OSPAR COMMISSION

Protecting and conserving the
North-East Atlantic and its resources

Liquid discharges from nuclear installations in 2016

Radioactive Substances Series

2018

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 Michel Chartier (convenor), France, Mr Andy Pynn, United Kingdom and Ms Inge Krol, Germany with the support of Miss Lucy Ritchie of the OSPAR Secretariat.

Contents

Executive summary

This annual report includes 2016 data of liquid radioactive discharges from nuclear installations and temporal trends for the period 1990 - 2016. 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.

Discharges of radioactive substances measured as total alpha and total beta activity (excluding tritium) from nuclear installations have decreased over the period 1990 – 2016. Discharges of tritium peaked in 2004.

There is a decrease in the total alpha activity discharged from all nuclear installations over the 25-year period. Discharges are at the lowest reported level since 1990, accounting for around 8% of the peak value in 1993.

Total beta activity (excluding tritium) from all nuclear installations has decreased markedly since 1990 and is now only about 4% of what it was in 1990.

Récapitulatif

Le présent rapport annuel comporte les données de 2016 sur les rejets radioactifs liquides provenant des installations nucléaires et les tendances temporelles pour la période de 1990 à 2016. 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 des activitès de démantèlement de gestion des déchets radioactifs hérités. 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.

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 2016. Les rejets de tritium ont atteint leur maximum en 2004.

L’activité d’alpha total rejetée par toutes les installations nucléaires a diminué au cours des vingt-cinq dernières années. Les rejets sont au niveau le plus bas enregistré depuis 1990, représentant environ 8 % du maximum enregistré en 1993.

L’activité de bêta total (à l’exclusion du tritium) rejetée par toutes les installations nucléaires a diminué de manière significative depuis 1990 et ne représente actuellement que 4 % du niveau enregistré en 1990.

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:

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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").

- 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 Fourth Periodic Evaluation of the Progress in Implementing the OSPAR Radioactive Substances Strategy, published in 2016 (OSPAR publication 2016/687), has also informed this report.

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 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).

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 and, as such, information should be based on the characteristics of individual radionuclides. Tritium is reported separately.

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[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).

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. The calculation of total-β varies between Contracting Parties, for example, in some cases it is the sum of individual radionuclide measurements and in other cases gross-β measurements are used.

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 sum of 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 2016

Introduction

Tables 1 to 3 summarise liquid radioactive discharges from nuclear installations for the period 1990 – 2015; data are taken from the OSPAR Annual Reports on Liquid Discharges from Nuclear Installations[5]. Reported discharges include data on operational discharges from nuclear power stations, nuclear fuel reprocessing plants, nuclear fuel fabrication and enrichment plants, and research and development facilities. Since 2006, exceptional discharges associated with historical or legacy waste and decommissioning are reported separately for some sites. In 2014 the Contracting Parties agreed to apply the definitions for ‘operational’ and ‘exceptional’ discharges adopted at RSC 2013 and these definitions were included in the guidance to the revised reporting formats for discharges made since 2013. Such differentiation is becoming particularly important where the magnitude of discharges associated with the recovery of historical and legacy wastes and decommissioning is clearly evident. In recent years, the contribution of ‘exceptional’ discharges from decommissioning has increased.

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 terabecquerels per year (TBq/y) for each sub-sector. The tables also give the percentage contributions from each sub-sector. Figures 1 to 3 show the trends in annual discharges of total alpha, tritium and total beta (excluding tritium) for the period 1990 to 2015.

Trends in total alpha discharges

Table 1 and Figure 1 show the total alpha activity discharged from 1990 to 2016. The total discharges of alpha activity from all nuclear installations in 2016 were 0.29 TBq which is 26% higher than the previous year. Annual alpha discharges have fluctuated in the range 0.17 – 0.3 TBq since 2007, and in 2016 were about 10% of the peak since 1990 (in 1993).

Discharges from the fuel reprocessing sub-sector contributed about 85% of the overall total alpha discharges in 2016 at 0.25 TBq. Operational discharges from Sellafield contributed about 78% (0.22 TBq). The variations mainly reflect spent fuel throughput and fuel burn up.

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

Total alpha discharges arising from decommissioning have been recorded separately since 2006. In 2016 the 'exceptional' discharges[2] from this sub-sector were 0.03 TBq (65% more than in 2015), about 10% of the total from all nuclear installations.

The discharges from the fuel fabrication and enrichment sub-sector contributed about 5% to the total alpha discharges in 2016 at 0.015 TBq, a return to a level seen in 2013 and 2014 after the 2015 increase. Most of the discharges of total alpha from this sub-sector are due to the discharges from the Springfields fuel fabrication plant in the UK.

Discharges of alpha activity from nuclear power plants and research and development facilities in 2016 were a very small fraction of the total discharge (<1.2%).

Trends in tritium discharges

Table 2 and Figure 2 present the discharges of tritium, a weak beta emitter with a low radiological impact. The total discharge of tritium in 2016 of about 18,000 TBq is very similar to annual discharges made in recent years and about 14% lower than the peak seen in 2004. Discharges of tritium are dominated by those from the reprocessing sector (81% in 2016, with 70% of the total from Cap de la Hague) and fluctuate largely in accordance with spent fuel reprocessing rates.

During 2016 the discharge of tritium by nuclear power stations increased by about 18% over the previous year and contributed a similar fraction of about 19% of the total tritium discharges from the nuclear sector; this fraction remains of the same order of magnitude from 1995. The UK's Advanced Gas-cooled Reactors contributed about 67% (2,200 TBq) of the total from power stations. The Pressurised Water Reactors in France contributed about 26% (850 TBq) of the total from power stations in 2016, which was similar to 2016. There were only small changes in the discharges of tritium from nuclear power stations in other countries.

Tritium discharges arising from exceptional discharges have been recorded separately since 2006, and continue to be a relatively small and variable contribution depending upon decommissioning and legacy waste management operations. Discharges in 2016 were 34 TBq (a 35% decrease over the previous year) which was less than 1% of the total across all sub-sectors.

Discharges from other sub-sectors were relatively very small.

Trends in total beta discharges

Table 3 and Figure 3 show that the discharges of total beta activity (excluding tritium) from all nuclear installations has decreased markedly since 1990 and are now only less than 50% of what they were in 1990. In 2016 total beta discharges were about 22 TBq, a small increase relative to the previous year but a value like the average of the last five years.

Historically, total beta discharges have been dominated by discharges from the reprocessing plants at Sellafield and the nuclear fuel fabrication plant at Springfields to a lesser extent. In 2016, the contribution of the reprocessing sub-sector (44%) is half the peak contribution of this sub-sector (89% in 2007); the reprocessing plants at Sellafield and Cap de la Hague contributed 37% and 8% respectively to operational discharges of total beta activity. Between the mid-1990s and 2002 total beta discharges from Sellafield were mainly attributable to the radionuclide technetium-99. The contribution from technetium-99 to the total beta discharge at Sellafield has reduced substantially since 2001 and since 2007 the annual discharges have been below 5 TBq. In 2016 the discharge of technetium-99 from Sellafield was 1.7 TBq, similar to discharges in recent years.

The nuclear fuel fabrication plant at Springfields contributed 8% to discharges of total beta activity in 2016. Discharges from nuclear fuel fabrication and enrichment sub-sector have decreased substantially since 2006 and are now at around 1% of the level that they were at the peak. In recent years discharges from the fuel fabrication sub-sector have been typically about 2 TBq and they show a slight downward trend.

Discharges from power stations over recent years have fluctuated but are typically one third to one half of the reprocessing sub-sector. In 2016 power stations were the second largest contributor (25%) to total discharges after reprocessing (44%).

Discharges from decommissioning, and the management of historical or legacy waste, have steadily increased in recent years and in 2016 were 23% of the total, primarily due to more nuclear installations entering the decommissioning phase. The contribution of exceptional discharges is becoming very significant, the third largest contributor and at nearly the same level as the power stations.

Discharges from the R&D sub-sector remained as the smallest contributor to total discharges.

