6 RADIOACTIVE SUBSTANCES

OSPAR countries have concentrated their efforts to reduce inputs of radionuclides by focussing on the nuclear sector; β-activity discharges from this sector have fallen by 38 % on average since the period 1995–2001. Environmental concentrations and exposure of humans and biota to some monitored radionuclides from the nuclear sector are low. Offshore oil and gas extraction is a substantial source of inputs of naturally occurring radionuclides to the sea, but monitoring began too recently to assess trends.

OSPAR Contracting Parties should cooperate

→ to continue to apply and further develop BAT for minimising discharges of radioactive substances from the nuclear sector;

→ to assess the contribution of the offshore oil and gas industry to marine radioactive pollution and to identify and implement appropriate management measures;

→ to continue monitoring programmes, improve assessment tools and develop environmental quality criteria, to evaluate the impacts of discharges on the marine environment.

Key OSPAR assessments

→ Towards the Radioactive Substances Strategy objectives

→ Implementation of BAT to minimise radioactive discharges

→ Liquid discharges from nuclear installations in 2007

The marine environment is exposed to radiation from both natural and artificial sources. Naturally occurring radionuclides (radioactive forms of elements) are derived from the weathering of minerals in the Earth's crust and from cosmic rays, while artificial radionuclides are released to the marine environment from a variety of past and present human activities associated with the nuclear industry and military uses. These include the operation of nuclear power plants and nuclear fuel reprocessing plants, atmospheric nuclear weapons testing and fallout from the 1986 Chernobyl accident. Human activities have also led to elevated levels of naturally occurring radionuclides, such as those released from offshore oil and gas installations and the phosphate fertiliser industry. Other potential sources of radionuclides in seawater are former dump sites for nuclear waste and sunken nuclear submarines. Estuarine and marine sediments that have accumulated radionuclides over long periods can be an additional source long after discharges from the point sources have stopped. OSPAR works under the Radioactive Substances Strategy to reduce inputs and levels of radionuclides in order to protect the marine environment and its users.

OSPAR Strategy objectives for radioactive substances

→ **Prevent pollution of the maritime area from ionising radiation through progressive and substantial reductions of discharges, emissions and losses of radioactive substances.**

→ **Reduce by 2020 discharges, emissions and losses of radioactive substances to levels where the additional concentrations in the marine environment above historic levels, resulting from such discharges, emissions and losses, are close to zero.**

→ **The ultimate aim is of concentrations in the environment near background values for naturally occurring radioactive substances and close to zero for artificial radioactive substances. In achieving this objective, the legitimate uses of the sea, technical feasibility, and radiological impacts on man and biota should be taken into account.**

What are the problems?

Radioactive substances affect living organisms

Radioactivity is associated with energy released from radionuclides through radiation. Ionising radiation occurs as electromagnetic rays (γ-rays), α-particles and β-particles. It can cause genetic, reproductive and cancerous effects in living organisms. Because of this, it has the potential to cause negative effects on marine organisms at the level of populations and to affect human health through seafood consumption. The potential for harm through radiation depends on the properties of the radionuclides, the amount of radiation energy absorbed by marine organisms (i.e. the dose) and the pathway through which they are exposed: γ-rays and β-particles can penetrate the skin, while α-particles cannot, but are particularly dangerous if ingested or inhaled.

The main sources from which radioactive substances are discharged into the OSPAR area are the nuclear sector (associated with electricity generation) and the non-nuclear sector (mainly the offshore oil and gas industry and medical uses).

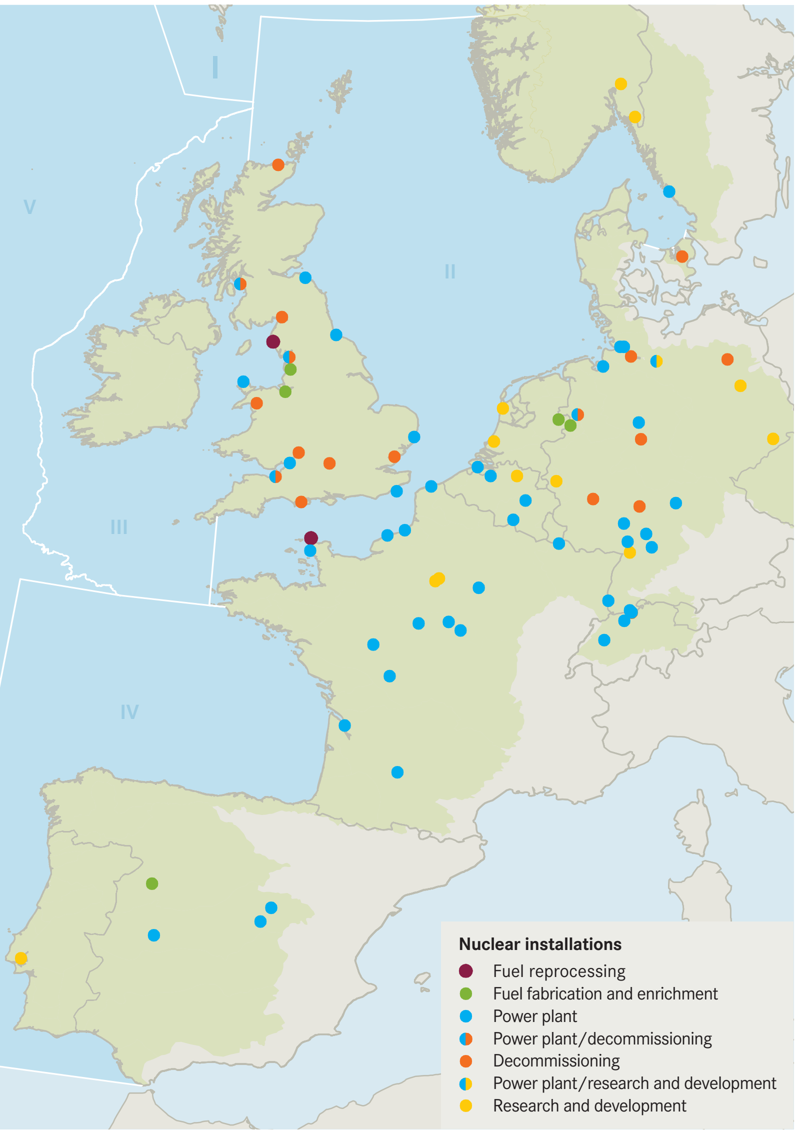
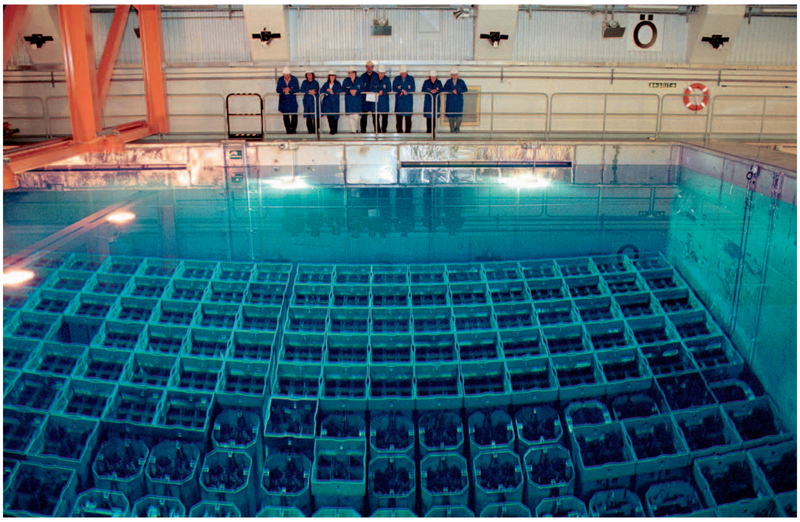


