OSPAR COMMISSION

Liquid discharges from nuclear installations, 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.

Contents

Executive summary

Discharges of radioactive substances measured as total alpha and total beta activity and excluding tritium from nuclear installations have decreased over the period 1990 – 2011. The discharges of tritium peaked in 2004.

This annual report includes the data of 2011 on liquid radioactive discharges from nuclear installations and temporal trends for the period 1990 - 2011. On this basis, an assessment has been made for the discharges from nuclear power stations, nuclear fuel reprocessing plants, nuclear fuel fabrication and enrichment plants, research and development facilities, and decommissioning and management of legacy radioactive wastes activities. Discharges are reported as total alpha, tritium and total beta activity (excluding tritium) in terabecquerel per year (TBq/y) for each type of nuclear installation.

There is a decrease in the total alpha activity discharged from all nuclear installations over the 21-year period. Discharges are at its lowest reported level since 1990, accounting for less than 6% of the peak value in 1993. In 2011, there was a 15% reduction compared to 2010 in alpha discharges from the fuel reprocessing sub-sector at Sellafield. The La Hague plant contributed 15% to the overall total alpha discharge, a slight increase relative to 2010. Total alpha discharges arising from decommissioning are insignificant.

Downward trends for discharges of tritium since 2004 were re-established. The total discharges of tritium fell slightly in 2011 compared to 2010. However, such trends were related to reprocessing throughput and could rise or fall in the future. La Hague registered a decrease of 10% in discharges in 2011 and Sellafield, an increase of 47%. Discharges of tritium from nuclear power stations contributed around 18% of the total tritium discharge. Tritium discharges arising from decommission are a very minor contributor although quite variable.

Total beta discharges (excluding tritium) from all nuclear installations are dominated by discharges from the reprocessing plant which contributed approximately 70% of the overall discharges. Discharges of Tc-99 discharges from Sellafield saw an increase of 33% in 2011 compared with 2010 figures. Total beta discharges from the fuel fabrication sub-sector at Springfields also went up by 12% in 2011. Total beta discharges (excluding tritium) arising from decommissioning were insignificant.

Récapitulatif

La mesure des activités d'alpha total et de bêta total, à l'exclusion du tritium, révèle que les rejets de substances radioactives, provenant des installations nucléaires, ont diminué entre 1990 et 2011. Les rejets de tritium ont atteint leur maximum en 2004.

Le présent rapport annuel comporte les données de 2011 sur les rejets radioactifs liquides provenant des installations nucléaires et les tendances temporelles pour la période de 1990 à 2011. Une évaluation a été réalisée, à partir de ces informations, portant sur les rejets provenant des centrales nucléaires, des usines de retraitement de combustible nucléaire, des usines de production de combustible nucléaire et des usines d'enrichissement, des installations de recherche et de développement ainsi que le démantèlement et la gestion des déchets radioactifs du passé. Les rejets sont notifiés au titre des activités d'alpha total, de tritium et de bêta total (à l'exclusion du tritium) et exprimés en terabecquerel par an (TBq/y) pour chaque type d'installation nucléaire.

L'activité d'alpha total rejetée par toutes les installations nucléaires a diminué au cours des vingt dernières années. Les rejets sont redescendus au même niveau qu'en 2009, réprésentant moins qu'un sixième du maximum enregistré en 1993. Par rapport à 2010, on note une diminution de 15% des rejets d'activité alpha des usines de production de combustible nucléaire à Springfields. La Hague a contribué 15% de l'ensemble des rejets d'activité d'alpha ; une légère augmentation de 69% des rejets de l'usine par rapport à 2010. Les rejets de total alpha provenant du déclassement sont négligeables.

Les tendances à la baisse des rejets de tritium que l'on observe depuis 2004 se sont confirmées. En 2011, on enregistre une légère diminution en comparaison avec 2010. Toutefois, ces tendances sont liées au débit des usines de retraitement, et pourraient augmenter ou diminuer à l'avenir. On a enregistré une diminution de 10% des rejets en 2011 à la Hague tandis qu'à Sellafield une réduction de 8% s'est avérée. Les rejets du tritium provenant du déclassement sont négligeables mais variables.

Les rejets totaux de total bêta (à l'exclusion du tritium) émanant de toutes les installations nucléaires représentent pour la plupart les rejets des usines de retraitement, contribuant environ 70% de l'ensemble des rejets. On relève une augmentation de 33% des rejets de Tc-99 de Sellafield par rapport à 2010. Pour cette même période on note également une hausse de 12% de l'usine de production de combustible nucléaire à Springfield. Les rejets de total bêta (à l'exclusion du tritium) provenant du déclassement sont négligeables.

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 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 of radionuclides from the nuclear sector. Regular reporting is therefore required in order to review progress towards the targets of the Radioactive Substances Strategy.

1.1 Programmes and measures

Since the mid 1980s, liquid discharges of radioactive substances from nuclear installations have been addressed first under the former Paris Convention and then under the OSPAR Convention. The following relevant measures [1] are applicable [2] under the OSPAR Convention:

- PARCOM Recommendation 88/4 on Nuclear Reprocessing Plants;
- PARCOM Recommendation 91/4 on Radioactive Discharges [3];
- PARCOM Recommendation 94/8 Concerning Environmental Impact Resulting from Discharges of Radioactive Discharges [4];
- OSPAR Decision 2000/1 on Substantial Reductions and Elimination of Discharges, Emissions and Losses of Radioactive Discharges, with Special Emphasis on Nuclear Reprocessing.

The OSPAR Radioactive Substances Committee agreed at its meeting in 2006 that discharges from “decommissioning and recovery of old waste” should be reported by Contracting Parties as “exceptional discharges”.

The OSPAR First and Third Periodic Evaluation of the Progress in Implementing the OSPAR Radioactive Substances Strategy, published in 2006 and 2009, have also informed this report. (OSPAR, 2006 and OSPAR, 2009).

1.2 Annual reporting

In 1985, Contracting Parties to the former Paris Convention initiated reporting on liquid discharges from nuclear installations. These data have subsequently been submitted annually by Contracting Parties, collated by the Secretariat and, following examination by the Expert Assessment Panel (EAP) of the OSPAR Radioactive Substances Committee, published by the OSPAR Commission in the form of annual reports. At first annual reports were published as part of the OSPAR Commission's general Annual Report, and from 1991 onwards they are published in the form of Annual OSPAR Reports on Liquid Discharges from Nuclear Installations in the OSPAR maritime area. From 1998 onwards, the annual reports also contain an assessment of liquid discharges which include a description of the trends from 1989 until the date of the latest report. Over time, reporting requirements and formats for data collection as regards nuclear installations have been regularly reviewed and updated in the light of experience and ongoing work under the OSPAR Commission. With a view to harmonising the way in which data and information are being established and reported, the OSPAR Commission adopted in 1996 a set of reporting formats for the annual

1 All measures referred to in this section can be downloaded from the OSPAR website www.ospar.org (under "programmes and measures").

2 OSPAR Decision 2000/1: France and the United Kingdom abstained from voting.

3 The implementation of this Recommendation requires an assessment to be carried out as to whether BAT is being applied in nuclear installations. Contracting Parties submit national reports that also contain discharge data on a regular basis thereby using the Guidelines for the submission of information about, and the assessment of, the application of BAT in nuclear facilities (reference number: 2004-03).

4 Assessments of the effect and relative contributions of remobilised historical discharges and current discharges of radioactive substances, including wastes, on the marine environment have been published in the Quality Status Report 2000 published by the OSPAR Commission in 2000 (ISBN 0 946956 52 9) and in the MARINA II Report published by the European Commission (EC, 2003).

Collection of Data on Liquid Discharges from Nuclear Installations (OSPAR agreement number: 1996-02), which were updated in 2010 to include a guide to generate “total-α” and “total-β” discharge data.

RSC decided at the meeting in 2006, that for data from 2005 onwards, discharges arising from decommissioning and the recovery and conditioning of legacy wastes should be reported separately from operational nuclear discharges. The discharges from such activities were reported as “Exceptional Discharges” and appear in this report in a separate table.

1.3 Parameters monitored and reported

Tables 1-8 of this report contain data on total-α (Table 1), tritium (Table 2), total-β (Table 3), and individual radionuclides (Tables 4-8). Figures 1-3 of this report show trends in discharges of total-α activity, tritium and total-β activity respectively.

Total-α and total-β values are useful as they will encompass the contribution to the overall activity from a wide range of radionuclides which, individually, would be difficult to measure or could be below detection limits. However, total-α and total-β values provide limited information about the potential harm as such information should be based on the characteristics of individual radionuclides. Tritium is reported separately.

There is currently little consistency in the approach adopted by Contracting Parties in the assessment of total-α and total-β quantities. Consequently, for the purposes of this report total-α quantities include measurements that are strictly gross-α. Similarly for total-β, quantities as gross-β measurements are included.

