OSPAR
COMMISSION

Protecting and conserving the
North-East Atlantic and its resources

Liquid discharges from nuclear installations, 2013

Radioactive Substances Series

2015

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, Ms Inge Krol, Germany and Mr Andy Mayall (United Kingdom) with the support of Ms Luisa Rodriguez Lucas and Miss Lucy Ritchie 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 – 2013. The discharges of tritium peaked in 2004.

This annual report includes the data of 2013 on liquid radioactive discharges from nuclear installations and temporal trends for the period 1990 - 2013. 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 23-year period. Discharges are at the lowest reported level since 1990, accounting for less than 7% of the peak value in 1993. In 2013, there was a 7% decrease compared to 2012 in alpha discharges from the fuel reprocessing subsector at Sellafield. Discharges at La Hague plant were similar to those reported in 2012. Total alpha discharges arising from decommissioning are insignificant.

In 2013 total discharges of tritium increased around 15% relative to 2012. The total discharges of tritium were the highest since 2006. However, such trends were related to reprocessing throughput and could rise or fall in the future. La Hague contributed 74% of the total tritium discharges and Sellafield saw a small increase compared to the previous year. Discharges of tritium from nuclear power stations contributed around 19% of the total tritium discharge. Tritium discharges arising from decommissioning 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 at Sellafield which contributed approximately 42% of the overall discharges. Discharges of Tc-99 discharges from Sellafield increased by 15% in 2013 compared with 2012 figures. 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 2013. Les rejets de tritium ont atteint leur maximum en 2004.

Le présent rapport annuel comporte les données de 2013 sur les rejets radioactifs liquides provenant des installations nucléaires et les tendances temporelles pour la période de 1990 à 2013. 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 trois dernières années. Les rejets sont au niveau le plus bas niveau enregistré depuis 1990, réprésentant moins de 7 %du maximum enregistré en 1993. Par rapport à 2012, on note en 2013 une baisse de 7 % des rejets d’activité alpha des usines de retraitement de combustible nucléaire à Sellafield. Les rejets de la Hague étaient similaires à ceux rapportés en 2012. Les rejets de total alpha provenant du déclassement sont négligeables.

En 2013, le total des rejets de tritium a augmenté de 15% par rapport à 2012. Les rejets totaux de tritium étaient les plus élevés depuis 2006. Toutefois, ces tendances sont liées au débit des usines de retraitement, et pourraient augmenter ou diminuer à l'avenir. La Hague a contribué 74 % de l'ensemble des rejets du tritium tandis qu'à Sellafield une légère augmentation s'est avérée. Les rejets du tritium des centrales nucléaires ont contribué environ 19 % des rejets totaux de tritium alors que les rejets 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 à Sellafield, contribuant environ 42 % de l'ensemble des rejets. En 2013, on relève une augmentation de 15 % des rejets de Tc-99 de Sellafield par rapport à 2012. 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 1998, 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 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, but from 1991 onwards they have been published in the form of Annual OSPAR Reports on Liquid Discharges from Nuclear Installations in the OSPAR Maritime Area. Since 1998, the annual reports have also contained an assessment of liquid discharges which includes 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 Collection of Data on Liquid Discharges from Nuclear Installations, which were updated in 2010 to include a guide to generate “total-α” and “total-β” discharge data. There was a further update of the set of reporting formats in 2013 (OSPAR Agreement number: 2013-10).

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[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).

RSC decided at its 2006 meeting 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. Typically, 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 2013

2.1 Introduction

Tables 1 to 3 (below) summarise liquid radioactive discharges from nuclear installations for the period 1990 – 2013 (data for 1990–2013 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, and research and development facilities. Since 2006, discharges from decommissioning are reported separately for some sites. Furthermore in 2014 the Contracting Parties agreed to apply the definitions for 'operational' and 'historical and legacy waste' adopted at RSC 2013 and these definitions were included in the guidance to the revised reporting formats for discharges made in 2013. Such differentiation will be particularly important where the magnitude of discharges associated with the recovery of historical and legacy wastes during decommissioning is clearly evident and it is expected to become more prominent in the future.

For each type of nuclear installation, Table 1 gives discharges of total alpha activity, Table 2 gives tritium discharges and Table 3 gives discharges of 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) discharges for the period 1990 to 2013.

2.2 Trends in total alpha discharges [5]

Figure 1 shows the total alpha activity discharged from 1990 to 2013. The total discharges from all nuclear installations in 2013 were 0.2 TBq which is similar to 2012. The discharges of alpha activity in 2013 are about 7% of the peak value in 1993.

Fuel reprocessing sub-sector - in 2013 the total alpha discharges from this sub-sector were 0.15 TBq, a small decrease from 0.16 TBq in 2012. Discharges from Sellafield were 0.13 TBq which is down by about 7% relative to 2012. Discharges from the La Hague plant in 2013 are reported to contribute 0.019 TBq to the overall total alpha discharge, which is similar to 2012. The total alpha discharges from La Hague plant were fairly constant in the period 2005 to 2011 except in 2009 which appeared an unusual year of low discharges. The variations reflect mainly fuel throughput, burn up and decay. This sub-sector contributes about 74% of the overall total alpha discharges in 2013.

The discharges from the fuel fabrication sub-sector were similar to 2012. Most of the discharges of total alpha from this sub-sector are due to the discharges from the Springfields site which during 2013 was 0.016 TBq, about 33 % lower than in 2012. This sub-sector accounted for 8% of the overall total alpha discharges in 2013.

Discharges from research and development facilities decreased in 2013 relative to the previous year. The discharges for 2013 were 57 MBq in total, a 36% drop. This sub-sector does not contribute significantly to the overall total (about 0.03 %).

Total alpha discharges arising from decommissioning have been recorded separately since 2006. In 2013 the discharges from this sub-sector were 0.03 TBq, reported as discharges associated with the management of historical or legacy waste.

2.3 Trends in tritium discharges

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[5] Discharge data have been rounded to two significant figures in this assessment report

Figure 2 presents the discharges of tritium. The total discharges of tritium increased to about 18,000 TBq in 2013, an increase of about 15% relative to 2012. The discharge amount in 2013 was the highest since 2006. The sum of the tritium discharges from all installations increased from around 8000 TBq/y during the period 1990 - 1992 to a peak of almost 21,000 TBq in 2004. This increase was mainly due to the discharges from La Hague which grew to 14,000 TBq in 2004. Since 2004 the discharges from La Hague have been lower and have fluctuated as tritium discharges tend to follow trends in reprocessing throughput. The reprocessing plant at La Hague contributed 74% of the total tritium discharge from all sectors in 2013.

The tritium discharges from Sellafield declined over the four-year period 2004-2007 to a low point of 630TBq in 2007. Since 2007 the discharges have fluctuated and rose to 2100 TBq by 2011. In 2012 the discharge from Sellafield was 1100 TBq, a decrease of about 1000 TBq (49%) relative to the previous year. In 2013 the discharges from Sellafield were 1400 TBq, an increase of 300 TBq relative to the previous year.

During 2013 nuclear power stations contributed about 19% of the total tritium discharges from the nuclear sector, which is similar to 2012. The discharges of tritium from this sub-sector increased by 34% in 2009 to 2900 TBq, ending a 6-year downward trend. In 2010, however, the discharges from the nuclear power sub-sector decreased again to 2500 TBq in 2011. In 2012, the discharges increased again to 3200 TBq, an increase of about 27%. Of the total discharges from nuclear power stations in 2013 the UK AGRs contributed about 54% (1800 TBq). This is an increase in the relative amount of the total discharges from this sub-sector of 5% and in the discharges of about 240 TBq relative to the previous year. The PWRs in France contributed about 25% (860 TBq), this is a decrease of 3% in the relative amount, and the discharges in 2013 were 13 TBq lower than in 2012. 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 in 2013 was 3.8 TBq. This is about the same level as in 2012 and is a minor contribution to the total discharges of tritium from the nuclear sector.

Tritium discharges arising from decommissioning have been recorded separately since 2006, and though they are a relative small contributor they are quite variable. Discharges in 2013 were 28 TBq, which is on the same level as in 2012.

2.4 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 2013 the discharges of the total beta was about 16 TBq, which is a decrease of 4 TBq (20 %) relative to the previous year. Historically, total beta discharges have been dominated by discharges from the reprocessing plant at Sellafield and the nuclear fuel fabrication plant at Springfields. In 2013, however, the discharges from La Hauge were a little higher than from Springfields and the top three 2013 contributions were: Sellafield 42 %, La Hague 19 % and Springfields 17 %. The discharges from all three of these facilities decreased relative to the previous year. Reprocessing contributed approximately 62% of the overall discharges in 2013, which is the same as the previous year.

