OSPAR COMMISSION

Liquid discharges from nuclear installations in 2008

Radioactive Substances Series

2010

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. It has been ratified by Belgium, Denmark, Finland, France, Germany, Iceland, Ireland, Luxembourg, Netherlands, Norway, Portugal, Sweden, Switzerland and the United Kingdom and approved by the European Community and Spain.

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. La Convention a été ratifiée par l'Allemagne, la Belgique, le Danemark, 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 et la Suisse et approuvée par la Communauté européenne et l'Espagne.

Acknowledgement

This report has been prepared by the expert assessment panel, comprising of Mr Bob Russ (leader), UK; Mr Michel Chartier, France; Mr Justin Gwynn, Norway and Mrs Ann-Christin Hägg, Sweden with the support of Ms Luisa Rodriguez Lucas and Ms Corinne Michel of the OSPAR Secretariat.

Contents

Executive summary

Discharges of radioactive substances, measured as total alpha and total beta activity and excluding tritium, from nuclear installations have decreased over the period 1990 – 2008. The discharges of tritium peaked in 2004.

This annual report includes the data of 2008 on liquid radioactive discharges from nuclear installations and temporal trends for the period 1990 - 2008. 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, and research and development facilities. Discharges are reported as total alpha, tritium and total beta activity (excluding tritium) in terabequerel 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 18-year period. Discharges of alpha activity are at their lowest level during the period, accounting 6% of the peak value in 1993. There was also a three-fold decrease in alpha discharges from the fuel fabrication sub-sector, in particular from the Springfields site. Compared to 2007, the alpha discharges from the reprocessing plant at Sellafield saw a slight increase of 1.6 % and a reduction of 18% from the reprocessing plant at La Hague. Total alpha discharges arising from decommissioning are insignificant.

Downward trends for discharges of **tritium** since 2004 were re-established. However, such trends were related to reprocessing throughput and could rise or fall in the future. Despite a 32% decrease of discharges of tritium from La Hague, it contributed over 70% of the total tritium discharges. Sellafield, which registered an increase of 24% in tritium discharges, contributed 7% of all total tritium discharges. Discharges of tritium from nuclear power stations dropped during 2008, but still contributed 20% to overall tritium discharges. The decrease was largely due to several AGR reactors being offline for safely checks and plant maintenance.

Total beta discharges (excluding tritium) from all nuclear installations was the lowest recorded by OSPAR since the collection of data and discharges were 5.5% compared to 1990 discharges. Decline in activity at Springfields meant that reprocessing now accounted for 76% of the total beta discharges overall. Compared with 2007, there was a 42% reduction in Sellafield discharges, a 52% reduction in Tc-99 discharges at Sellafield, representing only 17% of total beta discharges from the site as a whole and a 53% increase in Springfields discharges. 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 2008. Les rejets de tritium ont atteint leur maximum en 2004.

Le présent rapport annuel comporte les données de 2008 sur les rejets radioactifs liquides provenant des installations nucléaires et les tendances temporelles pour la période de 1990 à 2008. 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 ainsi que des installations de recherche et de développement. 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** rejeté par toutes les installations nucléaires a diminué au cours des dix-huit dernières années. Les rejets d'activité alpha sont à leur niveau le plus bas au cours de cette période, représentant 6 % du maximum enregistré en 1993. On a également relevé une réduction de deux tiers des rejets d'alpha provenant du sous-secteur de la production de combustible, en particulier du site de Springfields. Par rapport à 2007, il y a eu une légère augmentation de 1,6 % des rejets de Sellafield et une réduction de 18 %

des rejets provenant de l'usine de retraitement de La Hague. Les rejets de total alpha provenant du déclassement sont insignifiants.

Les tendances à la baisse des rejets de **tritium** que l'on observe depuis 2004 se sont confirmées. Toutefois, ces tendances sont liées au débit des usines de retraitement, et pourraient augmenter ou diminuer à l'avenir. Malgré une diminution de 32 % des rejets de tritium de La Hague, les rejets de celle-ci représentent plus de 70 % des rejets totaux de tritium. Sellafield, où l'on a enregistré une augmentation de 24 % des rejets de tritium, représente 7 % de tous les rejets totaux de tritium. Les rejets de tritium des centrales nucléaires ont diminué en 2008, mais représentent quand même 20 % des rejets totaux de tritium. La diminution est largement due à l'arrêt temporaire de plusieurs réacteurs avancés refroidis au gaz (réacteurs AGR) pour des contrôles de sécurité et des opérations d'entretien dans les centrales.

Les rejets de **total bêta** (à l'exclusion du tritium) de toutes les installations nucléaires sont les plus bas enregistrés par OSPAR depuis la collecte de données, et ces rejets représentent 5,5 % des rejets enregistrés en 1990. Le ralentissement des activités à Springfields signifie que le retraitement représente maintenant 76 % des rejets totaux de total bêta. Par rapport à 2007, il y a eu une réduction de 42 % des rejets de Sellafield ; une réduction de 52 % des rejets de Tc-99 à Sellafield, représentant seulement 17 % des rejets de total bêta de l'ensemble du site et une augmentation de 53 % des rejets de Springfields. Les rejets de total bêta (à l'exclusion du tritium) provenant du déclassement sont insignifiants.

1. Introduction

The possibility of harm to the marine environment and its users (including the consumers of food produced from the marine environment) from inputs of radionuclides caused by human activities was always a subject with which the 1972 Oslo and 1974 Paris Conventions were concerned – a concern taken over by the 1992 OSPAR Convention and taken forward in the work of implementing it. When the Paris Convention was adopted in 1974, in order to provide for international action against land-based sources of marine pollution, the Contracting Parties undertook "to adopt measures to forestall and, as appropriate, eliminate pollution of the maritime area from land-based sources by radioactive substances".

When the first Ministerial Meeting under the 1992 Convention of the OSPAR Commission was held in 1998 at Sintra, Portugal, agreement was reach on a strategy 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 and confirmed by the second Ministerial Meeting of the OSPAR Commission at Bremen in 2003. The OSPAR Radioactive Substances Strategy thus now provides that:

"In accordance with the general objective [of the OSPAR Convention], the objective of the Commission with regard to radioactive substances, including waste, is to prevent pollution of the 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:

a. legitimate uses of the sea;

b. technical feasibility;

c. radiological impacts on man and biota."

The Strategy further provides that:

"This strategy will be implemented in accordance with the Programme for More Detailed Implementation of the Strategy with regard to Radioactive Substances (OSPAR Agreement Number: 2001-03) in order to achieve by the year 2020 that the Commission will ensure that 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, emission and losses, are close to zero."

The Programme for More Detailed Implementation of the Strategy with regard to Radioactive Substances (the "RSS Implementation Programme") and the agreements made at the second OSPAR Ministerial Meeting, in effect, provide that

a. the Contracting Parties will each prepare a national plan for achieving the objective of the Strategy;

b. they will monitor and report on progress in implementing those plans, and

c. the OSPAR Commission will periodically evaluate progress against an agreed baseline.

Regular reporting from Contracting Parties is therefore required in order to review progress towards this target.

