OSPAR COMMISSION

Discharges of Radionuclides from the Non-nuclear Sectors in 2011

Radioactive Substances Series

2013

OSPAR Convention

The Convention for the Protection of the Marine Environment of the North-East Atlantic (the "OSPAR Convention") was opened for signature at the Ministerial Meeting of the former Oslo and Paris Commissions in Paris on 22 September 1992. The Convention entered into force on 25 March 1998.

The Contracting Parties are Belgium, Denmark, the European Union, Finland, France, Germany, Iceland, Ireland, Luxembourg, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

Convention OSPAR

La Convention pour la protection du milieu marin de l'Atlantique du Nord-Est, dite Convention OSPAR, a été ouverte à la signature à la réunion ministérielle des anciennes Commissions d'Oslo et de Paris, à Paris le 22 septembre 1992. La Convention est entrée en vigueur le 25 mars 1998.

Les Parties contractantes sont l'Allemagne, la Belgique, le Danemark, l'Espagne, la Finlande, la France, l'Irlande, l'Islande, le Luxembourg, la Norvège, les Pays-Bas, le Portugal, le Royaume-Uni de Grande Bretagne et d'Irlande du Nord, la Suède, la Suisse et l'Union européenne.

Acknowledgement

This report has been prepared by the Expert Assessment Panel of the OSPAR Radioactive Substances Committee, comprising of Mr Henning Natvig (convenor), Norway, Mr Michel Chartier, France and Ms Inge Krol, Germany with the support of Ms Luisa Rodriguez Lucas and Ms Corinne Michel of the OSPAR Secretariat.

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Executive summary

Annual data collection by OSPAR on discharges from the non-nuclear sector has only been taking place since 2006 (collecting data from 2005). Due to the incompleteness of datasets, no data have been published until 2009. This is the fifth annual report and assessment of discharges from the non-nuclear sector published by OSPAR.

The 2011 data reported by Contracting Parties were sufficient to make an assessment of discharges from the offshore oil and gas sub-sector, which is the major non-nuclear source. It is also possible to judge the relative contribution from the medical sub-sector. Only sparse data are available for the other non-nuclear sub-sectors (universities and research, radiochemical manufacturing and various others), but they are considered to be of minor importance.

The radionuclides reported from the offshore oil and gas industry are: Ra-226, Ra-228, Pb-210, discharged via produced water. The data are converted into total alpha and total beta (excluding tritium) activity in order to be able to compare the magnitude with discharges from other sectors.

In 2013, it has been agreed that a baseline could be established for Ra-226 and Ra-228 based on reported discharge data from 2005 – 2011 although a baseline for Pb-210 had not been considered, as datasets available needed further examination.

The offshore oil and gas sub-sector is the principal source of total alpha discharges, accounting for 97,8% of the total. This sub-sector also makes an 8,8 % contribution to the overall total beta from all sectors (nuclear and non-nuclear). In total, the non-nuclear sector contributed an estimated 55 % of the total beta discharges from all sectors, with the largest single contribution (45 %) coming from the iodine-131 discharges from the medical sub-sector. Tritium discharges from the non-nuclear sector are insignificant in comparison with those from the nuclear sector.

Récapitulatif

Le recueil annuel, par OSPAR, des données sur les rejets provenant du secteur non-nucléaire n’a lieu que depuis 2006 (recueil des données de 2005). Aucune donnée n’a été publiée avant 2009, les séries de données étant jusque-là incomplètes. Il s’agit donc du cinquième rapport annuel, et évaluation, des données sur les rejets provenant du secteur non nucléaire publié par OSPAR.

Les données de 2011, notifiées par les Parties contractantes, sont suffisantes pour permettre une évaluation des rejets provenant du sous-secteur pétrolier et gazier offshore, qui représente la source principale non nucléaire. Il est également possible d’évaluer la contribution relative du sous-secteur médical. On ne dispose que de données clairsemées pour les autres sous-secteurs non nucléaires (universités et recherche, industrie radiochimique et divers autres), mais on les considère de peu d’importance.

Les radionucléides notifiés, provenant de l’industrie pétrolière et gazière d’offshore, sont les Ra-226, Ra-228, et Pb-210, rejetés avec l’eau de production. Les données sont converties en activité alpha total et activité bêta total (à l’exception du tritium) afin de pouvoir en comparer la magnitude avec les rejets provenant d’autres secteurs.

En 2013, il a été convenu qu'une ligne de base pouvait être établie pour le Ra-226 et le Ra-228 sur la base des données de rejet notifiées à partir de 2005-2011, bien qu’aucune ligne de base n'ait été envisagée pour le Pb-210, car les ensembles de données disponibles doivent faire l'objet d'un examen supplémentaire.