Prior to 2002 the total beta discharges from Sellafield (2001, 120 TBq) 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 markedly since 2001 and since 2007 the yearly discharges have been below 5 TBq. In 2013 the discharge of technetium-99 from Sellafield was 1.1 TBq, an increase of 0.14 TBq (15 %) relative to the previous year. 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, 100 TBq; 2006, 21 TBq; 2007, 3 TBq). However, in 2008 the total beta discharges from Springfields rose by 53% to 4.6 TBq. During the period 2008-2012 discharges have fluctuated between 3.3 and 5 TBq and in 2013 it fell to 2.7 TBq. These numbers clearly highlight the variability of these much reduced discharges.

Table 1. Total alpha discharges 1990-2013

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
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	0,19	0,20
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	0,16	0,15
% 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	88,12	85,89	84,90	85,82	74,40
Nuclear Power Plants (TBq)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0,00	0,00
% 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	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	9,78	11,59	13,34	12,72	8,18
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	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	0,04	0,03	0,05	0,05	0,03
Decommissioning (TBq)																	0,00	0,00	0,01	0,00	0,00	0,00	0,00	0,03
% of all installations																	0,2	0,31	3,65	2,07	2,48	1,71	1,23	17,39

Table 2. Tritium discharges 1990-2013

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
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	15856	18219
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	12650	14800
% 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	79,8	79,8
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	3174	3387
% 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	20,0	18,6
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	3,89	3,8327
% 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	0,0	0,0
Decommissioning (TBq)																	16,90	25,07	11,18	1,90	0,81	6,03	27,57	28,10
% of all installations																	0,1	0,16	0,10	0,0	0,0	0,0	0,2	0,2

Table 3. Total beta (excl tritium) discharges 1990-2013

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
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	20,12	16,18
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	12,30	9,89
% 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	61,1	61,11
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	2,74	0,14
% 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	13,6	0,88
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	5	2,71
% 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	22,6	16,75
Reserch 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	0,00	0,00
% 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	0,0	0,00
Decommissioning (TBq)																	0,40	0,04	0,38	0,80	0,59	0,59	0,54	0,32
% of all installations																	0,0	0,1	1,4	3,0	2,6	2,3	2,7	2,00