FIGURE 6.1 *Nuclear installations in OSPAR countries discharging directly or indirectly to the OSPAR area in 2007.*



Spent fuel storage pond

The nuclear sector is the main source of artificial radionuclides

The number of nuclear installations in OSPAR countries discharging radionuclides directly or indirectly to the OSPAR area has been stable over the past ten years. In 2007, the 92 nuclear installations in operation and decommissioning in the OSPAR catchment comprised: nuclear power plants, which harness the heat produced in nuclear reactions and convert this to electrical energy; nuclear fuel fabrication and enrichment plants, which provide the uranium fuel for the power plants; nuclear fuel reprocessing plants, which recycle used nuclear fuel to recover uranium and plutonium; and research and development facilities relating to all aspects of the nuclear sector → **FIGURE 6.1**.

Nuclear fuel reprocessing plants and fuel fabrication and enrichment plants account for 98% of discharges of radionuclides from the nuclear sector. The radionuclides that are used as indicators of discharges from this sector are caesium-137 (^{137}Cs), technetium-99 (^{99}Tc), plutonium-239 (^{239}Pu), plutonium-240 (^{240}Pu), and tritium (^{3}H) → **TABLE 6.1**. Inputs of radionuclides to the sea are associated with liquid discharges and to a lesser extent with solid wastes and emissions to air.

Offshore oil and gas activities discharge naturally occurring radionuclides

The offshore oil and gas industry is the largest non-nuclear contributor of discharges of radioactive substances to the marine environment. Almost all the radionuclides discharged from this sector are from produced water (water extracted from the reservoir with the oil and gas) and from descaling the insides of pipes. A less important source is the use of radioactive substances (e.g. tritium) as tracers. The naturally occurring radionuclides in produced water include lead-210 (^{210}Pb), polonium-210 (^{210}Po), and radium-226 and -228 (^{226}Ra and ^{228}Ra).

Other non-nuclear sources are minor

The main source of radioactive discharges in the medical sector is from the use of radioactive iodine-131 (^{131}I) in the treatment of thyroid complaints → **TABLE 6.1**. However, its short half-life and discharge via sewers means that only negligible levels of ^{131}I reach the marine environment.

TABLE 6.1 *Radionuclides used as indicators of radioactive discharges for assessing progress in implementing the OSPAR Radioactive Substances Strategy.*

	Source	Radionuclide	Radiation	Half-life
Nuclear sector	Nuclear industries	Technetium-99 (^{99}Tc)	β-activity,	213 000 yr
		Caesium-137 (^{137}Cs)	β-activity, γ-activity	30.17 yr
		Plutonium-239 (^{239}Pu)[1]	α-activity	24 100 yr
		Plutonium-240 (^{240}Pu)[1]	α-activity	6560 yr
		Tritium (^{3}H)[2]	β-activity	12.3 yr
Non-nuclear sector	Offshore oil and gas industry	Lead-210 (^{210}Pb)	β-activity	22.3 yr
		Radium-226 (^{226}Ra)	α-activity, γ-activity	1600 yr
		Radium-228 (^{228}Ra)	β-activity	5.76 yr
		Thorium-228 (^{228}Th)[3]	α-activity	1.9 yr
	Medical uses	Technetium-99 (^{99}Tc)[4]	β-activity	213 000 yr
		Iodine-131 (^{131}I)	β-activity, γ-activity	8 d

[1] ^{239}Pu and ^{240}Pu are measured together (^{239,240}Pu). [2] Tritium discharges are reported, but no evaluation of these data has been carried out due to the lack of practicable abatement options. This will be kept under review. [3] Insufficient data reported for assessment. [4] Due to the short half-life (6 hours) of ^{99m}Tc, ^{99}Tc has been identified as the indicator radionuclide for the medical use of ^{99m}Tc.

Waste from the phosphate fertiliser industry was an important source of naturally occurring radionuclides to the marine environment until the early 1990s. All discharges from this industry ceased by 2005, due to plant closures and the use of operating systems that avoid discharges. Yet, past discharges still contribute to environmental concentrations and radiation doses.

What has been done?

Efforts have focused on pollution from nuclear installations

OSPAR's work to prevent and reduce pollution from radioactive substances has focused on the nuclear sector and the application of best available techniques (BAT) to minimise pollution of the marine environment by radioactive discharges. Examples of BAT for the nuclear sector include treatment systems for converting radionuclides in effluents into solid waste for disposal. Even when BAT is applied, low level radioactive discharges into the environment are usually unavoidable. Such liquid discharges and emissions to air are regulated through licences from the authorities. Regular reports to OSPAR indicate that the use of BAT is stipulated in national legislation and regulations and that management systems are in place to minimise radioactive discharges from the nuclear sector. OSPAR has established common tools and methods for monitoring and reporting discharges from nuclear installations, as well as baselines against which to monitor progress in reducing the amount of radioactive substances discharged by the nuclear sector. Statistical methods to evaluate progress towards achieving the objectives of the Radioactive Substances Strategy have also been identified for discharges from the nuclear sector. The work of OSPAR complements that by other international organisations, such as the EU and the International Atomic Energy Agency (IAEA).