1.1 Programmes and measures

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

---

1 All measures referred to in this chapter 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 93/5 Concerning Increases in Radioactive Discharges from Nuclear Reprocessing Plants;

PARCOM Recommendation 94/8 Concerning Environmental Impact Resulting from Discharges of Radioactive Discharges [4];

PARCOM Recommendation 94/9 Concerning the Management of Spent Nuclear Fuel (OECD, 2000);

OSPAR Decision 2000/1 on Substantial Reductions and Elimination of Discharges, Emissions and Losses of Radioactive Discharges, with Special Emphasis on Nuclear Reprocessing;

OSPAR Decision 2001/1 on the Review of Authorisations for Discharges or Releases of Radioactive Substances from Nuclear Reprocessing Activities;

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

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

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 and collated by the Secretariat and, following examination by the Expert Assessment Panel (EAP), published by the Commission in the form of annual reports; at first as part of the OSPAR Commission's general annual report, and from 1991 onwards in annual reports on discharges from nuclear sectors. From 1998 onwards, the annual reports (starting with 1996 data) also contain an assessment of liquid discharges which include a description of the trends from 1989 until the date of the latest report. The OSPAR Commission also published in 1998 a summary of the report on sources, inputs and temporal trends of radioactive discharges from nuclear installations for the years 1989 to 1995 (OSPAR, 1998).

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 Commission. With a view to harmonising the way in which data and information are being established and reported, the OSPAR Commission adopted in 1996 the reporting format used for annual data up to 2005 (OSPAR agreement number: 1996-02).

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.

---

2 OSPAR Decision 2000/1: France and the United Kingdom abstained from voting.
OSPAR Decision 2001/1: France, Switzerland 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).

1.3 Parameters monitored and reported

The tables in this annual report contain data on total alpha, total beta, tritium and individual radionuclides. The assessment in Chapter 2 and the Figures 1, 2 and 3 show trends in discharges of total alpha activity, total beta activity and tritium.

Total alpha and total beta 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 alpha and total beta 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 alpha and total beta quantities. Consequently, for the purposes of this report total alpha quantities include measurements that are strictly gross alpha; similarly for total beta, quantities as gross beta measurements are included.

Total alpha represents the measured radioactivity of alpha particle emitting radionuclides. These particles, which are composed of two protons and two neutrons, are emitted as a result of the decay of certain radionuclides, the so-called α-emitters. On average, the total liquid discharges of α-emitters from all nuclear sites represent mainly Pu-239, Pu-240 and Am-241 and, to a lesser extent, Th-230, Pu-238 and some other nuclides. [5.]

Total beta represents the measured radioactivity of beta particle emitting radionuclides. These particles, that are similar to electrons, except that they originate from (processes within) the atomic nucleus, 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 beta 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 beta particles. Tritium is discharged from most nuclear power plants, reprocessing plants and some research and development facilities.

5 For abbreviations of radionuclides see Chapter 3.

2. Assessment of the liquid radioactive discharges from nuclear installations in 2008

2.1 Introduction

Tables 1-3 summarise liquid radioactive discharges from nuclear installations for the period 1990 – 2008; data for 1990–2007 are taken from the OSPAR Annual Reports on Liquid Discharges from Nuclear Installations. Reported discharges include data from nuclear power stations, nuclear fuel reprocessing plants, nuclear fuel fabrication and enrichment plants, research and development facilities. Since 2006, discharges from decommissioning are reported separately.

For each type of nuclear installation, Table 1 gives total alpha activity, Table 2 gives tritium and Table 3 gives total beta activity (excluding tritium) in TBq/y as well as the ratio, as a percentage, of the total discharges from all installations. To facilitate comparison of the discharges year by year, Figures 1 to 3 show trends for total alpha, tritium and total beta (excluding tritium) for the time period 1990 to 2008.

2.2 Trends in total alpha discharges

Figure 1 shows a decrease of the total alpha activity discharged from all nuclear installations over the 17-year period. Discharges of alpha activity are at their lowest level during the period and in 2008 (0.144TBq) were less than one-tenth of the peak value in 1993. The alpha discharge in 2007 from Sellafield was 1.6% higher than the previous year Sellafield (2003, 0.41TBq; 2004, 0.29TBq; 2005, 0.25TBq; 2006, 0.21TBq; 2007, 0.125TBq; 2008, 0.127TBq). Despite this the overall trend is still downward, with a 1.4% decrease relative to the previous year, largely as a result of reductions in discharges from the reprocessing plant at La Hague. The La Hague plant contributed 0.0172TBq to the overall alpha discharge, this is a small proportion of the total, and was 18% lower than the previous year.

The decline in discharges from the fuel fabrication sub-sector continues, but the rate of decline is not so great as it was. The discharges from the Springfields site (2005, 0.25TBq; 2006, 0.11TBq; 2007, 0.026TBq; 2008, 0.022TBq) were 15% lower in 2008 than the previous year.

Discharges from research and development facilities continue to decline and for 2007 were only 90MBq in total. Total alpha discharges arising from decommissioning have been recorded separately since 2006, but do not contribute significantly to the overall total.

2.3 Trends in tritium discharges

Figure 2 presents the discharges of tritium, in terms of activity. The sum of the tritium discharges from all installations increased from around 8000TBq/y during the period 1990 - 1992 to a peak of 20634TBq in 2004. This increase was mainly due to the discharges from La Hague (2001, 9650TBq; 2002, 12000TBq; 2003, 11900TBq; 2004, 13900TBq). During the period 2005 to 2006 discharges of tritium from La Hague fell significantly (2005, 13500TBq; 2006, 11100TBq), but rose by 8% in 2007 (12000TBq). In 2008 the tritium discharges from La Hague to fell to 8190TBq, a reduction of 32% relative to 2007, largely as a result of reduced reprocessing throughput. Despite this reduction in discharges, the reprocessing plant at La Hague still contributed more than 70% of the total tritium discharge from all sectors in 2008 (11178TBq).

The tritium discharges from Sellafield declined over the four-year period 2004-2007 (2003, 3900TBq; 2004, 3170TBq; 2005, 1570TBq; 2006, 1090TBq; 2007, 628TBq), but increased in 2008 (778TBq) relative to 2007 to This is in part a consequence of reduced reprocessing throughput at Sellafield as a result of reduced reprocessing throughput, including the limited operation of the THORP facility throughout 2008. Tritium discharges from the reprocessing sub-sector are broadly proportional to throughput of fuel.

During 2008 nuclear power stations again contributed nearly 20% of the total tritium discharges from the nuclear sector. The discharges of tritium from this sector in 2008 (2192TBq) were again lower than the previous year, 2007 (2936TBq), and significantly lower than in 2005 (3429TBq). The UK AGRs accounted for approximately 66% of the total tritium discharges from the nuclear power sector in 2005 and this proportion reduced to under 50% in 2008. This was largely due to reduced reactor availability during 2008 to deal with nuclear safety checks and plant maintenance. The tritium discharges from the UK's AGRs during 2009 are expected to return to their normal levels.

The contribution to discharges of the research and development facilities remains low (6.15TBq). Tritium discharges arising from decommissioning have been recorded separately since 2006, and though they are a very minor contributor they are quite variable. Discharges in 2008 (11.2TBq) were less than half those in 2007 (24TBq).

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 over the past 17 years, from 491TBq (1990), down to 27.23TBq (2008). Historically, total beta discharges have been dominated by discharges from the reprocessing plant at Sellafield and the nuclear fuel plant at Springfields. These facilities together continue to contribute approximately 70% (2008) of the overall discharges, but this proportion continues to decline over time.

Prior to 2002 the high total beta discharges from Sellafield (2001, 123TBq) were mainly attributable to the radionuclide Technetium-99 (2001, 79TBq). The contribution from Technetium-99 to the total beta discharge at Sellafield has been reducing steadily (2001, 79TBq; 2002, 85TBq; 2003, 37TBq; 2004, 14TBq; 2005, 6.7TBq; 2006, 5.6TBq; 2007, 4.9TBq; 2008, 2.37TBq) and now accounts for less than 17% of the total beta discharge from that site. There was a more than 40% reduction in total beta discharges from Sellafield during 2008 relative to 2007 (2001, 123TBq; 2002, 112TBq; 2003, 83TBq; 2004, 73TBq; 2005, 43TBq; 2006, 29TBq; 2007, 24.8TBq; 2008, 14.3TBq), although the reduction in Tc-99 contributed to this overall reduction there were significant reductions in other radionuclides as well.