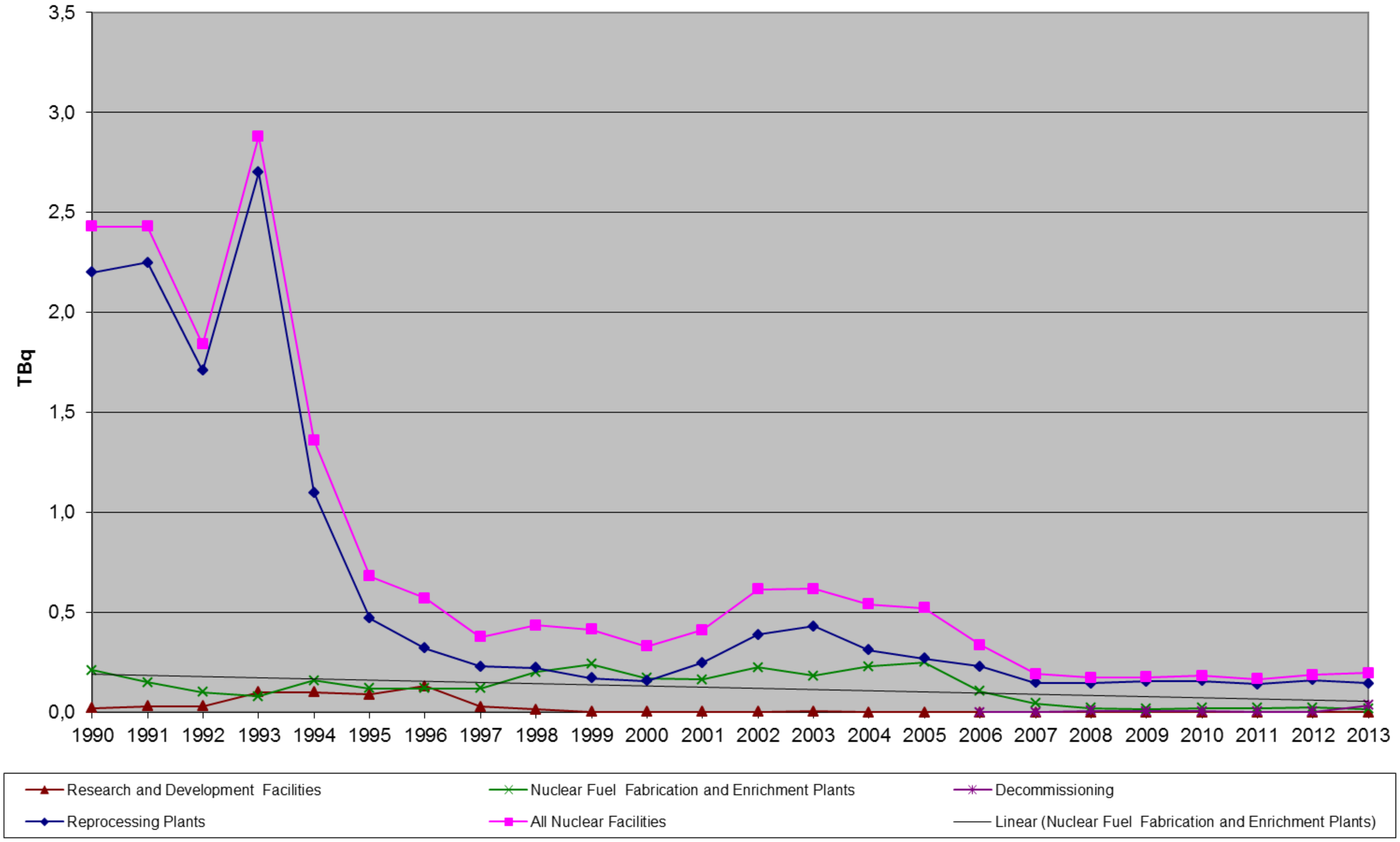


Figure 1. Total alpha activity discharge 1990 - 2013

Figure 2. Discharge of tritium 1990 – 2013

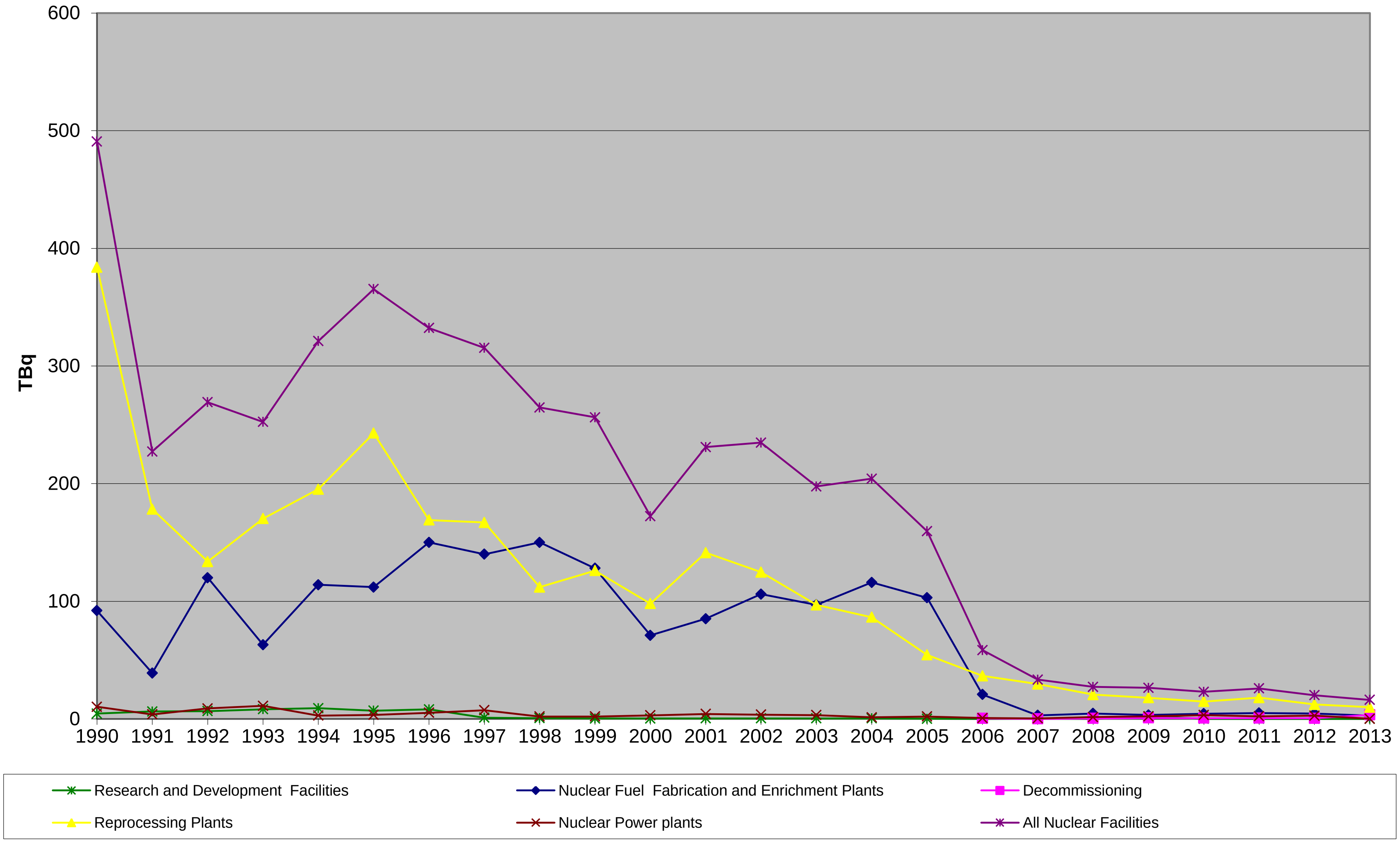


Figure 3. Total beta discharge 1990 - 2013

3. 2013 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. 2013/10). 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.

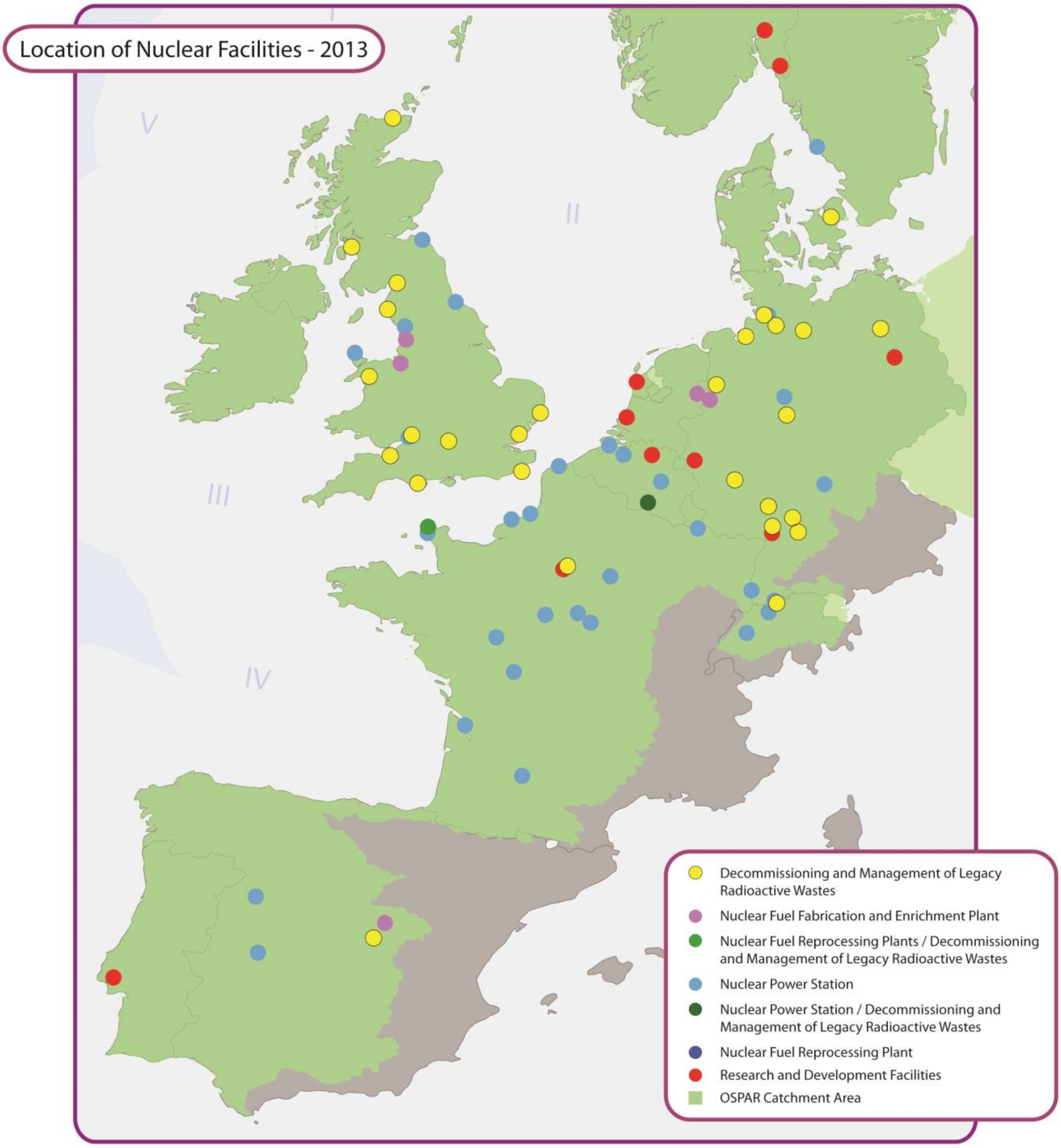
For radionuclides:

Ag: Silver
Am: Americium
Ba: Barium
Be: Beryllium
C: Carbon
Ce: Cerium
Cm: Curium
Co: Cobalt
Cr: Chromium
Cs: Caesium
Eu: Europium
Fe: Iron
Gd: Gadolinium
I: Iodine
Mn: Manganese
Na: Sodium
Nb: Niobium
Ni: Nickel
Np: Neptunium
Pm: Promethium
Pr: Praseodymium
Pu: Plutonium
Ra: Radium
Rb: Rubidium
Rh: Rhodium
Ru: Ruthenium
S: Sulphur
Sb: Antimony
Se: Selenium
Sr: Strontium
Tc: Technetium
Th: Thorium
U: Uranium
Y: Yttrium
Zn: Zinc
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
FR3	Cattenom	NPS	Mosel
FR4	Chinon	NPS	Loire
FR5	Chooz	NPS/ DMLRW	Meuse
FR6	Dampierre en-Burly	NPS	Loire
FR7	Fessenheim	NPS	Rhine
FR8	Flamanville	NPS	Channel
FR9	Golfech	NPS	Garonne
FR10	Gravelines	NPS	North Sea
FR11	Nogent-sur-Seine	NPS	Seine
FR12	Paluel	NPS	Channel
FR13	Penly	NPS	Channel
FR14	Saint Laurent	NPS	Loire
FR15	La Hague	NFRP/ DMLRW	English Channel
FR16	Civaux	NPS	Vienne
FR17	Fontenay-aux-Roses	DMLRW	Seine
FR18	Le Blayais	NPS	Gironde Estuary
FR19	Saclay	RDF	Etang de Saclay
Germany			
DE1a	Biblis A	DMLRW	Rhine – Shut down
DE1b	Biblis B	DMLRW	Rhine – Shut down
DE2	Brokdorf	NPS	Elbe
DE3	Brunsbüttel	DMLRW	Elbe – Shut down
DE4	Grafenrheinfeld	NPS	Main
DE5	Grohnde/Emmerthal	NPS	Weser
DE8a	Krümmel/Geesthacht	DMLRW	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	DMLRW	Neckar – Shut down
DE11b	Neckar-wesheim 2	NPS	Neckar
DE12	Obrigheim	DMLRW	Neckar – Shut down
DE13a	Philippsburg KKP1	DMLRW	Rhine – Shut down
DE13b	Philippsburg KKP2	NPS	Rhine
DE14	Rheinsberg	DMLRW	Havel – Shut down
DE15	Stade	DMLRW	Elbe – Shut down
DE16	Rodenkirchen-	DMLRW	Weser – Shut down

Country / Code	**Name of installation**	**Type**	**Discharging into**
	Unterweser		
DE17	Würgassen/Beverungen	DMLRW	Weser – Shut down
DE18	Karlsruhe	RDF	Rhine
DE19	Gronau	NFFEP	Vechte, IJsselmeer
DE24	HMI Berlin	RDF	Havel
DE25	Jülich	RDF	Rur
The Netherlands			
NL1	Borssele	NPS	Scheldt Estuary
NL3	Almelo	NFFEP	Municipal sewer system
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	DMLRW	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

Country / Code	Name of installation	Type	Discharging into
UK15	Sellafield	NFRP and DMLRW	Irish Sea
UK16	Capenhurst	NFFEP	Irish Sea via Rivacre Brook and Mersey Estuary
UK17	Springfields	NFFEP	Irish Sea via River Ribble
UK18	Dounreay	DMLRW	Pentland Firth
UK19	Harwell	DMLRW	River Thames
UK20	Winfrith	DMLRW	Weymouth Bay (English Channel)