Table 1. Total alpha discharges 1990-2016

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
All Nuclear Installations (TBq)	2.4E+00	2.4E+00	1.8E+00	2.9E+00	1.4E+00	6.8E-01	5.7E-01	3.8E-01	4.3E-01	4.1E-01	3.3E-01	4.1E-01	6.1E-01	6.2E-01	5.4E-01	5.2E-01	3.4E-01	1.9E-01	1.7E-01	1.8E-01	1.8E-01	1.7E-01	1.9E-01	2.0E-01	2.2E-01	2.3E-01	2.9E-01
Reprocessing Plants (TBq)	2.2E+00	2.3E+00	1.7E+00	2.7E+00	1.1E+00	4.7E-01	3.2E-01	2.3E-01	2.2E-01	1.7E-01	1.6E-01	2.5E-01	3.9E-01	4.3E-01	3.1E-01	2.7E-01	2.3E-01	1.5E-01	1.4E-01	1.5E-01	1.6E-01	1.4E-01	1.6E-01	1.5E-01	1.8E-01	1.9E-01	2.5E-01
% of all installations	91	93	93	94	81	69	56	61	51	41	48	60	63	70	57	52	68	77	83	88	86	85	86	74	83	82	85
Nuclear Power Plants (TBq)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3.4E-04	1.3E-05	3.9E-05	4.1E-05	3.4E-05
% of all installations	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.18	0.0069	0.018	0.018	0.012
Nuclear Fuel Fabrication (TBq)	2.1E-01	1.5E-01	1.0E-01	8.0E-02	1.6E-01	1.2E-01	1.2E-01	1.2E-01	2.0E-01	2.4E-01	1.7E-01	1.6E-01	2.2E-01	1.8E-01	2.3E-01	2.5E-01	1.1E-01	4.4E-02	2.2E-02	1.7E-02	2.1E-02	2.2E-02	2.4E-02	1.6E-02	1.4E-02	2.3E-02	1.5E-02
% of all installations	8.6	6.2	5.4	2.8	12	18	21	32	46	58	52	40	36	30	43	48	32	23	13	9.8	12	13	13	8.2	6.6	9.8	5.2
Research and Development Facilities (TBq)	2.0E-02	3.0E-02	3.0E-02	1.0E-01	1.0E-01	9.0E-02	1.3E-01	2.7E-02	1.3E-02	3.0E-03	1.8E-03	1.6E-03	2.1E-03	4.4E-03	9.0E-04	1.0E-03	1.2E-04	1.2E-04	9.0E-05	6.2E-05	6.2E-05	7.7E-05	8.9E-05	5.7E-05	7.3E-03	1.3E-04	1.2E-04
% of all installations	0.82	1.2	1.6	3.5	7.4	13	23	7.2	3.0	0.73	0.55	0.38	0.34	0.71	0.17	0.2	0.035	0.063	0.052	0.035	0.034	0.047	0.048	0.029	3.3	0.1	0.0
Decommissioning (TBq)																	5.8E-04	5.9E-04	6.3E-03	3.6E-03	4.5E-03	2.8E-03	2.3E-03	3.4E-02	1.6E-02	1.8E-02	3.0E-02
% of all installations																	0.17	0.31	3.6	2.1	2.5	1.7	1.2	17	7.2	7.9	10.3

Table 2. Tritium discharges 1990-2016

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
All Nuclear Installations (TBq)	7.2E+03	8.8E+03	7.7E+03	1.1E+04	1.3E+04	1.5E+04	1.7E+04	1.8E+04	1.6E+04	1.9E+04	1.7E+04	1.6E+04	1.9E+04	2.0E+04	2.1E+04	1.9E+04	1.6E+04	1.6E+04	1.1E+04	1.4E+04	1.4E+04	1.3E+04	1.6E+04	1.8E+04	1.7E+04	1.8E+04	1.8E+04
Reprocessing Plants (TBq)	5.0E+03	6.5E+03	5.0E+03	7.5E+03	9.8E+03	1.2E+04	1.4E+04	1.5E+04	1.3E+04	1.5E+04	1.3E+04	1.2E+04	1.5E+04	1.6E+04	1.7E+04	1.5E+04	1.2E+04	1.3E+04	9.0E+03	1.1E+04	1.1E+04	1.1E+04	1.3E+04	1.5E+04	1.4E+04	1.5E+04	1.4E+04
% of all installations	69	74	65	68	76	82	80	81	79	82	80	77	81	80	83	81	79	81	80	78	80	81	80	81	82	86	81
Nuclear Power Plants (TBq)	2.2E+03	2.3E+03	2.7E+03	3.4E+03	3.0E+03	2.7E+03	3.3E+03	3.4E+03	3.4E+03	3.3E+03	3.2E+03	3.5E+03	3.6E+03	3.8E+03	3.6E+03	3.4E+03	3.4E+03	2.9E+03	2.2E+03	2.9E+03	2.8E+03	2.5E+03	3.2E+03	3.4E+03	3.0E+03	2.8E+03	3.3E+03
% of all installations	30	26	35	31	24	18	19	19	21	18	20	22	19	19	17	19	22	19	20	22	20	18	20	19	18	16	19
Nuclear Fuel Fabrication (TBq)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
% of all installations	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Research and Development Facilities (TBq)	1.0E+02	3.2E+01	2.4E+01	8.8E+01	1.2E+02	1.7E+01	1.5E+01	1.6E+01	1.4E+01	1.6E+01	7.0E+00	5.8E+00	1.2E+01	1.8E+01	7.0E+00	1.8E+01	5.4E+00	7.0E+00	6.7E+00	4.7E+00	1.4E+01	5.0E+00	2.5E+00	5.7E+00	6.1E+00	3.9E+00	3.0E+00
% of all installations	1.4	0.37	0.31	0.81	0.91	0.11	0.089	0.089	0.086	0.085	0.042	0.037	0.062	0.092	0.034	0.095	0.035	0.045	0.06	0.035	0.1	0.037	0.016	0.031	0.036	0.022	0.017
Decommissioning (TBq)																	1.7E+01	2.5E+01	1.1E+01	1.9E+00	8.1E-01	6.0E+00	2.8E+01	2.8E+01	1.7E+01	5.2E+01	3.4E+01
% of all installations																	0.11	0.16	0.10	0.014	0.0057	0.045	0.17	0.15	0.1	0.3	0.2

Table 3. Total beta (excl. tritium) discharges 1990-2016

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
All Nuclear Installations (TBq)	4.9E+02	2.3E+02	2.7E+02	2.5E+02	3.2E+02	3.7E+02	3.3E+02	3.2E+02	2.6E+02	2.6E+02	1.7E+02	2.3E+02	2.3E+02	2.0E+02	2.0E+02	1.1E+02	5.8E+01	3.3E+01	2.7E+01	2.6E+01	2.3E+01	2.6E+01	2.0E+01	2.1E+01	2.1E+01	2.0E+01	2.2E+01
Reprocessing Plants (TBq)	3.8E+02	1.8E+02	1.3E+02	1.7E+02	2.0E+02	2.4E+02	1.7E+02	1.7E+02	1.1E+02	1.3E+02	9.8E+01	1.4E+02	1.2E+02	9.7E+01	8.6E+01	5.4E+01	3.7E+01	3.0E+01	2.1E+01	1.8E+01	1.5E+01	1.8E+01	1.2E+01	9.9E+00	1.1E+01	1.2E+01	9.8E+00
% of all installations	78	78	50	67	61	66	51	53	42	49	57	61	53	49	42	52	63	89	76	68	64	70	61	47	52	62	44
Nuclear Power Plants (TBq)	1.0E+01	3.8E+00	8.9E+00	1.1E+01	2.8E+00	3.4E+00	5.2E+00	7.4E+00	2.0E+00	2.0E+00	3.0E+00	4.2E+00	3.6E+00	3.2E+00	1.3E+00	2.0E+00	7.5E-01	4.6E-01	1.5E+00	2.1E+00	3.2E+00	2.2E+00	2.7E+00	4.6E+00	3.7E+00	3.4E+00	5.5E+00
% of all installations	2.1	1.7	3.3	4.4	0.86	0.94	1.6	2.3	0.76	0.78	1.7	1.8	1.5	1.6	0.64	1.9	1.3	1.4	5.6	7.9	14	8.6	14	21.90	18	17	25
Nuclear Fuel Fabrication (TBq)	9.2E+01	3.9E+01	1.2E+02	6.3E+01	1.1E+02	1.1E+02	1.5E+02	1.4E+02	1.5E+02	1.3E+02	7.1E+01	8.5E+01	1.1E+02	9.7E+01	1.2E+02	1.0E+02	2.1E+01	3.0E+00	4.6E+00	3.3E+00	4.5E+00	5.0E+00	4.5E+00	2.7E+00	2.9E+00	1.8E+00	1.7E+00
% of all installations	19	17	45	25	36	31	45	44	57	50	41	37	45	49	57	98	35	8.9	17	12	19	19	23	13	14	9	8
Reserch and Development Facilities (TBq)	4.5E+00	6.3E+00	6.6E+00	8.2E+00	9.1E+00	7.0E+00	8.1E+00	9.9E-01	6.6E-01	3.6E-01	3.0E-01	4.6E-01	4.6E-01	4.4E-01	4.7E-01	9.5E-02	6.2E-02	1.3E-01	6.7E-02	2.3E+00	1.8E-02	1.5E-02	6.7E-04	6.4E-04	1.4E-01	6.6E-01	8.8E-03
% of all installations	0.91	2.8	2.5	3.2	2.8	1.9	2.4	0.31	0.25	0.14	0.17	0.2	0.2	0.22	0.23	0.09	0.11	0.4	0.25	8.7	0.08	0.06	0.0033	0.0030	0.65	3	0.04
Decommissioning (TBq)																	4.0E-01	4.1E-02	3.8E-01	8.0E-01	5.9E-01	5.9E-01	5.4E-01	3.2E-01	2.8E+00	2.1E+00	5.1E+00
% of all installations																	0.019	0.12	1.4	3.0	2.6	2.3	2.7	2	13	10	23