Total-α represents the measured radioactivity of α-particle emitting radionuclides. These particles are emitted as a result of the decay of certain radionuclides, the so-called α-emitters. On average, the total liquid discharges of α-emitters from all nuclear sites represent mainly Pu-239, Pu-240 and Am-241 and, to a lesser extent, Th-230, Pu-238 and some other nuclides. Total-β represents the measured radioactivity of β-particle emitting radionuclides. These particles are emitted as a result of the decay of certain radionuclides, the so-called β-emitters. On average, the total liquid discharges of β-emitters from all nuclear sites represent mainly Ru-106, Sr-90, Pu-241, Cs-137, Tc-99 and, to a lesser extent, a range of other radionuclides. Total-β in this report excludes tritium, which is reported separately.

Tritium (H-3) is an isotope of hydrogen that emits low-energy radiation in the form of β-particles. Tritium is discharged from most nuclear power plants, reprocessing plants and some research and development facilities.

2. Assessment of the liquid radioactive discharges from nuclear installations in 2011

Introduction

Tables 1 to 3 summarise liquid radioactive discharges from nuclear installations for the period 1990 – 2011; data for 1990–2011 are taken from the OSPAR Annual Reports on Liquid Discharges from Nuclear Installations. Reported discharges include data from nuclear power stations, nuclear fuel reprocessing plants, nuclear fuel fabrication and enrichment plants, research and development facilities. Since 2006, discharges from decommissioning are reported separately.

For each type of nuclear installation, Table 1 gives total alpha activity, Table 2 gives tritium and Table 3 gives total beta activity (excluding tritium) in TBq/y as well as the ratio, as a percentage, of the total discharges from all installations. To facilitate comparison of the discharges year by year, Figures 1 to 3 show trends for total alpha, tritium and total beta (excluding tritium) for the time period 1990 to 2011.

Trends in total alpha discharges

Figure 1 shows that the total alpha activity discharged in 2011 (0.165TBq) from all nuclear installations is at its lowest reported level since 1990. Discharges of alpha activity in 2011 are only 6% of the peak value in 1993.

Fuel reprocessing sub-sector - in 2011 the total alpha discharge from Sellafield was about 15% lower than the previous year (2005, 0.25TBq; 2006, 0.21TBq; 2007, 0.125TBq; 2008, 0.127TBq; 2009, 0.154TBq; 2010, 0.134TBq; 2011, 0,117TBq). In 2011 the La Hague plant contributed 0.0232TBq (15%) to the overall total alpha discharge, which is a slight increase relative to 2010. The total alpha discharges from La Hague plant remain fairly constant since 2005 except in 2009 which appears as an unusual year of low discharges (2005, 0.022TBq; 2006, 0.025TBq; 2007, 0.021TBq; 2008, 0.020TBq; 2009, 0.013TBq; 2010, 0.022TBq). The variations reflect mainly fuel throughput, burn up and decay.

The discharges from the fuel fabrication sub-sector have increased slightly in 2011 relative to 2010. The total alpha discharge from the Springfields site during 2011 was about 4,5 % higher than in 2010 (2005, 0.25TBq; 2006, 0.11TBq; 2007, 0.026TBq; 2008, 0.022TBq; 2009, 0.017TBq; 2010, 0,021TBq; 2011, 0.022TBq). This sub-sector amounts to 13 % of the overall total alpha discharge.

Discharges from research and development facilities increased in 2011 relative to the previous year. The discharges for 2011 were 77MBq in total, a 25% growth, but they do not contribute significantly to the overall total (less than 0.05%). Total alpha discharges arising from decommissioning have been recorded separately since 2006, but do not contribute significantly to the overall total.

Trends in tritium discharges

Figure 2 presents the discharges of tritium, in terms of activity. The total discharges of tritium decreased to 13485TBq in 2011, which is the next lowest discharge since 1995. The sum of the tritium discharges from all installations increased from around 8000TBq/y during the period 1990 - 1992 to a peak of 20634TBq in 2004. This increase was mainly due to the discharges from La Hague (2001, 9650TBq; 2002, 12000TBq; 2003, 11900TBq; 2004, 13900TBq). During the period 2005 to 2006 discharges of tritium from La Hague fell significantly (2005, 13500TBq; 2006, 11100TBq), but rose by 8% in 2007 (12000TBq). In 2008 the tritium discharges from La Hague fell to 8190TBq, but rose by 11% in 2009 to 9130TBq. In 2010 the discharges from La Hague rose further by 9% to 9950TBq. In 2011 the discharges from La Hague fell to 8920TBq, a decrease of 10 % i.e. of 1030TBq. As mentioned in earlier reports, tritium discharges tend to follow trends in reprocessing throughput. The reprocessing plant at La Hague contributed 66% of the total tritium discharge from all sectors in 2011 (13485TBq). The tritium discharges from Sellafield declined over the four-year period 2004-2007 to a low point of 628TBq in 2007, but increased in 2008 (778TBq) and increased further in 2009 to 1510TBq. In 2010 there was a decrease by 8 % in the discharges to 1390TBq. In 2011 the discharge rose again to 2070TBq, this is an increase of 49%.

During 2011 nuclear power stations contributed about 18.5 % of the total tritium discharges from the nuclear sector. The discharges of tritium from this sub-sector increased by 34% in 2009 to 2948TBq, ending a 6-year downward trend. In 2010, however, the discharges from the nuclear power sub-sector decreased again to 2830TBq, and in 2011 the discharges fell further to 2486 TBq, a decrease of 12% relative to 2010. Of the total discharges from the nuclear power stations the UK AGRs contributed 49 % (1217TBq), this is a drop of 20% (312TBq). The PWR in France contributed 34% (841TBq), this is a decrease of 6.5%. For the other contributing countries there are only small changes for the discharges of tritium from the nuclear power stations.

The contribution to discharges from the research and development facilities (3.01TBq) showed a significant decrease from the tritium discharges (14.7TBq) in the previous year. The higher value in 2010 was mainly due to an increase in the discharges from the Norwegian reactor in Halden, which had an incident where tritium diffused into the cooling water during an experiment that year.

Tritium discharges arising from decommissioning have been recorded separately since 2006, and though they are a very minor contributor they are quite variable. Discharges in 2011, 6.03TBq is a significant increase from the two previous years, but is still only about a fourth of the year with the highest discharge, 2007 (25.07TBq).

Trends in total beta discharges

Figure 3 shows that the sum of total beta activity (excluding tritium) from all nuclear installations has decreased markedly since monitoring started in 1990. In 2011 the discharges of the total beta was 25.9TBq, which is a slight increase from the previous year. Historically, total beta discharges have been dominated by discharges from the reprocessing plant at Sellafield and the nuclear fuel plant at Springfields. The top three 2011 contributions were: Sellafield, 58.9%; Springfields 19.3% and La Hague 11%. Reprocessing contributes approximately 70 % of the overall discharges.

Prior to 2002 the high total beta discharges from Sellafield (2001, 123TBq) were mainly attributable to the radionuclide Technetium-99 (2001, 79TBq). The contribution from Technetium-99 to the total beta discharge at Sellafield has been reducing steadily over the period 2001-2008 (2001, 79TBq; 2002, 85TBq; 2003, 37TBq; 2004, 14TBq; 2005, 6.7TBq; 2006, 5.6TBq; 2007, 4.9TBq; 2008, 2.37TBq), but there was a 30% increase in Tc-99 discharges in 2009 (3.08TBq). In 2010 the discharge of Technetium-99 from Sellafield was 1,4TBq, less than half of the 2009 number. In 2011 the discharge of Technetium from Sellafield was 1.59TBq, an increase of 13.5 % from the previous year. The 7-year downward trend (to 2008) in total beta discharges from Sellafield (2001, 123TBq; 2002, 112TBq; 2003, 83TBq; 2004, 73TBq; 2005, 43TBq; 2006, 29TBq; 2007, 24.8TBq; 2008, 14.3TBq) ended in 2009 with a 24% rise relative to 2008, mostly due to radionuclides other than Tc-99. In 2010 the total beta discharges from Sellafield dropped by 40% relative to 2009. In 2011 the discharge was 15.2TBq, an increase of 33% relative to 2010.

In the 3 years prior to 2008, the most significant change noted in total beta discharges was the decline in beta discharges from the fuel fabrication sub-sector, in particular from the Springfields site (2005, 103TBq; 2006, 20.7TBq; 2007, 3TBq). However, in 2008 the total beta discharges from Springfields rose by 53% to 4.58TBq, in 2009 there was a 29% reduction on the 2008 figure to 3.27TBq, in 2010 there was a 33% increase on the 2009 figure to 4.45TBq, and in 2011 there was a further 12% increase in the discharge to 4.99TBq. This numbers clearly highlights the variability of these much reduced discharges.