Le sous-secteur de l’industrie pétrolière et gazière d’offshore est la source principale de rejets d’alpha total représentant 97,8 % du total. La contribution de ce sous-secteur aux rejets de bêta total provenant de tous les secteurs (nucléaires et non nucléaires) s’élève à 8,8 %. Au total, le secteur non-nucléaire contribue à une quantité estimée représentant 55 % des rejets de bêta total provenant de tous les secteurs, la contribution unique la plus importante (45 %) provenant des rejets d’iodine-131 par le sous-secteur médical. Les rejets de tritium provenant du secteur non-nucléaire sont négligeables par rapport à ceux du secteur non nucléaire.

1. Introduction

Work to prevent and reduce pollution from ionising radiation in the North-East Atlantic was first undertaken within the framework of the former 1974 Convention for the Prevention of Marine Pollution from Land-based Sources (the “Paris Convention”) and then under the 1992 Convention for the Protection of the Marine Environment of the North-East Atlantic (the “OSPAR Convention”), which replaces the Paris Convention and establishes the OSPAR Commission.

At the first Ministerial Meeting of the OSPAR Commission (20-24 July 1992, Sintra, Portugal) an OSPAR Strategy for Radioactive Substances was adopted to guide the future work of the OSPAR Commission on protecting the marine environment of the North-East Atlantic against radioactive substances arising from human activities. This strategy was revised at the third Ministerial Meeting of the OSPAR Commission (23-24 September 2010, Bergen, Norway), where the Strategy of the OSPAR Commission for the Protection of the Marine Environment of the North-East Atlantic 2010-2020 (the “North-East Atlantic Environment Strategy”) was adopted.

The North-East Atlantic Environment Strategy sets out OSPAR’s vision, objectives, strategic directions and action for the period up to 2020. In Part I, the new Strategy gives prominence to the overarching implementation of the ecosystem approach and the need for integration and coordination of OSPAR’s work across themes and groups. In Part II, the Strategy provides its thematic strategies for Biodiversity and Ecosystems, Eutrophication, Hazardous Substances, Offshore Oil and Gas Industry and Radioactive Substances.

The Radioactive Substances thematic Strategy (Radioactive Substances Strategy) sets the objective of preventing pollution of the OSPAR maritime area from ionising radiation through progressive and substantial reductions of discharges, emissions and losses of radioactive substances, with the ultimate aim 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 following issues should, *inter alia*, be taken into account: (1) radiological impacts on man and biota, (2) legitimate uses of the sea, and (3) technical feasibility.

As its timeframe, the Radioactive Substances Strategy further declares that the OSPAR Commission will implement this Strategy progressively by making every endeavour, through appropriate actions and measures to ensure that by the year 2020 discharges, emissions and losses of radioactive substances are reduced 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 Radioactive Substances Strategy provides that in accordance with the provisions of the OSPAR Convention and the findings of the Quality Status Report 2010, the OSPAR Commission will, where appropriate, develop and maintain programmes and measures to identify, prioritise, monitor and control the emissions, discharges and losses of the radioactive substances caused by human activities which reach, or could reach, the marine environment.

To this end, the Radioactive Substances Strategy requires the OSPAR Commission to continue the annual collection of data on discharges from the non-nuclear sector. Regular reporting is therefore required in order to review progress towards the targets of the Radioactive Substances Strategy.

The OSPAR Commission adopted in 2005 a set of reporting procedures to be used for annual reporting of data on discharges from the non-nuclear sector (OSPAR Agreement number: 2005-07), which were updated in 2009. Trial runs of reporting made in accordance with the procedures were conducted in 2006 and 2007 with data from 2004 and 2005. Both these datasets and the 2006 data reported in 2008 were incomplete and could not be published. This report presents and assesses the 2011 data, and for the offshore oil and gas sector, presents also the total discharges from 2005 to 2011.

This report includes an estimate on uncertainty (given as +/- numerical values after the value of discharged water) for Ra-226, Ra-228 and Pb-210 for the oil and gas sectors. The estimate was requested by the Expert Assessment Panel so that they can report on discharge data measurement uncertainty.

An overview of potential non-nuclear sources of radioactive discharges is given in Table 1 below.

Table 1

Non-nuclear sectors with the potential to discharge radioactive substances to the OSPAR maritime area

Contracting Party	Oil/gas extraction (inc. on-shore)	Phosphate Industry	Titanium-Dioxide Pigment	Steel	Rare Earth	Medical	Universities and Research Centres	Radio chemical production
Belgium	Not present	Present	Present	Present	Not present	Present	Present	?
Denmark	Present	Present	Not present	Not present	Not present	Present	Present	?
Finland	Not present	Present	Present	Present	Not present	Present	Present	?
France	Present	Present	Present	Present	Present	Present	Present	?
Germany	Present	Not present	Present	Present	Not present	Present	Present	?
Iceland	Not present	Not present	Not present	Not present	Not present	Present	Present	?
Ireland	Present	Not present	Not present	Not present	Not present	Present	Present	Not present[1]
Luxembourg	Not present	Not present	Not present	Present	Not present	Present	Present	?
Netherlands	Present	Present	Present	Present	Not present	Present	Present	?
Norway	Present	Not present	Present	Present	Not present	Present	Present	?
Portugal	Not present	Present	Not present	Present	Not present	Present	Present	?
Spain	Present	Present	Present	Present	Not present	Present	Present	Not present
Sweden	Not present	Not Present	Not present	Not Present	Not present	Present	Present	?
Switzerland	Not present	Not present	Not present	Not Present	Not present	Present	Present	Present (GTLD manufacture)
United Kingdom	Present	Not present	Present	Present	Present	Present	Present	Present