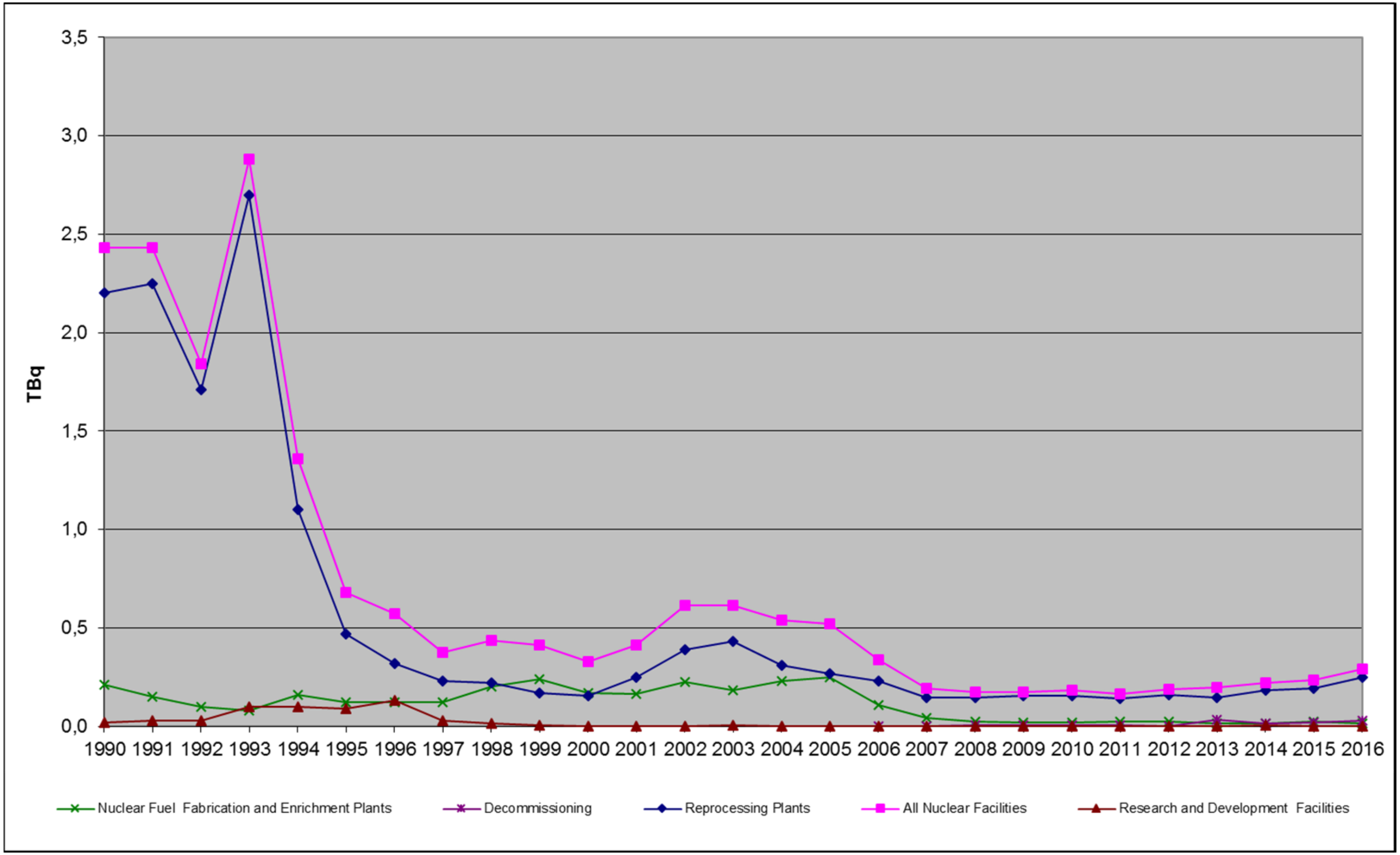


Figure 1. Total alpha activity discharge 1990 – 2016

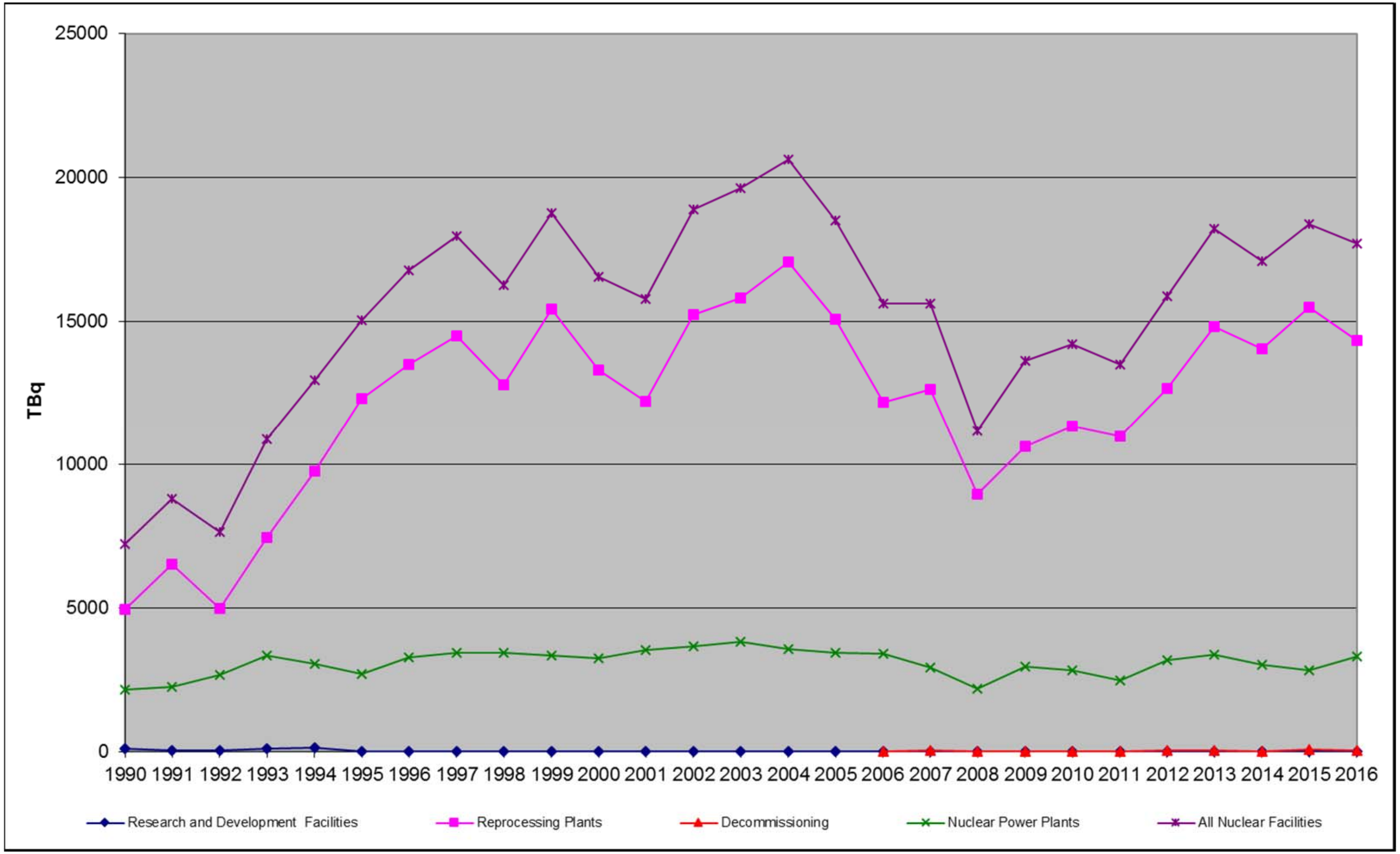


Figure 2. Discharge of tritium 1990 – 2016

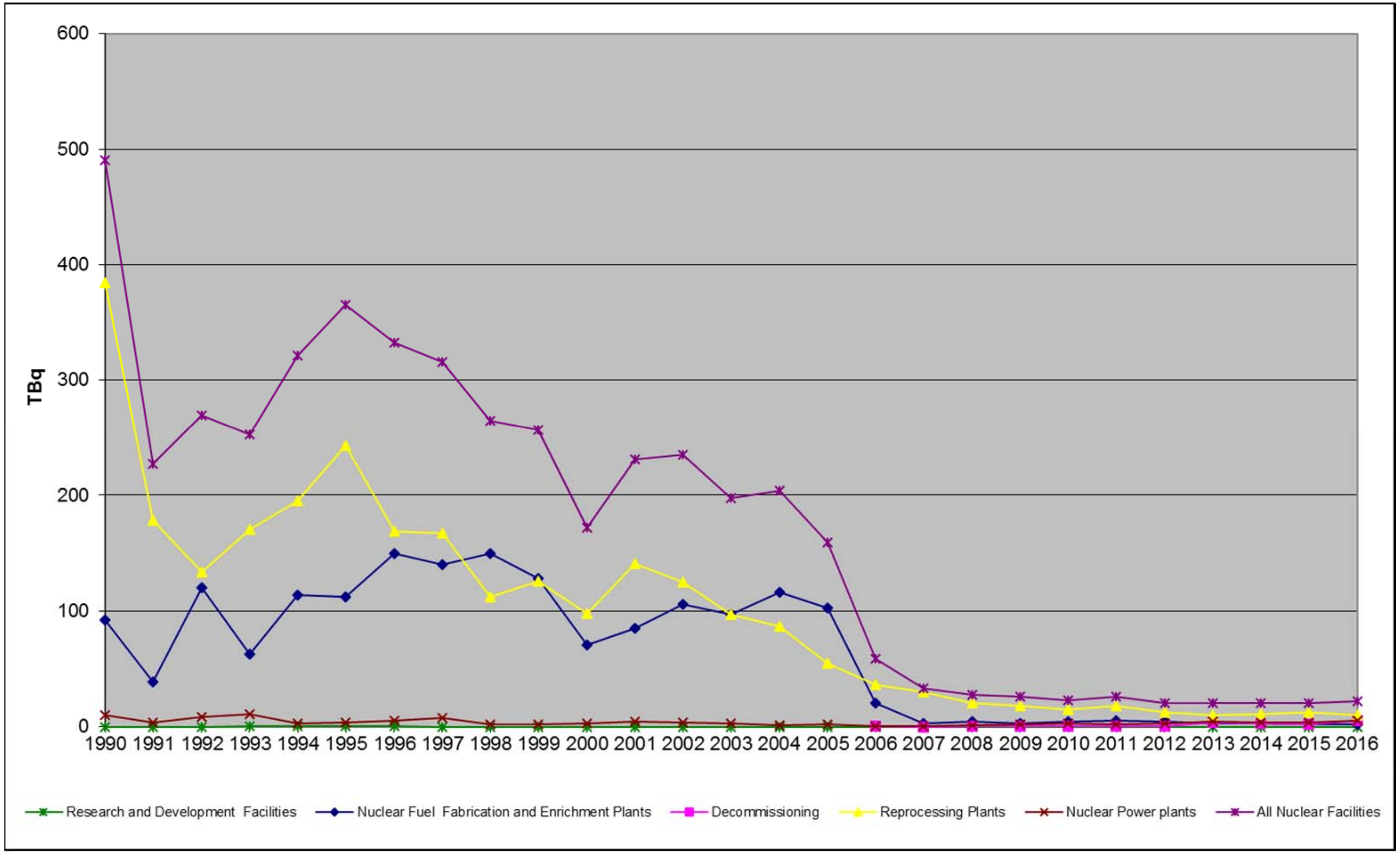


Figure 3. Total beta discharge 1990 - 2016

3. 2016 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.

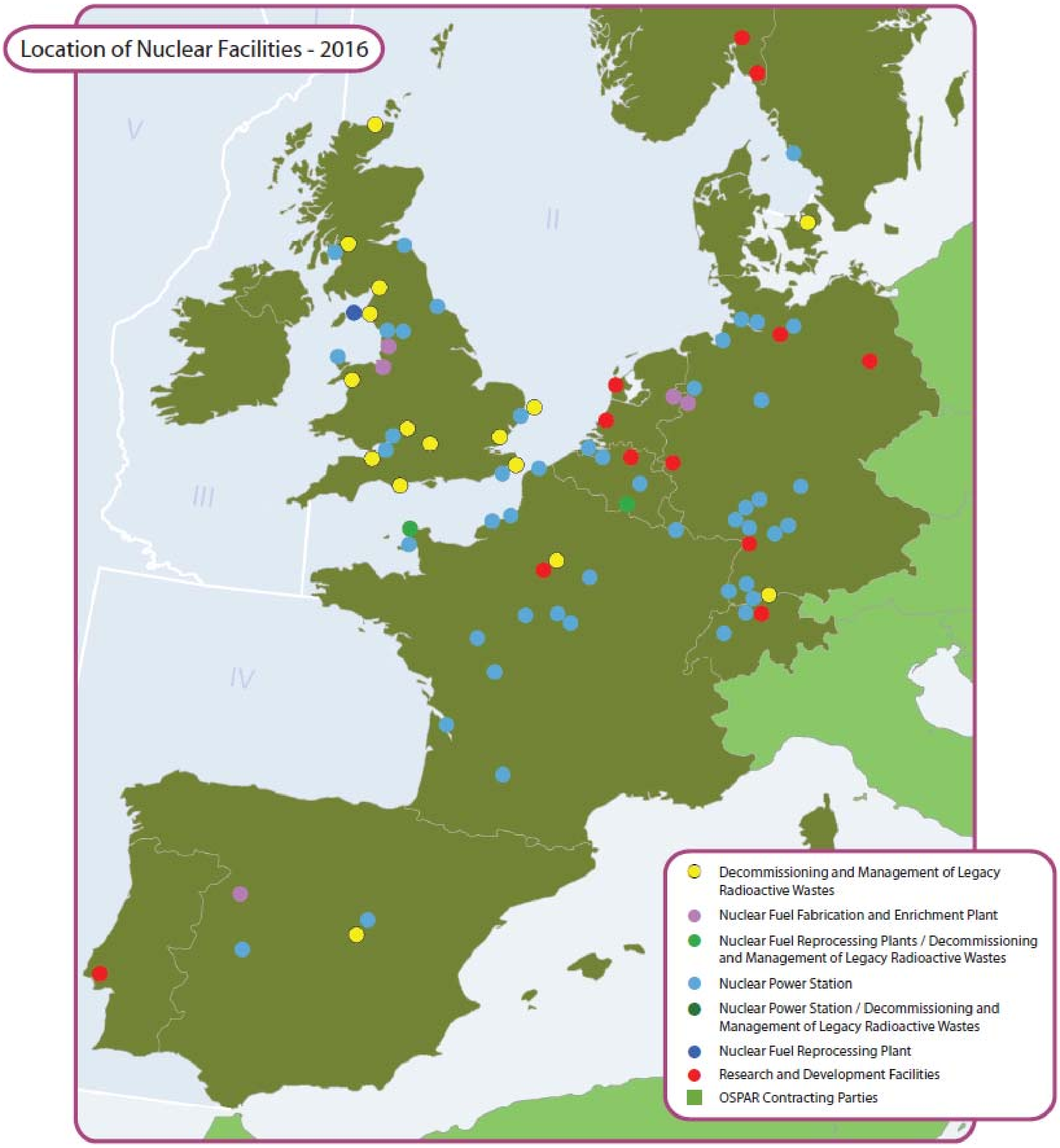
For radionuclides:

Ag:	Silver	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

Country / Code	**Name of installation**	**Type**	**Discharging into**
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			

Country / Code	Name of installation	Type	Discharging into
DE1a	Biblis A	DMLRW	Rhine
DE1b	Biblis B	DMLRW	Rhine