Table 1. Total alpha discharges 1990-2011

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
All Nuclear Installations (TBq)	2,43	2,43	1,84	2,88	1,36	0,68	0,57	0,38	0,43	0,41	0,33	0,41	0,61	0,62	0,54	0,52	0,34	0,19	0,17	0,18	0,18	0,17
Reprocessing Plants (TBq)	2,20	2,25	1,71	2,70	1,10	0,47	0,32	0,23	0,22	0,17	0,16	0,25	0,39	0,43	0,31	0,27	0,23	0,15	0,14	0,15	0,16	0,14
% of all installations	90,5	92,6	92,9	93,8	80,9	69,1	56,1	61,0	50,9	41,2	47,7	59,9	63,3	69,8	57,3	51,7	68,2	76,54	83,46	88,1175	85,892	84,8998
Nuclear Power Plants (TBq)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
% of all installations	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nuclear Fuel Fabrication (TBq)	0,21	0,15	0,10	0,08	0,16	0,12	0,12	0,12	0,20	0,24	0,17	0,16	0,22	0,18	0,23	0,25	0,11	0,04	0,02	0,02	0,02	0,02
% of all installations	8,6	6,2	5,4	2,8	11,8	17,6	21,1	31,8	46,1	58,1	51,7	39,7	36,3	29,5	42,5	48,1	31,6	23,09	12,84	9,77632	11,5893	13,3427
Research and Development Facilities (TBq)	0,02	0,03	0,03	0,10	0,10	0,09	0,13	0,03	0,01	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
% of all installations	0,8	1,2	1,6	3,5	7,4	13,2	22,8	7,2	3,0	0,7	0,5	0,4	0,3	0,7	0,2	0,2	0,0	0,06	0,05	0,03547	0,03391	0,0468
Decommissioning (TBq)																	0,00	0,00	0,01	0,00	0,00	0,00
% of all installations																	0,2	0,31	3,65	2,07071	2,4848	1,71069

Table 2. Tritium discharges 1990-2011

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
All Nuclear Installations (TBq)	7224	8798	7658	10902	12931	15040	16779	17956	16244	18771	16548	15759	18880	19637	20637	18517	15607	15594	11178	13593	14185	13485
Reprocessing Plants (TBq)	4959	6513	4969	7460	9770	12310	13500	14500	12800	15420	13300	12210	15220	15800	17070	15070	12190	12628	8968	10640	11340	10990
% of all installations	68,6	74,0	64,9	68,4	75,6	81,8	80,5	80,8	78,8	82,1	80,4	77,5	80,6	80,5	82,7	81,4	78,6	81,0	80,2	78,3	79,9	81,5
Nuclear Power Plants (TBq)	2164	2252	2666	3354	3044	2713	3264	3440	3430	3335	3241	3543	3648	3819	3560	3429	3394	2936	2193	2948	2830	2486
% of all installations	30,0	25,6	34,8	30,8	23,5	18,0	19,5	19,2	21,1	17,8	19,6	22,5	19,3	19,4	17,3	18,5	21,7	18,8	19,6	21,7	19,9	18,4
Nuclear Fuel Fabrication (TBq)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
% of all installations	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Research and Development Facilities (TBq)	101	32	24	88	118	17	15	16	14	16	7	6	12	18	7	18	5	6	6	2,40	14,22	3,01
% of all installations	1,4	0,4	0,3	0,8	0,9	0,1	0,1	0,1	0,1	0,1	0,0	0,0	0,1	0,1	0,0	0,1	0,0	0,0	0,1	0,0	0,1	0,0
Decommissioning (TBq)																	16,90	25,07	11,18	1,90	0,81	6,03
% of all installations																	0,1	0,16	0,10	0,0	0,0	0,0

Table 3. Total beta (excl tritium) discharges 1990-2011

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
All Nuclear Installations (TBq)	491	227	269	252	321	365	332	315	265	256	172	231	235	198	204	105	58	33,42	27,23	26,38	23,05	25,88
Reprocessing Plants (TBq)	384	178	134	170	195	243	169	167	112	126	98	141	125	97	86	54	37	29,61	20,67	17,91	14,75	18,05
% of all installations	78,2	78,4	49,7	67,4	60,8	66,5	50,9	53,0	42,3	49,1	56,9	61,2	53,1	49,0	42,3	51,8	62,5	88,6	75,9	67,9	64,0	69,8
Nuclear Power Plants (TBq)	10,3	3,8	8,9	11,1	2,8	3,4	5,2	7,4	2,0	2,0	3,0	4,2	3,6	3,2	1,3	2,0	0,75	0,46	1,53	2,1	3,2	2,23
% of all installations	2,1	1,7	3,3	4,4	0,9	0,9	1,6	2,3	0,8	0,8	1,7	1,8	1,5	1,6	0,6	1,9	1,3	1,4	5,6	7,9	14,0	8,6
Nuclear Fuel Fabrication (TBq)	92	39	120	63	114	112	150	140	150	128	71	85	106	97	116	103	21	3	5	3	4	5
% of all installations	18,7	17,1	44,6	25,0	35,5	30,7	45,1	44,4	56,7	49,9	41,2	36,8	45,1	49,1	56,8	98,0	35,4	8,9	16,8	12,4	19,3	19,3
Research and Development Facilities (TBq)	4,5	6,3	6,6	8,2	9,1	7,0	8,1	1,0	0,66	0,36	0,30	0,46	0,46	0,44	0,47	0,09	0,06	0,13	0,07	2,31	0,02	0,02
% of all installations	0,9	2,8	2,5	3,2	2,8	1,9	2,4	0,3	0,2	0,1	0,2	0,2	0,2	0,2	0,2	0,1	0,1	0,4	0,2	8,7	0,1	0,1
Decommissioning (TBq)																	0,40	0,04	0,38	0,80	0,59	0,59
% of all installations																	0,0	0,1	1,4	3,0	2,6	2,3