1 Fluorine (F-18) is produced in Ireland for Positron Emission Tomography (PET). However, F-18 has a half life of 109,8 minutes and so is not reported.

2. Assessment of the radioactive discharges from non-nuclear sources in 2011

2.1 Introduction

RSC 2004 agreed that Contracting Parties should report the discharges from their non-nuclear sub-sectors annually using the agreed reporting template. Data has been collected for the years 2005 - 2011. Not all Contracting Parties have provided data, for 2011: 6 out of 8 Contracting Parties reported for oil/gas; 8 Contracting Parties reported on their university and research; and, 7 Contracting Parties reported on their medical sector. The number of Contracting Parties reporting and the completeness of the reports seem to have reached a plateau somewhere short of 100%.

There is sufficient data to make an assessment for 2011. The reports for produced water discharges from the oil/gas sub-sector cover the major contributions and, although incomplete, it is possible to judge the relative contribution from the medical sub-sector. Other sub-sectors are either well reported or make relatively insignificant contributions.

It has been necessary to estimate certain discharges from incomplete data – consequently care needs to be taken in using this assessment report for purposes other than those envisaged by OSPAR RSC. In this assessment report the term “total beta” means total beta (excluding tritium) – the full definition is used in headings, but the abbreviation is used in the text.

2.2 Discharges from the oil/gas sub-sector

Data was provided by Norway, the Netherlands, the United Kingdom (UK), Ireland, Germany and Denmark. The total discharges of the three nuclides Ra-226, Ra-228 and Pb-210 from this sub-sector in 2011 was 1,78 TBq, a slight decrease from the previous year. The UK, Norway and the Netherlands are the principal contributors, and in 2011 the relative contributions, based on produced water activities, were: Norway 49 %, UK 32,5 %, the Netherlands 14,5 %. The Danish contribution was about 3,8 %, a slight decrease from the previous year. The other Contracting Parties that reported amounted less than 0,2 %. There is an unknown, but probably minor, contribution from the other 2 Contracting Parties with an oil/gas industry. Four of the Contracting Parties has included estimates of uncertainty for discharges of radioactive substances with produced water. The calculation of uncertainty seems, however, not to be done in the same way by the Contracting Parties that has reported on this. RSC 2003 has agreed to establish a baseline for discharge of Ra-226 and Ra-228 nuclides from the oil and gas sub-sector based on the reported discharges in the years 2005 – 2011. When the baseline is finally established it would be possible to use this to evaluate if there is a trend in the annual total discharges of these radionuclides from the oil and gas sub-sector. The assessments below are based on produced water discharge data, the data on scale discharges are improving, but is very small compared to the produced water contribution. In 2011 the reported data on these discharges was lower than in 2010.

Total alpha and total beta discharges from produced water have been estimated based on reported measured values for Pb-210, Ra-226 and Ra-228 and using the formulae agreed at RSC to include contributions from key radioactive daughter products in the respective decay chains.

Although the formulae for calculating the total alpha and total beta discharges from the oil/gas sub-sector were derived in order that comparison could be made with the equivalent discharges from the nuclear sector, it should be remembered that total alpha and total beta discharges for the oil/gas sector are estimated values, rather than directly measured values. To that extent they differ from the measured values reported for the nuclear sector.

a) total alpha from produced water discharges

The agreed formula for the calculation of total alpha discharges from produced water is:

Total alpha (TBq) = (5xRa-228)+(4xRa-226)+(1xPb-210).

The formula assumes equilibrium in these decay chains at the time of discharge.

The total alpha discharges, not including scale, are given below; for comparison the reported radium-226 and the equivalent nuclear contributions are also illustrated.