OSPAR has not developed BAT for reducing discharges of radionuclides from the non-nuclear sector, but started collecting data on annual discharges from non-nuclear sources in 2005.

Discharge of produced water

Environmental quality criteria are not yet developed

Traditionally, radiological protection has been based on the protection of humans. However, it is now recognised that environmental protection must be addressed in its own right and that tools must be developed to assess radiation exposure and risk to marine organisms. OSPAR has assessed doses to marine life from the most significant radionuclides and will develop environmental quality criteria for the marine environment in the light of progress in other international forums. OSPAR is currently reviewing the development by the International Commission on Radiological Protection of a framework to demonstrate radiological protection of the environment, as well as the development of policy and regulatory approaches by other international bodies, such as the EU and the IAEA. These organisations, together with countries and other key organisations (the UN Scientific Committee on the Effects of Atomic Radiation, the International Union of Radioecology, the Organisation for Economic Co-operation and Development), participate in the comprehensive IAEA Plan of Activities on the Radiation Protection of the Environment.

Did it work?

Progress for the nuclear sector

OSPAR has identified indicator radionuclides for discharges from each of the sectors against which progress towards the objective of the OSPAR Radioactive Substances Strategy is being assessed → **TABLE 6.1**. This was achieved by establishing the composition of discharges from the various sectors and the significance of the radiation dose of the radionuclides involved. OSPAR has collected data on annual discharges of indicator radionuclides from the nuclear sector since 1990 and from non-nuclear sources since 2005. The data for the nuclear and non-nuclear sectors differ widely with respect to temporal period and quantity. For the nuclear sector, the period between 1995 and 2001 has been agreed as the baseline period against which progress towards the objective of the Radioactive Substances Strategy is evaluated. Mean values of discharges of the individual indicator radionuclides in the baseline period have been established. There are too few reported data to develop a baseline for assessing trends in discharges from the non-nuclear sector. As well as the individual indicator radionuclides, total α-activity and total β-activity (excluding tritium) are used to indicate discharges of radioactive substances across sectors as a whole.

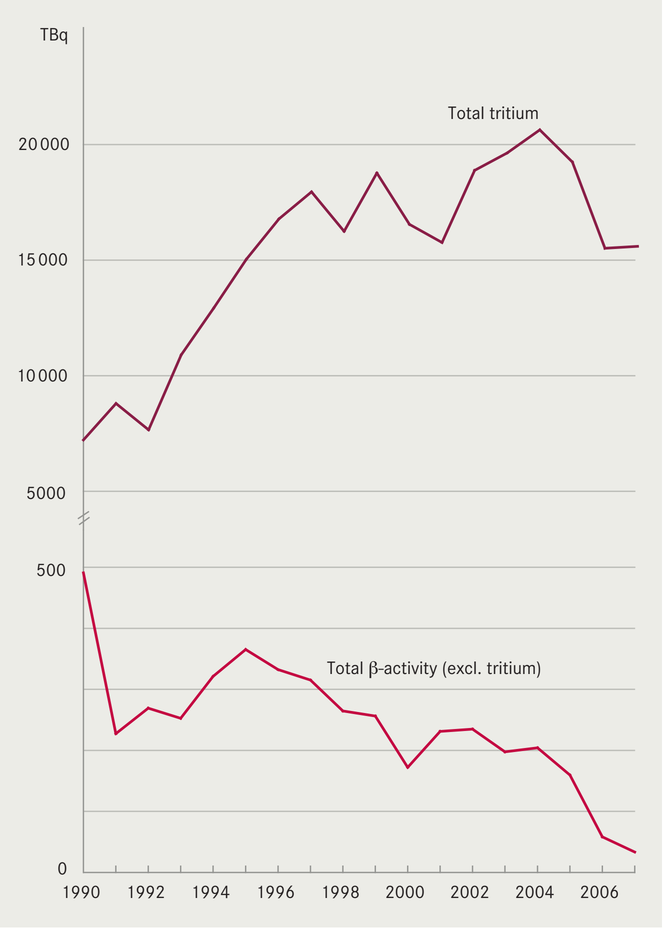


FIGURE 6.2 *Annual discharges of total β-activity (excl. tritium) and tritium from the nuclear sector between 1990 and 2007. Discharges of total α-activity are not shown because they are much smaller; they decreased from almost 2.5 TBq in 1990 to less than 1 TBq in 1995 and have remained below 1 TBq/yr since then.*