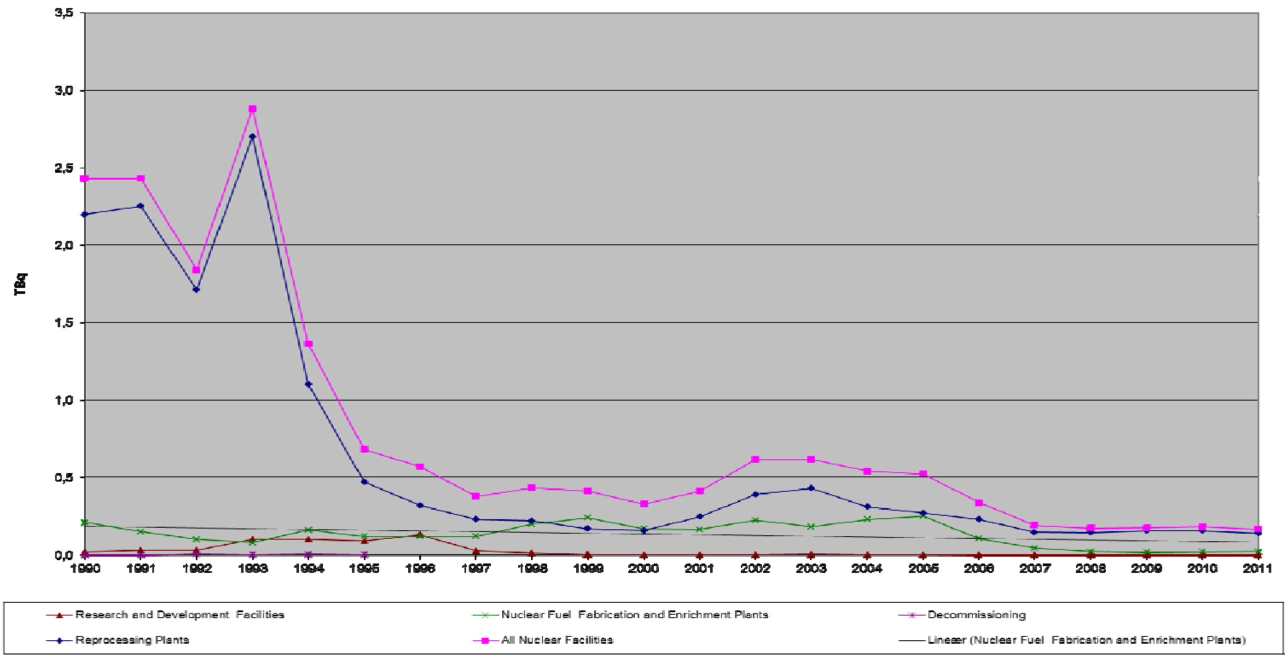

Figure 1. Total alpha discharges 1990 - 2011

Figure 2. Tritium Discharges 1990 - 2011

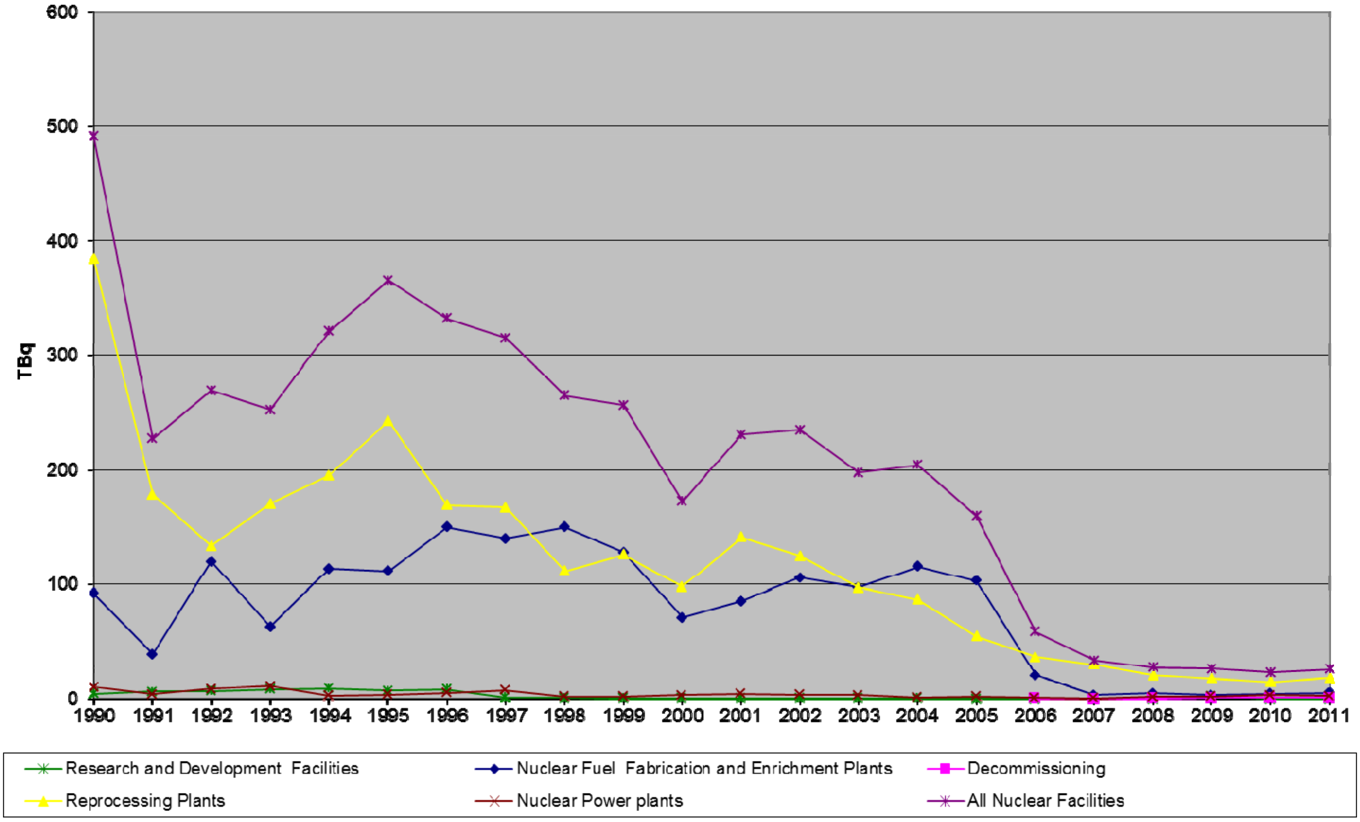

Figure 3. Total beta discharges 1990 - 2011

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3. 2011 data and information

This section presents information on the location of the nuclear installations and data and information on liquid discharges for each OSPAR Contracting Party under the following categories of nuclear installations draining into the OSPAR maritime area:

Table 4:	Nuclear Power Stations;
Table 5:	Nuclear Fuel Reprocessing Plants;
Table 6:	Nuclear Fuel Fabrication and Enrichment Plants;
Table 7:	Research and Development Facilities;
Table 8:	Discharges from decommissioning and treatment/recovery of old radioactive waste.

Further detailed information with respect to individual plants is presented in endnotes after the entire set of tables.

The columns, headings and abbreviations used in the tables correspond to the reporting requirements set out in the current reporting format (OSPAR Agreement No. 1996-02-update 2010). The following abbreviations are used in the tables:

AGR:	Advanced Gas Cooled Reactor;
GCR:	Gas Cooled Reactor;
UNGG:	Natural Uranium Gas Graphite (French equivalent for GCR);
PWR:	Pressurised Water Reactor;
THTR:	Thorium High Temperature Reactor;
BWR:	Boiling Water Reactor;
NA:	Not applicable;
NI:	No information;
ND:	Not detectable.

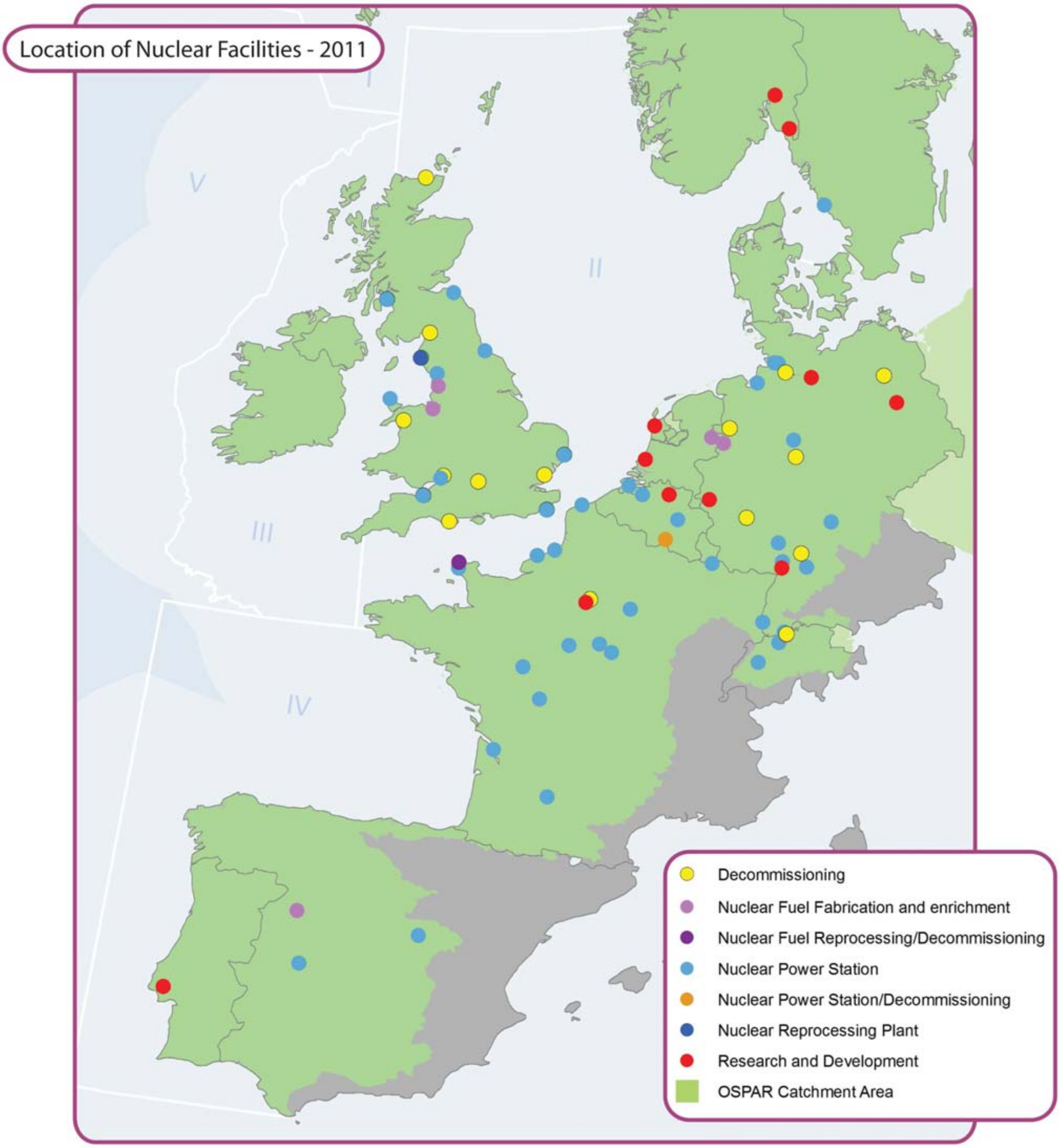
For radionuclides:

Ag:	Silver	Gd:	Gadolinium	Rh:	Rhodium
Am:	Americium	I:	Iodine	Ru:	Ruthenium
Ba:	Barium	Mn:	Manganese	S:	Sulphur
Be:	Beryllium	Na:	Sodium	Sb:	Antimony
C:	Carbon	Nb:	Niobium	Se:	Selenium
Ce:	Cerium	Ni:	Nickel	Sr:	Strontium
Cm:	Curium	Np:	Neptunium	Tc:	Technetium
Co:	Cobalt	Pm:	Promethium	Th:	Thorium
Cr:	Chromium	Pr:	Praseodymium	U:	Uranium
Cs:	Caesium	Pu:	Plutonium	Y:	Yttrium
Eu:	Europium	Ra:	Radium	Zn:	Zinc
Fe:	Iron	Rb:	Rubidium	Zr:	Zirconium

All data on discharge limits and releases of radionuclides have been entered in the tables using continental decimal system. The data values are expressed in scientific number format, *e.g.* 0,0009 as 9,0E-04.

3.1 Map of nuclear installations

The map shows the location of nuclear facilities in OSPAR countries discharging directly or indirectly to the OSPAR maritime area.



3.2 Location of nuclear installations

The location and type of each installation is listed in the table below.