Total alpha 2005-2011

	Oil/gas		[**Nuclear**]
	Total alpha	[**Ra-226**]	[**Total alpha**]
2005	6,4 TBq	[0,81 TBq]	[0,52 TBq]
2006	6,9 TBq	[0,78 TBq]	[0,34 TBq]
2007	7,4 TBq	[0,90 TBq]	[0,19 TBq]
2008	6,76 TBq	[0,82 TBq]	[0,17 TBq]
2009	7,4 TBq	[0,94 TBq]	[0,18 TBq]
2010	7,6 TBq	[1,03 TBq]	[0,18 TBq]
2011	7,6 TBq	[0,95 TBq]	[0,17 TBq]

There is a large number (>100) of offshore installations contributing to this total, but it is understood that approximately 20 % arises from just two installations in the Troll Oilfield in the Norwegian sector of the North Sea. As mentioned above, it has been agreed that a baseline could be established for Ra-226 and Ra-228. However to evaluate if there is a trend in total alpha, a baseline for Pb-210, which was not been considered, also needs to be established. It is therefore too early to establish if there is any trend in the level of total alpha discharges from this sub-sector.

b) total beta (excluding tritium) from produced water discharges

The agreed formula for the calculation of total beta discharges from produced water is:

Total beta (TBq) = (4xRa-228)+(2xRa-226)+(2xPb-210)

The formula assumes equilibrium in these decay chains at the time of discharge.

The total beta discharges, not including scale, are given below; for comparison the equivalent nuclear contributions are also illustrated.

Total beta (excluding tritium) 2005-2011

	Oil/gas	[Nuclear]
2005	4,25 TBq	[160 TBq]
2006	4,67 TBq	[58 TBq]
2007	4,94 TBq	[33,4 TBq]
2008	4,54 TBq	[27,2 TBq]
2009	5,02 TBq	[29,8TBq]
2010	4,94 TBq	[23,1 TBq]
2011	5,03 TBq	[25,9 TBq]

c) Tritium

Tritium is used as a tracer in the oil industry, and 0,08 TBq was used in the Norwegian sector during 2011. The nuclear industry discharges of tritium are more than 160 000 times higher than this. Norway also used 0,054 TBq of other beta-emitting radionuclides in tracer investigations.

2.3 Medical sub-sector

RSC originally agreed that iodine-131 and technetium-99 (arising from the decay of the medical product technetium-99m) should be reported from the medical sub-sector. At RSC 09 it was decided that so little technetium-99 was generated from the medical use of technetium-99m that data collection for technetium-99 could cease, and consequently no data was provided for 2009.

Reporting of iodine-131 discharges is not required where delay tanks are used to deal with liquid effluents.

a) total alpha discharges

No alpha emitting radionuclides are reported from this sub-sector.

b) total beta (excluding tritium) discharges

The reported discharges of iodine-131 over the period have been in the range 16 to 21 TBq/y. In 2010 there was an increase in the discharges from the medical sector and the sum of data provided amounts to 26 TBq. The main reason for this increase is that the Belgian contribution is increased with approximately 5 TBq in 2010 compared with the previous years. In 2011 the total reported discharges of Iodine-131 were 22 TBq, which is more in line with the reported discharges in the period before 2010. The total amount reported is however an under-estimate of the total discharges, as not all Contracting Parties reported. Iodine-131 is widely used in medicine, and in Europe its use is assumed to be approximately proportional to population. In the absence of data from Contracting Parties on their populations living on the North-East Atlantic watershed/catchment area, a very rough estimate has been made to allow for those Contracting Parties that did not report their medical discharges; the actual discharge of iodine-131 is likely to be 26 $\pm$ 5 TBq/y. This is on the same level as the discharges of total beta from the nuclear industry, which in 2011 amounted to 25,9 TBq.

2.4 University and research sub-sector

It is difficult to make an assessment of the discharges from this sector as reporting is very variable. From the data that has been provided it has been possible to conclude that this sector is not a significant contributor to total beta (< 0,5 TBq/y) or tritium (< 0,5 TBq/y) and there are no reported alpha emitting radionuclide discharges.

2.5 Radiochemical manufacturing sub-sector

Radiochemical manufacturing is carried out in several of the Contracting Parties, however only the UK and Switzerland have reported separately on this sub-sector in 2011. The discharges from this sub-sector are usually included in those for the nuclear site on which the processes are carried out. The data below reflects the discharges from UK and Switzerland.

a) total alpha

The reported total alpha discharge for 2011 was 7 MBq. This is a very minor contribution to the overall total alpha discharge to the maritime area.

b) total beta (excluding tritium)

The sum of the reported beta emitters plus the reported total beta during 2011 amounts to 0,2 TBq, an increase from the previous year, but still a minor contribution of total beta discharges to the marine environment. This is principally due to discharges of Carbon-14.

c) tritium

In 2011 tritium discharges amounted to 0,02 TBq, This is a decrease from the previous year when Sweden reported a discharge of 5,6 TBq. The UK contribution is also decreased from 1,15 TBq in 2010 to 0,165 TBq in 2011. These discharges represent a minor contribution to tritium discharges; nuclear sector discharges of tritium are more than 50 000 times greater than this. However, these discharges of tritium are in the form of tritium labelled organic compounds, which have significantly different environmental pathways/fates to that of tritiated water, as discharged by the nuclear industry, and cannot be compared directly.