NPS: Nuclear Power Stations

RDF: Research and Development Facilities

NFRP: Nuclear Fuel Reprocessing Plants

NFFEP: Nuclear Fuel Fabrication and Enrichment Plants

DMLRW: Decommissioning and Management of Legacy Radioactive Wastes

Table 4 Nuclear Power Stations (in TB/q)

Operational discharges of radioactive substances 2013

Specific radionuclides

Location Ref	Site	Discharges to	Reactors Number and Type	Installed Capacity	Net Electrical Outpu	Calculated Total-a	Calculated Total-b	Tritium	other radio nuclides	total a-activity	total b-activity (ex.Tritium)	Co58	Co60	Zn65	Sr90	Zr/Nb95	Ru106	Ag110m	Sb125	Cs134	Cs137	Ce144	S35	Notes
BE01	Doel	Schelde	4 PWR	2911	2E+07	6,50E-06	3,48E-03	3,66E+01	5,24E-04	6,50E-06	2,44E-04	1,11E-04	2,88E-04	2,84E-05	2,10E-06	6,74E-05	1,23E-04	1,06E-04	4,05E-04	3,63E-05	1,46E-03	8,22E-05		(2)
BE02	Tihange	Meuse	1PWR	962	7E+06	4,25E-07	5,90E-04	4,79E-01	8,50E-05	4,25E-07	6,82E-05	4,71E-05	7,60E-05	1,94E-05	1,74E-06	6,90E-06	2,18E-05	1,41E-04	1,10E-05	8,61E-06	8,72E-05	1,59E-05		(2)
BE02	Tihange	Meuse	1PWR	1008	5E+06	6,53E-07	5,12E-03	2,30E+01	9,96E-04	6,53E-07	1,46E-03	1,93E-04	1,74E-03	2,03E-05	5,27E-06	2,38E-05	6,38E-05	2,19E-04	8,36E-05	3,09E-05	2,64E-04	2,24E-05		(2)
BE02	Tihange	Meuse	1PWR	1045,8	8E+06	9,45E-07	3,51E-03	1,90E+01	2,29E-04	9,45E-07	1,11E-03	1,30E-04	1,31E-03	2,00E-05	7,61E-06	5,06E-05	5,76E-05	9,18E-05	4,11E-05	5,95E-05	3,81E-04	2,26E-05		(2)
CH01	Beznau	Aare	2 PWR	365/365	6E+06	1,60E-07	3,90E-04	8,60E+00	3,90E-04	1,60E-07	3,90E-04	1,10E-05	6,10E-05	1,20E-07	5,40E-07	1,50E-07		7,10E-06	5,80E-05	6,30E-06	1,10E-04	4,70E-07		(15)
CH02	Gösgen	Aare	1PWR	985	6E+06	1,30E-07	4,30E-06	1,80E+01	4,30E-06	1,30E-07	4,30E-06		9,80E-07											(15)
CH03	Leibstadt	Rhine	1BWR	1220	1E+07	4,20E-07	6,10E-05	1,40E+00	6,10E-05	4,20E-07	6,10E-05	1,30E-06	4,40E-05	6,10E-06					1,10E-06		9,70E-07			(15)
CH04	Mühleberg	Aare	1BWR	373	3E+06	2,60E-08	2,70E-03	1,70E-01	2,70E-03	2,60E-08	2,70E-03	5,00E-04	1,50E-03	6,80E-05	5,60E-07	8,80E-07		6,60E-07	4,00E-06		9,70E-06			(15)
CH06	ZWILAG	Aare				2,60E-09	3,70E-04	1,80E-03	3,70E-04	2,60E-09	3,70E-04		9,90E-06				5,50E-06		5,00E-06	3,70E-06	3,40E-04			(16)
DE11a	Neckar-Westheim 1	Neckar	1PWR	840	0	0,00E+00		9,60E-02																(5)
DE11b	Neckar-Westheim 2	Neckar	1PWR	1400	1E+07	0,00E+00		2,10E+01																
DE13a	Philippsburg 1	Rhine	1BWR	926	0	0,00E+00	3,34E-05	7,17E-03	3,34E-05			3,64E-07	1,08E-05	5,21E-06				7,90E-07		1,12E-06	5,15E-06			(5)
DE13b	Philippsburg 2	Rhine	1PWR	1468	9E+06	0,00E+00	2,39E-05	1,15E+01	2,39E-05			2,15E-06	6,77E-06			5,90E-08		5,96E-07		1,09E-06	4,89E-06			
DE16	weser	Weser	1PWR	1410	0	0,00E+00	3,37E-05	3,52E+00	3,37E-05				1,38E-05						1,41E-05		5,67E-07			(5)
DE1a	Biblis A	Rhine	1PWR	1225	0	0,00E+00	1,58E-05	2,23E+00	1,58E-05				9,28E-06						5,83E-06		4,02E-07			(5)
DE1b	Biblis B	Rhine	1PWR	1300	0	0,00E+00	3,28E-06	1,92E+00	3,28E-06				7,75E-07						2,37E-06		4,34E-08			(5)
DE2	Brokdorf	Elbe	1PWR	1480	1E+07	0,00E+00	3,08E-07	2,29E+01	3,08E-07															
DE3	Brunsbüttel	Elbe	1BWR	806	0	0,00E+00	1,60E-05	2,41E-03	1,60E-05				5,95E-06		3,21E-08						4,54E-06			(5)
DE4	Grafenrheinfeld	Main	1PWR	1345	1E+07	0,00E+00	1,32E-05	1,63E+01	1,32E-05			4,36E-08	1,28E-05			2,30E-07								
DE5	Grohnde/Emmerthal	Weser	1PWR	1430	1E+07	0,00E+00	2,11E-06	1,94E+01	2,11E-06				1,02E-06											
DE8a	Krümmel/Geesthacht	Elbe	1BWR	1402	0	0,00E+00		3,35E-04																(5)
DE9a	Lingen/Emsland	Ems	1PWR	1400	1E+07	0,00E+00		1,57E+01																
ES01	Almaraz	Tagus	2 PWR	2093,88	2E+07	0,00E+00	5,67E-03	4,45E+01	5,67E-03	ND		6,83E-04	8,41E-04	2,40E-05	7,40E-06	3,29E-04	1,14E-04	2,14E-04	1,47E-04	8,31E-04	7,34E-04	ND		(7)(8)(9)
ES03	Trillo	Tagus	1PWR	1066	7E+06	0,00E+00	2,59E-04	1,82E+01	2,59E-04	ND		7,04E-06	6,53E-05	ND	ND	9,37E-06	ND	7,44E-06	5,38E-06	3,12E-06	1,10E-05	ND		(7)(8)(9)
FR01	Belleville	Loire	2 PWR	2600		0,00E+00	4,26E-04	5,91E+01	4,26E-04			1,20E-04	8,40E-05					3,50E-05	4,80E-05	3,10E-05	4,10E-05			(3)(4)
FR03	Cattenom	Mosel	4 PWR	5200		0,00E+00	9,51E-04	1,11E+02	9,51E-04			1,36E-04	4,83E-04					8,90E-05	6,20E-05	2,10E-05	3,80E-05			(3)(4)
FR04	Chinon	Loire	4 PWR	3600		0,00E+00	5,81E-04	4,49E+01	5,81E-04			2,26E-04	1,31E-04					7,60E-05	4,30E-05	1,50E-05	1,90E-05			(3)(4)
FR05	Chooz	Meuse	2 PWR	2900		0,00E+00	2,98E-04	6,38E+01	2,98E-04			7,20E-05	5,90E-05					5,50E-05	2,60E-05	1,30E-05	1,50E-05			(3)(4)
FR06	Dampierre-en-Burly	Loire	4 PWR	2900		0,00E+00	1,41E-04	5,34E+01	1,41E-04			4,00E-06	5,20E-05					2,10E-05	1,20E-05	7,00E-06	9,00E-06			(3)(4)
FR07	Fessenheim	Rhine	2 PWR	3600		0,00E+00	7,29E-04	5,00E+01	7,29E-04			1,16E-04	2,68E-04					8,40E-05	4,90E-05	2,30E-05	3,80E-05			(3)(4)
FR08	Flamanville	North Sea (Channel)	2 PWR	1800		0,00E+00	3,27E-04	1,42E+01	3,27E-04			1,20E-04	3,10E-05					8,20E-05	2,00E-05	5,00E-06	6,00E-06			(3)(4)
FR09	Golfech	Garonne	2 PWR	2600		0,00E+00	5,13E-04	4,90E+01	5,13E-04			2,57E-04	1,20E-04					1,40E-05	3,20E-05	1,00E-05	1,10E-05			(3)(4)
FR10	Gravelines	North Sea	6 PWR	2600		0,00E+00	1,44E-04	6,93E+01	1,44E-04			3,00E-05	2,10E-05					9,00E-06	2,60E-05	8,00E-06	1,00E-05			(3)(4)
FR11	Nogent-sur-Seine	Seine	2 PWR	5400		0,00E+00	4,61E-03	6,08E+01	4,61E-03			7,08E-04	2,11E-03					8,89E-04	2,00E-04	5,10E-05	9,00E-05			(3)(4)
FR12	Paluel	North Sea (Channel)	4 PWR	3600		0,00E+00	5,37E-04	4,47E+01	5,37E-04			1,65E-04	9,10E-05					1,55E-04	3,40E-05	1,40E-05	1,70E-05			(3)(4)
FR13	Penly	North Sea (Channel)	2 PWR	2600		0,00E+00	5,32E-04	5,90E+01	5,32E-04			1,43E-04	1,28E-04					7,20E-05	4,70E-05	1,60E-05	2,00E-05			(3)(4)
FR14	Saint Laurent	Loire	2 PWR	5200		0,00E+00	1,13E-03	1,04E+02	1,13E-03			4,41E-04	3,36E-04					2,50E-05	1,70E-04	1,30E-05	3,70E-05			(3)(4)
FR16	Civaux	Vienne	2 PWR	2600		0,00E+00	7,84E-04	5,90E+01	7,84E-04			1,47E-04	3,96E-04					2,60E-05	1,11E-04	8,00E-06	3,00E-05			(3)(4)
FR18	Le Blayais	Gironde Estuary	4 PWR	1800		0,00E+00	1,35E-04	1,47E+01	1,35E-04			1,30E-05	4,30E-05					9,00E-06	1,80E-05	2,00E-05	9,00E-06			(3)(4)
NL01	Borssele	Scheldt Estuary	1PWR	520	3E+06	0,00E+00	0,00E+00	6,78E+00		ND	1,74E-04	1,04E-06	3,11E-05	ND	ND	1,10E-05	ND	5,45E-06	ND	ND	6,20E-06	ND	NI	(6)
SE02	Ringhals 1- 4	Kattegat	1BWR	865	6E+06	4,69E-07	4,26E-04	4,20E-01	1,10E-04	4,69E-07	4,26E-04	5,50E-05	2,00E-04	ND	5,60E-06	2,74E-06	ND	2,60E-05	ND	ND	2,60E-05	ND	ND	10c)(11)
SE02	Ringhals 1-4	Kattegat	1PWR	865	7E+06	1,10E-07	6,08E-05	9,90E+00	3,84E-05	1,10E-07	6,08E-05	1,10E-06	8,10E-06	ND	1,10E-06	6,40E-07	ND	8,10E-06	4,70E-07	ND	1,70E-06	ND	ND	10c)(12)
SE02	Ringhals 1- 4	Kattegat	1PWR	1047	7E+06	8,28E-08	2,84E-04	2,10E+01	8,94E-05	8,28E-08	2,84E-04	8,00E-05	1,80E-05	ND	ND	7,80E-06	ND	5,30E-05	1,80E-05	ND	1,20E-06	ND	ND	10c)(13)
SE02	Ringhals 1-4	Kattegat	1PWR	940	8E+06	6,57E-08	3,60E-04	9,80E+00	9,45E-05	6,57E-08	3,60E-04	2,50E-04	9,50E-06	ND	ND	1,52E-06	ND	1,80E-06	3,70E-07	ND	3,30E-07	ND	ND	10c)(14)
UK05b	Dungeness B	English Channel	2 AGR			0,00E+00	1,86E-01	2,10E+02	3,99E-03				4,93E-04								3,32E-03		1,78E-01	
UK06	Hartlepool	North Sea	2 AGR			0,00E+00	1,49E+00	3,22E+02	6,71E-04				1,61E-04								1,52E-03		1,49E+00	
UK07a	Heysham 1	Morecambe Bay	2 AGR			0,00E+00	4,45E-01	3,33E+02	6,17E-03				2,33E-04								4,49E-03		4,34E-01	
UK07b	Heysham 2	Morecambe Bay	2 AGR			0,00E+00	4,81E-02	3,63E+02	1,19E-02				9,81E-05								2,70E-03		3,34E-02	
UK08b	Hinkley Point B	Severn Estuary	2 AGR			0,00E+00	4,29E-01	2,51E+02	3,40E-03				1,17E-04								1,32E-03		4,24E-01	
UK09b	Hunterston B	Firth of Clyde	2 AGR				9,21E-01	3,15E+02	8,75E-05	2.88E-5			4,60E-04										9,20E-01	
UK10	Oldbury	Severn Estuary	2 GCR			0,00E+00	1,91E-01	1,23E-01	8,04E-02												1,11E-01			
UK11b	Sizewell B	North Sea	1PWR			0,00E+00	1,30E-02	4,11E+01	1,20E-02												1,00E-03			
UK12	Torness	North Sea	2 AGR			3,51E-06	8,75E-01	3,61E+02	2,56E-03	3,51E-06			1,14E-04										8,72E-01	
UK14	Wylfa	Irish Sea	2 GCR			0,00E+00	3,59E-03	2,11E+00	3,59E-03															