In the 3 years prior to 2008, the most significant change noted in total beta discharges was the decline in beta discharges from the fuel fabrication sub-sector, in particular from the Springfields site (2005, 103TBq; 2006, 20.7TBq; 2007, 3TBq). However, in 2008 the total beta discharges from Springfields rose by 53%, from a very low base. This did not affect the overall downward trend for the whole nuclear sector as it was more than compensated by the major reduction in total beta discharges from Sellafield, mentioned above.

Table 1. Total alpha discharges 1990-2008

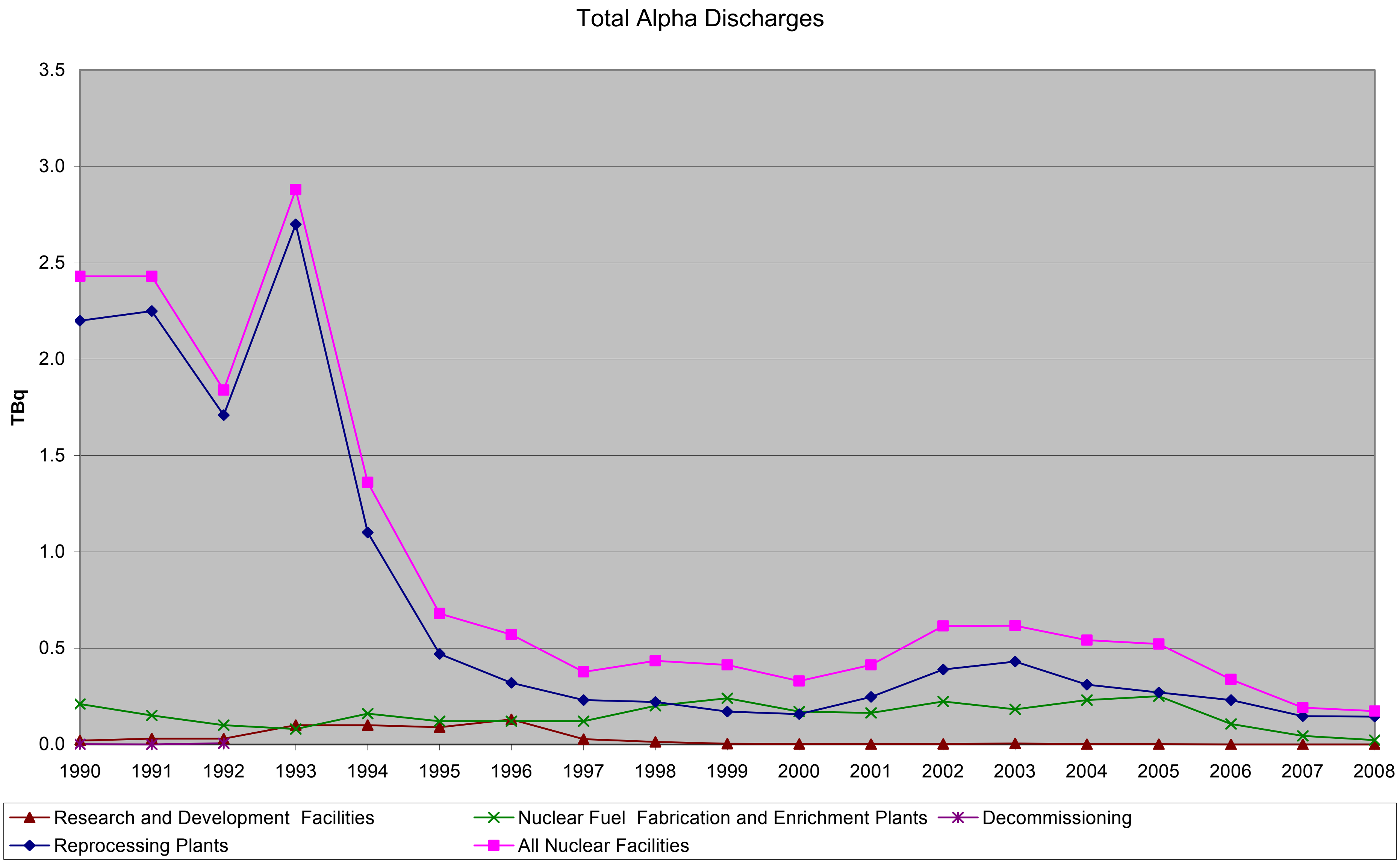
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
All Nuclear Installations (TBq)	2.43	2.43	1.84	2.88	1.36	0.68	0.57	0.38	0.43	0.41	0.33	0.41	0.61	0.62	0.54	0.52	0.34	0.19	0.17
Reprocessing Plants (TBq)	2.20	2.25	1.71	2.70	1.10	0.47	0.32	0.23	0.22	0.17	0.16	0.25	0.39	0.43	0.31	0.27	0.23	0.15	0.14
% 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
Nuclear Power Plants (TBq)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
% of all installations	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nuclear Fuel Fabrication (TBq)	0.21	0.15	0.10	0.08	0.16	0.12	0.12	0.12	0.20	0.24	0.17	0.16	0.22	0.18	0.23	0.25	0.11	0.04	0.02
% 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
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
% 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
Decommissioning (TBq)																	0.00	0.00	0.01
% of all installations																	0.2	0.31	3.65

