NRPA Bulletin

Statens strålevern

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Discharges of radioactive waste from the British reprocessing plant near Sellafield

The Sellafield plant on the northwest coast of England discharges radioactive waste into the Irish Sea. Much of the waste is transported by ocean currents to the North Sea, along the Norwegian coast and up to the Arctic. In 1994, discharges of the long-lived radionuclide technetium-99 showed a sharp increase. However, discharges of most radioactive substances are still appreciably lower than they were in the '70s and '80s. Based on current knowledge, the concentrations of anthropogenic radioactivity in the marine environment do not represent a health hazard. Even so, the Norwegian authorities are working to achieve reductions in the discharges of long-lived radioactive waste such as technetium-99. They are doing so in the knowledge that discharges can be reduced using current technology, and because no one is certain of the mechanisms controlling the way technetium behaves in the marine environment. A precautionary approach is therefore called for.

The Sellafield plant on the northwest coast of England.

Discharge of radioactive waste

The plant near Sellafield in the UK that processes spent nuclear fuel has released radioactive waste into the Irish Sea for several decades as a normal part of its operations. The discharges were greatest in the '70s and at the start of the '80s, and have since then been reduced thanks to the introduction of new clean-up techniques.

In March 1994, discharges of technetium-99 (^{99}Tc) from Sellafield increased sharply together with higher discharges of iodine-129 (^{129}I). The increases were due to actions initiated to deal with old Magnox waste, which had been stored in tanks since the mid-'80s pending the commissioning of a new waste handling plant. This plant, which became operational in 1994, does not remove ^{99}Tc from the waste. Technetium-99 has a physical half-life of 213,000 years. It is highly water-soluble and is therefore transported by ocean currents. The highest ^{99}Tc discharges, recorded in 1995, were about 40 times higher than the 1993 levels and have led to a large increase in ^{99}Tc concentrations along the Norwegian coast. The reprocessing plant at La Hague in France also releases radioactive waste into the marine environment. While ^{99}Tc discharges from La Hague are far lower than from Sellafield, discharges of the long-lived radioactive isotope ^{129}I are somewhat higher than at Sellafield.

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Norwegian Radiation Protection Authority, P.O. Box 55, 1332 Østerås · Tel.: +47 67 16 25 00 · Fax: +47 67 14 74 07
E-mail: nrpa@nrpa.no · www.nrpa.no
Inquiries to: Head of Department Per Strand · Tel.: + 47 67 16 25 64

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Regulating discharges in the future

The Environment Agency of England and Wales (the Agency) recently completed a round of consultations on new recommendations for regulating radioactive discharges from Sellafield. A proposed new regime of discharge recommends lower discharge limits for eight radioactive substances released to water and for fourteen released to the air, while retaining the other limits. However, since actual discharges are far below the existing limits, there is room for substantial increases in real discharges. Indeed, British Nuclear Fuels plc, (BNFL), which owns and runs the Sellafield plants, anticipates a substantial increase in discharges of the majority of nuclides in the run-up to 2008. The Agency now recommends retaining the discharge limits for ^{99}Tc until 2006, and thereafter lowering them.

The Agency also recommends raising the discharge limits should it prove necessary to dispose of stored liquid waste on safety grounds. The UK Health & Safety Executive regards the tanks holding high- and intermediate level liquid waste at the Sellafield plant as a safety risk, and wants to see this waste reduced to a minimum. The safety risk involved in storing liquid waste on land is one of the reasons for retaining the discharge limits for ^{99}Tc. The costs of such storage in relation to the utility effect in the form of reduced radiation dose to the population (cost-benefit analysis) is a further important part of the reasoning behind the new proposal for future regulation of radioactive discharges from Sellafield.

The current ^{99}Tc discharges to the sea will therefore continue unless the problems associated with using the new abatement techniques can be resolved rapidly enough to ensure that a substantial part of the existing waste can be treated before being released to the sea. According to the plan, the tanks holding ^{99}Tc waste will be emptied by the end of 2006 at the latest, after which the discharge limits will be lowered.