2.6 Other non-nuclear sub-sectors.

Discharges were reported for the phosphate industry, titanium dioxide pigment manufacture, and primary steel manufacture. None of these sub-sectors made a significant contribution to the overall discharges of total alpha, total beta or tritium.

2.7 Summary and conclusions.

For 2011 the overall summary including comparison with the nuclear sector is shown below:

	Non-nuclear sector (TBq)					Nuclear sector (TBq)
	Oil/gas	Medical	Univ/R&D	Radiochem	**Total**	
Total alpha	7,6	-	-	-	**7,6**	0,17
Total beta	5,03	26 ± 5*	0,44	0,02	**31,5 ± 5**	25,9
Tritium	0,08	-	0,42	0,21	**0,7**	13485

* estimate based on 20,07 TBq reported by 7 Contracting Parties

The oil/gas sub-sector is the principal source of total alpha discharges, accounting for 97,8 % of the total. This sub-sector also makes an 8,8 % contribution to the overall total beta from all sectors (nuclear + non-nuclear). In total, the non-nuclear sector contributed an estimated 55 % of the total beta discharges from all sectors, with the largest single contribution (45 %) coming from the iodine-131 discharges from the medical sub-sector. Tritium discharges from the non-nuclear sector are insignificant in comparison with those from the nuclear sector.

3. 2011 data and information

In this section of the report, data and information on discharges from the non-nuclear sectors are presented for each Contracting Party.

The columns, headings and abbreviations used in the tables correspond to the reporting requirements set out in the reporting format (OSPAR Agreement number 2005-07 - 2009 update). The following abbreviations for radionuclides (elements) are used in the tables:

C:	Carbon	Po:	Polonium
Cr:	Chromium	Ra:	Radium
H-3:	Tritium	S:	Sulphur
I:	Iodine	Th:	Thorium
P:	Phosphorus	Pu:	Plutonium
Pb:	Lead		

3.1 Data reported on discharges from the offshore oil and gas industry

Contracting Parties have been invited to report the estimated discharges from offshore installations of radioactive substances:

a. in produced water (Pb-210, Ra-226, Ra-228);

b. from descaling and decommissioning operations (Pb-210, Ra-226, Ra-228, Th-228);

c. from tracer experiments (H-3, other beta and gamma emitters).

Table 3.1 shows the data from the offshore oil and gas industry.

Table 3.1. Discharges from the offshore oil and gas industry in 2011, in terabecquerel (TBq). Shaded boxes are not applicable.

		CP	OSPAR Region 1	Pb-210	Ra-226	Ra-228	Th-228	H-3	Other β/γ emitters
Produced water, TBq (DE1) (DE2) (NL1) (NL2) (NL3) (NO1) (NO2) (NO3) (NO4) (UK1) (UK2) (UK3) (UK4) (UK5)		DK	II	1,30E-02	3,80E-02	1,70E-02			
		DE	II	<7,00E-06	2,07E-04	1,70E-05			
		IE	III	1,31E-06	1,85E-06	3,46E-07			
		NL	II	8,80E-03	1,20E-01	1,30E-01			
		NO	I	4,00E-03	5,30E-02	4,10E-02			
		NO	II	3,10E-02	4,15E-01	3,30E-01			
		UK	II	3,90E-02	3,20E-01	2,20E-01			
		UK	III						
Descaling operations, both offshore and onshore, from normal production that leads to discharges (UK6)	Radioactivity in suspended solids arising from water-jet descaling (TBq)	NO	II	4,00E-07	4,30E-07	9,80E-07			
		UK	II	2,30E-04	3,20E-04	1,50E-04	9,00E-05		
	Radioactivity in solution as a result of descaling using acids or scale dissolvers (TBq) (UK7)								
Descaling operations, both offshore and onshore, from decommissioning of oil and gas installations that leads to discharges (NO5) (UK8)	Radioactivity in suspended solids arising from water-jet descaling (TBq)	NO	II	9,50E-10	9,30E-10	1,30E-10			
		UK	II						
	Radioactivity in solution as a result of descaling using acids or scale dissolvers (TBq)								
Radioactivity discharged as a result of tracer experiments (TBq) (NO3) (UK9)		NO	II					2,00E-02	
		UK	II						
Total discharged radioactivity, TBq (UK10)									

Further details on the data reported in Table 3.1 are given below.

1. The five OSPAR sub-regions are:

   (I) The Arctic,

   (II) The Greater North Sea (including the English Channel),

   (III) the Celtic seas,

   (IV) the Bay of Biscay/Golfe de Gascogne and Iberian coastal waters, and

   (V) the wider Atlantic.

   The definitions of these and a map are given in the Strategy for the Joint Assessment and Monitoring Programme.

Germany

DE1 Activity of Pb-210 in the produced water of Platform A6-A is lower than the MDA (minimal detectable activity). Total activity is lower than 7,5 MBq. Based on volume of produced water x MDA.