DE2	Brokdorf	NPS	Elbe
DE3	Brunsbüttel	DMLRW	Elbe
DE4	Grafenrheinfeld	NPS	Main
DE5	Grohnde/Emmerthal	NPS	Weser
DE8a	Krümmel/Geesthacht	DMLRW	Elbe
DE8b	Geesthacht	RDF	Elbe
DE9a	Lingen/Emsland	NPS	Ems
DE9b	Lingen	DMLRW	Ems - via municipal sewer system
DE10	Mülheim-Kärlich	DMLRW	Rhine
DE11a	Neckar-westheim 1	DMLRW	Neckar
DE11b	Neckar-wesheim 2	NPS	Neckar
DE12	Obrigheim	DMLRW	Neckar
DE13a	Philippsburg KKP1	DMLRW	Rhine
DE13b	Philippsburg KKP2	NPS	Rhine
DE14	Rheinsberg	DMLRW	Havel
DE15	Stade	DMLRW	Elbe
DE16	Rodenkirchen-Unterweser	DMLRW	Weser
DE17	Würgassen/Beverungen	DMLRW	Weser
DE18	Karlsruhe	RDF	Rhine
DE19	Gronau	NFFEP	Vechte, IJsselmeer
DE24	HMI Berlin	RDF	Havel
DE25	Jülich	RDF	Rur