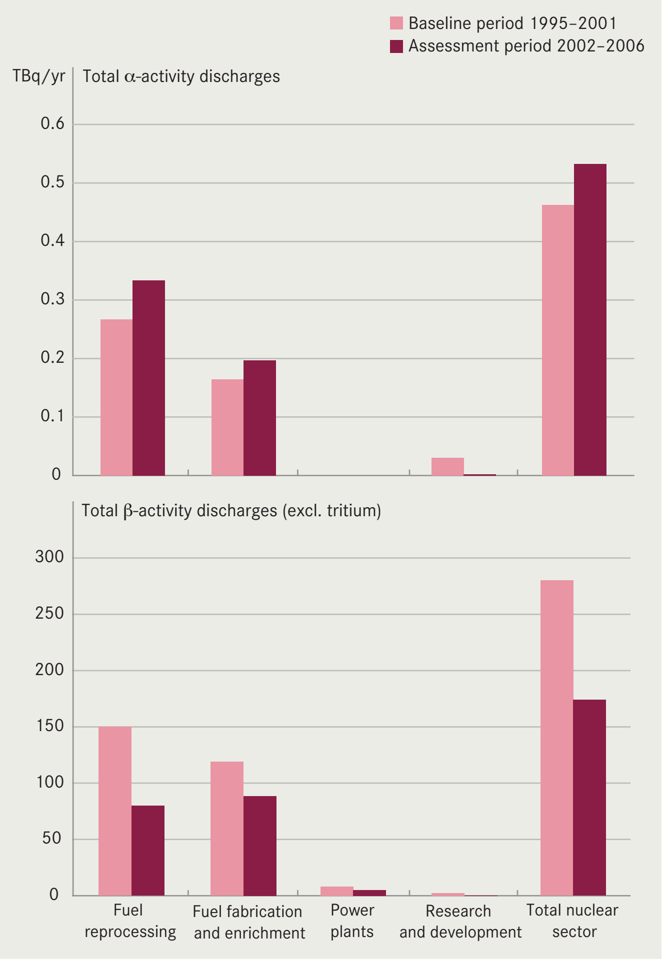


FIGURE 6.3 *Average discharges of total α-activity and total β-activity (excl. tritium) from the nuclear sector in the period 2002–2006 relative to the baseline period 1995–2001. The increase in α-activity discharges is not statistically significant.*

Discharges of some radionuclides from the nuclear sector have decreased

Annual discharges from nuclear installations show that of the assessed radionuclides the β-emitter tritium accounts for most discharges, numerically several magnitudes more than the total α-activity and total β-activity from other radionuclides discharged from the nuclear sector → **FIGURE 6.2**. Tritium discharges mainly relate to nuclear reprocessing plants. Although they appear high in terms of activity, tritium discharges have very low radiotoxicity to humans and biota. There is currently no technology capable of removing tritium from industrial radioactive waste streams.

Average discharges from the nuclear industries in the period 2002–2006 relative to the 1995–2001 baseline period show that there has been a statistically significant decrease of 38 % in total β-activity discharges (excluding tritium), but no statistically significant change in total α-activity discharges → **FIGURE 6.3**.

France and the UK have demonstrated through their reports on implementing OSPAR Recommendation 91/4 that BAT has been applied to minimise radionuclide discharges from their reprocessing plants. For example, the French authorities required the operators of the La Hague facility to achieve further reductions in discharges when they reviewed discharge authorisations. Since 2002, the nuclear fuel reprocessing plant at Sellafield (UK) has achieved reductions in discharges of ^{99}Tc, a radionuclide to which both the 1998 and 2003 OSPAR Ministerial Meetings drew special attention → **BOX 6.1**. Discharges of ^{99}Tc are expected to fall further and be maintained at low levels.

Nuclear and non-nuclear sectors contribute in different ways

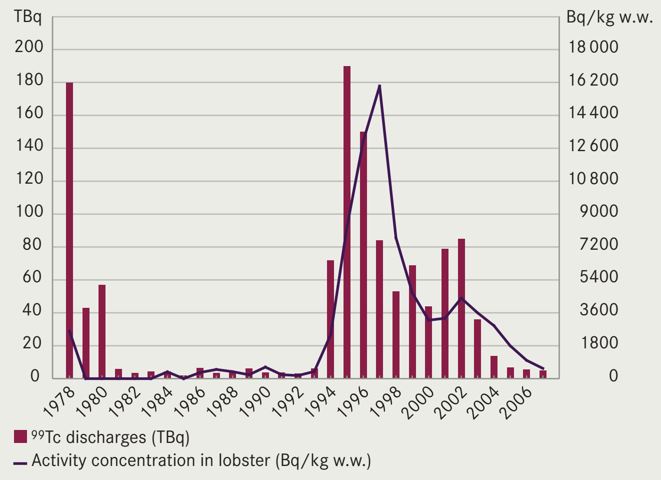
The activity concentrations of naturally occurring radionuclides discharged from the offshore oil and gas industry are very low, both in produced water and in scale from pipes. However, the volumes of produced water are very large which results in substantial discharges of radionuclides. Annual discharges of total α-activity from the offshore oil and gas industry ranged from 6.4 TBq in 2005 to 7.4 TBq in 2007, while annual discharges of total β-activity (excluding tritium) were lower ranging from 4.3 TBq in 2005 to 4.9 TBq in 2007. These are best estimates calculated from the radioactivity of individual indicator radionuclides, rather than from measurements of total α-activity and total β-activity.

BOX 6.1 Drastic reduction in technetium discharges from Sellafield

The reduction of ^{99}Tc discharges from the nuclear fuel reprocessing plant at Sellafield (UK) shows how OSPAR measures have helped to address a site-specific source of radioactive discharges. At Sellafield, reprocessing of spent nuclear fuel produces liquid waste containing ^{99}Tc and other radionuclides. The waste was initially discharged to the Irish Sea after several years of decay storage. Following public concern over these discharges, the waste was retained in storage tanks after 1981. The Enhanced Actinide Removal Plant (EARP) was built at Sellafield to treat the waste, but was not designed to remove ^{99}Tc. As a result, when EARP started treating the backlog of waste in 1994, ^{99}Tc discharges and concentrations in the marine environment increased.

In response to concerns expressed by some OSPAR countries, in particular Ireland and Norway, and the joint statement by OSPAR Ministers for a reduction of ^{99}Tc discharges, the UK reduced Sellafield's ^{99}Tc discharge limit from 200 to 90 TBq/yr, from 1 January 2000, and reviewed potential abatement techniques for ^{99}Tc. The solution implemented in 2003 for new arisings of waste was vitrification and storage on land, but this technology was unsuitable for the residual stored waste. Research by Norway showed that doses to critical groups in the UK from ^{99}Tc discharges to sea were higher than via disposal on land. This finding supported the development of a method involving precipitation of ^{99}Tc and then storage on land.

A full-scale trial of the technique was launched, during which discharges from waste treatment were suspended. The trial was a success and the technology was implemented, allowing the UK to reduce the ^{99}Tc discharge limit to 10 TBq/yr in April 2006. Actual discharges were below 5 TBq in 2007. By the end of 2007 all the stored technetium-bearing waste (medium-active concentrate) had been treated and associated discharges of ^{99}Tc from this main source at Sellafield ended.