Country / Code	Name of installation	Type	Discharging into
Belgium			
BE1	Doel	NPS	Schelde
BE2	Tihange	NPS	Meuse
BE3	Mol	RDF	River Mol-Neet
Denmark			
DK1	Risø	DMLRW	Kattegat through Roskilde Fjord
France			
FR1	Belleville	NPS	Loire
FR2	Cattenom	NPS	Mosel
FR3	Chinon	NPS	Loire
FR4	Chooz	NPS/ DMLRW	Meuse
FR5	Civaux	NPS	Vienne
FR6	Dampierre en-Burly	NPS	Loire
FR7	Fessenheim	NPS	Rhine
FR8	Flamanville	NPS	Channel
FR9	Fontenay-aux-Roses	DMLRW	Seine
FR10	Golfech	NPS	Garonne
FR11	Gravelines	NPS	North Sea
FR12	Le Blayais	NPS	Gironde Estuary
FR13	La Hague	NFRP/ DMLRW	English Channel
FR14	Nogent-sur-Seine	NPS	Seine
FR15	Paluel	NPS	Channel
FR16	Penly	NPS	Channel
FR17	Saclay	RDF	Etang de Saclay
FR18	Saint Laurent	NPS	Loire
Germany			
DE1a	Biblis A	NPS	Rhine – Shut down
DE1b	Biblis B	NPS	Rhine – Shut down
DE2	Brokdorf	NPS	Elbe
DE3	Brunsbüttel	NPS	Elbe – Shut down
DE4	Grafenrheinfeld	NPS	Main
DE5	Grohnde/Emmerthal	NPS	Weser
DE8a	Krümmel/Geesthacht	NPS	Elbe – Shut down
DE8b	Geesthacht	RDF	Elbe
DE9a	Lingen/Emsland	NPS	Ems
DE9b	Lingen	DMLRW	Ems - via municipal sewer system – Shut down
DE10	Mülheim-Kärlich	DMLRW	Rhine – Shut down
DE11a	Neckar-westheim 1	NPS	Neckar – Shut down
DE11b	Neckar-wesheim 2	NPS	Neckar
DE12	Obrigheim	DMLRW	Neckar – Shut down
DE13a	Philippsburg KKP1	NPS	Rhine – Shut down
DE13b	Philippsburg KKP2	NPS	Rhine
DE14	Rheinsberg	DMLRW	Havel – Shut down
DE15	Stade	DMLRW	Elbe – Shut down
DE16	Rodenkirchen-Unterweser	NPS	Weser – Shut down
DE17	Würgassen/Beverungen	DMLRW	Weser – Shut down
DE18	Karlsruhe	RDF	Rhine
DE19	Gronau	NFFEP	Vechte, IJsselmeer
DE22	HMI Berlin	RDF	Havel
DE23	Jülich	RDF	Rur
The Netherlands			
NL1	Borssele	NPS	Scheldt Estuary
NL3	Almelo	NFFEP	Municipal sewer system

Country / Code	Name of installation	Type	Discharging into
NL4	Delft	RDF	Sewage system
NL5	Petten	RDF	North Sea
Norway			
NO1	Halden	RDF	River Tista (Skagerrak)
NO2	Kjeller	RDF	River Nitelva (Skagerrak)
Portugal			
PT1	Campus de Sacavém	RDF	Tagus River
Spain			
ES1	Almaraz	NPS	Tagus
ES2	José Cabrera	NPS	Tagus
ES3	Trillo	NPS	Tagus
ES4	Juzbado	NFFEP	River Tormes - Duero
Sweden			
SE2	Ringhals 1-4	NPS	Kattegat
Switzerland			
CH1	Beznau	NPS	Aare
CH2	Gösgen	NPS	Aare
CH3	Leibstadt	NPS	Rhine
CH4	Mühleberg	NPS	Aare
CH5	Paul Scherrer Institute	RDF	Aare
CH6	ZWILAG Würenlingen	DMLRW	Aare
United Kingdom			
UK1	Berkeley	DMLRW	Severn Estuary
UK2	Bradwell	DMLRW	North Sea
UK4	Chapelcross	DMLRW	Solway Firth
UK5a	Dungeness A	DMLRW	English Channel
UK5b	Dungeness B	NPS	English Channel
UK6	Hartlepool	NPS	North Sea
UK7a	Heysham 1	NPS	Morecambe Bay
UK7b	Heysham 2	NPS	Morecambe Bay
UK8a	Hinkley Point A	DMLRW	Severn Estuary
UK8b	Hinkley Point B	NPS	Severn Estuary
UK9a	Hunterston A	DMLRW	Firth of Clyde
UK9b	Hunterston B	NPS	Firth of Clyde
UK10	Oldbury	NPS	Severn Estuary
UK11a	Sizewell A	DMLRW	North Sea
UK11b	Sizewell B	NPS	North Sea
UK12	Torness	NPS	North Sea
UK13	Trawsfynydd	DMLRW	Trawsfynydd lake
UK14	Wylfa	NPS	Irish Sea
UK15	Sellafield	NFRP	Irish Sea
UK16	Capenhurst	NFFEP	Irish Sea via Rivacre Brook and Mersey Estuary
UK17	Springfields	NFFEP	Irish Sea via River Ribble
UK19	Harwell	DMLRW	River Thames
UK20	Winfrith	DMLRW	Weymouth Bay (English Channel)

NPS: Nuclear Power Stations

NFRP: Nuclear Fuel Reprocessing Plants

RDF: Research and Development Facilities

NFFEP: Nuclear Fuel Fabrication and Enrichment Plants

DMLRW: Decommissioning and Management of Legacy Radioactive Wastes

Table 4 Nuclear Power Stations

Location Ref.	Country Site	Discharges to	Reactors Number and Type	Installed Capa-city MW (e) 2011	Net Electrical Output MW (e).h 2011	Operational discharges of radioactive substances in 2011 (TBq)															
								Specific radionuclides													
						Tritium	other (1) radio-nuclides	Total-α activity	Total-β activity (excluding tritium)	Co 58	Co 60	Zn 65	Sr 90	Zr/Nb 95	Ru 106	Ag 110m	Sb 125	Cs 134	Cs 137	Ce 144	S 35
	Belgium (2)																				
BE1	Doel	Schelde	4 PWR	433,0	3 328 526	5,52E+01	2,36E-03	6,90E-06	8,67E-03	1,36E-03	1,68E-03	6,88E-05	4,27E-06	1,28E-04	2,80E-04	5,93E-04	1,58E-03	3,80E-05	2,88E-04	1,74E-04	0,00E+00
				433,0	3 570 909									1,54E-04							
				1006,0	7 911 687																
				1039,0	7 978 470																
BE2	Tihange	Meuse	3 PWR	962,0	6 848 283	3,93E+01	6,47E-04	8,70E-10	8,26E-03	1,45E-03	4,29E-03	0,00E+00	0,00E+00	2,45E-05	4,85E-05	7,00E-04	3,12E-04	1,18E-04	5,90E-04	0,00E+00	0,00E+00
				1008,0	7 322 515									1,26E-04							
				1045,8	8 981 889																
	France (3)			**Total Parc :** 4,42E-08 MWh (4)																	
FR1	Belleville	Loire	2 PWR	2600		5,87E+01	2,03E-04			3,82E-05	4,88E-05					1,05E-05	2,93E-05	9,79E-06	1,25E-05		
FR2	Cattenom	Mosel	4 PWR	5200		8,82E+01	1,17E-03			2,65E-04	4,61E-04					4,45E-05	9,27E-05	3,99E-05	9,34E-05		
FR3	Chinon	Loire	4 PWR	3600		5,42E+01	3,76E-04			5,72E-05	7,23E-05					1,58E-04	2,79E-05	9,55E-06	1,15E-05		
FR4	Chooz	Meuse	2 PWR	2900		5,23E+01	3,74E-04			5,10E-05	1,89E-04					2,13E-05	2,37E-05	1,06E-05	3,23E-05		
FR5	Civaux	Vienne	2 PWR	2900		2,98E+01	1,69E-04			6,42E-06	2,95E-05					5,30E-05	9,66E-06	3,69E-06	6,66E-06		
FR6	Dampierre-	Loire	4 PWR	3600		4,49E+01	3,57E-04			7,08E-05	6,89E-05					3,78E-05	4,94E-05	1,57E-05	2,43E-05		
FR7	Fessenheim	Rhine	2 PWR	1800		1,22E+01	3,30E-04			9,17E-05	3,08E-05					1,29E-04	2,31E-05	3,81E-06	5,30E-06		
FR8	Flamanville	North Sea	2 PWR	2600		6,35E+01	3,28E-04			1,09E-04	6,36E-05					1,47E-05	4,26E-05	1,40E-05	1,78E-05		
FR10	Golfech	Garonne	2 PWR	2600		6,49E+01	1,26E-04			1,86E-05	2,72E-05					7,58E-06	2,21E-05	6,81E-06	8,47E-06		
FR11	Gravelines	North Sea	6 PWR	5400		7,54E+01	1,64E-03			1,20E-04	8,12E-04					2,73E-04	9,19E-05	5,00E-05	8,48E-05		
FR12	Le Blayais	Gironde	4 PWR	3600		4,88E+01	3,57E-04			1,02E-04	8,24E-05					5,01E-05	2,86E-05	9,53E-06	1,18E-05		
FR14	Nogent-	Seine	2 PWR	2600		5,84E+01	4,35E-04			2,10E-04	3,79E-05					3,94E-05	4,48E-05	1,61E-05	1,97E-05		
FR15	Paluel	North Sea	4 PWR	5200		1,10E+02	8,43E-04			2,95E-04	1,89E-04					3,31E-05	7,47E-05	2,88E-05	3,49E-05		
FR16	Penly	North Sea	2 PWR	2600		5,84E+01	1,99E-04			4,92E-05	5,83E-05					3,29E-05	1,42E-05	5,50E-06	1,13E-05		
FR18	Saint Laurent	Loire	2 PWR	1800		2,15E+01	1,94E-04			2,30E-05	6,10E-05					4,00E-05	1,73E-05	6,72E-06	9,09E-06		
	Federal Republic of Germany			(5)																	
DE1a	Biblis A	Rhine	1 PWR	1225	2234763	7,06E+00	1,63E-05			3,68E-08	4,32E-06					8,42E-08	2,15E-06	4,42E-08	5,97E-07		
DE1b	Biblis B	Rhine	1 PWR	1300	1732851	1,16E+01	9,06E-05			5,22E-07	3,00E-06			2,92E-07		2,55E-06	9,79E-06		1,30E-06		
DE2	Brokdorf	Elbe	1 PWR	1480	10217057	1,42E+01	2,60E-06												1,75E-08		
DE3	Brunsbüttel	Elbe	1 BWR	806	0	3,25E-03	1,31E-05				5,24E-06	2,26E-07	1,05E-08						1,83E-06		
DE4	Grafenrheinfeld	Main	1 PWR	1345	9044236	1,49E+01	6,59E-05			1,43E-06	5,36E-05					1,80E-07					
DE5	Grohnde/Emme	Weser	1 PWR	1430	10166953	1,75E+01	5,26E-06				4,28E-06										
DE8a	Krümmel/Geest	Elbe	1 BWR	1402	0	7,26E-03															
DE9a	Lingen/Emsland	Ems	1 PWR	1400	11559045	1,81E+01	7,87E-07				6,70E-08										
DE11a	Neckar-Westhe	Neckar	1 PWR	840	1462066	6,03E+00															
DE11b	Neckar-Westhe	Neckar	1 PWR	1400	11554953	2,30E+01	5,62E-08									5,62E-08					
DE13a	Philippsburg 1	Rhine	1 BWR	*926*	1480591	3,64E-01	6,76E-05			6,90E-06	1,71E-05	1,06E-05						9,17E-07	1,04E-05		
DE13b	Philippsburg 2	Rhine	1 PWR	1468	11313990	1,50E+01	2,85E-05			7,56E-07	2,43E-06							7,44E-06	1,00E-05		
DE16	Rodenkirchen/U	Weser	1 PWR	1410	2489479	1,25E+00	3,20E-05			3,72E-07	2,50E-05			2,02E-07					1,21E-06		
	The Netherlands								(6)												
NL1	Borssele	Westerscheld	1 PWR	520	3,92E+6	6,50E+0	7,88E-5	< MDL	1,80E-4	1,21E-7	4,07E-5	< MDL	< MDL	1,62E-6	< MDL	3,15E-6	< MDL	< MDL	7,12E-6	< MDL	NI