Country / Code	**Name of installation**	**Type**	**Discharging into**
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

Country / Code	Name of installation	Type	Discharging into
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 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

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

Draft Liquid Discharges from nuclear installations in 2016

Table 4 Nuclear Power Stations (in TBq/y)

Location Ref	Year	Site	Discharges to	Reactors Number and Type	Installed Capacity MW.h	Net Electrical Output MW	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	2016	Doel	Schelde	4 PWR	2,911.00	22,067,994	5.75E-06	2.52E-03	4.18E+01	1.03E-03	5.75E-06	4.59E-04	3.59E-04	5.43E-04	4.75E-05	2.34E-06	1.49E-04	2.17E-05	9.49E-05	4.69E-04	2.36E-05	2.51E-04	1.32E-04		(2)
BE02	2016	Tihange	Meuse	3 PWR	962.00	2,811,805	1.52E-07	1.24E-04	4.20E-02	4.44E-05	1.52E-07	2.26E-05	1.50E-05	3.39E-05	3.55E-06	2.92E-07	5.10E-06	1.33E-05	7.44E-05	3.84E-06	2.66E-06	1.74E-05	8.32E-06		(2)
BE02	2016	Tihange	Meuse		1,008.00	8,593,924	1.22E-06	7.83E-03	3.25E+01	4.28E-04	1.22E-06	3.28E-03	1.16E-04	3.95E-03	4.47E-05	3.15E-06	4.83E-05	1.43E-04	1.22E-03	6.56E-05	1.79E-05	1.57E-04	5.11E-05		(2)
BE02	2016	Tihange	Meuse		1,045.80	7,809,049	1.09E-06	4.52E-03	8.06E+00	7.38E-04	1.09E-06	1.37E-03	7.06E-04	1.68E-03	1.98E-05	6.73E-06	1.13E-04	6.31E-05	2.59E-04	1.54E-04	1.92E-05	3.47E-04	2.39E-05		(2)
CH01	2016	Beznau	Aare	2 PWR	365/365	3,034,283.00	1.30E-07	2.00E-04	1.90E+00	2.00E-04	1.30E-07	2.00E-04	9.50E-06	5.80E-05		8.60E-07	6.70E-08		2.10E-07	2.30E-05	6.00E-06	7.30E-05	2.30E-07		(15)
CH02	2016	Gösgen	Aare	1 PWR	985	8,167,270.00	2.10E-07	2.50E-06	1.20E+01	2.50E-06	2.10E-07	2.50E-06		7.80E-08											(15)
CH03	2016	Leibstadt	Rhine	1 BWR	1220	6,075,415.00	2.40E-07	1.20E-04	4.40E-01	1.20E-04	2.40E-07	1.20E-04	1.50E-06	1.00E-04	6.50E-06							5.00E-07			(15)
CH04	2016	Mühleberg	Aare	1 BWR	373	2,946,170.00	1.40E-08	2.60E-04	1.10E-01	2.60E-04	1.40E-08	2.60E-04	4.40E-05	1.30E-04	7.20E-06	5.00E-07			9.40E-07		9.60E-08	3.90E-06			(15)
CH06	2016	Zwilag	Aare				3.20E-09	3.90E-04	3.20E-03	3.90E-04	3.20E-09	3.90E-04		7.60E-06						8.30E-06	1.80E-06	3.70E-04			(15)
DE1a	2016	Biblis A	Rhine	1 PWR	1225			7.79E-05	4.26E-01	7.79E-05				4.79E-05						1.54E-06		2.78E-07			(5)
DE1b	2016	Biblis B	Rhine	1 PWR	1300			5.91E-07	4.53E-01	5.91E-07				2.34E-07						3.38E-08		1.12E-08			(5)
DE2	2016	Brokdorf	Elbe	1 PWR	1480	1.12E+07			1.15E+01																
DE3	2016	Brunsbüttel	Elbe	1 BWR	806			1.03E-05	4.34E-04	1.03E-05				2.28E-06		2.61E-08						4.10E-06			(5)
DE4	2016	Grafenrheinfeld	Main	1 PWR	1345	4.36E+06		8.22E-05	1.04E+00	8.22E-05				1.42E-05			9.30E-09		8.57E-08	2.05E-07					(16)
DE5	2016	Grohnde/Emmerthal	Weser	1 PWR	1430	1.04E+07		3.25E-07	6.99E+00	3.25E-07															
DE8a	2016	Krümmel/Geesthacht	Elbe	1 BWR	1402			5.59E-07	1.14E-03	5.59E-07				3.00E-07						2.30E-07		2.90E-08			(5)
DE9a	2016	Lingen/Emsland	Ems	1 PWR	1406	1.10E+07			1.05E+01																
DE11a	2016	Neckar-Westheim 1	Neckar	1 PWR	840				1.33E-02																(5)
DE11b	2016	Neckar-Westheim 2	Neckar	1 PWR	1400	1.12E+07			1.45E+01																
DE13a	2016	Philippsburg 1	Rhine	1 BWR	926			7.57E-06	6.10E-02	7.57E-06			2.70E-07	4.80E-06		3.80E-08	1.30E-07					2.10E-06			(5)
DE13b	2016	Philippsburg 2	Rhine	1 PWR	1468	1.13E+07		2.74E-05	1.10E+01	2.74E-05			2.70E-06	1.10E-05			5.60E-07		1.00E-07			1.00E-05			
DE16	2016	Rodenkirchen/Unterweser	Weser	1 PWR	1410			2.89E-06	1.35E+00	2.89E-06				2.04E-06								8.52E-07			(5)
ES01	2016	Almaraz	Tagus	2 PWR	2 094	15174 269		9.78E-03	3.41E+01	9.78E-03	ND		1.39E-03	1.41E-03	3.80E-05	1.73E-05	6.16E-04	1.43E-04	9.74E-04	3.30E-04	4.87E-04	1.16E-03	7.86E-05		(7)(8)(9)(16)
ES03	2016	Trillo	Tagus	1 PWR	1 066	8004 547		5.61E-04	1.77E+01	5.61E-04	ND		3.95E-06	2.51E-05	ND	ND	3.63E-06	ND	5.75E-06	ND	ND	4.56E-06	ND		(7)(8)(9)(16)
FR01	2016	Belleville	Loire	2 PWR	2600	Total = 3,09 E8 MWh		5.07E-04	5.46E+01	5.07E-04			2.76E-04	7.50E-05					1.70E-05	4.50E-05	1.60E-05	1.80E-05			(3)(4)
FR03	2016	Cattenom	Mosel	4 PWR	5200			5.78E-04	1.22E+02	5.78E-04			1.17E-04	1.93E-04					3.00E-05	6.70E-05	2.40E-05	3.60E-05			(3)(4)
FR04	2016	Chinon	Loire	4 PWR	3600			5.08E-04	4.39E+01	5.08E-04			5.70E-05	2.38E-04					8.50E-05	4.00E-05	1.40E-05	1.90E-05			(3)(4)
FR05	2016	Chooz	Meuse	2 PWR	2900			2.92E-04	6.63E+01	2.92E-04			3.20E-05	1.30E-04					3.70E-05	2.70E-05	9.00E-06	1.20E-05			(3)(4)
FR06	2016	Dampierre-en-Burly	Loire	4 PWR	3600			9.24E-04	4.55E+01	9.24E-04			2.33E-04	3.73E-04					1.11E-04	4.30E-05	1.50E-05	1.90E-05			(3)(4)
FR07	2016	Fessenheim	Rhine	2 PWR	1800			3.60E-04	1.69E+01	3.60E-04			2.50E-05	3.90E-05					1.51E-04	2.20E-05	4.00E-06	6.00E-06			(3)(4)
FR08	2016	Flamanville	North Sea (Channel)	2 PWR	2600			2.55E-04	6.25E+01	2.55E-04			8.10E-05	1.03E-04					1.00E-05	1.90E-05	5.00E-06	6.00E-06			(3)(4)
FR09	2016	Golfech	Garonne	2 PWR	2600			2.19E-04	6.35E+01	2.19E-04			4.70E-05	3.30E-05					1.00E-05	4.50E-05	9.00E-06	1.40E-05			(3)(4)
FR10	2016	Gravelines	North Sea	6 PWR	5400			2.21E-03	5.90E+01	2.21E-03			1.22E-04	1.00E-03					5.18E-04	1.79E-04	5.00E-05	6.90E-05			(3)(4)
FR11	2016	Nogent-sur-Seine	Seine	2 PWR	2600			2.22E-04	7.25E+01	2.22E-04			3.00E-05	2.30E-05					3.40E-05	4.20E-05	1.50E-05	1.90E-05			(3)(4)
FR12	2016	Paluel	North Sea (Channel)	4 PWR	5200			1.07E-03	5.28E+01	1.07E-03			2.76E-04	5.19E-04					1.50E-05	6.20E-05	1.20E-05	1.00E-04			(3)(4)
FR13	2016	Penly	North Sea (Channel)	2 PWR	2600			2.80E-04	5.01E+01	2.80E-04			8.30E-05	5.10E-05					8.00E-06	1.70E-05	6.00E-06	8.00E-06			(3)(4)
FR14	2016	Saint Laurent	Loire	2 PWR	1800			3.40E-04	2.37E+01	3.40E-04			2.80E-05	1.04E-04					1.26E-04	2.00E-05	7.00E-06	8.00E-06			(3)(4)
FR16	2016	Civaux	Vienne	2 PWR	2900			2.59E-04	6.96E+01	2.59E-04			1.00E-05	1.03E-04					4.90E-05	2.00E-05	1.80E-05	2.40E-05			(3)(4)
FR18	2016	Le Blayais	Gironde Estuary	4 PWR	3600			2.92E-04	4.26E+01	2.92E-04			8.00E-05	4.50E-05					4.50E-05	3.60E-05	1.20E-05	1.40E-05			(3)(4)
NL01	2016	Borssele	Scheldt Estuary	1 PWR	520	3,750,000.00	3.22E-07	1.64E-05	6.53E+00		3.22E-07	1.64E-05	3.00E-08	1.11E-05	ND	ND	2.61E-06	ND	1.50E-07	ND	4.00E-08	2.35E-06	ND	NI	(6)
SE02	2016	Ringhals 1	Kattegat	1 BWR	881	6745900	1.42E-07	3.16E-04	6.00E-01	1.36E-04	1.42E-07	3.16E-04	1.80E-05	8.40E-05	1.80E-06	2.40E-06	4.30E-07		6.70E-06		1.50E-06	6.50E-05			(10a)(10b)(10c)(11)
SE02	2016	Ringhals 2	Kattegat	1 PWR	865	735800	1.76E-07	1.10E-04	7.50E-01	9.77E-05	1.76E-07	1.10E-04		6.90E-06		5.60E-07			1.70E-06	1.50E-06		1.70E-06			(10a)(10b)(10c)(12)
SE02	2016	Ringhals 3	Kattegat	1 PWR	1063	7815000	2.45E-07	1.34E-03	1.90E+01	1.09E-03	2.45E-07	1.34E-03	5.20E-05	3.70E-05	5.60E-07	2.60E-08	1.79E-05		1.40E-04	5.00E-06		2.80E-07			(10a)(10b)(10c)(13)
SE02	2016	Ringhals 4	Kattegat	1 PWR	1123	8733200	1.55E-07	3.36E-04	1.30E+01	1.48E-04	1.55E-07	3.36E-04	1.60E-04	1.10E-05	2.40E-07		2.05E-06		1.40E-05			6.10E-07			(10a)(10b)(10c)(14)
UK05b	2016	Dungeness B	English Channel	2 AGR				5.52E-01	3.06E+02	3.55E-03				8.67E-04								1.15E-03		5.46E-01	
UK06	2016	Hartlepool	North Sea	2 AGR				1.50E+00	3.59E+02	4.54E-04				1.26E-04								1.93E-03		1.50E+00	
UK07a	2016	Heysham 1	Morecambe Bay	2 AGR				1.13E+00	4.00E+02	3.59E-03				1.57E-04								2.15E-03		1.12E+00	
UK07b	2016	Heysham 2	Morecambe Bay	2 AGR				8.18E-02	3.65E+02	1.28E-02				9.99E-05								1.02E-03		6.79E-02	
UK08b	2016	Hinkley Point B	Severn Estuary	2 AGR				2.65E-01	2.39E+02	3.70E-03				1.16E-04								1.21E-03		2.60E-01	
UK09b	2016	Hunterston B	Firth of Clyde	2 AGR			2.32E-05	7.30E-01	2.48E+02	9.87E-03	2.32E-05			4.80E-04										7.20E-01	
UK10	2016	Oldbury	Severn Estuary	2 GCR				2.01E-01	1.57E-01	3.48E-02												1.66E-01			
UK11b	2016	Sizewell B	North Sea	1 PWR				4.86E-03	2.21E+01	4.51E-03												3.47E-04			
UK12	2016	Torness	North Sea	2 AGR			9.16E-07	1.02E+00	2.91E+02	1.60E-03	9.16E-07			1.24E-04										1.02E+00	
UK14	2016	Wylfa	Irish Sea	2 GCR				3.37E-03	1.17E-01	3.37E-03															

