th Central Scientific Institute, Roskomgridromet's Typhoon Institute of Science and The Naval Central Laboratory of Medicine. Civilian scientists have since 1967 not been granted permission to perform research closer than 50-100 kilometres to the dumping sites. []*

A joint Norwegian-Russian research expedition to the Kara Sea in August/September 1992 was not granted permission to go within the 12-mile boundary of Novaya Zemlya, or to take tests at the dumping fields in the Kara Sea. A new Norwegian-Russian research expedition was undertaken in the Kara Sea in September/October 1993. This expedition was granted permission to examine the dumping sites in the Kara Sea, as well as those in the Tsivolky- and Stepovogo Fjords. They were, however, not permitted to examine the Abrosimova Bay where, among other things, most reactors containing fuel have been dumped. Promises have been made in Russia that this bay may be examined in 1995.

Results of the first Norwegian-Russian expedition indicate following pollution of sediments in the Kara Sea: 137Cs-radioactivity from 3 to 22 Bq/m3, 90 Sr-radioactivity from 3 to 12 Bq/m3, and 239Pu+ 240Pu-radioactivity of approximately 1.8 to 11.5 mBq/m3. Measurements indicate this pollution is due to contributions from reprocessing in Sellafield (UK), the rivers Ob and Jenitsej, and fallout following the Chernobyl accident [] . The preliminary results of

the 1993 expedition indicate a possible leakage from one of the dumping sites in Stepovogo Bay.[]

Following the completion of the examinations of the submarine *Komsomolets in the beginning of September 1993, the science ship Akademik Mstislav Keldysh sailed to the Abrosimova Bay to examine the conditions of the dumped objects. This ship is equipped with two manned submarines with video cameras and test-equipment for radioactivity. Results of these examinations have as of yet not been released.*

Radioactivity has furthermore been measured on the eastern coastline of Novaya Zemlya. The examinations were performed by scientists from the nuclear testing field at the Matotchin Straight on Novaya Zemlya. [] It was claimed that, with one exception, elevated gamma-radiation was not detected. The exception concerns Abrosimova Bay, where parts of a used fuel assembly was found on the beach. Here, values exceeding 100 Roentgen/h was measured.[]