Location Ref.	Country Site	Discharges to	Reactors Number and Type	Installed Capa-city MW (e) 2011	Net Electrical Output MW (e).h 2011	Operational discharges of radioactive substances in 2011 (TBq)															
								Specific radionuclides													
						Tritium	other (1) radio-nuclides	Total-α activity	Total-β activity (excluding tritium)	Co 58	Co 60	Zn 65	Sr 90	Zr/Nb 95	Ru 106	Ag 110m	Sb 125	Cs 134	Cs 137	Ce 144	S 35
	Spain (7) (8)																				
ES1	Almaraz	Tagus	2 PWR	1 957	15 257 000	6,45E+01	5,67E-03	ND	NI	8,54E-04	7,47E-04	8,49E-05	3,81E-05	8,47E-04	1,02E-04	1,99E-04	1,31E-04	1,31E-05	1,19E-04	ND	ND
ES3	Trillo	Tagus	1 PWR	1 066	7 836 000	1,58E+01	2,59E-04	ND	NI	1,83E-06	7,39E-05	ND	ND	7,20E-06	ND	3,10E-06	4,90E-06	4,96E-06	1,81E-05	ND	ND
	Sweden						(9c)	(9a)	(9b)												
SE2	Ringhals 1-4	Kattegatt (10	BWR	865	5 971 271	4,90E-01	6,73E-04	1,04E-06	1,13E-03	1,20E-04	2,70E-04	2,80E-06	1,40E-06	8,00E-06	ND	2,10E-05	ND	ND	3,10E-05	ND	ND
		(11)	PWR	865	1 726 663	1,10E+01	7,12E-05	7,69E-07	1,46E-04	1,30E-05	3,30E-05	ND	1,60E-06	2,02E-06	ND	1,90E-05	3,80E-06	ND	3,30E-06	ND	ND
		(12)	PWR	1047	7 144 614	1,50E+01	2,52E-04	6,88E-07	3,80E-04	3,90E-05	3,50E-05	ND	6,50E-06	2,03E-05	ND	2,10E-05	6,50E-06	ND	7,60E-07	ND	ND
		(13)	PWR	940	4 102 442	1,10E+01	2,50E-04	9,56E-07	9,63E-04	6,50E-04	3,20E-05	ND	ND	2,28E-05	ND	3,20E-06	6,40E-06	ND	1,10E-07	ND	ND
	Switzerland																				
CH1	Beznau	Aare	2 PWR	380/380	5 804 800	8,60E+00		1,50E-08	4,00E-04	5,00E-05	5,00E-05		5,70E-07	3,00E-07		1,20E-06	4,90E-05	7,00E-06	1,30E-04		
CH2	Gösgen	Aare	1 PWR	1035	7 910 300	1,90E+01		<2.00E-7	1,60E-06		4,40E-07										
CH3	Leibstadt	Rhine	1 BWR	1220	9 481 346	2,00E+00		3,30E-07	8,90E-05	3,10E-06	6,40E-05	1,20E-05									
CH4	Mühleberg	Aare	1 BWR	390	2 504 296	1,80E-01		3,70E-07	1,50E-03	1,80E-04	8,60E-04	3,30E-05	1,70E-06				1,10E-05		1,50E-05		
	United Kingdom																				
UK5b	Dungeness B	English	2 AGR			1,40E+1	1,21E-3				5,63E-4								6,76E-4		5,54E-02
UK6	Hartlepool	North Sea	2 AGR			3,37E+2	7,93E-3				2,83E-4								4,56E-3		9,75E-01
UK7a	Heysham 1	Morecambe	2 AGR			4,18E+2	4,79E-3				2,28E-4								1,44E-3		5,07E-01
UK7b	Heysham 2	Morecambe	2 AGR			3,13E+2	1,05E-2				6,55E-5								9,52E-4		3,19E-02
UK8b	Hinkley Point B	Severn	2 AGR			1,35E+2	3,57E-3				1,51E-4								1,86E-3		2,48E-01
UK9b	Hunterston B	Firth of Clyde	2 AGR																		
UK10	Oldbury	Severn	2 GCR			2,34E-1	9,78E-2												1,96E-1		
UK11b	Sizewell B	North Sea	1 PWR			4,29E+1	1,60E-2												7,80E-3		
UK12	Torness	North Sea	2 AGR																		
UK14	Wylfa	Irish Sea	2 GCR			6,90E+0	6,23E-3														

Table 5 Nuclear Fuel Reprocessing Plants

Location ref	La Hague (FR13)		Sellafield (UK15)
Discharges to	English Channel		Irish Sea
Type of Fuel Reprocessed Capacity (t/y)	PWR + BWR		Magnox, AGR, LWR
Radionuclide	TBq released per annum (1)	Normed releases in TBq per GWye (39,1 GWye in 2011)	TBq released in 2011 (2) (3)
Tritium	8,92E+3		2,07E+3
Total-α	2,32E-2	5,93E-4	1,17E-1
Total-β	2,85E+0	7,29E-2	1,52E+1
C 14	6,99E+0		6,39E+0
S 35			
Mn 54	1,73E-3		
Fe 55			
Co 57	7,50E-5		
Co 58	1,44E-4		
Co 60	5,58E-2		6,46E-2
Ni 63	2,88E-2		
Zn 65	ND		
Sr 89	ND		
Sr 90	8,55E-2		1,93E+0
(Sr 90 + Cs 137)			
(Zr + Nb 95)	ND		1,87E-1
Tc 99	1,99E-2		1,59E+0
Ru 103	ND		
Ru 106	1,23E+0		2,04E+0
(Ru + Rh) 106	2,47E+0		
Ag 110m	ND		
Sb 124	ND		
Sb 125	9,68E-2		
I 129	1,25E+0		4,00E-1
Cs 134	5,19E-2		9,45E-2
Cs 137	6,71E-1		5,86E+0
Ce 144	1,83E-4		4,71E-1
(Ce + Pr) 144	3,66E-4		
Pm 147			
Eu 152			
Eu 154	9,83E-4		
Eu 155	1,47E-4		
Np 237	5,55E-5		4,31E-2
Pu 239+240	1,53E-3		1,06E-1
Pu 241	1,30E-1		2,41E+0
Am 241	2,58E-3		3,18E-2
Cm 242	9,61E-6		
Cm 243+244	1,52E-3		3,93E-3
Uranium (in kg)	2,35E+1		2,74E-10