Table 5 Nuclear Fuel Reprocessing Plants (operational discharges)

	TBq released per annum	TBq released per annum
Location Ref	FR15	UK15
Year	2016	2016
Site	La Hague	Sellafield
Discharges to	English Channel	Irish Sea
Type of fuel reprocessed	PWR, BWR	Magnox, AGR, LWR
Capacity (t/y)	1600	
Tritium	1.23E+4	2.03E+3
Total-a	2.18E-2	2.25E-1
Total-b	1.66	8.09E+0
C14	7.55	4.81E+0
S35		
Mn54	2.39E-3	
Fe55		
Co57	5.85E-5	
Co58	4.97E-4	
Co60	5.80E-2	3.34E-2
Ni63	1.00E-2	
Zn65	1.03E-4	
Sr89		
Sr90	9.17E-2	9.69E-1
(Sr90 + Cs137)		
(Zr + Nb95)		8.25E-2
Tc99	3.13E-2	1.69E+0
Ru103		
Ru106	1.37E+0	1.09E+0
(Ru + Rh) 106	2.74E+0	

Ag110m		
Sb124		
Sb125	4.86E-2	
I129	1.42E+0	5.22E-1
Cs134	5.03E-2	6.49E-2
Cs137	6.16E-1	2.36E+0
Ce144		2.10E-1
(Ce + Pr) 144	1.34E-5	
Pm147		
Eu152		
Eu154	3.00E-4	
Eu155		
Np237	9.37E-5	2.55E-2
Pu239+240	1.42E-3	1.55E-1
Pu241	1.13E-1	2.68E+0
Am241	2.29E-3	2.45E-2
Cm242	9.11E-6	
Cm 243+244	1.32E-3	2.96E-3
Uranium (kg)	16.3	
Notes	**(1)**	**(2)**

Table 6 Nuclear Fuel Fabrication and Enrichment Plants (operational discharges) (in TBq/y) (2016 Data)

Location Ref	Site	Discharges to	Type of Fuel	Capacity (t/y)	Production	Calculated Total-a	Calculated Total-b	Activity	TBq released
DE19	Gronau	Vechte, IJsselmeer	Uranium enrichment					Total-a	
ES04	Juzbado	River Tormes - Duero	PWR, BWR	400	279.1	1.96E-05		Total-a	1.96E-05
NL03	Urenco, Almelo	Municipal sewer system	Uranium enrichment	6200	5217	6.00E-07		Total-a	6.00E-7
NL03	Urenco, Almelo	Municipal sewer system	Uranium enrichment	6200	5217		1.60E-06	Total-b (b- & g- emitting rn)	1.60E-6
UK16	Capenhurst	Irish Sea via Rivacre Brook and Mersey Estuary	Uranium enrichment			1.99E-05		Uranium-a	3.65E-6
UK16	Capenhurst	Irish Sea via Rivacre Brook and Mersey Estuary	Uranium enrichment					Uranium daughters	7.49E-6
UK16	Capenhurst	Irish Sea via Rivacre Brook and Mersey Estuary	Uranium enrichment					Other-a	8.73E-6
UK16	Capenhurst	Irish Sea via Rivacre Brook and Mersey Estuary	Uranium enrichment				4.62E-06	Tc99	4.62E-6
UK16	Capenhurst	Irish Sea via Rivacre Brook and Mersey Estuary	Uranium enrichment					Tritium	
UK17	Springfields	Irish Sea via River Ribble	GCR, AGR, PWR fuel fabrication			1.50E-2		Total-a	1.50E-2
UK17	Springfields	Irish Sea via River Ribble	GCR, AGR, PWR fuel fabrication				1.71E+00	Total-b	1.71E+0
UK17	Springfields	Irish Sea via River Ribble	GCR, AGR, PWR fuel fabrication					Tc99	2.66E-2
UK17	Springfields	Irish Sea via River Ribble	GCR, AGR, PWR fuel fabrication					Th230	1.45E-3
UK17	Springfields	Irish Sea via River Ribble	GCR, AGR, PWR fuel fabrication					Th232	1.52E-4
UK17	Springfields	Irish Sea via River Ribble	GCR, AGR, PWR fuel fabrication					Uranium-a	1.08E-2
UK17	Springfields	Irish Sea via River Ribble	GCR, AGR, PWR fuel fabrication					Np237	3.70E-4