Table 5: Nuclear Fuel Reprocessing Plants

Location Reference	FR15	FR15	UK15
Year	2013	2013	2013
Site	La Hague	La Hague	Sellafield
Discharges to	English Channel	English Channel	Irish Sea
Type of fuel reprocessed	PWR, BWR		Magnox, AGR, LWR
Capacity (t/y)	1699 t/y		
Tritium	1,34E+04		1,35E+3
Total-a	1,85E-02	3,89E-04	1,27E-1
Total-b	2,99E+00	6,29E-02	6,84E+0
C14	8,58E+00		5,49E+0
S35			
Mn54	3,17E-03		
Fe55			
Co57	1,10E-04		
Co58	1,64E-03		
Co60	7,56E-02		4,64E-2
Ni63	2,16E-02		
Zn65	ND		
Sr89	ND		
Sr90	2,28E-01		4,94E-1
(Sr90 + Cs137)			
(Zr + Nb95)	ND		9,00E-2
Tc99	7,73E-02		1,06E+0
Ru103			
Ru106	1,22E+00		5,70E-1
(Ru + Rh) 106	2,44E+00		
Ag110m			
Sb124			
Sb125	1,16E+00		
I129	1,56E+00		2,87E-1
Cs134	2,57E-02		7,25E-2
Cs137	4,87E-01	2,99E+00	2,57E+0
Ce144	1,09E-05		1,88E-1
(Ce + Pr) 144	2,18E-05		
Pm147			
Eu152			
Eu154	2,78E-04		
Eu155	2,39E-05		
Np237	8,46E-05		3,38E-2
Pu239+240	1,39E-03		1,19E-1
Pu241	1,30E-01		2,12E+0
Am241	1,50E-03		1,66E-2
Cm242	6,48E-06		
Cm 243+244	1,07E-03		1,76E-3
Uranium (kg)	1,78E+01		
Notes	(1)		**-2**

Table 6 Nuclear Fuel Fabrication and Enrichment Plants (operational discharges) (in TBq/y) (2013 Data)