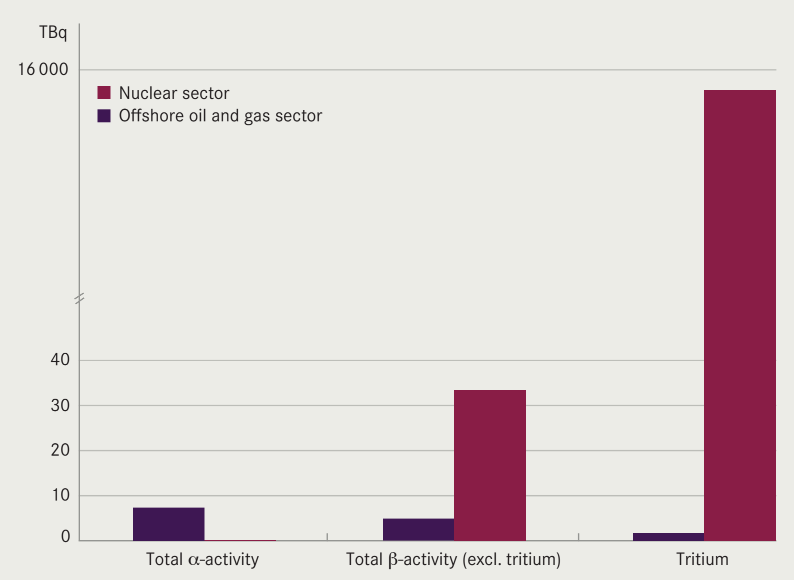


FIGURE 6.4 *Comparison of activity discharges from the offshore oil and gas sector and the nuclear sector in 2007.*

Seaweed is used as matrix to measure marine concentrations of radioactive substances

A comparison of the estimated radioactivity discharged in 2007 from the offshore oil and gas industry and that measured in discharges from the nuclear sector provides an indication of the relative magnitudes of the radioactivity discharged → **FIGURE 6.4**. On the basis of these data, the offshore oil and gas industry is the dominant source of total α-activity, whereas the nuclear sector is the dominant source of total β-activity. For tritium, discharges from the nuclear sector are far higher than those from its use as a tracer in the Norwegian oil and gas industry.

Radionuclides used in the medical sector (e.g. ^{131}I and ^{99m}Tc) are either short-lived or estimated to make a very small contribution to marine radioactivity at the regional level. The total activity of ^{131}I discharged by nine OSPAR countries in 2007 was estimated at 20 TBq. In 2007, the sum of the ^{99}Tc discharged from the decay of the medical product ^{99m}Tc for the five OSPAR countries that reported data was only 1 MBq. OSPAR will no longer require reporting data on ^{99}Tc from medical uses.

How does this affect the quality status?

Environmental concentrations of some radionuclides from the nuclear sector have decreased

To assess progress towards the OSPAR objective on concentrations of radioactive substances in the marine environment, the OSPAR maritime area was sub-divided into 15 monitoring areas, taking into account ocean circulation, the location of nuclear sources and potential impact areas. For each of the 15 areas, where data were available, mean concentrations of the indicator radionuclides associated with discharges from the nuclear sector in seawater, seaweed, molluscs and fish in the period 2002–2006 → **TABLE 6.1** were compared with mean concentrations for the 1995–2001 baseline period → **FIGURE 6.5**. Limited concentration data are available for the naturally occurring radionuclides identified by OSPAR as indicators for discharges from the offshore oil and gas industry → **TABLE 6.1** as well as for the α-emitting, naturally occurring radionuclide ^{210}Po (half-life 138.4 days), which is an important contributor to the total dose received by man and marine organisms.

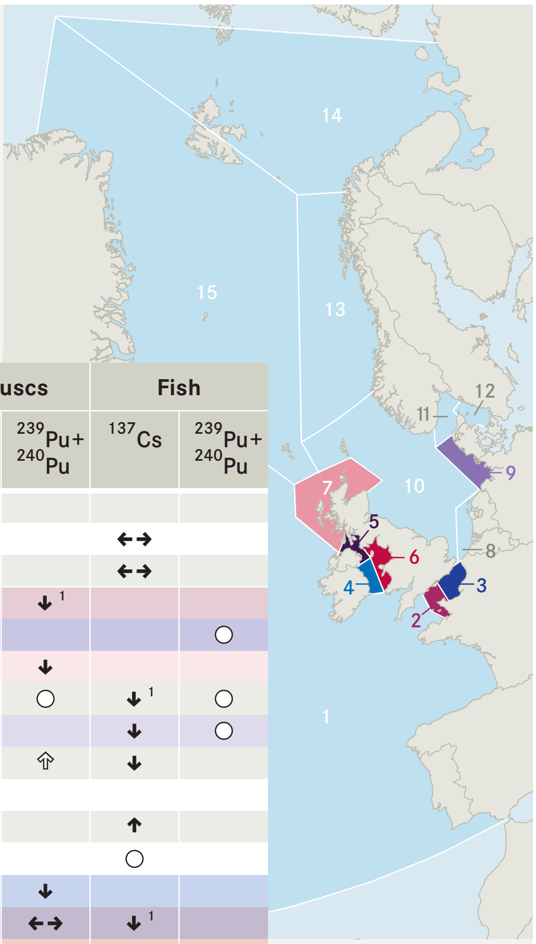
It was not always possible to compare the mean concentrations for the period 2002–2006 with the corresponding concentrations for the baseline period (1995–2001) or to undertake statistical analysis. This was due to a lack of data or because too many values were below the limits of detection → **FIGURE 6.5-A**. In some cases, only one of the two statistical tests applied provided evidence for a significant change. Of the 24 cases where both statistical tests gave strong evidence for a change between the baseline period and the assessment period, the change was a reduction in every case but one (^{137}Cs in fish in the Kattegat).