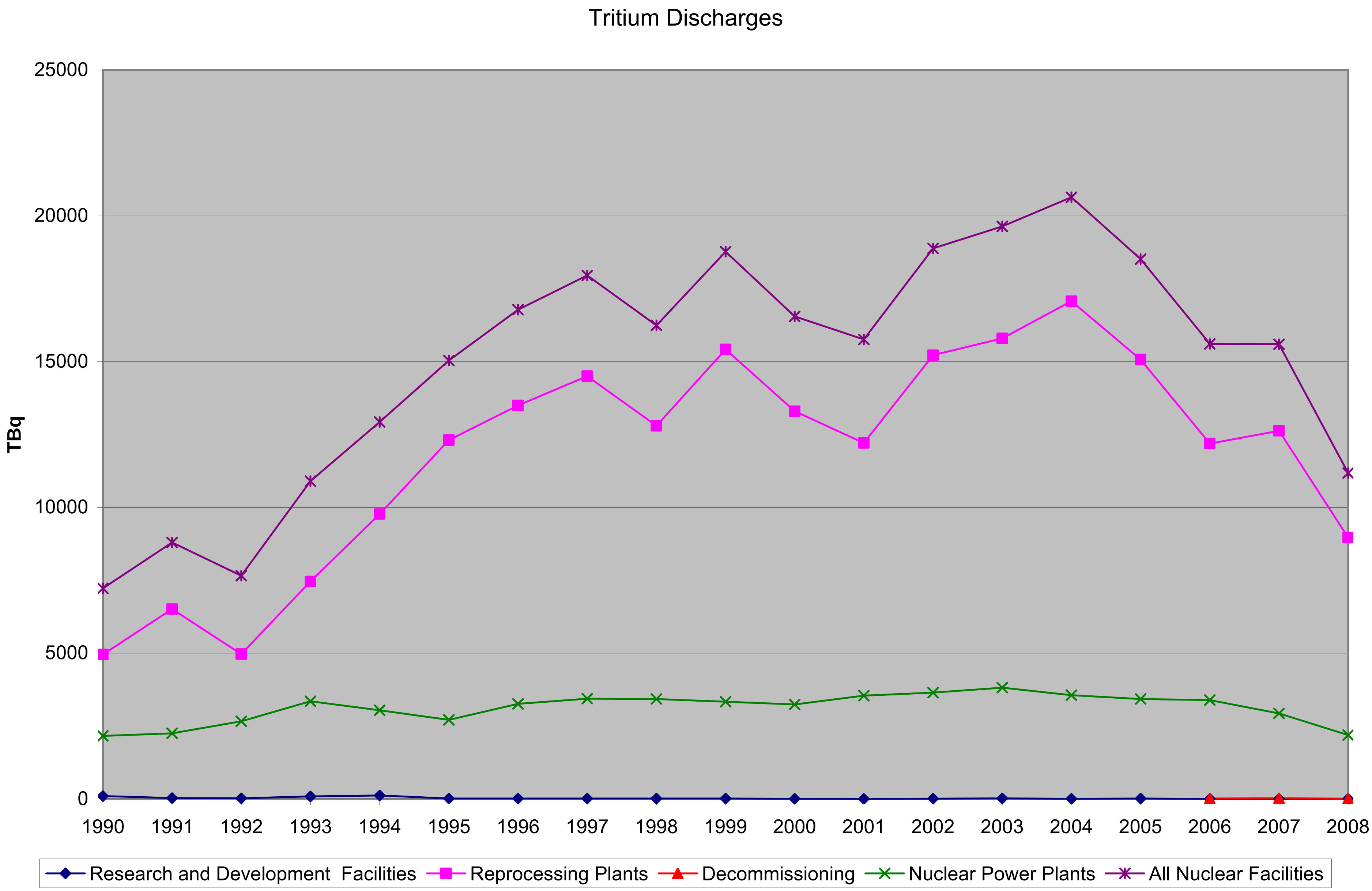
Table 2. Tritium discharges 1990-2008

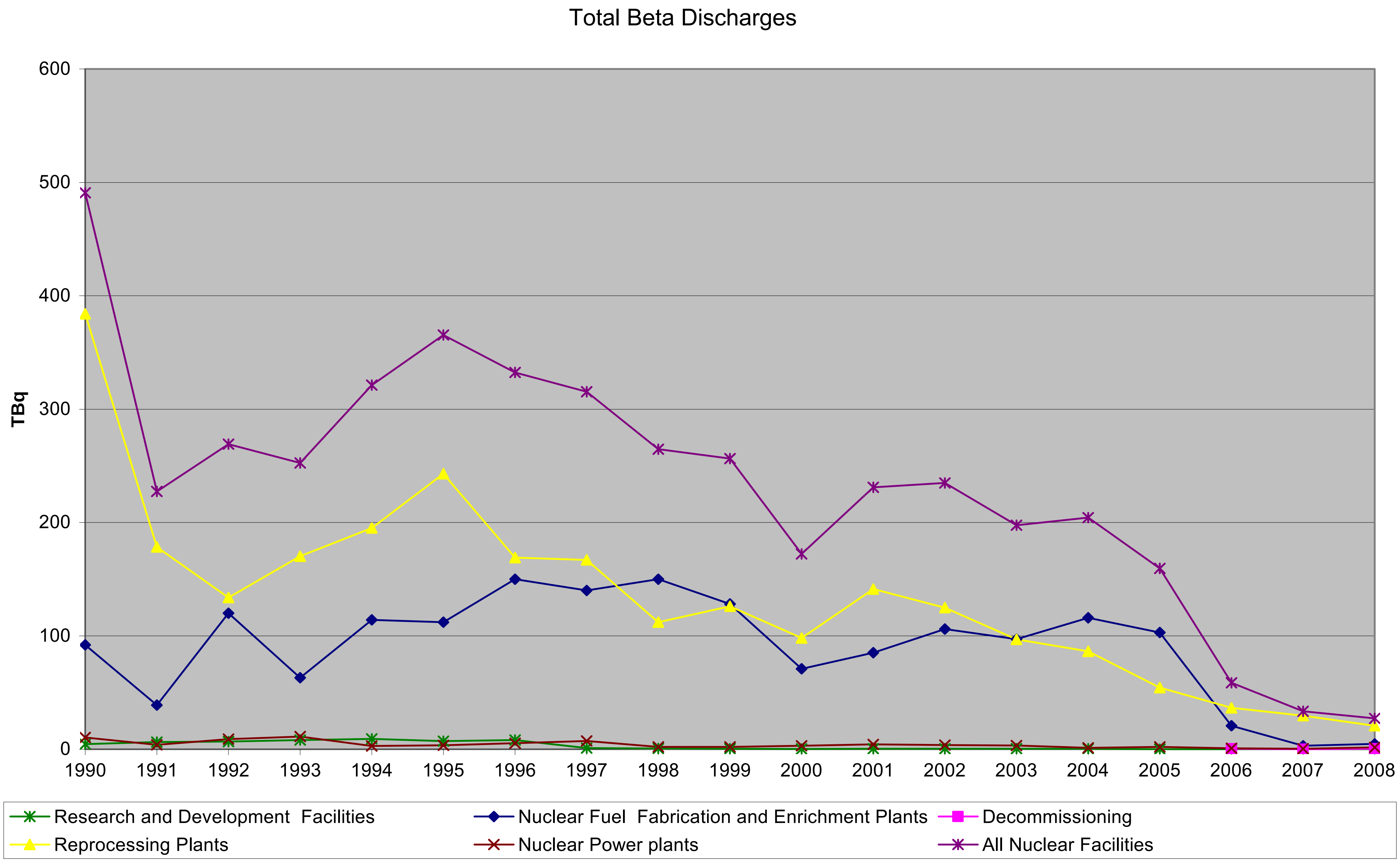
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
All Nuclear Installations (TBq)	7224	8798	7658	10902	12931	15040	16779	17956	16244	18771	16548	15759	18880	19637	20637	18517	15607	15594	11178
Reprocessing Plants (TBq)	4959	6513	4969	7460	9770	12310	13500	14500	12800	15420	13300	12210	15220	15800	17070	15070	12190	12628	8968
% 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
Nuclear Power Plants (TBq)	2164	2252	2666	3354	3044	2713	3264	3440	3430	3335	3241	3543	3648	3819	3560	3429	3394	2936	2193
% 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
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
% 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
Decommissioning (TBq)																	16.90	25.07	11.18
% of all installations																	0.1	0.16	0.10

Table 3. Total beta (excl tritium) discharges 1990-2008

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
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
Reprocessing Plants (TBq)	384	178	134	170	195	243	169	167	112	126	98	141	125	97	86	54	37	29.61	20.67
% 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
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
% 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
Nuclear Fuel Fabrication (TBq)	92	39	120	63	114	112	150	140	150	128	71	85	106	97	116	103	21	3	5
% of all installations	18.7	17.1	44.6	25.0	35.5	30.7	45.1	44.4	56.7	49.9	41.2	36.8	45.1	49.1	56.8	98.0	35.4	8.9	16.8
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
% 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
Decommissioning (TBq)																	0.40	0.04	0.38
% of all installations																	0.0	0.1	1.4


Total Alpha Discharges
TBq
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
Research and Development Facilities
Nuclear Fuel Fabrication and Enrichment Plants
Decommissioning
Reprocessing Plants
All Nuclear Facilities


Tritium Discharges
TBq
25000
20000
15000
10000
5000
0
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
Research and Development Facilities
Reprocessing Plants
Decommissioning
Nuclear Power Plants
All Nuclear Facilities


Total Beta Discharges
TBq
600
500
400
300
200
100
0
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
Research and Development Facilities
Nuclear Fuel Fabrication and Enrichment Plants
Decommissioning
Reprocessing Plants
Nuclear Power plants
All Nuclear Facilities