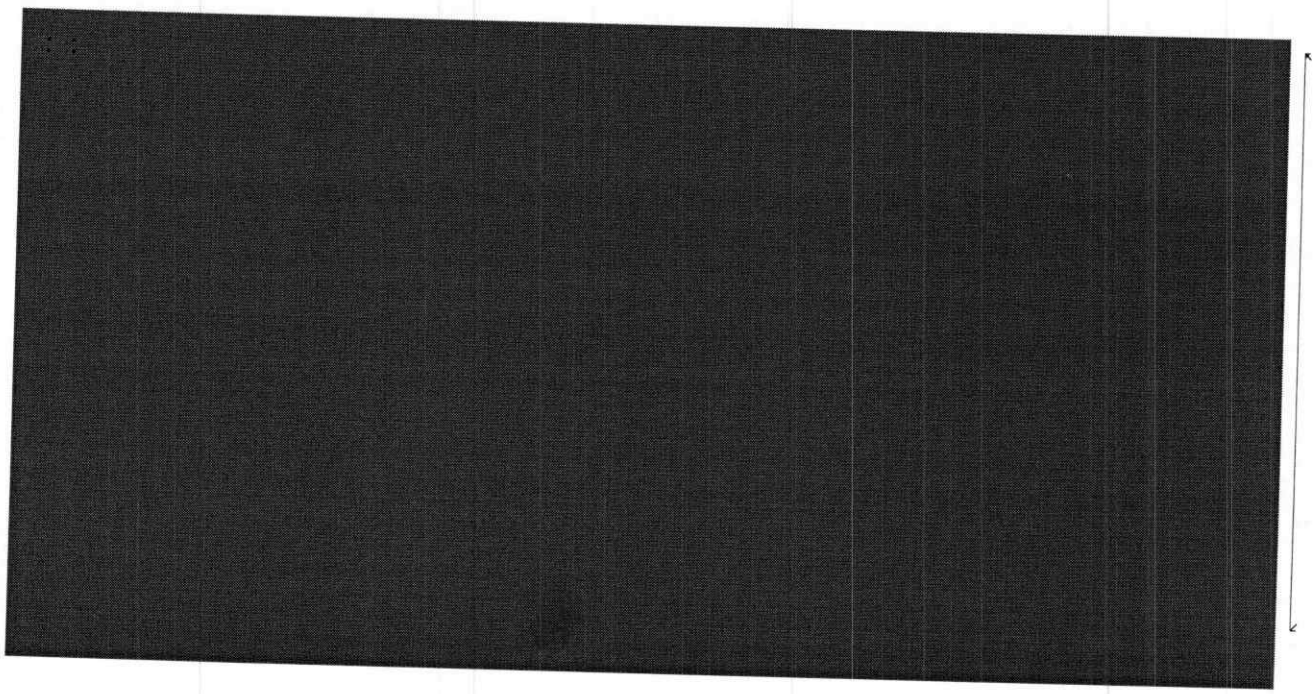
[1] 93 PBq/2.5MCi (official Russian figures) and 46 PBq/1.24 MCi (IAEA-estimate) accordingly. Source: Jablokov, A.V. et al, 1993.
[2] IAEA, 1991.
[3] The name of the document was: "Temporary sanitary requirements for the dumping at sea from naval installations of the liquid waste containing long-life radioactive substances" of 1960. Source: Jablokov, A.V, et al, 1993.
[4] Jablokov, A.V, et al, 1993.
[5] Ibid.
[6] Council of Ministers of USSR Decree no. 222" carries "Measures for providing the fulfilment of the commitments by the Soviet side in connection with the Convention for prevention of contamination of the sea by dumping of waste and other materials of 1972".
[7] IAEA , 1991.
[8] Decree from president Boris Yeltsin no. 613-rp, 24th of October 1992.
[9] In Jablokov, A.V. et al, 1993, the amount of radioactivity dumped in the Arctic Ocean is said to be approximately 85,000 TBq (2.3 million Ci). This amount, however, does not include the submarine reactors dumped without fuel, plus one reactor containing fuel. The total amount of radioactive waste dumped in the sea, including these reactors, is thus 115,000 TBq (3.1 million Ci) long-life isotopes. According to calculations by "Lawrence Livermore National Laboratory" in the USA, the nuclear reactors dumped in the Kara Sea might have had a radioactivity of as much as 322,000 TBq (8.7million Ci) at the time of dumping. Source: Mount, M. et al. 1993.
[10] IAEA, 1991.
[11] Jablokov A.V, et al, 1993.
[12] Ibid.
[13] The cleansing of the liquid radioactive waste is done by filtering the waste through special filters, and thereafter mixing it with sea water in a separate tank. The mixed water is then dumped in the Barents Sea. This cleansing technology is regarded as unsatisfactory by the county authorities in Murmansk. Source: Sovietsky Murman, 17th of October 1992.
[14] The figure 6,508 is taken from the Jablokov Report. In file documents from A. Solotkov the total amount of containers of radioactive waste dumped in the Kara Sea is claimed to be 11,090. The difference is probably explained by the fact that nearly 5,000 containers are loaded

in some of the ships sunk in the Kara Sea.

[15] Ibid.
[16] Polyarnaya Pravda, 25th of September 1991, Murmansk.
[17] Ibid.
[18] Jablokov A.V, et al, 1993.
[19] Ibid.
[20] Jablakov A. V. et al, 1993.
[21] Mount et al, 1993.

[22] The radioactivity reaching the Arctic Ocean through the rivers Ob and Jenitsej originates in many different sources. In the two rivers' fluvial basin, several nuclear power plants, the test field at Semipalatinsk in Kazakhstan, approximately 60 civil nuclear test explosions, three plutonium plants containing enormous waste storages (Mayak, Tomsk-7, and Donovo) are situated. There are several reprocessing plants for used fuel assemblies at these three military nuclear complexes. Bellona is working on an extensive charting of sources of radioactive pollution in the fluvial basin of the two rivers.

[23] Conversations held with engineer Andrei Solotkov at the nuclear icebreaker base "Atomflot" in Murmansk, July 1992.
[24] Jablokov A.V. et al. 1993
[25] Joint Russian-Norwegian Expert Group for Investigation of Radioactive Contamination in the Northern Seas 1993.
[26] Føyn L. & Nikitin A., 1993.
[27] Jablokov A.V. et al.
[28] Ibid.



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