ND: not detectable

Table 6 Nuclear Fuel Fabrication and Enrichment Plants

Location Ref.	Country/ site	Discharges to	Type of Fuel	Capacity (t/y)	Production	Activity	TBq released in 2011
	Federal Republic of Germany						
DE19	Gronau	Vechte, IJsselmeer	Uranium enrichment			total - α	4,6E-09
	Netherlands						
NL3	Urenco, Almelo	Municipal sewer system	Uranium enrichment	4950	4659	total - α	7,00E-07
						total - β (β- & γ- emitting rn)	
	Spain						
ES4	Juzbado	River Tormes - Duero	PWR, BWR	400	357,9	total - α	1,87E-5
	United Kingdom						
UK16	Capenhurst	Irish Sea via Rivacre Brook and Mersey Estuary	Uranium enrichment			Uranium - α	5,10E-6
						Uranium daughters	6,40E-6
						other - α	1,56E-5
						Tc 99	5,20E-6
						Tritium	
UK17	Springfields	Irish Sea via River Ribble	GCR, AGR, PWR fuel fabrication			total - α	2,20E-2
						total - β	4,99E+0
						Tc 99	9,52E-2
						Th 230	1,60E-3
						Th 232	1,60E-4
						Uranium - α	1,65E-2
						Np 237	5,80E-4

Table 7 Research and Development Facilities

Location Ref.	Country/ site	Discharges to	Reactors Number & Type	Installed Capacity	Radionuclides	TBq released per annum in 2011
	Belgium			(1)		
BE3	**Mol**	River Mol-Neet	2	129 MWth	Total-α	2,96E-05
					Total-β	1,48E-04
					H 3	2,02E+00
					Sr 90/Y 90	3,08E-05
					Co 60	2,18E-05
					Cs 134	1,11E-05
					Cs 137	1,46E-04
					Total activitiy	2,02E+00
	France					2,10E-4
FR17	Saclay	Etang de Saclay	Centre de recherches du Commissariat à l'énergie atomique		α	4,50E-05
					other radionuclides	6,80E-05
					Tritium	1,72E-02
	Germany					
DE8b	Geesthacht	Elbe	1		Tritium	4,5E-04
					β/γ – emitting radionuclides	8,1E-06
DE18	Karlsruhe	Rhine	No reactors		Tritium	3,9E-01
					β/γ – emitting radionuclides	1,9E-04
DE22	HZ Berlin	Havel	1		Tritium	2,2E-04
					β/γ – emitting radionuclides	1,7E-07
DE23	Jülich	Rur	1		Tritium	1,0E+00
					β/γ – emitting radionuclides	1,3E-04
	Netherlands					
NL4	Delft (2) (3) (4)	Sewage system	1 Research reactor	2 MWth	α – emitting radionuclides	<1,00E-07
					β – emitting radionuclides including tritium	6,0E-06
					γ – emitting radionuclides	3,6E-06
					total	9,6E-06
NL5	Petten (5) (6) (7)	North Sea	1 high flux Research reactor Research reactor	50 MWth	Tritium	1,52E-01
					α – emitting radionuclides	1,88E-06
					β/γ – emitting radionuclides	1,41E-02
					total	1,72E-01

	Norway (8)					
NO1	Halden (9)	River Tista (Skagerrak)	1 BWR D2O as moderator	(10)	Tritium	1,40E+00
					Total α	ND
					Total β	3,43E-04
					Ag-110m	7,40E-07
					Cr-51	1,80E-05
					Mn-54	1,10E-06
					Mn-56	NA
					Co-58	2,00E-06
					Co-60	4,80E-05
					Sr-90	1,80E-06
					Zr-95	4,50E-06
					Nb-95	1,10E-05
					Sb-125	ND
					Cd-109	NA
					I-131	8,50E-06
					Cs-134	1,30E-05
					Cs-137	8,10E-05
					Ce-141	7,60E-07
					Ce-144	9,30E-06
NO2	Kjeller (9)	River Nitelva (Skagerrak)	1 JEEP II, heavy water and cooled Research Reactor	(10)	Tritium	2,94E-02
					Total-α	5,46E-07
					Total-β	9,42E-06
					Co 58	ND
					Co 60	3,25E-06
					Zn 65	4,60E-08
					Sr 90	4,53E-06
					Zr/Nb 95	ND
					Ru 103	ND
					Ru 106	ND
					Ru/Rh 106	ND
					Ag 110m	ND
					Sb 125	ND
					I 125	ND
					I 131	ND
					Cs 134	ND
					Cs 137	1,44E-06
					Ce 144	ND
					Pu 238	5,50E-09
					Pu 239/240	4,71E-07
					Am 241	1,80E-08
					Pu 241	NA
	Portugal					
PT1	Campus de Sacavém	Residual Water Treatment Municipal Plant	1 Research Swimming Pool Reactor		Total-β	3,16E-04
	Switzerland					
CH5	Paul Scherrer Institute	Aare	1 research reactor		Tritium	2,10E-02
					Total-β activity	3,80E-05
					(excluding tritium)	
					Total-α activity	2,10E-07

Table 8 Discharges from decommissioning and treatment/recovery of old radioactive waste in 2011

Location Ref.	Country Site	Discharges to	Reactors Number and Type	Exceptional discharges of radioactive substances in 2011 (TBq)																
						Specific radionuclides														
				Tritium	other (1) radio-nuclides	Total-α activity	Total-β activity (excluding tritium)	Co 58	Co 60	Zn 65	Sr 90	Na 22	Ru 106	Ag 110m	Sb 125	Cs 134	Cs 137	Ce 144	S 35	Pu 241
	Denmark			(2) (3)																
DK1	Risø	Kattegat through	No reactors	1,40E-01			6,85E-05													
		Roskilde Fjord																		
	France		**Type of fuel reprocessed**																	
FR4	Chooz (4)	Meuse	1 PWR	1,37E-03	2,02E-04				3,75E-06		4,57E-06						1,79E-04			
FR9	Fontenay-aux-Roses	Seine	No reactor	1,40E-05		2,00E-06	5,00E-6													
FR13	La Hague	English Channel	PWR + BWR			2,72E-03	3,84E-1		7,85E-4		4,65E-2		2,70E-1				8,06E-2			
	Federal Republic of Germany																			
D9b	Lingen	Ems	1 BWR	2,9E-06	7,9E-07	6,4E-09											7,6E-07			
D10	Mülheim-Kärlich	Rhine	1 PWR	3,1E-05	2,0E-06				4,3E-07											
D12	Obrigheim	Neckar	1 PWR	3,5E-03	1,1E-04	1,3E-08			1,7E-05						5,7E-07		2,0E-06			
D14	Rheinsberg	Havel	1 PWR	5,5E-05	6,4E-06	6,6E-08			4,3E-07		4,4E-07						1,3E-06			
D15	Stade	Elbe	1 PWR	2,2E-03	1,8E-05	4,5E-09			1,8E-06								2,1E-06			
D17	Würgassen/Beverungen	Weser	1 BWR	1,3E-04	9,6E-07				6,3E-07								1,1E-07			
	Spain																			
ES2	José Cabrera (5)	Tagus	1PWR																	
	Switzerland																			
CH6	ZWILAG (6)	Aare		1,1E-01		4,4E-09	2,8E-04		6,7E-06						3,6E-06	4,7E-06	2,0E-04			
	United Kingdom																			
UK1	Berkeley	Severn	2 GCR	3,8E-03	2,1E-04												9,7E-05			
UK2	Bradwell	North Sea	2 GCR	7,6E-03	4,3E-03												3,4E-03			
UK4	Chapelcross (7)	Solway Firth	4 GCR																	
UK5a	Dungeness A	English	2 GCR	8,4E-02	6,1E-03												8,3E-03			
UK8a	Hinkley Point A	Severn	2 GCR	2,8E-02	1,0E-01												2,4E-02			
UK9a	Hunterston A	Firth of Clyde	2 CGR																	
UK11a	Sizewell A	North Sea	2 GCR	5,6E-02	8,1E-02												1,9E-01			
UK13	Trawsfynydd (8)	Trawsfynydd	2 GCR	1,4E-03	8,2E-04												3,9E-04			
UK19	Harwell	River Thames	No reactors	2,7E-03		5,3E-06	7,1E-05		5,0E-07								9,5E-06			
UK20	Winfrith	Weymouth Bay	No reactors	5,6E+00	1,2E-02	9,9E-05											2,5E-03			

3.3 Endnotes to data tables 4 to 8

Table 4

(1) The value indicated corresponds to the sum of individually assessed nuclides.