3. 2008 data and information

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

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

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

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

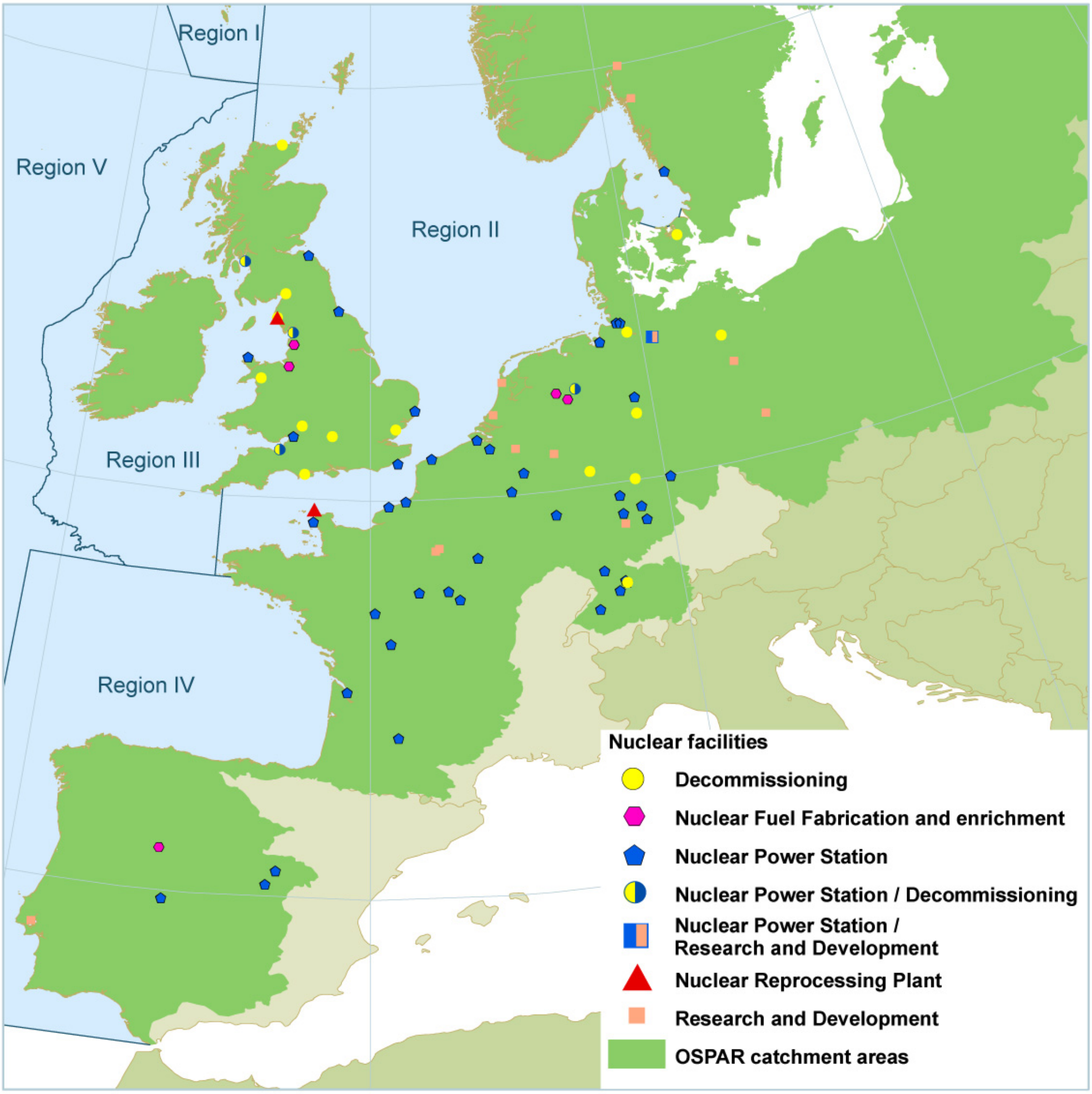
For radionuclides:

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 Contracting Parties discharging directly or indirectly to the OSPAR Regions.



3.2 Location of nuclear installations

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

Country / Code	Name of installation	Type	Discharging into
Belgium			
BE1	Doel	NPS	Schelde
BE2	Tihange	NPS	Meuse
BE3	Mol	RDF	River Mol-Neet
Denmark			
DK1	Risø	DMLRW	Kattegat through Roskilde Fjord
France			
FR1	Belleville	NPS	Loire
FR2	Cattenom	NPS	Mosel
FR3	Chinon	NPS	Loire
FR4	Chooz	NPS	Meuse
FR5	Civaux	NPS	Vienne
FR6	Dampierre en-Burly	NPS	Loire
FR7	Fessenheim	NPS	Rhine
FR8	Flamanville	NPS	Channel
FR9	Fontenay-aux- Roses	RDF	Seine
FR10	Golfech	NPS	Garonne
FR11	Gravelines	NPS	North Sea
FR12	Le Blayais	NPS	Gironde Estuary
FR13	La Hague	NFRP	English Channel
FR14	Nogent-sur-Seine	NPS	Seine
FR15	Paluel	NPS	Channel
FR16	Penly	NPS	Channel
FR17	Saclay	RDF	Etang de Saclay
FR18	Saint Laurent	NPS	Loire
Germany			
DE1	Biblis A/Biblis B	NPS	Rhine
DE2	Brokdorf	NPS	Elbe
DE3	Brunsbüttel	NPS	Elbe
DE4	Grafenrheinfeld	NPS	Main
DE5	Grohnde/Emmerthal	NPS	Weser
DE7	Kahl	DMLRW	Main – Shut down
DE8a	Krümmel/Geesthacht	NPS	Elbe
DE8b	Geesthacht	RDF	Elbe
DE9a	Lingen/Emsland	NPS	Ems
DE9b	Lingen	DMLRW	Ems - via municipal sewer system – Shut down
DE10	Mülheim-Kärlich	DMLRW	Rhine – Shut down
DE11a	Neckar-westheim 1	NPS	Neckar
DE11b	Neckar-wesheim 2	NPS	Neckar
DE12	Obrigheim	DMLRW	Neckar – Shut down
DE13a	Philippsburg KKP1	NPS	Rhine
DE13b	Philippsburg KKP2	NPS	Rhine
DE14	Rheinsberg	DMLRW	Havel – Shut down
DE15	Stade	DMLRW	Elbe – Shut down
DE16	Rodenkirchen-Unterweser	NPS	Weser
DE17	Würgassen/Beverungen	DMLRW	Weser – Shut down
DE18	Karlsruhe	RDF	Rhine
DE19	Gronau	NFFEP	Vechte, IJsselmeer
DE20	Hanau	NFFEP	Main - via municipal sewer system
DE22	HMI Berlin	RDF	Havel
DE23	Jülich	RDF	Rur
DE24	Rossendorf	RDF	Elbe
The Netherlands			
NL1	Borssele	NPS	Scheldt Estuary

Country / Code	Name of installation	Type	Discharging into
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	NPS	Tagus
ES3	Trillo	NPS	Tagus
ES4	Juzbado	NFFEP	River Tormes - Duero
Sweden			
SE2	Ringhals 1-4	NPS	Kattegat
Switzerland			
CH1	Beznau	NPS	Aare
CH2	Gösgen	NPS	Aare
CH3	Leibstadt	NPS	Rhine
CH4	Mühleberg	NPS	Aare
CH5	Paul Scherrer Institute	RDF	Aare
CH6	ZWILAG Würenlingen	DMLRW	Aare
United Kingdom			
UK1	Berkeley	DMLRW	Severn Estuary
UK2	Bradwell	DMLRW	North Sea
UK3	Calder Hall	DMLRW	Irish Sea
UK4	Chapelcross	DMLRW	Solway Firth
UK5a	Dungeness A	NPS	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	NPS	North Sea
UK11b	Sizewell B	NPS	North Sea
UK12	Torness	NPS	North Sea
UK13	Trawsfynydd	DMLRW	Trawsfynydd lake
UK14	Wylfa	NPS	Irish Sea
UK15	Sellafield	NFRP	Irish Sea
UK16	Capenhurst	NFFEP	Irish Sea via Rivacre Brook and Mersey Estuary
UK17	Springfields	NFFEP	Irish Sea via River Ribble
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: Decommissiong and Management of Legacy Radioactive Wastes