The recommended discharge regulation also requires BNFL to implement the first stage of its research and development project on new decontamination technology to remove ^{99}Tc. Waste generated after 2003 will not result in ^{99}Tc discharges, but will be diverted to tanks holding high-level waste and converted to solids in the same way as is done at the THORP and La Hague reprocessing plants.

Decontamination techniques

Technetium-99 discharges to the sea can only be avoided by continuing to store intermediate level waste in tanks at the plant until techniques are available to remove ^{99}Tc from the waste. The UK is working on two possible ways to reduce ^{99}Tc discharges. One is to divert waste containing ^{99}Tc to storage tanks holding high-level liquid waste for conversion into solids (vitrification). The second is to introduce new decontamination techniques that also remove ^{99}Tc. Use of a precipitant, tetraphenylphosphonium bromide (TPP), to remove ^{99}Tc from the liquid waste is relevant in this context. Technetium-99 is subsequently cemented and stored below ground together with other radioactive waste after waste treatment in the Enhanced Actinide Removal Plant (EARP).

The UK authorities have been reluctant to test and use TPP in conjunction with subsequent underground storage. This is on the ground that ^{99}Tc is a mobile radioactive substance with a very long half-life and that it could leak into the environment from an underground storage site. Untreated ^{99}Tc is therefore released into the sea rather than run the risk of potential leakage from a land-based storage site.

Consequences for health and environment

Based on current knowledge, ^{99}Tc levels along the Norwegian coast are of little consequence for health. However, there is some uncertainty about the impact of increasing concentrations of ^{99}Tc over a long period. More knowledge will need to be obtained regarding the effects of radioactive contamination of the marine ecosystem. It is necessary to show caution when it comes to discharging particularly long-lived radionuclides, both to protect the marine environment and economic and social interests. Applying the precautionary principle will be important, since it is difficult to conceive possible future counter-measures that would be effective in the event of widespread pollution of the marine environment.

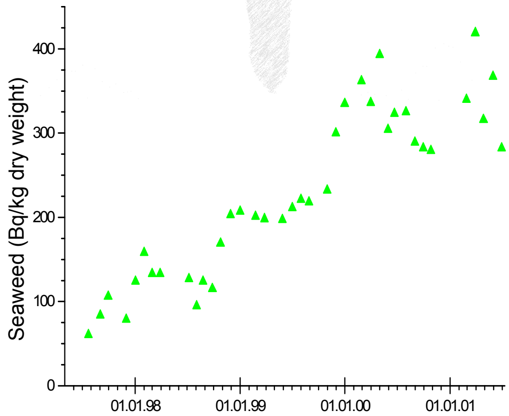
In the context of possible health and safety consequences, the argument that underground storage of ^{99}Tc is inadvisable due to the risk of uptake of ^{99}Tc into the food chain does not sit well with the fact that untreated discharges of ^{99}Tc are being released into the marine environment.

Like a number of other countries, the United Kingdom has assumed an obligation under OSPAR (the Oslo-Paris Convention for the Protection of the Marine Environment of the North-East Atlantic) to substantially reduce discharges of radioactive waste to the sea in the period to 2020. In the international arena, the focus is now on establishing a basis for protection of the environment against radioactive pollution. OSPAR, the International Atomic Energy Agency (IAEA), the International Union of Radioecology (IUR) and the European Union have all launched programmes to look into this issue.

Environmental monitoring in Norway

National programmes for monitoring radioactive pollution are co-ordinated by the Norwegian Radiation Protection Authority (NRPA) and carried out in co-operation with a number of other agencies and institutions. Fisheries monitoring is performed for the Ministry of Fisheries by the NRPA in collaboration with the Institute of Marine Research and the Directorate of Fisheries. In 1999, a marine monitoring programme was started for the Ministry of the Environment. This programme is a collaboration between the NRPA and, among other bodies, the Institute of Marine Research. The aims of the collaboration are to document the levels of and monitor the trends in radioactive pollution in Norwegian coastal and sea areas.