DE2 Uncertainty for Ra-226: +/- 3%.

DE3 Uncertainty for Ra-228: +/- 8%.

The Netherlands

NL1 Uncertainty for Pb-210: +/- 10%

NL2 Uncertainty for Ra-226: +/- 10%

NL3 Uncertainty for Ra-228: +/- 10%

Norway

NO1 Data for Pb-210 are based on samples all with concentrations under the detection limits. Half of the detection limits are used as concentration for calculation of the amount of Pb-210 discharged. The uncertainty for Pb-210 is therefore set equal to the discharges.

NO2 Uncertainty for Pb-210: +/- 0,031

NO3 Uncertainty for Ra-226: +/- 0,069

NO4 Uncertainty for Ra-228: +/- 0,042

NO5 The discharges from descaling operations are measured discharges from onshore descaling operations only.

United Kingdom

UK1 Around 98-99% of the data in Table 3.1 arises from discharges to the North Sea (OSPAR sub-region II). In 2011, two operators reported discharges to OSPAR Region III of Ra-226 (0,0065 TBq), Ra-228 (0,0042 TBq) and Pb-210 (0,0004 TBq).

Uncertainty for Pb-210: +/- 0,002

Uncertainty for Ra-226: +/- 0,022

Uncertainty for Ra-228: +/- 0,019.

UK2 The total activity of each radionuclide analysed per installation was calculated using the activity concentrations provided in Environmental Emissions Monitoring System (EEMS) and multiplying by the mass of particulate and solution for the produced water discharged over the period. The total activity provided in the report is based on the sum of the average activity for each of the specified radionuclides per installation.

UK3 The uncertainty values presented in Table 3.1 were derived by subtracting the average activity concentration values (Bq/g) from the upper limit activity concentration (Bq/g) for combined dissolved and particulate fractions of produced water samples collected during 2006-2008. It should be noted in addition to the uncertainty presented in Table 3, it is estimated that between 30% (of the total dissolved activity) and 70% (of total particulate activity) of the reported discharges for Ra-226 and Ra-228 were derived from data that are below detection limits (LoD); around 90% of reported Pb-210 discharges are derived from below LoD measurements. This is likely to have resulted in overestimation of annual discharges reported by the UK oil and gas industry.

UK4 There is no information currently collected on the amount of Pb-210 in produced water. The figure for Pb-210 in produced water is derived from the analysis of Po-210 by assuming that Pb-210 and Po-210 are in secular equilibrium.

UK5 The figure for Ra-228 is determined from the reported activity of Ac-228 in EEMS on the assumption that Ac-228 and Ra-228 are in secular equilibrium.

UK6 Discharges of 0,011TBq total alpha and 0,006 TBq total beta/gamma (excluding tritium) from onshore and offshore descaling were reported to the statutory regulators during 2011.

UK7 A protocol for discharges resulting from use of acids/dissolvers is yet to be developed. It is understood, however, that because the use of acids and scale dissolvers is less widespread, the activity discharged is primarily due to jet washing.

UK8 No operator reported discharges of scale from decommissioning operations during 2011.

UK9 The data generally provided under this heading is the amount of the particular tracer administered. No operator reported carrying out tracer experiments during 2011.

UK10 The total figures given in the report are for the contributions due to produced water and activity in discharges from offshore descaling activities (for both normal and decommissioning operations, as appropriate).

3.2 Data reported on discharges from other non-nuclear sectors

Contracting Parties have been invited to report the estimated discharges from the following other non-nuclear sources of radioactive substances:

a. the medical sector (I-131);

b. universities and research centres (H-3, C-14, P-32, S-35, Cr-51, I-125);

c. phosphate industry (Pb-210, Po-210, Ra-226);

d. titanium dioxide pigment manufactures (Pb-210, Po-210, Ra-226, Ra-228);

e. primary steel manufacture (Pb-210, Po-210);

f. radiochemical production (H-3, C-14, S-35, Cr-51, I-125, Pb-210, Po 210).

Table 3.2 shows the data reported from non-nuclear sector other than offshore oil and gas.

Table 3.2. Discharges from non-nuclear sector other than offshore oil and gas in 2011, in terabecquerel (TBq). Shaded boxes are not applicable.