Table 4 Nuclear Power Stations

Location Ref.	Country Site	Discharges to	Reactors Number and Type	Installed Capa-city MW (e)	Net Electrical Output MW (e).h	Operational discharges of radioactive substances (TBq) Tritium	other (1) radio-nuclides	Specific radionuclides gross a-activity	gross b-activity (ex.Tritium)	Co 58	Co 60	Zn 65	Sr 90	Zr/Nb 95	Ru 106	Ag 110m	Sb 125	Cs 134	Cs 137	Ce 144	S 35
	Belgium (2) (3)																				
BE1	Doel	Schelde	4 PWR	392.5	2,681,153	4.17E+01	3.10E-03	0.00E+00	1.70E-06	3.92E-04	5.54E-04	3.00E-07	0.00E+00	2.22E-05	1.20E-04	6.56E-04	4.11E-04	1.74E-05	2.64E-04	0.00E+00	
				433	3,475,290									8.92E-05							
				1006	6,901,239																
				1008	7,442,522																
BE2	Tihange	Meuse	3 PWR	962	7,250,355	3.37E+01	1.77E-02	1.36E-09	0.00E+00	6.78E-03	6.90E-03	1.80E-05	0.00E+00	1.81E-04	0.00E+00	7.33E-04	6.75E-05	1.97E-04	4.83E-04	0.00E+00	
				1008	7,112,834									4.93E-04							
				1015	8,377,027																
	France (4) (5)				(6)																
FR1	Belleville	Loire	2 PWR	2600		5.1E+01	2.30E-04			5.9E-05	4.1E-05			3.0E-07		8.0E-06	2.9E-05	8.0E-06	5.1E-05		
FR2	Cattenom	Mosel	4 PWR	5200		1.1E+02	1.09E-03			3.4E-04	2.6E-04					3.3E-05	8.3E-05	4.2E-05	8.6E-05		
FR3	Chinon	Loire	4 PWR	3600		3.2E+01	3.03E-04			7.0E-05	8.0E-05					4.5E-05	3.6E-05	1.2E-05	1.4E-05		
FR4	Chooz	Meuse	2 PWR	2900		6.0E+01	3.85E-04			2.4E-05	1.6E-04					2.2E-05	6.1E-05	2.0E-05	2.3E-05		
FR5	Civaux	Vienne	2 PWR	2900		4.8E+01	1.78E-04			1.9E-05	6.0E-05					4.6E-05	1.3E-05	5.0E-06	9.0E-06		
FR6	Dampierre-	Loire	4 PWR	3600		4.5E+01	4.60E-04			6.0E-05	6.4E-05					1.7E-04	4.8E-05	1.8E-05	2.2E-05		
FR7	Fessenhein	Rhine	2 PWR	1800		2.1E+01	5.05E-04			8.1E-05	1.5E-04					1.7E-04	2.1E-05	8.0E-06	1.6E-05		
FR8	Flamanville	North Sea	2 PWR	2600		3.2E+01	4.51E-04			1.5E-04	8.9E-05					1.8E-05	9.8E-05	1.6E-05	1.7E-05		
FR10	Golfech	Garonne	2 PWR	2600		6.1E+01	1.89E-04			5.2E-05	4.7E-05					1.2E-05	2.1E-05	8.0E-06	1.5E-05		
FR11	Gravelines	North Sea	6 PWR	5400		6.0E+01	1.07E-03			1.6E-04	4.8E-04					1.6E-04	8.3E-05	2.0E-05	6.6E-05		
FR12	Le Blayais	Gironde	4 PWR	3600		4.8E+01	8.95E-04			8.3E-05	1.3E-04					5.3E-04	3.4E-05	3.1E-05	4.9E-05		
FR14	Nogent-	Seine	2 PWR	2600		4.9E+01	2.90E-04			9.8E-05	7.1E-05					2.0E-05	2.8E-05	1.2E-05	1.6E-05		
FR15	Paluel	North Sea	4 PWR	5200		1.2E+02	1.56E-03			5.9E-04	3.1E-04					7.7E-05	1.2E-04	4.6E-05	6.4E-05		
FR16	Penly	North Sea	2 PWR	2600		7.2E+01	5.19E-04			1.7E-04	2.1E-04					8.0E-06	3.3E-05	6.0E-06	1.5E-05		
FR18	Saint Laure	Loire	2 PWR	1800		2.8E+01	1.62E-04			2.6E-05	4.4E-05					2.7E-05	1.7E-05	6.0E-06	9.0E-06		
	Federal Republic of Germany																				
DE1a	Biblis A	Rhine	1 PWR	1225	8960829	7.63E+0	1.97E-5				7.22E-6					7.53E-7	7.30E-6	2.86E-8	1.81E-6		
DE1b	Biblis B	Rhine	1 PWR	1300	10975041	1.09E+1	1.06E-5				1.61E-6						6.35E-6		3.86E-7		
DE2	Brokdorf	Elbe	1 PWR	1440	12042400	2.15E+1															
DE3	Brunsbüttel	Elbe	1 BWR	806	0	4.58E-2	1.11E-4			4.09E-7	2.47E-5	6.32E-5	4.15E-7	3.25E-9		1.10E-7			3.62E-6	1.22E-7	
DE4	Grafenrheir	Main	1 PWR	1345	10330499	1.55E+1	2.57E-5			3.54E-7	2.07E-5			1.66E-7		5.89E-8					
DE5	Grohnde/Er	Weser	1 PWR	1430	11169844	2.07E+1	2.48E-4			9.19E-6	1.24E-4							2.29E-7	6.05E-8		
DE8a	Krümmel/G	Elbe	1 BWR	1402	0	7.10E-2															
DE9a	Lingen/Ems	Ems	1 PWR	1400	11490541	1.95E+1															
DE11a	Neckar-We	Neckar	1 PWR	840	4187792	5.10E+0	1.22E-6				2.87E-7										
DE11b	Neckar-We	Neckar	1 PWR	1400	11431720	2.10E+1	3.69E-7			2.31E-7	1.38E-7										
DE13a	Philippsbur	Rhine	1 BWR	*357*	6423289	3.79E-1	8.12E-5			3.72E-6	1.96E-5	3.98E-5				4.20E-7		5.80E-8	2.51E-6		
DE13b	Philippsbur	Rhine	1 PWR	1458	11429510	1.73E+1	7.71E-5			4.70E-6	2.08E-5	2.78E-6		1.53E-6		6.40E-8			1.93E-5	1.20E-6	
DE16	Rodenkirch	Weser	1 PWR	1410	9776485	1.85E+1	8.27E-5			2.70E-6	6.06E-5								1.12E-7		
	The Netherlands								(13)												
NL1	Borssele	Westerschel	1 PWR	520	3.99E+6	6.53E+0	NI	9.00E-2	2.24E-4	4.12E-6	6.56E-5	<MDA	<MDA	1.45E-5	<MDA	6.73E-6	3.40E-7	9.80E-7	1.24E-5	2.10E-7	NI