Location Ref	Year	Site	Discharges to	Type of Fuel	Capacity (t/y)	Production	Calculated Total-a	Calculated Total-b	Activity	TBq released	Notes
DE19	2013	Gronau	Vechte, IJsselmeer	Uranium enrichment					Total-a		
ES04	2013	Juzbado	River Tormes - Duero	PWR, BWR	400	3,99E+02	1,50E-05		Total-a	1,50E-05	
NL03	2013	Urenco, Almelo	Municipal sewer system	Uranium enrichment	6200	5,43E+03	7,00E-07		Total-a	7,00E-07	
NL03	2013	Urenco, Almelo	Municipal sewer system	Uranium enrichment	6200	5,43E+03		4,10E-06	Total-b (b- & g- emitting rn)	4,10E-06	
UK16	2013	Capenhurst	Irish Sea via Rivacre Brook and Mersey Estuary	Uranium enrichment			1,83E-05		Uranium-a	2,92E-06	
UK16	2013	Capenhurst	Irish Sea via Rivacre Brook and Mersey Estuary	Uranium enrichment					Uranium daughters	4,82E-06	
UK16	2013	Capenhurst	Irish Sea via Rivacre Brook and Mersey Estuary	Uranium enrichment					Other-a	1,06E-05	
UK16	2013	Capenhurst	Irish Sea via Rivacre Brook and Mersey Estuary	Uranium enrichment				1,18E-06	Tc99	1,18E-06	
UK16	2013	Capenhurst	Irish Sea via Rivacre Brook and Mersey Estuary	Uranium enrichment					Tritium	Nil	
UK17	2013	Springfields	Irish Sea via River Ribble	GCR, AGR, PWR fuel fabrication			1,60E-02		Total-a	1,60E-02	
UK17	2013	Springfields	Irish Sea via River Ribble	GCR, AGR, PWR fuel fabrication				2,71E+00	Total-b	2,71E+00	
UK17	2013	Springfields	Irish Sea via River Ribble	GCR, AGR, PWR fuel fabrication					Tc99	5,61E-02	
UK17	2013	Springfields	Irish Sea via River Ribble	GCR, AGR, PWR fuel fabrication					Th230	1,90E-03	
UK17	2013	Springfields	Irish Sea via River Ribble	GCR, AGR, PWR fuel fabrication					Th232	1,60E-04	
UK17	2013	Springfields	Irish Sea via River Ribble	GCR, AGR, PWR fuel fabrication					Uranium-a	1,00E-02	
UK17	2013	Springfields	Irish Sea via River Ribble	GCR, AGR, PWR fuel fabrication					Np237	3,11E-03	

Table 7 Research and Development Facilities (in TB/q)

Location	Site	Discharges to	Reactors Number and Type	Installed Capacity	Calculated Total-a	Calculated Total-b	Radionuclides	TBq released per annum	Notes
BE03	Mol	River Mol-Neet	2 research reactors		5,43E-06		Total-a	5,43E-06	(1)
BE03	Mol	River Mol-Neet	2 research reactors			1,87E-04	Total-b	1,29E-04	
BE03	Mol	River Mol-Neet	2 research reactors				H3	1,84E+00	
BE03	Mol	River Mol-Neet	2 research reactors				Sr90/Y90	1,27E-05	
BE03	Mol	River Mol-Neet	2 research reactors				Co60	1,31E-05	
BE03	Mol	River Mol-Neet	2 research reactors				Cs134	7,60E-06	
BE03	Mol	River Mol-Neet	2 research reactors				Cs137	2,46E-05	
BE03	Mol	River Mol-Neet	2 research reactors				Total activitiy	1,84E+00	
CH05	Paul Scherrer	Aare					Tritium	8,00E-02	
CH05	Paul Scherrer	Aare				7,62E-05	β-and γ-emitting radionuclides		
CH05	Paul Scherrer	Aare					Be7	1,40E-07	
CH05	Paul Scherrer	Aare					Na22	9,20E-08	
CH05	Paul Scherrer	Aare					Sc47	7,20E-07	
CH05	Paul Scherrer	Aare					Mn54	6,20E-08	
CH05	Paul Scherrer	Aare					Co57	2,30E-08	
CH05	Paul Scherrer	Aare					Co58	2,40E-09	
CH05	Paul Scherrer	Aare					Co60	8,00E-07	
CH05	Paul Scherrer	Aare					Sr90/Y90	1,30E-05	
CH05	Paul Scherrer	Aare					Ag110m	3,00E-08	
CH05	Paul Scherrer	Aare					In111	3,10E-08	
CH05	Paul Scherrer	Aare					Sb125	5,20E-08	
CH05	Paul Scherrer	Aare					I125	1,20E-06	
CH05	Paul Scherrer	Aare					Cs134	4,90E-08	
CH05	Paul Scherrer	Aare					Cs137	3,50E-05	
CH05	Paul Scherrer	Aare					Tb161	2,50E-06	
CH05	Paul Scherrer	Aare					Lu177	2,20E-05	
CH05	Paul Scherrer	Aare					Au195	4,40E-07	
CH05	Paul Scherrer	Aare					Bi207	2,10E-08	
CH05	Paul Scherrer	Aare			1,89E-07		a-emitting radionuclides		
CH05	Paul Scherrer	Aare					U234/238	1,40E-07	
CH05	Paul Scherrer	Aare					Pu238/Am241	2,50E-08	
CH05	Paul Scherrer	Aare					Pu239/240	2,40E-08	
DE18	Karlsruhe	Rhine	0		1,80E-06		Total a-activity	1,80E-06	
DE18	Karlsruhe	Rhine	0				Tritium	6,70E-02	
DE18	Karlsruhe	Rhine	0			2,10E-06	Other radionuclides	2,10E-06	
DE24	HMI Berlin	Havel	1		1,10E-08		Total a-activity	1,10E-08	
DE24	HMI Berlin	Havel	1				Tritium	6,30E-04	
DE24	HMI Berlin	Havel	1			1,30E-07	Other radionuclides	1,30E-07	
DE25	Jülich	Rur	1				Tritium	1,90E+00	
DE25	Jülich	Rur	1			1,40E-04	Other radionuclides	1,40E-04	
NL04	Delft	Sewage system	1 Research reactor	2 MWth			a-emitting radionuclides	ND	(2)(3)
NL04	Delft	Sewage system	1 Research reactor	2 MWth		4,27E-06	Total-b	4,27E-06	(2)(3)(4)
NL04	Delft	Sewage system	1 Research reactor	2 MWth			g-emitting radionuclides	4,30E-06	(2)(3)
NL04	Delft	Sewage system	1 Research reactor	2 MWth			Total		
NL05	Petten	North Sea	1 high flux and 1 low flux research reactor	50 MWth			Tritium		(5)(6)
NL05	Petten	North Sea	1 high flux and 1 low flux research reactor				a-emitting radionuclides		(5)(6)
NL05	Petten	North Sea	1 high flux and 1 low flux research reactor	30kWth			b/g-emitting radionuclides		(5)(6)(7)
NL05	Petten	North Sea	1 high flux and 1 low flux research reactor				Total		(5)(6)(7)
NO01	Halden	River Tista (Skage	1 BWR D2O as moderator				Tritium	8,40E-01	(8)(9)(10)
NO01	Halden	River Tista (Skage	1 BWR D2O as moderator		0,00E+00		Total-a	ND	(8)(9)(10)

Table 7 Research and Development Facilities (in TB/q)

Location	Site	Discharges to	Reactors Number and Type	Installed Capacity	Calculated Total-a	Calculated Total-b	Radionuclides	TBq released per annum	Notes
BE03	Mol	River Mol-Neet	2 research reactors		5,43E-06		Total-a	5,43E-06	(1)
BE03	Mol	River Mol-Neet	2 research reactors			1,87E-04	Total-b	1,29E-04	
BE03	Mol	River Mol-Neet	2 research reactors				H3	1,84E+00	
BE03	Mol	River Mol-Neet	2 research reactors				Sr90/Y90	1,27E-05	
BE03	Mol	River Mol-Neet	2 research reactors				Co60	1,31E-05	
BE03	Mol	River Mol-Neet	2 research reactors				Cs134	7,60E-06	
BE03	Mol	River Mol-Neet	2 research reactors				Cs137	2,46E-05	
BE03	Mol	River Mol-Neet	2 research reactors				Total activitiy	1,84E+00	
CH05	Paul Scherrer	Aare					Tritium	8,00E-02	
CH05	Paul Scherrer	Aare				7,62E-05	β-and γ-emitting radionuclides		
CH05	Paul Scherrer	Aare					Be7	1,40E-07	
CH05	Paul Scherrer	Aare					Na22	9,20E-08	
CH05	Paul Scherrer	Aare					Sc47	7,20E-07	
CH05	Paul Scherrer	Aare					Mn54	6,20E-08	
CH05	Paul Scherrer	Aare					Co57	2,30E-08	
CH05	Paul Scherrer	Aare					Co58	2,40E-09	
CH05	Paul Scherrer	Aare					Co60	8,00E-07	
CH05	Paul Scherrer	Aare					Sr90/Y90	1,30E-05	
CH05	Paul Scherrer	Aare					Ag110m	3,00E-08	
CH05	Paul Scherrer	Aare					In111	3,10E-08	
CH05	Paul Scherrer	Aare					Sb125	5,20E-08	
CH05	Paul Scherrer	Aare					I125	1,20E-06	
CH05	Paul Scherrer	Aare					Cs134	4,90E-08	
CH05	Paul Scherrer	Aare					Cs137	3,50E-05	
CH05	Paul Scherrer	Aare					Tb161	2,50E-06	
CH05	Paul Scherrer	Aare					Lu177	2,20E-05	
CH05	Paul Scherrer	Aare					Au195	4,40E-07	
CH05	Paul Scherrer	Aare					Bi207	2,10E-08	
CH05	Paul Scherrer	Aare			1,89E-07		a-emitting radionuclides		
CH05	Paul Scherrer	Aare					U234/238	1,40E-07	
CH05	Paul Scherrer	Aare					Pu238/Am241	2,50E-08	
CH05	Paul Scherrer	Aare					Pu239/240	2,40E-08	
DE18	Karlsruhe	Rhine	0		1,80E-06		Total a-activity	1,80E-06	
DE18	Karlsruhe	Rhine	0				Tritium	6,70E-02	
DE18	Karlsruhe	Rhine	0			2,10E-06	Other radionuclides	2,10E-06	
DE24	HMI Berlin	Havel	1		1,10E-08		Total a-activity	1,10E-08	
DE24	HMI Berlin	Havel	1				Tritium	6,30E-04	
DE24	HMI Berlin	Havel	1			1,30E-07	Other radionuclides	1,30E-07	
DE25	Jülich	Rur	1				Tritium	1,90E+00	
DE25	Jülich	Rur	1			1,40E-04	Other radionuclides	1,40E-04	
NL04	Delft	Sewage system	1 Research reactor	2 MWth			a-emitting radionuclides	ND	(2)(3)
NL04	Delft	Sewage system	1 Research reactor	2 MWth		4,27E-06	Total-b	4,27E-06	(2)(3)(4)
NL04	Delft	Sewage system	1 Research reactor	2 MWth			g-emitting radionuclides	4,30E-06	(2)(3)
NL04	Delft	Sewage system	1 Research reactor	2 MWth			Total		
NL05	Petten	North Sea	1 high flux and 1 low flux research reactor	50 MWth			Tritium		(5)(6)
NL05	Petten	North Sea	1 high flux and 1 low flux research reactor				a-emitting radionuclides		(5)(6)
NL05	Petten	North Sea	1 high flux and 1 low flux research reactor	30kWth			b/g-emitting radionuclides		(5)(6)(7)
NL05	Petten	North Sea	1 high flux and 1 low flux research reactor				Total		(5)(6)(7)
NO01	Halden	River Tista (Skagerrak)	1 BWR D2O as moderator				Tritium	8,40E-01	(8)(9)(10)
NO01	Halden	River Tista (Skagerrak)	1 BWR D2O as moderator		0,00E+00		Total-a	ND	(8)(9)(10)