Sector	CP	OSPAR Region [1]	Discharges of specified radionuclides (TBq)														
			I-131	H-3	C-14	P-32	S-35	Cr-51	I-125	Pb-210	Po-210	Ra-226	Ra-228	Th-228	Am-241	Total Alpha	Total Beta/ Gamma
Medical Sector (BE1) (DK1) (CH1) (NL1) (ES1) (UK1)	BE	II	7,37E+00														
	CH	II	1,05E-02														
	DK	II	2,13E+00														
	IE	III	6,36E-01														
	NO	I	3,20E-01														
	NO	II	7,93E-01														
	SE	II	2,56E-01														
	UK	II	8,10E+00														
	UK	III	2,26E+00														
Universities & Research centres (BE2) (BE3) (IE1) (NL2) (ES1) (UK2)	BE	II		1,16E-02	1,91E-01				2,47E+00								
	CH	II		2,64E-02	3,60E-03												
	IE	III		6,38E-04	5,12E-03	1,27E-04	2,00E-06	NI	1,05E-04								
	LU	II		2,00E-04	1,50E-04	5,00E-06	4,00E-06		2,50E-05								
	NO	I		6,34E-04	5,00E-05	0,00E+00	6,88E-04	0,00E+00	4,00E-06								
	NO	II		4,39E-04	9,00E-06	2,00E-06	4,52E-04	1,00E-06	0,00E+00								
	ES	IV		1,95E-03	9,20E-04	4,62E-03	2,82E-02	1,19E-03	6,80E-04								
	SE	II		5,50E-03	2,00E-02	5,00E-04	-	1,00E-05	7,50E-05								
	UK	II		1,89E-01	1,27E-01	2,45E-02	1,53E-02	2,42E-03	3,18E-02								
	UK	III		1,87E-01	7,94E-03	3,52E-03	5,40E-03	7,97E-05	4,21E-04								
Phosphate industry (ES2) (UK3)	NL	II								5,10E-04	2,60E-04						
Titanium dioxide pigment manufacturers (ES3) (UK4)	NL	II								3,80E-03	3,80E-03	3,80E-03	1,90E-03				
	ES	IV								3,00E-05	3,00E-05	2,00E-05	<5,00E-05				
Primary steel manufacture (NL3) (ES4) (UK5)	NL	II								-	-						
Radiochemical production (CH2) (ES5)	CH	II		1,37E-02													
	UK	II		n/d	2,06E-01		n/d	n/d	n/d	n/d	n/d					7,01E-06	3,20E-04
	UK	III		1,65E-01	1,53E-03		n/d	n/d	n/d	n/d	n/d					n/d	n/d

Further details on the data reported in Table 3.2 are given below.

1. The five OSPAR sub-regions are:

(I) The Arctic,

(II) The Greater North Sea (including the English Channel),

(III) the Celtic seas,

(IV) the Bay of Biscay/Golfe de Gascogne and Iberian coastal waters, and

(V) the wider Atlantic.

The definitions of these and a map are given in the Strategy for the Joint Assessment and Monitoring Programme.

Belgium

BE1 I-131: the value given represent all I-131 delivered to the hospitals. Most hospitals have deep freeze toilets which are used for hospitalised patients treated in isolation rooms. A few hospitals do use holding tanks to reduce the concentration in the liquid discharges. However, the limit in Belgium is set at 45 Bq/l. In practice, the isotope will always be kept at least 10 half times to decay and is only released after verification and when all storage tanks are full.

Values reported for H-3, C-14 and I-125 represent the amounts delivered to the laboratories (private institutions or companies, universities, research centres and hospitals laboratories performing “In Vitro or Clinical Biology” practices).

BE2 For information:
Decision was made by RSC-OSPAR that from 2008, Tc-99 values should not be reported anymore. Nevertheless since calculated values are available for Belgium (with following assumptions) we give here its value as information and for potential trend purposes for whom it concerns. The reported estimations were made by help of the “transported radionuclides” in Belgium to hospitals, universities and research centres in our country (authorisation needed). Since no data is available about the real discharges, we calculated a maximum upper level; all delivered radionuclides and their activity are completely discharged with their original amount of activity. For 2011 this gives a value of 2,06E-05 TBq.

a) Nuclide properties (decay scheme)

^{99}Mo → ^{99m}Tc → ^{99}Tc with

$T_{1/2}$ = 2,75 days = 2,38 E+05 s $T_{1/2}$ = 6 hours = 2,16 E+04 s $T_{1/2}$ = 2,14 E+05 years = 6,75 E+12 s

b) Explication calculation:

From following equation $Activity = \lambda N = \frac{0,693}{T_{1/2}} \times 6,02 \times 10^{23} \times \frac{mass}{A_{mass}}$ and presuming that all ^{99}Mo is transferred into ^{99}Tc leads to:

$$\frac{mass_{^{99}Mo}}{A_{mass,^{99}Mo}} = \frac{mass_{^{99}Tc}}{A_{mass,^{99}Tc}} \quad \text{or} \quad Activity_{^{99}Mo} \times T_{1/2,^{99}Mo} = Activity_{^{99}TC} \times T_{1/2,^{99}Tc} \quad \text{or}$$

$$Activity_{^{99}Tc} = \frac{Activity_{^{99}Mo} \times T_{1/2,^{99}Mo}}{T_{1/2,^{99}Tc}}$$

$$Activity_{TC-99} = \frac{\left(5{,}85 \times 10^{14}\, Bq\right) \times \left(2{,}38 \times 10^{5}\, s\right)}{\left(6{,}75 \times 10^{12}\, s\right)} = 2{,}06 \times 10^{7}\, Bq = 2{,}06 \times 10^{-5}\, TBq$$

BE3 Research centres & Universities use holding tanks to reduce the concentration of P-32, S-35 and Cr-51.