Marine sample materials such as seawater, seaweed, shrimps, mussels and lobsters are routinely analysed for ^{99}Tc, radioactive caesium (^{137}Cs) and plutonium ($^{239+240}Pu$). The results show raised concentrations of ^{99}Tc that are likely to be a result of the increased discharges from Sellafield. Uptake of ^{99}Tc is highest in seaweed, whereas uptake by fish in general appears to be low. The highest recorded levels approach 900 becquerels per kilogram (Bq/kg) dry weight of seaweed/kelp.



Trend in ^{99}Tc concentrations in bladder wrack in Hillesøy in Troms county after the increased discharges at Sellafield.

The Norwegian Radiation Protection Authority (NRPA) is the competent national authority in the area of radiation protection and nuclear safety in Norway, and co-ordinates monitoring of radioactive pollution in the environment at the national level. The NRPA is organised under the Ministry of Health, but in 1999 it also became the formal competent authority for the Ministry of the Environment in the area of radioactive pollution of the external environment.

Facts about Sellafield

The Sellafield plants are situated in the northwest of England near the Irish Sea. The plants are owned and run by British Nuclear Fuels plc, (BNFL), a company operating in 15 countries. The first plants in the area went into operation in 1947. A variety of activities are carried out on the sites.

Calder Hall nuclear power station

Calder Hall, the world's oldest commercial nuclear power station, went into operation in 1956. It has four nuclear reactors, all of which are running and supply the Sellafield plant with electricity. Spent fuel from Calder Hall and other power stations in the United Kingdom is transferred to the fuel handling plant.

Plant for handling spent fuel

The Fuel Handling Plant was opened in 1985. The plant stores spent fuel from the Magnox reactors and from advanced gas-cooled reactors in under-water containers before these are sent on to the reprocessing plants to extract uranium and plutonium.

Reprocessing plants

The reprocessing plants extract uranium and plutonium from spent fuel rods. The two plants near Sellafield are the only ones that perform reprocessing in the United Kingdom.

B205 Sellafield Magnox Reprosessing plant

This plant went into commercial operation in 1964 and is still running. Magnox fuel, which is used in the oldest gas-cooled reactors in the United Kingdom, is not suitable for direct disposal. It is the reprocessing of magnox fuel at the B205 plant that gives rise to the bulk of ^{99}Tc discharges from Sellafield. The old gas-cooled reactors are scheduled to be phased out in the present decade. The B-205 plant is likely to be closed down in 2012.

THORP (THermal Oxide Reprocessing Plant)

THORP went into operation in 1994. It reprocesses fuel from advanced gas-cooled reactors and light water reactors in the UK and elsewhere.

MOX production

The uranium and plutonium recovered at the reprocessing plants can be used to produce new fuel, so-called MOX (Mixed OXide fuel). Up to now the MOX Demonstration Facility has carried out testing and the Sellafield MOX plant has so far only produced uranium fuel. The final licence for full operation was granted in December 2001.

Waste treatment plants

Several plants exist for decontamination of liquid radioactive waste. EARP (Enhanced Actinide Removal Plant) treats low- and intermediate-level liquid waste. Radioactive substances are removed from the waste flow and then cemented, after which the decontaminated liquid is then released into the sea.

Storage of radioactive waste

Sellafield Vitrification Plant

Large quantities of high-level liquid radioactive waste (HAL) are stored in waste tanks at the Sellafield plant. HAL is generated at both of the reprocessing plants. At the vitrification plant HAL is incorporated in solid glass blocks and the volume reduced to 1/3 by converting the liquid to powder. This is stored in steel tanks, which are placed in air-cooled storage facilities.

Drigg waste storage facility

Drigg is the national waste storage facility for low-level radioactive waste for all UK industry.