Table 7 Research and Development Facilities (operational discharges) (in TBq/y) (2016 Data)

Location Ref	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		6.28E-05		Total-a	6.28E-05	(1)
BE03	Mol	River Mol-Neet	2			7.28E-04	Total-b	1.19E-04	
BE03	Mol	River Mol-Neet	2				H3	9.09E-01	
BE03	Mol	River Mol-Neet	2				Sr90/Y90	2.07E-04	
BE03	Mol	River Mol-Neet	2				Co60	3.23E-05	
BE03	Mol	River Mol-Neet	2				Cs134	9.79E-06	
BE03	Mol	River Mol-Neet	2				Cs137	3.59E-04	
BE03	Mol	River Mol-Neet	2				Total activitiy	9.10E-01	
CH05	Paul Scherrer Institute	Aare					Tritium	1.90E-01	
CH05	Paul Scherrer Institute	Aare				6.26E-05	b-and g-emitting radionuclides		
CH05	Paul Scherrer Institute	Aare					Be7	1.1E-05	
CH05	Paul Scherrer Institute	Aare					Na22	8.1E-08	
CH05	Paul Scherrer Institute	Aare					Sc46	7.0E-09	
CH05	Paul Scherrer Institute	Aare					Sc47	7.1E-07	
CH05	Paul Scherrer Institute	Aare					Mn54	4.2E-07	
CH05	Paul Scherrer Institute	Aare					Co56	1.4E-08	
CH05	Paul Scherrer Institute	Aare					Co60	7.2E-07	
CH05	Paul Scherrer Institute	Aare					Rb83	9.8E-09	
CH05	Paul Scherrer Institute	Aare					Sr85	3.9E-09	
CH05	Paul Scherrer Institute	Aare					Y88	7.2E-09	
CH05	Paul Scherrer Institute	Aare					Sr89	7.2E-09	
CH05	Paul Scherrer Institute	Aare					Sr90	1.2E-06	
CH05	Paul Scherrer Institute	Aare					In111	1.2E-07	
CH05	Paul Scherrer Institute	Aare					Sb124	1.1E-07	
CH05	Paul Scherrer Institute	Aare					Cs134	5.0E-08	
CH05	Paul Scherrer Institute	Aare					Cs137	1.3E-05	
CH05	Paul Scherrer Institute	Aare					Ce141	7.9E-09	
CH05	Paul Scherrer Institute	Aare					Gd149	7.1E-08	
CH05	Paul Scherrer Institute	Aare					Tb160	1.8E-08	
CH05	Paul Scherrer Institute	Aare					Tb161	2.8E-08	
CH05	Paul Scherrer Institute	Aare					Lu172	2.1E-08	
CH05	Paul Scherrer Institute	Aare					Lu177	3.5E-05	
CH05	Paul Scherrer Institute	Aare					Bi207	5.6E-09	
CH05	Paul Scherrer Institute	Aare			1.3E-08		a-emitting radionuclides		
CH05	Paul Scherrer Institute	Aare					U234/238	1.3E-08	
DE8b	HZ Geesthacht	Elbe	1		2.2E-08		Total a-activity	2.2E-08	shut down 2010
DE8b	HZ Geesthacht	Elbe	1				Tritium	1.2E-03	
DE8b	HZ Geesthacht	Elbe	1			4.9E-05	Other radionuclides	4.9E-05	
DE18	Karlsruhe (KIT)	Rhine	No reactors				Total a-activity		
DE18	Karlsruhe (KIT)	Rhine	No reactors				Tritium	3.3E-01	
DE18	Karlsruhe (KIT)	Rhine	No reactors			3.4E-06	Other radionuclides	3.4E-06	
DE24	HZ Berlin	Havel	1				Total a-activity		
DE24	HZ Berlin	Havel	1				Tritium	2.5E-04	
DE24	HZ Berlin	Havel	1			3.5E-08	Other radionuclides	3.5E-08	
DE25	Jülich	Rur	1				Total a-activity		shut down 2006
DE25	Jülich	Rur	1				Tritium	5.2E-01	
DE25	Jülich	Rur	1			1.2E-04	Other radionuclides	1.2E-04	
FR19	Saclay	Etang de Saclay	1 research reactor (Orphée)		4.10E-05		Total-a	4.10E-5	
FR19	Saclay	Etang de Saclay	1 research reactor (Orphée)			1.60E-05	Other radionuclides	1.60E-5	(1a)
FR19	Saclay	Etang de Saclay	1 research reactor (Orphée)				Tritium	1.56E-2	
NL04	Delft	Sewage system	1 Research reactor	2 MWth			a-emitting radionuclides	ND	(2)(3)
NL04	Delft	Sewage system	1 Research reactor	2 MWth		2.73E-06	Total-b	2.73E-06	(2)(3)(4)
NL04	Delft	Sewage system	1 Research reactor	2 MWth			g-emitting radionuclides	3.9E-06	(2)(3)
NL04	Delft	Sewage system	1 Research reactor	2 MWth			Total		(2)(3)(4)
NL05	Petten	North Sea	1 high flux and 1 low flux research reactor	50 MWth			Tritium	1.60E-01	(5)(6)
NL05	Petten	North Sea	1 high flux and 1 low flux research reactor		9.90E-06		a-emitting radionuclides	9.90E-06	(5)(6)
NL05	Petten	North Sea	1 high flux and 1 low flux research reactor	30kWth		7.70E-03	b/g-emitting radionuclides	7.70E-03	(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	8.60E-01	(8)(9)(10)
NO01	Halden	River Tista (Skagerrak)	1 BWR D2O as moderator				Total-a	ND	(8)(9)(10)
NO01	Halden	River Tista (Skagerrak)	1 BWR D2O as moderator			1.03E-04	Total-b	1.03E-04	(8)(9)(10)
NO01	Halden	River Tista (Skagerrak)	1 BWR D2O as moderator				Ag110m	1.40E-06	(8)(9)(10)
NO01	Halden	River Tista (Skagerrak)	1 BWR D2O as moderator				Cr51	1.30E-05	(8)(9)(10)
NO01	Halden	River Tista (Skagerrak)	1 BWR D2O as moderator				Mn54	2.90E-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	1.80E-07	(8)(9)(10)
NO01	Halden	River Tista (Skagerrak)	1 BWR D2O as moderator				Co60	9.50E-06	(8)(9)(10)
NO01	Halden	River Tista (Skagerrak)	1 BWR D2O as moderator				Sr90	1.10E-06	(8)(9)(10)
NO01	Halden	River Tista (Skagerrak)	1 BWR D2O as moderator				Zr95	1.90E-06	(8)(9)(10)
NO01	Halden	River Tista (Skagerrak)	1 BWR D2O as moderator				Nb95	4.10E-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	3.90E-7	(8)(9)(10)
NO01	Halden	River Tista (Skagerrak)	1 BWR D2O as moderator				I131	2.80E-05	(8)(9)(10)
NO01	Halden	River Tista (Skagerrak)	1 BWR D2O as moderator				Cs134	1.50E-06	(8)(9)(10)
NO01	Halden	River Tista (Skagerrak)	1 BWR D2O as moderator				Cs137	4.00E-05	(8)(9)(10)
NO01	Halden	River Tista (Skagerrak)	1 BWR D2O as moderator				Ce141	5.80E-07	(8)(9)(10)
NO01	Halden	River Tista (Skagerrak)	1 BWR D2O as moderator				Ce144	7.90E-07	(8)(9)(10)

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NO02	Kjeller	River Nitelva (Skagerrak)	1 JEEP II, heavy water and cooled research reactor				Tritium	1.05E-03	(8)(9)(10)
NO02	Kjeller	River Nitelva (Skagerrak)	1 JEEP II, heavy water and cooled research reactor		2.21E-06		Total-a	2.21E-06	(8)(9)(10)
NO02	Kjeller	River Nitelva (Skagerrak)	1 JEEP II, heavy water and cooled research reactor			5.62E-08	Total-b	5.62E-08	(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	7.70E-09	(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	2.35E-08	(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	ND	(8)(9)(10)
NO02	Kjeller	River Nitelva (Skagerrak)	1 JEEP II, heavy water and cooled research reactor				Cs137	2.50E-08	(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	2.74E-09	(8)(9)(10)
NO02	Kjeller	River Nitelva (Skagerrak)	1 JEEP II, heavy water and cooled research reactor				Pu239/240	3.36E-07	(8)(9)(10)
NO02	Kjeller	River Nitelva (Skagerrak)	1 JEEP II, heavy water and cooled research reactor				Am241	4.60E-09	(8)(9)(10)
NO02	Kjeller	River Nitelva (Skagerrak)	1 JEEP II, heavy water and cooled research reactor				Pu241	NA	(8)(9)(10)