Denmark

DK1 The radioactive discharge from the medical sector was reported from the individual hospitals. It is discharged through the sewage system, mostly as urine.

Ireland

IE1 The figures are based on results reported by 9 educational establishments and 7 commercial research laboratories that are licensed to use the specified radionuclides. The nature of the discharges is principally biological and pharmacological science research based and takes place via a dedicated sink to a foul sewer. In general, the amount disposed of is estimated through radionuclides use logs. This is especially true for the educational sector.

Broadly similar amounts of H-3 (638 vs 465 MBq) and C-14 (5119 vs 8841 MBq) were discharged in 2011 compared to 2010. The increase in P-32 discharges from 2,4 MBq in 2010 to 127 MBq results from a significant increase in use of this radionuclide by one university for research purposes.

In general, discharges of other radionuclides have remained similar.

The Netherlands

NL1 In the Netherlands, delay tanks are used. For the years prior to 2008, the reported estimate of discharges from the medical sector is based on the number of therapeutic and diagnostic procedures, reported to the RIVM institute by the hospitals in the context of a yearly survey, and the recommended activity per procedure.

NL2 The discharges of the Delft and Petten research centres are already reported as total (reactors + different laboratories) discharges for the nuclear sector and are therefore not reported here. This is also true for the production of radiopharmaceuticals which takes place in Petten.

NL3 The discharges from primary steel manufacture are below the level requiring a permit and are therefore no longer reported.

Spain

ES1 There are holding tanks to reduce the concentration of I-131 in the liquid discharges to below 10 Bq/l.

ES2 Two plants process phosphates and produce both phosphoric acid and phosphate fertiliser; the residual phosphogypsum is piled and no radioactive liquid effluents are released into the river because the system works as a closed circuit.

ES3 There is only one Titanium dioxide plant that is located on the South West coast. According to current Spanish legislation, NORM industries are not obliged to report on radioactive discharges. The provided activity values have been estimated from a study that is being carried out by the Sevilla and Huelva Universities. Therefore they are generic values.

ES4 According to the available information, in Spain there are no integrated steel plants. The Spanish steel making plants (conversion of pig iron to steel) operate a dry gas cleaning process and, for this reason, no discharges of Pb-210 and Po-210 take place.

ES5 Not present.

Switzerland

CH1 Discharges from holding tanks in hospitals.

CH2 Manufactures of gaseous Tritium Light Devices (GTLD) and tritium-labelling service of various organic compounds.

United Kingdom

UK1 Medical Sector: This sector has been interpreted as being hospitals, clinics and medically related laboratories. Only I-131 is required to be reported for this sector in 2011.

UK2 Universities and Research Centres: This has been interpreted to include all universities, educational establishments, medical research facilities and research institutes. This category also includes operators involved in pharmaceutical research and the manufacture of pharmaceuticals, as well as non-medical commercial laboratories (laboratories associated with medical activities are included in the Medical Sector). The percentage of the discharge due to the pharmaceutical, commercial laboratories and non-commercial (other) sectors from England and Wales and Scotland are as follows:

Table. Percentage contribution to universities & research centres discharges

Radionuclides	Region II			Region III		
	Others[a]	Pharma-ceuticals	Laboratories	Others[a]	Pharma-ceuticals	Laboratories
H-3	32,3%	64,9%	2,78%	2,42%	97,6%	0,00%
C-14	1,27%	95,3%	3,38%	16,2%	83,6%	0,15%
P-32	99,8%	0,11%	0,13%	89,2%	10,8%	0,00%
S-35	94,5%	1,58%	3,88%	86,5%	13,5%	0,00%
Cr-51	99,3%	0,74%	0,00%	100%	0,00%	0,00%
I-125	22,9%	77,0%	0,16%	100%	0,00%	0,00%

[a] includes universities, educational establishments and medical research facilities

Due to the range of facilities, the method of estimation and origin is not uniform. Information from previous reviews suggests the majority of organisations estimate discharges based upon direct measurement of discharges.

UK3 Phosphate Industry: No longer present in the UK.

UK4 Titanium Dioxide Industry: One operator reported discharges of total alpha and total beta/gamma (excluding tritium) in 2011 of 13,5GBq and 8,26GBq respectively. Measurements of this type are not required to be reported in the OSPAR reporting procedures.

UK5 Primary Steel Manufacturing: There are three primary steel manufacturing plants in the UK, two on the east coast of England (sub-region II) and one in Wales (sub-region III). However, the plants operate a dry gas cleaning process and any dust removed from the stack is either retained, recycled or sent to landfill. There are no liquid discharges arising from this process.

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