There are statistically significant falls relative to the baseline period in the mean concentration of ^{137}Cs in seawater, seaweed, molluscs and fish in many of the monitoring areas in Regions II and III → **FIGURE 6.5-A**. Statistically significant changes in indicator radionuclides other than ^{137}Cs vary across the 15 monitoring areas, especially for seawater. The changes in mean concentrations of other radionuclides than ^{137}Cs in seaweed, molluscs and fish are more consistent, with decreases relative to the baseline period in a number of monitoring areas in Regions II and III. This is particularly apparent in parts of the Channel (monitoring area 2) and the Irish Sea and Scottish waters (monitoring areas 4 and 7), due to the reductions in discharges from La Hague (France) and Sellafield (UK). The higher ^{99}Tc discharges from Sellafield in the mid- to late 1990s are

FIGURE 6.5

A: *Summary of statistical tests on mean concentrations in 2002–2006 relative to the baseline period (1995–2001) by OSPAR Region, monitoring area, environmental compartment and radionuclide.*

B: *Time series of environmental concentrations (1995–2006) for some indicator radionuclides and matrixes with statistically significant change between assessment and baseline period.*



A

OSPAR Regions and monitoring areas		Seawater				Seaweed		Molluscs		Fish	
		^{3}H	^{137}Cs	^{99}Tc	^{239}Pu+^{240}Pu	^{137}Cs	^{99}Tc	^{137}Cs	^{239}Pu+^{240}Pu	^{137}Cs	^{239}Pu+^{240}Pu
Region I	13		⇩	⬅➡	⬅➡	⬅➡	⬅➡				
	14		○	⬅➡	⬅➡					⬅➡	
	15		⬇		⬅➡	⬇ [1]	⬅➡			⬅➡	
Region II	2	⇩ [1]	○			⬇ [1]	⬇		⬇ [1]		
	3	○	○			⇧ [1]	⬇ [1]				○
	7	○	○			⬇ [1]	⬇		⬇		
	8	⬅➡	○		○				○	⬇ [1]	○
	9	⇧ [1]	⬇	○	⬅➡					⬇	○
	10	⇧ [1]	⬅➡	○	⬅➡		⬅➡		⇧	⬇	
	11		⬅➡	⬅➡	⬅➡	⬅➡	⬅➡				
	12	○	⇧ [1]	⬇		⬇	⬅➡			⬆	
Region III	1	⇩ [1]	○	○		⇩ [1]	○			○	
	4		⬇	⇩		⬇	⬇		⬇		
	5		⬇				⬅➡		⬅➡	⬇ [1]	
	6	⬅➡ [1]	⬇	⬅➡			⇩	⬇	⬅➡		
	7	○	○			⬇ [1]	⬇		⬇		
Region IV	1	⇩ [1]	○	○		⇩ [1]	○			○	

Change in concentration:

↓ Downward; ↑ Upward; ←→ No change

⬇ Confirmed by two statistical tests

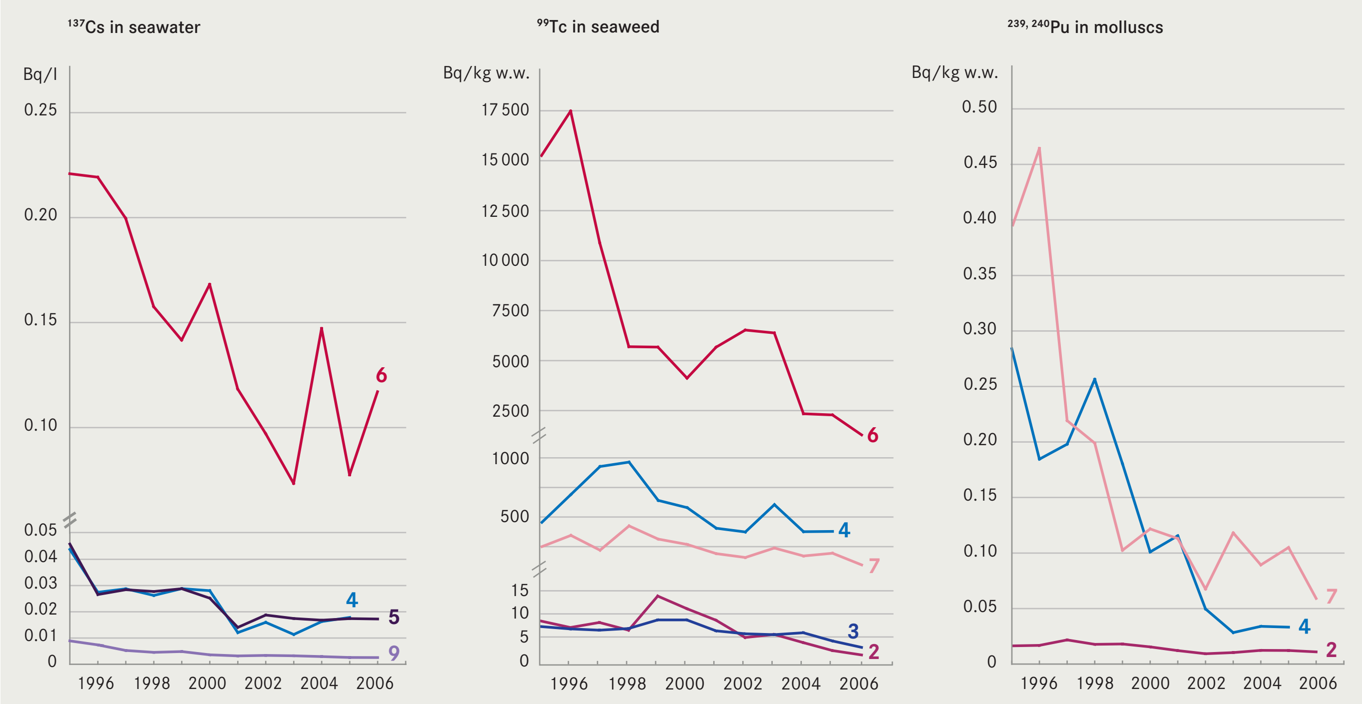
⇩ Confirmed by one of two statistical tests

○ Data do not allow statistical tests

[1] Some/most data for baseline and/or assessment period are below detection limit

Blank field: no data

B



reflected in peaks of this radionuclide in seaweed (monitoring areas 4 and 7) → **FIGURE 6.5-B**. However, some monitoring areas in Regions I and II still have elevated concentrations of radionuclides due to out-flowing Baltic Sea water contaminated with radionuclides from the 1986 Chernobyl accident → **FIGURE 6.6** or due to the remobilisation of radionuclides from Irish Sea sediments from past discharges and their transport by the prevailing ocean currents. Concentrations in monitoring areas in Region I mostly show no change because concentrations in water and biota are very low. Given the limited data for Region IV, few statistical changes can be determined. There are no monitoring data for Region V.