Location Ref.	Country Site	Discharges to	Reactors Number and Type	Installed Capa-city MW (e)	Net Electrical Output MW (e).h	Operational discharges of radioactive substances (TBq) Tritium	other (1) radio-nuclides	Specific radionuclides gross a-activity	gross b-activity (ex.Tritium)	Co 58	Co 60	Zn 65	Sr 90	Zr/Nb 95	Ru 106	Ag 110m	Sb 125	Cs 134	Cs 137	Ce 144	S 35
	Spain (14) (15)																				
E1	Almaraz	Tagus	2 PWR	1 957	13 372 069	25.80	0.006	ND	NI	9.99E-04	6.08E-04	1.91E-05	5.00E-05	3.68E-04	8.34E-05	3.71E-04	1.94E-04	1.30E-05	2.57E-04	5.58E-07	NI
E2	José	Tagus	1 PWR	(16)		0.13	1.64E-04	ND	NI	ND	1.64E-04	ND	ND	ND	ND	ND	ND	ND	ND	ND	NI
E3	Trillo	Tagus	1 PWR	1 066	7 739 509	15.90	9.20E-04	ND	NI	2.21E-05	1.47E-04	5.80E-06	ND	2.27E-05	ND	2.49E-05	9.99E-06	ND	2.64E-05	ND	NI
	Sweden																				
S2	Ringhals 1-	Kattegat (18)	BWR	835	538	5.20E-1	1.60E-3	1.30E-5		3.10E-4	6.60E-4	8.70E-7		8.70E-5		4.50E-5	1.70E-5		2.40E-4		
		(19)	PWR	866	691	6.30E+0	1.90E-4	7.00E-7		1.20E-5	1.60E-5			3.74E-6		2.30E-8	2.80E-5		3.50E-6		
		(20)	PWR	1045	914	2.10E+0	3.10E-4	4.00E-8		7.20E-7	1.20E-5			5.50E-7		6.00E-6	1.40E-6		1.70E-7		
		(21)	PWR	935	882	1.10E+1	1.50E-3	5.30E-7		1.10E-3	7.50E-5	4.00E-7		1.23E-4		1.23E-6			4.10E-6	1.20E-6	
	Switzerland																				
CH1	Beznau	Aare	2 PWR	380/380	6,030,000	1.20E+1	8.40E-4	6.00E-8		1.90E-4	7.80E-5		1.70E-6	1.40E-7			5.60E-5	1.70E-6	1.30E-4		
CH2	Gösgen	Aare	1 PWR	1020	7,964,000	1.70E+1	1.20E-5	<1.5E-7			3.00E-6										
CH3	Leibstadt	Rhine	1 BWR	1220	9,307,700	1.40E+0	1.50E-4	2.00E-6		1.40E-5	1.20E-4	1.00E-6							4.20E-6		
CH4	Mühleberg	Aare	1 BWR	372	2,973,200	1.20E-1	2.10E-3	6.50E-8		1.80E-4	8.70E-4	2.90E-5	4.70E-7						1.50E-4		
	United Kingdom																				
UK5a	Dungeness A	English	2 GCR			9.51E-2	8.16E-3												2.36E-2		
UK5b	Dungeness B	English	2 AGR			1.73E+2	1.50E-3				7.18E-4								2.40E-3		2.50E-01
UK6	Hartlepool	North Sea	2 AGR			3.97E+0	1.51E-3				5.35E-5								1.99E-3		6.00E-03
UK7a	Heysham 1	Morecambe	2 AGR			2.20E+0	5.42E-3				1.88E-4								1.08E-3		1.00E-03
UK7b	Heysham 2	Morecambe	2 AGR			2.88E+2	1.06E-2				3.70E-5								7.10E-4		6.81E-02
UK8	Hinkley Point B	Severn	2 AGR			7.79E+1	3.54E-3				2.28E-4								4.19E-3		1.50E-01
UK9	Hunterston B	Firth of Clyde	2 AGR			6.62E+1		9.81E-5	8.82E-3		3.3 E-4										1.37E-01
UK10	Oldbury	Severn	2 GCR			1.84E-1	1.27E-1												3.09E-1		
UK11a	Sizewell A	North Sea	2 GCR			1.45E-1	1.11E-1												1.77E-1		
UK11b	Sizewell B	North Sea	1 PWR			5.16E+1	1.50E-2												5.00E-3		
UK12	Torness	North Sea	2 AGR			358		1.80E-5	4.71E-3		3.16E-4										1.88E-02
UK14	Wylfa	Irish Sea	2 GCR			3.00E+0	1.20E-2														

Table 5 Nuclear Fuel Reprocessing Plants

Location ref	**La Hague (FR13)**		**Sellafield (UK15)**
Discharges to	English Channel		Irish Sea
Type of Fuel Reprocessed Capacity (t/y)	PWR + BWR		Magnox, AGR, LWR
Radionuclide	**TBq released per annum (1)**	**Normed releases in TBq per GWye (? GWye)**	**TBq released (2) (3)**
Tritium	8.19E+3		7.78E+2
Total-α	1.72E-2	5.50E-4	1.27E-1
Total-β	6.37	2.04E-1	1.43E+1
C 14	6.24		7.19E+0
S 35			nil
Mn 54	2.26E-3		nil
Fe 55			nil
Co 57	7.31E-5		nil
Co 58	6.41E-5		nil
Co 60	9.72E-2		7.21E-2
Ni 63	6.44E-2		nil
Zn 65	ND		nil
Sr 89	ND		nil
Sr 90	1.59E-1		1.70E+0
(Sr 90 + Cs 137)			6.81E+0
(Zr + Nb 95)	ND		1.25E-1
Tc 99	7.41E-2		2.37E+0
Ru 103	ND		nil
Ru 106	3.37		1.39E+0
(Ru + Rh) 106	6.74		as above
Ag 110m	ND		nil
Sb 124	ND		nil
Sb 125	3.80E-1		nil
I 129	1.04		1.99E-1
Cs 134	7.50E-2		1.15E-1
Cs 137	8.92E-1		5.11E+0
Ce 144	7.55E-5		3.54E-1
(Ce + Pr) 144	1.51E-4		as above
Pm 147			nil
Eu 152			nil
Eu 154	5.55E-4		nil
Eu 155	8.08E-5		nil
Np 237	4.27E-4		4.30E-2
Pu 239+240	1.69E-3		1.08E-1
Pu 241	1.20E-1		2.44E+0
Am 241	2.74E-3		2.97E-2
Cm 242	1.14E-5		nil
Cm 243+244	1.35E-3		2.92E-3
Uranium (in kg)	19.3		2.76E+2

ND: not detectable

Table 6 Nuclear Fuel Fabrication and Enrichment Plants

Location Ref.	Country/ site	Discharges to	Type of Fuel	Capacity (t/y)	Production	Activity	TBq released
	Federal Republic of Germany						
DE19	Gronau	Vechte, IJsselmeer	Uranium enrichment			total - α	2.3E-9
DE20	Hanau	Main - via municipal sewer system	PWR, MOX				
	Netherlands						
NL3	Urenco, Almelo	Municipal sewer system	Uranium enrichment	4500	3644	total - α	6.00E-7
						total - β (β- & γ- emitting rn)	5.30E-6
	Spain						
E4	Juzbado (1)	River Tormes - Duero	PWR, BWR			total - α	1.27E-5
	United Kingdom						
UK16	Capenhurst	Irish Sea via	Uranium enrichment			Uranium - α	1.43E-4
		Rivacre Brook and				Uranium daughters	1.02E-5
		Mersey Estuary				other - α	1.63E-5
						Tc 99	1.73E-5
						Tritium	
UK17	Springfields	Irish Sea via	GCR, AGR, PWR			total - α	2.20E-2
		River Ribble	fuel fabrication			total - β	4.58E+0
						Tc 99	6.77E-2
						Th 230	1.80E-3
						Th 232	2.30E-4
						Uranium α	1.30E-2
						Np 237	2.00E-3

