Assessment of naturally occurring radionuclides discharged by the offshore oil & gas industry

Discharges of naturally occurring radionuclides by the oil and gas industry result in a minimal increase of seawater concentrations in the North-East Atlantic, with total environmental concentrations likely to be near background. The additional seawater concentrations resulting from oil and gas discharges would not result in a significant radiological impact to humans or the marine environment.

Background

Society's need for energy, has resulted in the extraction of oil and gas from the OSPAR Maritime Area. When oil and gas is extracted from the earth it is usually extracted as a mixture with water and other substances naturally present in the underground oil and gas reservoirs, including naturally occurring radioactive materials (NORM). The oil is separated from the mixture and the water, called produced water, along with the NORM, is returned to the underground reservoir or discharged into the marine environment. OSPAR has assessed the impact of these discharges including progress towards OSPAR's ultimate aim of ensuring that concentrations of naturally occurring radioactive substances in the marine environment are near background.

Assessment methodology

There are almost 200 offshore oil and gas installations in the OSPAR Maritime Area of the North-East Atlantic that discharge produced water into the sea. Contracting Parties to the OSPAR Convention have reported on the total volume of produced water discharged, and total activities of three indicator radionuclides (Radium-226, Radium-228 and Polonium-210). To understand the impact of these discharges, the OSPAR Radioactive Substances Committee used a model called 'DORIS' o assess the magnitude of additional concentrations in seawater and sediment that might result from such discharges within the OSPAR Maritime Area. 'DORIS' is a 'box model' which means that the environment is divided into different 'boxes' or compartments that represent different geographic areas and also components of the environment (e.g. seawater and sediment). The flow of materials between compartments can be calculated based on information such as water currents and contaminant behaviour. More information on the modelling approach may be found in this OSPAR report.

The discharging installations were identified and plotted using a Geographical Information System (GIS) and overlaid on the model compartments. Nine areas were identified which contain one or more discharging installations, shown in Figure 1. The total discharges of indicator radionuclides into each of these areas were calculated from information provided by the relevant Contracting Parties. The DORIS model was then used to calculate the additional concentrations of these radionuclides in seawater and sediment in both these and more distant areas.

Figure 1. Spatial distribution of discharging installations in relation to the DORIS marine compartments.

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Comparison with background levels

The highest modelled additional concentrations in seawater were found in the compartments containing discharging installations. These values were compared with the typical range of background values found in seawater to determine whether the total environmental concentrations could be considered to be near background values. Table 1 shows that, for the indicator radionuclides Po-210, Pb-210, Ra-226 and Ra-228, the additional concentrations resulting from discharges from the oil and gas industry are less than 1% of the typical range in background levels.

INDICATOR RADIONUCLIDES

Po – Polonium
Pb – Lead
Ra - Radium

Comparison with background levels

A comparison of the highest modelled additional concentrations with lowest background values typically observed provides an upper estimate of how much produced water discharges could increase environmental concentrations of naturally occurring radionuclides in seawater. This comparison shows that the increase in environmental concentrations is no more than 10%. This means that, in practice, any additional concentrations would be indistinguishable from routinely measured background levels.

Table 1: Selection of the typical background values is described in (ICG MOD report). The variability (range) is the difference between the typical low and high-end values. All values are presented in mBq/l

Indicator radionuclide	Typical range of background levels low – high (range)	Highest modelled additional concentration	Additional concentration as % of range	Additional concentration as % of low-end background value
Po-210	0.4 – 3.4 (3.0)	0.001	0.03%	0.25%
Pb-210	0.4 – 3.4 (3.0)	0.001	0.03%	0.25%
Ra-226	1.3 – 6.3 (5.0)	0.016	0.30%	1.20%
Ra-228	0.2 – 3.3 (3.1)	0.019	0.90%	9.50%

Radiological impact of additional concentrations

The highest modelled additional concentrations in seawater were found in the compartments containing discharging installations. These values were compared with the typical range of background values found in seawater to determine whether the total environmental concentrations could be considered to be near background values.
Table 1 shows that, for the indicator radionuclides Po-210, Pb-210, Ra-226 and Ra-228, the additional concentrations resulting from discharges from the oil and gas industry are less than 1% of the typical range in background levels.

Conclusion

The comparisons of additional concentrations with typical background concentrations, taken together with an assessment on possible radiological impact, indicate that the total environmental concentrations of naturally radionuclides in seawater are near background levels.