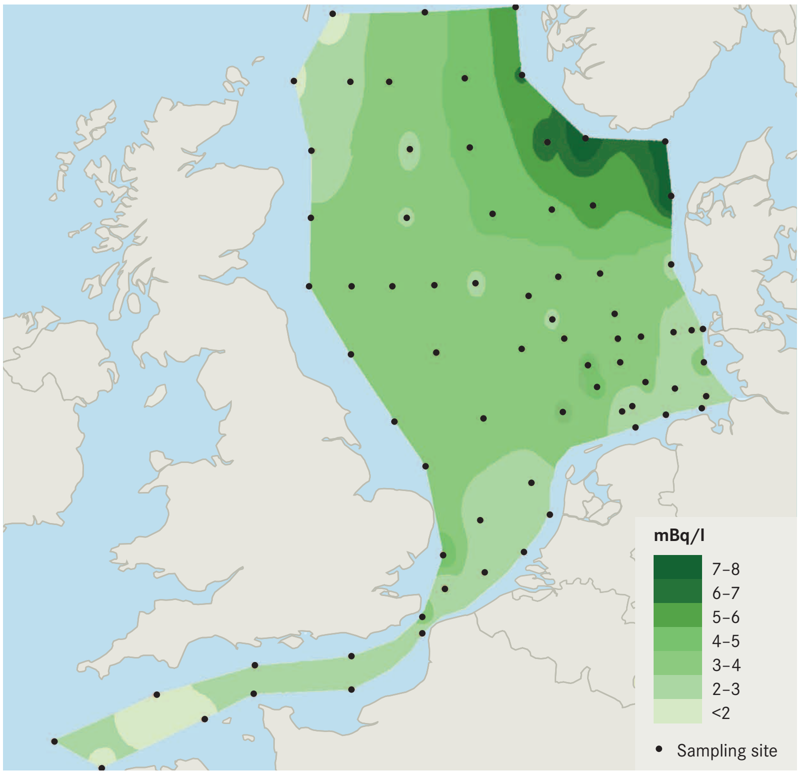


FIGURE 6.6 *Distribution of ^{137}Cs concentrations in the North Sea in summer 2005 showing the influence of the Chernobyl fallout from the Baltic Sea.*

Source	Radionuclide	Maximum doses (µSv/yr)
Nuclear sector	^{3}H	0.01
	^{99}Tc	1
	^{137}Cs	1
	^{239,240}Pu	1–10
Offshore oil and gas industry	^{210}Po	10–1000
	^{210}Pb	1–10
	^{226}Ra	10
	^{228}Ra	10

Elevated concentrations of naturally occurring radionuclides difficult to detect

Concentrations of naturally occurring radionuclides in seawater or marine organisms represent total environmental concentrations, i.e., both natural background concentrations and any contributions from the offshore oil and gas industry. OSPAR has not assessed trends in concentrations of naturally occurring radionuclides associated with discharges from the offshore oil and gas industry due to the limited amount of data available. As concentrations of these radionuclides from natural sources vary considerably within the OSPAR area, it is difficult to detect elevated levels originating from offshore oil and gas activities. Further work is needed to improve data availability and to assess the significance of naturally occurring radionuclides being discharged from the offshore oil and gas industry.

Doses to man are well below internationally accepted dose limits

Doses to man from seafood consumption have been calculated in two ways, either from reported levels of radionuclides in seafood or by modelling the possible uptake by seafood of radionuclides measured in seawater. The estimated doses to man from radionuclides associated with the nuclear sector cover a wide range of values → **TABLE 6.2**, but are well below the current international dose limit of 1000 µSv/yr set by the IAEA and EU for members of the public arising from all practices involving radioactive materials. ^{137}Cs and ^{239,240}Pu represent most of the total dose arising from discharges from the nuclear sector. In comparison, doses from naturally occurring radionuclides (e.g. ^{210}Po) can be up to one thousand times higher than those arising from ^{137}Cs and ^{239,240}Pu. Doses calculated for the naturally occurring radionuclides include the natural background concentration and should not be taken as coming entirely from the oil and gas industry.

Impacts on biota are unlikely

OSPAR has considered knowledge available on the impact of environmental radioactivity on marine life and its application to the OSPAR area. An EU project has recently proposed a method – ERICA (Environmental Risk from Ionising Contaminants: Assessment and management) – to assess and manage environmental risk from radioactive substances. The ERICA environmental risk assessment methodology sets a screening value of 10 µGy/h to characterise the potential risk to the structure and function of marine ecosystems. This is the lowest level at which effects at the ecosystem level are likely to occur according to current scientific understanding. According to the data available,