Table 7 Research and Development Facilities (in TB/q)

Location	Site	Discharges to	Reactors Number and Type	Installed Capacity	Calculated Total-a	Calculated Total-b	Radionuclides	TBq released per annum	Notes
NO01	Halden	River Tista (Skagerrak)	1 BWR D2O as moderator			1,35E-04	Total-b	1,35E-04	(8)(9)(10)
NO01	Halden	River Tista (Skagerrak)	1 BWR D2O as moderator				Ag110m	5,00E-08	(8)(9)(10)
NO01	Halden	River Tista (Skagerrak)	1 BWR D2O as moderator				Cr51	2,90E-05	(8)(9)(10)
NO01	Halden	River Tista (Skagerrak)	1 BWR D2O as moderator				Mn54	7,10E-08	(8)(9)(10)
NO01	Halden	River Tista (Skagerrak)	1 BWR D2O as moderator				Mn56	ND	(8)(9)(10)
NO01	Halden	River Tista (Skagerrak)	1 BWR D2O as moderator				Co58	1,10E-06	(8)(9)(10)
NO01	Halden	River Tista (Skagerrak)	1 BWR D2O as moderator				Co60	1,70E-05	(8)(9)(10)
NO01	Halden	River Tista (Skagerrak)	1 BWR D2O as moderator				Sr90	6,20E-06	(8)(9)(10)
NO01	Halden	River Tista (Skagerrak)	1 BWR D2O as moderator				Zr95	8,60E-07	(8)(9)(10)
NO01	Halden	River Tista (Skagerrak)	1 BWR D2O as moderator				Nb95	1,50E-06	(8)(9)(10)
NO01	Halden	River Tista (Skagerrak)	1 BWR D2O as moderator				Sb125	ND	(8)(9)(10)
NO01	Halden	River Tista (Skagerrak)	1 BWR D2O as moderator				Cd109	ND	(8)(9)(10)
NO01	Halden	River Tista (Skagerrak)	1 BWR D2O as moderator				I131	4,10E-06	(8)(9)(10)
NO01	Halden	River Tista (Skagerrak)	1 BWR D2O as moderator				Cs134	4,60E-06	(8)(9)(10)
NO01	Halden	River Tista (Skagerrak)	1 BWR D2O as moderator				Cs137	6,70E-05	(8)(9)(10)
NO01	Halden	River Tista (Skagerrak)	1 BWR D2O as moderator				Ce141	6,20E-08	(8)(9)(10)
NO01	Halden	River Tista (Skagerrak)	1 BWR D2O as moderator				Ce144	6,10E-07	(8)(9)(10)
NO02	Kjeller	River Nitelva (Skagerrak)	1 JEEP II, heavy water and cooled research reactor				Tritium	9,33E-01	(8)(9)(10)
NO02	Kjeller	River Nitelva (Skagerrak)	1 JEEP II, heavy water and cooled research reactor		2,52E-07		Total-a	2,52E-07	(8)(9)(10)
NO02	Kjeller	River Nitelva (Skagerrak)	1 JEEP II, heavy water and cooled research reactor			7,11E-06	Total-b	7,11E-06	(8)(9)(10)
NO02	Kjeller	River Nitelva (Skagerrak)	1 JEEP II, heavy water and cooled research reactor				Co58	ND	(8)(9)(10)
NO02	Kjeller	River Nitelva (Skagerrak)	1 JEEP II, heavy water and cooled research reactor				Co60	2,26E-06	(8)(9)(10)
NO02	Kjeller	River Nitelva (Skagerrak)	1 JEEP II, heavy water and cooled research reactor				Zn65	ND	(8)(9)(10)
NO02	Kjeller	River Nitelva (Skagerrak)	1 JEEP II, heavy water and cooled research reactor				Sr90	2,83E-06	(8)(9)(10)
NO02	Kjeller	River Nitelva (Skagerrak)	1 JEEP II, heavy water and cooled research reactor				Zr/Nb95	ND	(8)(9)(10)
NO02	Kjeller	River Nitelva (Skagerrak)	1 JEEP II, heavy water and cooled research reactor				Ru103	ND	(8)(9)(10)
NO02	Kjeller	River Nitelva (Skagerrak)	1 JEEP II, heavy water and cooled research reactor				Ru106	ND	(8)(9)(10)
NO02	Kjeller	River Nitelva (Skagerrak)	1 JEEP II, heavy water and cooled research reactor				Ru/Rh106	ND	(8)(9)(10)
NO02	Kjeller	River Nitelva (Skagerrak)	1 JEEP II, heavy water and cooled research reactor				Ag110m	ND	(8)(9)(10)
NO02	Kjeller	River Nitelva (Skagerrak)	1 JEEP II, heavy water and cooled research reactor				Sb125	ND	(8)(9)(10)
NO02	Kjeller	River Nitelva (Skagerrak)	1 JEEP II, heavy water and cooled research reactor				I125	ND	(8)(9)(10)
NO02	Kjeller	River Nitelva (Skagerrak)	1 JEEP II, heavy water and cooled research reactor				I131	ND	(8)(9)(10)
NO02	Kjeller	River Nitelva (Skagerrak)	1 JEEP II, heavy water and cooled research reactor				Cs134	6,60E-08	(8)(9)(10)
NO02	Kjeller	River Nitelva (Skagerrak)	1 JEEP II, heavy water and cooled research reactor				Cs137	1,83E-06	(8)(9)(10)
NO02	Kjeller	River Nitelva (Skagerrak)	1 JEEP II, heavy water and cooled research reactor				Ce144	ND	(8)(9)(10)
NO02	Kjeller	River Nitelva (Skagerrak)	1 JEEP II, heavy water and cooled research reactor				Pu238	7,00E-10	(8)(9)(10)
NO02	Kjeller	River Nitelva (Skagerrak)	1 JEEP II, heavy water and cooled research reactor				Pu239/240	ND	(8)(9)(10)
NO02	Kjeller	River Nitelva (Skagerrak)	1 JEEP II, heavy water and cooled research reactor				Am241	2,30E-09	(8)(9)(10)
NO02	Kjeller	River Nitelva (Skagerrak)	1 JEEP II, heavy water and cooled research reactor				Pu241	NA	(8)(9)(10)
FR19	Saclay	Etang de Saclay	Centre de recherches du		4,92E-05		Total-a	4,92E-05	
FR19	Saclay	Etang de Saclay	Commissariat à l'énergie			8,54E-05	Other radionuclides	8,54E-05	
FR19	Saclay	Etang de Saclay	atomique et aux énergies alternatives				Tritium	1,21E-02	