Table 8 Discharges associated with historical or legacy wastes (exceptional discharges) (in TBq/y) (2016 Data)										**Notes**
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)**	**Notes**
CH06	ZWILAG Würenlingen	Aare								(12)
D10	Mülheim-Kärlich	Rhine	1 PWR	6.10E-07	1.10E-07		1.10E-07			(6)
D12	Obrigheim	Neckar	1 PWR	3.40E-04	8.00E-05	1.40E-07	8.00E-05	1.40E-07		(7)
D14	Rheinsberg	Havel	1 PWR	4.20E-07	2.80E-06	2.10E-07	2.80E-06	2.10E-07		(8)
D15	Stade	Elbe	1 PWR	7.70E-06	6.30E-09	1.10E-10	6.30E-09	1.10E-10		(9)
D9b	Lingen	Ems	1 BWR	9.20E-07	1.60E-07		1.60E-07			(5)
DK01	Risø	Kattegat through Roskilde Fjord	No reactors	3.00E-03			2.23E-04		2.23E-04	(2)(3)
ES02	José Cabrera	Tagus	1PWR	5.52E-03	6.20E-06	1.58E-08	6.20E-06			(11)
FR05	Chooz	Meuse	1 PWR	1.06E-03	1.24E-03		1.24E-03		1.24E-03	(4)
FR15	La Hague	English Channel	PWR + BWR			1.23E-03	1.85E-02	1.23E-3	1.85E-2	
FR17	Fontenay-aux-Roses	Seine	No reactors	3.40E-06		1.80E-7	2.00E-7			
UK01	Berkeley	Severn	2 GCR	4.77E-5	6.36E-5		6.36E-05			
UK02	Bradwell	North Sea	2 GCR	2.48E-1	9.30E-3		9.30E-03			
UK04	Chapelcross	Solway Firth	4 GCR	4.86E-09	1.02E-08	4.86E-09		4.86E-9		
UK05a	Dungeness A	English Channel	2 GCR	1.30E-2	4.93E-3		4.93E-03			
UK08a	Hinkley Point A	Severn	2 GCR	1.52E-3	2.44E-2		2.44E-02			
UK09a	Hunterston A	Firth of Clyde	2 GCR	4.59E-04	1.56E-03	6.39E-04		6.39E-04		
UK11a	Sizewell A	North Sea	2 GCR	1.24E-2	5.72E-2		_			
UK13	Trawsfynydd	Trawsfynydd	2 GCR	1.30E-3	7.00E-4		7.00E-04			(13)
UK15	Sellafield	Irish Sea	3 GCR, reprocessing,waste management	1.92E+1		2.80E-02	4.97E+00	2.80E-2	4.97E+0	(14)
UK18	Dounreay	Pentland Firth	No reactors	8.55E-02	1.26E-03	1.40E-04		1.40E-04		
UK19	Harwell	River Thames	No reactors	1.10E-3		4.60E-06	9.06E-06	4.60E-6	9.06E-6	
UK20	Winfrith	Weymouth Bay	No reactors	1.42E+1	9.47E-4		2.07E-03	9.28E-06		

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 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 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 criteria set out in Commission Recommendation 2004/2/EURATOM of 18 December 2003 on standardised information on radioactive airborne and liquid discharges into the environment from nuclear power reactors and reprocessing plants in normal operation.

(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-106, Ag-110m, Sb-122, Sb-124, Sb-125, Te-123m, I-131, Cs-134, Cs-137, Ce-144. Other radionuclides for Trillo: Mn-54, Fe-55, Co-58, Co-60, Ni-63, Nb-95, Zr-95, Ag-110m, 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, excludning 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, the highest value of the detection limit in Bq/kg is given in parenthesis for the key radionuclides: Cr-51, Mn-54, Fe-59, Co-57, Co 58, Co-60 (0.082), Ni-63, Zn-65, As-76, Nb-95, Ag-110m, Sb-124, Sr-90 (0.13), Cs-134, Cs-137 (0.14), Pu-238 (2.4E-3), Pu-239/Pu-240 (2.2E-3), Am-241 (6.7E-4), Cm-242, Cm-244, H-3 (20).

(12) For Ringhals unit 2 the following radionuclides were detected, the highest value of the detection limit in Bq/kg is given in parenthesis for the key radionuclides: Mn-54, Co-60 (0.10), Ni 63, Ag-110m, Sb-124, Sb-125, Sr-90 (0.13), Cs-137 (0.14), Pu-238 (5.0E-3), Pu-239/Pu-240 (2.4E-3), Am-241 (6.1E-4), Cm-242, Cm-244, H-3 (19).

(13) For Ringhals unit 3 the following radionuclides were detected, the highest value of the detection limit in Bq/kg is given in parenthesis for the key radionuclides: Cr-51, Mn-54, Fe-59, Co-58, Co 60 (0.28), Ni-63, Zn-65, Zr-95, Nb-95, Ag-110m, Sb-124, Sb-125, Sr-90 (0.13), Te-123m, Cs 137 (0.40), Pu-238 (4.4E-3), Pu-239/Pu-240 (2.1E-3), Am-241 (6.9E-4), Cm-242, Cm-244, H-3 (25).

(14) For Ringhals unit 4 the following radionuclides were detected, the highest value of the detection limit in Bq/kg is given in parenthesis for the key radionuclides: Cr-51, Mn-54, Fe-59, Co-57, Co 58, Co-60 (0.12), Ni-63, Zn-65, Zr-95, Nb-95, Ag-110m, Sb-124, Te-123m, Cs-137 (0.38), Pu-238 (3.9E-3), Pu-239/Pu-240 (2.4E-3), Am-241 (6.6E-4), Cm-242, Cm-244, H-3 (22). Not detected Sr-90 (0.27). (15) Total-B value is the sum of the radioactivity of individual radionuclides that do not belong to tritium and alpha emitters.

(16) Highest values of detection limit, among all the measurements below the detection limit, for Almaraz (Bq/m3) H-3: 1.98E+05, Co-60: 6.85E+03, Sr-90: 4.11E+02, Cs-137: 1.17E+04, Total-alpha: 8.88E+02. For Trillo (Bq/m3) H-3: 5.66E+04, Co-60: 3.64E+03, Sr-90: 9.84E+02, Cs-137: 4.00E+03, Total-alpha: 9.18E+02.

(17) No power operation since 2015.

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 for tritium and iodine-129 vary depending on the annual mass throughput of uranium in THORP (Thermal Oxide Reprocessing Plant).

Table 7

(1a) France informs that the line entitled "other radionuclides" corresponds to the sum “gamma emitters + strontium-90”

(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: Fe-59, Zr-97, Ru-103

All these have been included in the Total-β.

From IFE Kjeller, these radionuclides are: Ra-223, Th-227, U-234, U-235, U-238, Cm-244

All these have been included in the Total-α.

The increase in total–α discharges from IFE-Kjeller is associated with legacy wastes (clean-up work of the decommissioned reprocessing test facility). It is not possible to separate the discharges from the research and development from the discharges associated with the legacy waste at the site, as the discharges are managed through a shared water treatment system. The discharges, licensed by the Norwegian Radiation Protection Authority, will continue for a limited period.

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

(10) The highest detection limits are listed in the following tables if available:

Radionuclide (IFE-Kjeller)	**Highest DL [Bq/m3]**
^{3}H	2000000
^{22}Na	1000
^{51}Cr	4000
^{54}Mn	700
^{59}Fe	700
^{58}Co	700
^{60}Co	1300
^{65}Zn	1500
^{90}Sr	11
^{95}Zr	1400
^{95}Nb	800
^{103}Ru	500

^{106}Ru	10000
^{110m}Ag	1300
^{124}Sb	4000
^{125}Sb	600
^{125}I	6000
^{131}I	140
^{134}Cs	300
^{137}Cs	1200
^{133}Ba	1100
^{144}Ce	5000
^{223}Ra	21000
^{227}Th	2100
^{234}U	2
^{235}U	2
^{238}U	3
^{238}Pu	7
^{239,240}Pu	2
^{241}Am	2
^{243}Cm	2
^{244}Cm	2

Radionukcide (IFE-Halden)	**Highest DL [Bq/m3]**
H-3	300000
Cr-51	1500
Mn-54	95
Fe-59	400
Co-58	200

Co-60	110
Sr-90	1
Nb-95	125
Zr-95	180
Zr-97	14300
Ru-103	130
Cd-109	430
Ag-110m	75
I-131	240
Cs-134	100
Cs-137	300
Ce-141	40
Ce-144	250
Ba-140	1300
La-140	200

(11) Shut down in 2006

(12) Shut down in 2010

Table 8

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

(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 “PF+PA+C14+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, Sr-90, Cs-137.

(12) 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.

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

(14) Total Beta is calculated in the same way as in Table 5

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