(2) For Belgium, the nuclides included are:

ß-Activity for Tihange: Sr-89, Sr-90, ß-Activity for Doel: Sr-89, Sr-90, Other radionuclides for Tihange: Na-24, Cr-51, Mn54, Co-57, Co-58, Co-60, Fe-59, Zn-65, Zr-95, Nb-95, Mo-99, Tc99m, Ru-103, Ru-106, Ag-110m, Sb-122, Te-123m, Sb-124, Sb-125, I-131, Cs-134, Cs-136, Cs-137, Ba-140, La-140, Ce-141, Ce-144, Other radionuclides for Doel: Cr-51, Mn-54, Co-57, Co-58, Co-60, Fe-59, Zn-65, Zr-95, Nb-95, Ru-103, Ru-106, Ag-110m, Te-123m, Sb-124, Sb-125, I-131, Cs-134, Cs-137, Ba-140, La-140, Ce-141, Ce-144.

(3) France explains that there is no simple relationship between the production of electricity and discharges of radioactive effluent other than tritium. This is because the amounts of effluent discharged depend on many factors: the condition of fuel cladding (first barrier), the processing carried out in the various existing plants, the operational mode of the reactor (load-following or providing basic power) and, above all, the volume of work carried out during shutdowns for refuelling.

Moreover, electricity is produced according to a programme fixed station by station at national level, and deliberate shutdowns, either during stand-by periods or for work to be carried out, are fixed by national criteria: the end of a natural cycle, arrangements for maintenance depending on the availability of teams of workers, constraints of the national grid and the demand for electricity.

It is easy to understand that a unit can operate over a calendar year and can produce a lot of power if it has been refuelled at the end of the previous year and if it is made to extend its cycle. In this case, the production of effluent will be minimised (no work is carried out). On the other hand, a unit shutdown for a long time (decennial shut-down, typically) will show an increase in the production of effluent and a decrease in the power supplied. During the next year, these two scenarios may be reversed. There is therefore good reason not to attempt a comparison of one site with another over short periods (= 10 years) as regards the quantity of radioactive effluent (other than tritium) discharged for a given amount of electrical energy produced.

In order to eliminate the variability associated with specific operating conditions of each reactor, it is more appropriate for a given year to consider the total amount of electricity generated by the French facilities in the OSPAR area. In 2011, their net electrical output was 442 millions of MWh.

(4) Data from the producers EDF.

(5) 7 German Nuclear Power Stations (Biblis A, Biblis B, Brunsbüttel, Krümmel, Neckar-Westheim 1, Phillippsburg 1 and Rodenkirchen/Unterweser) finally closed down on 6 August 2011.

(6) "Total-β" values represent an assimilation of β-emitting and γ-emitting radionuclides.

(7) Regarding the nuclear power plants, the discharge data have been estimated taking into account the 2004/2/Euratom recommendation criteria.

(8) Other radionuclides for Almaraz: Cr-51, Mn-54, Fe-55, Fe-59, Co-58, Co-60, Ni-63, Zn-65, Sr-89, Sr-90, Nb-95, Zr-95, Ru-103, Ru-106, Ag-110m, Sb-122, Sb-124, Sb-125, Te-123m, Cs-134, Cs-137, Ba-140. Other radionuclides for Trillo: Mn-54, Fe-55, Co-58, Co-60, Ni-63, Nb-95, Zr-95, Ag-110m, Te-123m, Sb-122, Sb-124, Sb-125, I-131, Cs-134, Cs-137. In both cases activities for Fe-55 and Ni-63 have been estimated from Co-60 using factors that have been obtained as a result of the analysis of annual compound samples.

(9a) The value reported corresponds to the sum of individually assessed α-emitting radionuclides.

(9b) The value reported corresponds to the sum of individually assessed β-emitting radionuclides, excluding H-3 but including the other β-emitting nuclides in the table.

(9c) The value reported corresponds to the sum of the detected radionuclides not mentioned in the table.

(10) For Ringhals unit 1 the following radionuclides were detected: Cr-51, Mn-54, Fe-59, Co-57, Co-58, Co-60, Ni-63, Zn-65, Zr-95, Nb-95, Ag-110m, Sb-124, Sr-90, Cs-137, I-131, H-3, Pu-238, Pu-239/240, Am-241, Cm-242, Cm-244.

(11) For Ringhals unit 2 the following radionuclides were detected: Cr-51, Mn-54, Co-58, Co-60, Zr-95, Nb-95, Ag-110m, Sb-124, Sb-125, Sr-89, Sr-90, Te-123m, Cs-137, H-3, Pu-238, Pu-239/240, Am-241, Cm-242, Cm-244.

(12) For Ringhals unit 3 the following radionuclides were detected:, Cr-51, Mn-54, Fe-59, Co-58, Co-60, Zr-95, Nb-95, Ag-108m, Ag-110m, Sb-124, Sb-125, Sr-89, Sr-90, Te-123m, Cs-137, H-3, Pu-238, Pu-239/240, Am-241, Cm-244.

(13) For Ringhals unit 4 the following radionuclides were detected: Cr-51, Mn-54, Fe-59, Co-57, Co-58, Co-60, Ni-63, Zr-95, Nb-95, Ag-110m, Sn-113, Sb-124, Sb-125, Sr-89, Te-123m, Cs-137, H-3, Pu-238, Pu-239/240, Am-241, Cm-242, Cm-244.

Table 5

(1) Discharges of the Centre de Stockage de la Manche (low and intermediate level waste disposal site) are included in the La Hague discharges.

(2) The values of the liquid discharge limits for tritium and iodine-129 vary depending on the annual mass throughput of uranium in THORP (Thermal Oxide Reprocessing Plant), at Sellafield which was 613 tonnes in 2002.

(3) Discharges from Calder Hall Nuclear Power Station are included in the discharges from Sellafield.

Table 7

(1) The installed capacity is the maximum value. The reactors function in a discontinuous way, often at a fraction of their maximum.

(2) Delft site refers to Research reactor of Technical University Delft and different laboratories.

(3) The data represent the total emissions/discharges from the Reactor Institute Delft (RID) complex, including the Research Reactor (HOR) and different laboratories (it is not possible to make a distinction between the various sources). The discharges from the RID-HOR are substantially lower than the total values reported.

(4) "Total-β" value represents all β-emitting nuclides, including tritium.

(5) The data represent the total emissions/discharges from the Petten complex. This will lead to an overestimate of the discharges of the reactor (it is not possible to distinguish the discharges from the reactor). The LFR (“Low Flux Reactor”) is no longer in use since December 2010.

(6) Petten site refers to Research reactor of EU-JRC, the low-flux research reactor (no longer in use since December 2010), Hot Cell Laboratories, Mo Production Facilities and Decontamination and Waste Treatment of NRG.

(7) "Total-β" value represents an assimilation of β-emitting and γ-emitting radionuclides.

(8) Some radionuclides reported to be discharged in small amounts by IFE are not included as specific nuclides in the spreadsheet.

From IFE Kjeller, these radionuclides are: Na-22, Ba-133, U-234, U-235, U-238 and Cm-244

From IFE Halden, these radionuclides are: Ru-103, Ru-106, Fe-59, I-130, I-132, I-133, I-134, I-135 and Zn-65

All these have been included in the total-β or total-α.

(9) Annual discharge data of gaseous effluents are also available.

(10) Figure for Total-β does not include tritium.

Table 8

(1) The value indicated corresponds to the sum of individually assessed nuclides.

(2) Additionally reporting required at discharges of H-3 above 2 TBq in one month.

Additionally reporting required at discharges of Gross-β above 0,3E-03 TBq in one month.

(3) All three Danish research reactors have been taken out of operation and the process of decommissioning has started. As a consequence the discharge limits and the reporting obligations set in the Operational limits and Conditions have been revised. The annual discharges reported are now exclusively from the Waste Management Plant.

(4) France informs that the column entitled "other radionuclides" corresponds to the sum of individual radionuclides measured by gamma spectrometry. It includes mainly: Mn-54, Co-58, Co-60, Ag-110m, Te-123m, Sb-124, Sb-125, I-131, Cs-134, Cs-137. It does not take into account pure β-emitters (C-14, Ni-63) owing to the fact that their measurement was initiated in 2002 and has not been implemented yet in all French nuclear power plants.

(5) There were no discharges from José Cabrera.

(6) A central interim storage facility including a waste treatment plant (ZWILAG) was put in operation in Switzerland. First year of reporting of discharges from this facility is 2005. Since 2010 only operational waste from the nuclear power stations and the research and development facility Paul Scherrer Institute is treated.

(7) Hunterston A gross-α and β-activity excluding tritium. This value includes Pu-241 discharge limit 1 TBq, discharged 6,3E-05 TBq.

(8) Trawsfynydd shut down in 1993, reactors decommissioned.

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OSPAR COMMISSION

Victoria House
37-63 Southampton Row
London WC1B 4DA
United Kingdom

t: +44 (0)20 7430 5200
f: +44 (0)20 7242 3737
e: secretariat@ospar.org
www.ospar.org

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