Table 8 Discharges associated with historical or legacy wastes (exceptional discharges) (in TBq/y) (2013 Data)

Location Ref	Site	Discharges to	Facility type	Tritium	other radionuclides (1)	Calculated total-a	Calculated total-b	total a-activity	total b-activity (ex.Tritium)	C14	Na22	S35	Co58	Co60	Zn65	Sr90	Zr/Nb95	Tc99	Ru106	Ag110m	Sb125	I129	Cs134	Cs137	Ce144	Np237	Pu239/240	Pu241	Am241	Cm243/244	Notes
DE09b	Lingen	Ems	1 BWR	6,30E-05	9,48E-07	3,51E-08	9,48E-07	3,51E-08																9,28E-07							(5)
DE10	Mülheim-Kärlich	Rhine	1 PWR	2,12E-05	1,35E-06		1,35E-06							3,16E-07																	(6)
DE12	Obrigheim	Neckar	1 PWR	3,87E-04	7,96E-05	1,57E-07	7,96E-05	1,57E-07						1,12E-05										2,14E-06							(7)
DE14	Rheinsberg	Havel	1 PWR	9,80E-06	3,25E-06	9,24E-08	3,25E-06	9,24E-08					1,85E-07	9,72E-08									8,71E-07								(8)
DE15	Stade	Elbe	1 PWR	2,35E-04	2,60E-06	2,18E-09	2,60E-06	2,18E-09						9,64E-08		1,33E-09					1,66E-09			2,73E-07							(9)
DE17	Würgassen/Bever	Weser	1 BWR	4,07E-05	2,00E-08		2,00E-08							2,00E-08																	(10)
DK01	Risø	Kattegat	No reactors	6,89E-02			1,99E-04		1,99E-04																						(2)(3)
ES02	José Cabrera	Tagus	1PWR	1,55E-02	4,68E-05	1,33E-07	4,68E-05	1,33E-07					ND	1,54E-05	ND	ND	ND		ND	ND	ND		ND	1,20E-05	ND						(11)
FR ?	AMI dont CHI A	Loire	Lab + 1 UNGG	1,42E-04	1,58E-05				1,02E-05									5,62E-06													
FR05	Chooz	Meuse	1 PWR	8,94E-04	4,56E-04	0,00E+00	4,56E-04		4,55E-06					4,55E-06		3,30E-06								4,40E-04							(4)
FR15	La Hague	English Channe	PWR + BWR			2,30E-03	9,70E-01							6,19E-04		6,59E-02		5,63E-02						9,50E-02							
FR17	Fontenay-aux-Ros	Seine	No reactors	6,00E-06		1,50E-07	2,50E-06																								
UK01	Berkeley	Severn	2 GCR	1,59E-04	3,44E-05	0,00E+00	3,44E-05																	7,26E-05							
UK02	Bradwell	North Sea	2 GCR	8,30E-03	5,00E-04	0,00E+00	5,00E-04																	8,00E-04							
UK04	Chapelcross	Solway Firth	4 GCR	1,61E-03	1,52E-03	1,37E-06	0,00E+00	1,37E-06																							
UK05a	Dungeness A	English Channe	2 GCR	6,67E-02	5,43E-03	0,00E+00	5,43E-03																	3,98E-03							
UK08a	Hinkley Point A	Severn	2 GCR	1,67E-01	2,55E-01	0,00E+00	2,55E-01																	5,01E-02							
UK09a	Hunterston A	Firth of Clyde	2 GCR	2,91E-03		1,07E-04	1,90E-03	1,07E-04	1,90E-03																			4,50E-05			
UK11a	Sizewell A	North Sea	2 GCR	1,05E-01	4,53E-02	0,00E+00	4,53E-02																	1,24E-01							
UK13	Trawsfynydd	Trawsfynydd	2 GCR	4,51E-03	1,73E-03	0,00E+00	1,73E-03																	1,14E-03							
UK15	Sellafield	Irish Sea	3 GCR	1,78E+01		3,03E-02	2,14E+00	3,03E-02	2,14E+00	3,49E-02				4,32E-03		5,69E-01	4,29E-03	4,31E-02	1,27E-02			5,87E-03	1,12E-02	6,78E-01	4,01E-03	7,46E-04	3,32E-02	1,07E+00	2,87E-03	1,86E-07	
UK18	Dounreay	Pentland Firth	No reactors	8,88E-02		3,81E-04	1,68E-04	3,81E-04	1,68E-04							3,00E-02								3,03E-03							
UK19	Harwell	River Thames	No reactors	2,54E-03		5,16E-06	5,04E-05	5,16E-06	5,04E-05					8,90E-08										1,84E-06							
UK20	Winfrith	Weymouth Bay	No reactors	9,75E+00	1,38E-02	9,83E-04	1,64E-02	9,83E-04																2,58E-03							

3.3 Endnotes to data tables 4 to 8

Table 4

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

(2) ß-Activity for Tihange/Doel: Sr-89, Sr-90, Fe-55. Other radionuclides for Tihange/Doel: Cr-51, Mn54, Co-57, Fe-59, Ru-103, Te-123m, Sb-124, I-131, Ba-140, La-140, Ce-141.

(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 shut down 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 2012, their net electrical output was 315 millions of MWh.

(4) Data from the producers EDF.

(5) No power operation since 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, I-131, Cs-134, Cs-137. Other radionuclides for Trillo: Cr-51, Mn-54, Fe-55, Co-58, Co-60, Ni-63, Zr-95, Nb-95, Ag-110m, Sb-122, Sb-124, Sb-125, Te-123m, 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.

(9) Total-α activity reported for Spanish NPP is actually a “Total-α” measurement.

(10a) the value reported corresponds to the sum of individually assessed α-emitting radionuclides

(10b) the value reported corresponds to the sum of individually assessed β-emitting radionuclides, excluding H-3 but including the other beta emitting nuclides in the table

(10c) the value reported corresponds to the sum of the detected radionuclides not mentioned in the table

(11) 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, As-76, Zr-95, Nb-95, Ag-110m, Sb-124, Sb-125, Sr-90, Te-123m, Cs-137, I-131, H-3, Pu-238, Pu-239/Pu-240, Am-241, Cm-242, Cm-244

(12) For Ringhals unit 2 the following radionuclides were detected: Cr-51, Mn-54, Co-58, Co-60, Ni-63, Zr-95, Nb-95, Ag-110m, Sb-122, Sb-124, Sb-125, Sr-89, Sr-90, Te-123m, Cs-137, H-3, Pu-238, Pu-239/Pu-240, Am-241, Cm-242, Cm-244

(13) For Ringhals unit 3 the following radionuclides were detected: Cr-51, Mn-54, Co-58, Co-60, Ni-63, Zr-95, Nb-95, Ag-108m, Ag-110m, Sb-124, Sb-125, Te-123m, Cs-137, H-3, Pu-238, Pu-239/Pu-240, Am-241, Cm-242, Cm-244

(14) 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, Sb-124, Sb-125, Te-123m, H-3, Pu-238, Pu-239/Pu-240, Am-241, Cm-242, Cm-244

(15) Total-B value is the sum of the radioactivity of individual radionuclides that do not belong to tritium and alpha emitters.

(16) 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.

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 through THORP (Thermal Oxide Reprocessing Plant) at 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 Halden, these radionuclides are: I-133, Zn-65 Fe-59, Ru-103, Hf-175, Hf-181, Ir-192, Sb-122, La-140, Eu-154 and Eu-155.

From IFE Kjeller, the radionuclide is: Ba-133

All these have been included in the Total-▯.

(9) Figure for Total-▯ does not include tritium.

(10) The highest detection limits for radionuclides reported as “not detected” (ND) are listed in the following tables if available:

Radionuclide (Halden)	Highest value of detection limit Bq/m3
Mn56	NA
Sb125	5,00E+02
Cd109	NA

Radionuclide (Kjeller)	Highest value of detection limit Bq/m3
Co58	200
Zn65	1300
Zr/Nb95	500/200
Ru103	500
Ru106	9000
Ru/Rh106	NA
Ag110m	600
Sb125	500
I125	60000
I131	20
Ce144	4000
Pu239/240	18
Pu241	NA

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 monthly liquid discharges 2011 (PF+PA+Ni63, Fe55, Sr90, Tc99).

(5) Shut down in 1977.

(6) Shut down in 1986.

(7) Shut down in 2005.

(8) Shut down in 1990.

(9) Shut down in 2003.

(10) Shut down in 1994.

(11) Other radionuclides for José Cabrera: Fe-55, Co-60, Ni-63, Cs-137.

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ISBN 978-1-909159-91-4
Publication Number: 660/2015