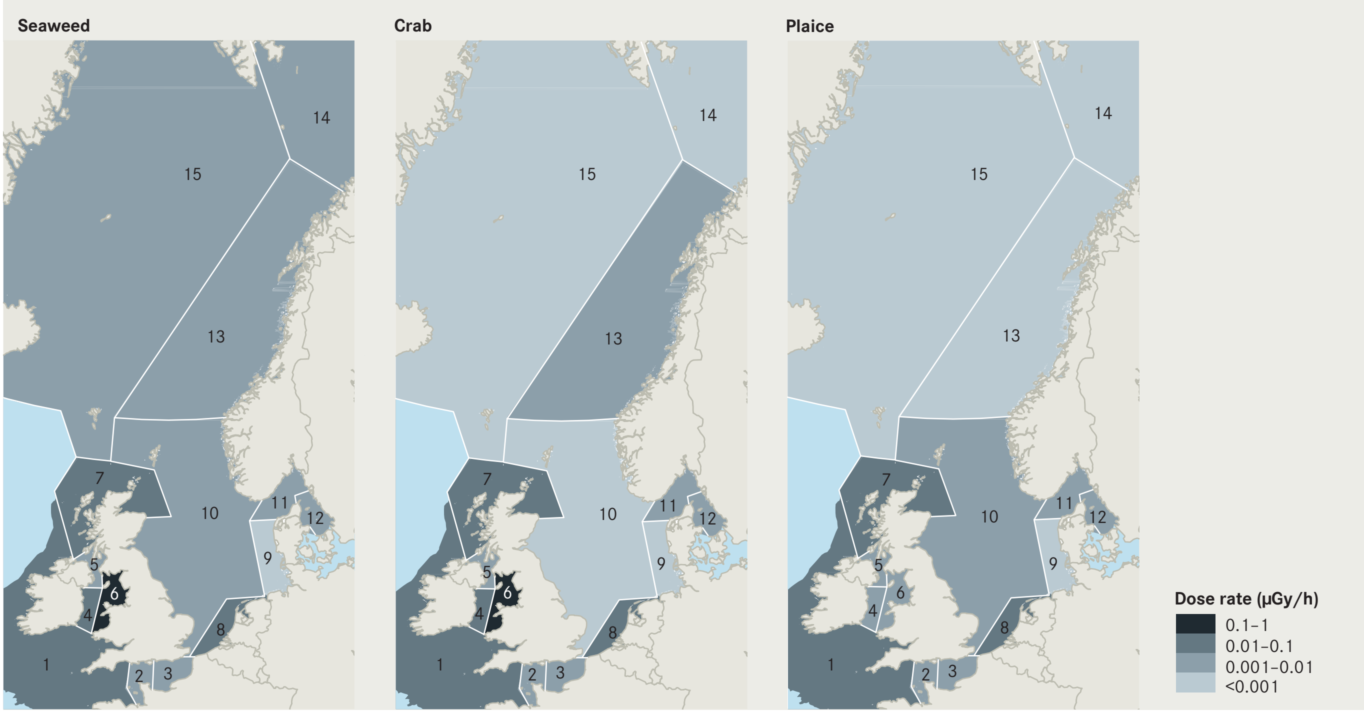


FIGURE 6.7 *Maximum total dose rates to seaweed, crab and plaice estimated from data on concentrations of the assessment radionuclides (^{137}Cs, ^{99}Tc, ^{239,240}Pu) in seawater in 2006.*

calculated dose rates to marine biota are below this screening value. In the OSPAR area, the highest dose rates to biota occur in the Irish Sea near Sellafield (monitoring area 6). Monitoring areas 9 to 15 have the lowest dose rates → **FIGURE 6.7**.

What happens next?

Progress made for the nuclear sector but efforts must continue

To date, progress on reducing discharges of radioactive substances has focused on the nuclear sector. This sector accounts for the main inputs to the marine environment of β-emitting radionuclides in the OSPAR area, mostly in Regions II and III. For some radionuclides such as tritium, reduction technologies at an industrial scale are not currently available. OSPAR countries have reduced discharges of specific radioactive substances from the nuclear sector, reported the application of BAT, and determined doses to humans and marine biota. National reporting provides the following evidence:

- Total β-activity discharges (excluding tritium) from the nuclear sector, in particular discharges of ^{99}Tc, have fallen and related concentrations in seawater and biota have decreased in a number of monitoring areas.
- The effect of discharges and concentrations of radioactive substances from the nuclear sector on the overall quality status of the OSPAR area and doses and impacts on humans and biota are considered low.
- In Regions I and II, elevated concentrations of certain radionuclides are mainly due to the transport of these radionuclides by ocean currents.

However, there are currently too few data to show conclusively whether the objective of the Radioactive Substances Strategy for 2020 will be met. Abatement at source is still important, based on the precautionary approach and the principle of prevention, and BAT must continue to be applied and developed to minimise the impact of radioactive discharges.

Progress on the non-nuclear sector cannot yet be assessed

Best estimates suggest that a substantial contribution to the releases of radioactive substances in the OSPAR area is made by the naturally occurring radionuclides discharged with produced water from the offshore oil and gas industry, which is concentrated in Regions II, III and the Norwegian Sea (Region I). Additional discharges from offshore installations result from descaling operations. Inputs to the sea of radioactive substances from medical uses are minor compared to those from the nuclear sector and the offshore oil and gas industry. Collection of data for the non-nuclear sector and the associated indicator radionuclides only began in 2005, so the time series available are too short to assess trends in discharges, concentrations and doses in the marine environment. OSPAR should endeavour to assess the contribution of the non-nuclear sector to the pollution of the OSPAR area by radioactive substances and to identify appropriate management measures for implementation by OSPAR countries.

Evidence base and assessment tools must improve

OSPAR should improve the evidence base and assessment tools for evaluating progress towards the OSPAR objectives for all indicator radionuclides from the nuclear and non-nuclear sectors. OSPAR should achieve this by the following:

- Continue to collect systematically data on discharges and concentrations of the indicator radionuclides.
- Further develop tools to estimate and assess doses to evaluate impacts of discharges on the environment.
- Further develop statistical trend analysis techniques, taking advantage of experience gained in other contexts.
- Develop environmental quality criteria for the protection of the marine environment against adverse effects of radioactive substances.

Delivering OSPAR Strategy objectives for radioactive substances

→ LEGEND: BACK-COVER FOLD-OUT

OSPAR Region	Reduce discharges of radioactivity[1]	Change[1] in environmental radioactivity from assessed radionuclides	Key factors and pressures	Outlook for pressures	Action needed
Region I	Nuclear industry: none Offshore oil/gas industry: **?**	← → * *	Offshore oil and gas industry Transport of nuclear discharges (Regions II, III) Legacy discharges Transport of Chernobyl fallout	**?**	📄 OSPAR 📈 OSPAR
Region II	Nuclear industry: ↓ * * * Offshore oil/gas industry: **?**	← → * *	Nuclear industry Offshore oil and gas industry Transport of nuclear discharges (Region III) Legacy discharges Transport of Chernobyl fallout	**?**	📄 OSPAR 📈 OSPAR
Region III	Nuclear industry: ↓ * * * Offshore oil/gas industry: **?**	↓ * *	Nuclear industry Offshore oil and gas industry Legacy discharges	**?**	📄 OSPAR 📈 OSPAR
Region IV	Nuclear industry: ↓ * * * Offshore oil/gas industry: non-discharging	← → *	Nuclear industry	**?**	📄 OSPAR 📈 OSPAR
Region V	Nuclear industry: none Offshore oil/gas industry: none	No data	Transport of legacy and contemporary nuclear discharges (Region III)	**?**	🔭 OSPAR

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[1] *Mean of period 2002–2006 relative to mean of baseline period 1995–2001.*