Table 7 Research and Development Facilities

Location Ref.	Country/ site	Discharges to	Reactors Number & Type	Installed Capacity	Radionuclides	TBq released per annum
	Belgium			(1)		
BE3	**Mol**	River Mol-Neet	2		Total-alpha	1.45E-05
					Total-beta	1.51E-04
					H-3	2.70E+00
					Sr-90/Y-90	3.38E-05
					Co-60	4.00E-12
					Cs-134	0.00E+00
					Cs-137	1.44E-10
					Total activitiy	2.70E+00
	France					
FR17	Saclay	Etang	Centre de recherches du		α	6.00E-5
		de Saclay	Commissariat à l'énergie		other radionuclides	7.45E-4
			atomique		Tritium	3.03E-02
	Germany					
DE8b	Geesthacht	Elbe	1		Tritium	1.3E-04
					other radionuclides	1.9E-05
DE18	Karlsruhe	Rhine	No reactors		Tritium	1.5E+00
					other radionuclides	9.1E-06
DE22	HMI Berlin	Havel	1		Tritium	4.6E-04
					other radionuclides	1.5E-07
DE23	Jülich	Rur	1		Tritium	2.2E-01
					other radionuclides	9.1E-05
DE24	Rossendorf	Elbe	No reactors		Tritium	1.8E-04
					other radionuclides	9.9E-07
	Netherlands					
NL4	Delft (2) (3) (4)	Sewage system	1 Research reactor	2 MWth	α – emitting radionuclides	<1E-07
					β – emitting radionuclides including tritium	4.92E-06
					γ – emitting radionuclides	<2,58E-06
					total	(<8,0E-06)
NL5	Petten (5) (6) (7)	North Sea	1 high flux	50 MWth	Tritium	2.00E-01
			Research reactor		α - emitting radionuclides	4.87E-06
			1 low flux	30kWth	β/γ – emitting radionuclides	6.50E-02
			Research reactor		total	2.65E-01
	Norway (8)					
NO1	Halden (9)	River Tista	1 BWR		Tritium	2.20E+00
		(Skagerrak)	D2O as		Total α	NA
			moderator	(10)	Total β	5.23E-04
					Ag-110m	2.20E-06
					Cr-51	3.00E-05
					Mn-54	9.80E-07
					Mn-56	NA
					Co-58	1.80E-05
					Co-60	4.60E-05
					Sr-90	5.20E-06
					Zr-95	5.80E-06
					Nb-95	1.10E-05
					Sb-125	7.00E-09
					Cd-109	2.40E-8
					I-131	2.50E-05

					Cs-134	3.90E-05
					Cs-137	2.60E-04
					Ce-141	1.90E-06
					Ce-144	2.20E-05
NO2	Kjeller (11)	River Nitelva (Skagerrak)	1 JEEP II, heavy water and cooled Research Reactor		Tritium	1.69E+00
					Total-α	1.04E-05
					Total-β	1.31E-04
					Co 58	ND
					Co 60	3.31E-05
					Zn 65	2.75E-06
					Sr 90	1.22E-05
					Zr/Nb 95	ND
					Ru 103	ND
					Ru 106	ND
					Ru/Rh 106	ND
					Ag 110m	ND
					Sb 125	ND
					I 125	4.49E-05
					I 131	1.26E-06
					Cs 134	4.10E-06
					Cs 137	3.21E-05
					Ce 144	3.83E-07
					Pu 238	4.69E-08
					Pu 239/240	7.65E-06
					Am 241	9.07E-07
					Pu 241	NA
	Portugal					
PT1	Campus de Sacavém	Residual Water Treatment Municipal Plant	1 Research Swimming Pool Reactor		Total-β	2.86E-04
	Switzerland					
CH5	Paul Scherrer Institute	Aare	1 research reactor		Tritium	3.10E-01
					Total activity without tritium	4.5E-05
					β– and γ– emitting radionuclides	
					Be-7	1.1E-07
					Na-22	4.1E-07
					S-35	9.7E-06
					Mn-54	3.2E-07
					Co-56	6.2E-08
					Co-57	7.2E-07
					Co-58	4.8E-07
					Co-60	1.3E-06
					Sr-85	2.6E-07
					Sr/Y-90	6.0E-06
					I-125	3.4E-06
					Cs-134	5.2E-07
					Cs-137	1.6E-05
					α - emitting radionuclides	
					U-234/238	1.7E-08
					Pu-238/Am-241	5.7E-08
					Pu-239/240	1.2E-07
					Cm-243/244	6.5E-09

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

Location Ref.	Country Site	Discharges to	Reactors Number and Type	Exceptional discharges of radioactive substances (TBq): Tritium	other (1) radio-nuclides	Specific radionuclides: gross a-activity	gross b-activity (ex.Tritium)	Co 58	Co 60	Zn 65	Sr 90	Na22	Ru 106	Ag 110m	Sb 125	Cs 134	Cs 137	Ce 144	S 35	Pu-241
	Denmark			(2) (3)																
DK1	Risø	Kattegat through Roskilde Fjord	No reactors	3.87E-01			1.28E-01													
	France		Type of fuel reprocessed																	
FR4	Chooz (10)	Meuse	1 PWR	1.25E-03	4.48E-04			6.50E-06	8.64E-06					6.65E-06	1.90E-05	6.30E-06	3.75E-04			
FR9	Fontenay-aux-Roses	Seine	No reactor	1.11E-5	1.21E-5	1.78E-6														
FR13	La Hague	English Channel	PWR + BWR			3.06E-3	2.06E-1		2.08E-2		1.01E-2						1.78E-1			
	Federal Republic of Germany																			
D7	Kahl	Main	1 BWR																	
D9	Lingen	Ems	1 BWR	3.59E-05	2.53E-06	2.49E-09			3.60E-8								2.45E-6			
D10	Mülheim-Kärlich	Rhine	1 PWR	2.46E-04	1.31E-05				4.86E-6											
D12	Obrigheim	Neckar	1 PWR	9.45E-02	9.60E-05	6.46E-08			2.34E-5		2.35E-8			3.61E-07			9.77E-7			
D14	Rheinsberg	Havel	1 PWR	1.70E-03	5.21E-06	4.57E-07			5.57E-7		3.18E-7						9.73E-7			
D15	Stade	Elbe	1 PWR	4.88E-02	9.81E-06	1.50E-08			3.61E-6								1.81E-6			
D17	Würgassen/Beverungen	Weser	1 BWR	3.93E-02	1.46E-05				8.55E-6		6.62E-7						5.38E-6			
	Switzerland																			
CH6	ZWILAG (4)	Aare		3.40E-1	2.60E-3	7.80E-9			6.70E-6						2.40E-6	6.00E-5	2.50E-3			
	United Kingdom																			
UK1	Berkeley Severn		2 GCR	4.89E-5	1.25E-3												3.75E-4			
UK2	Bradwell	North Sea	2 GCR	2.00E-2	5.43E-2												5.45E-2			
UK3	Calder Hall (5)	Irish Sea	4 GCR			REPORTED WITH SELLAFIELD DISCHARGES														
UK4	Chapelcross (6)	Solway Firth	4 GCR	2.49E-4		2.51E-3	1.02E-3													
UK8a	Hinkley Point A	Severn	2 GCR	2.94E-1	3.70E-1												1.10E-1			
UK9a	Hunterston A (7)	Firth of Clyde	2 CGR	6.10E-4		1.35E-4	3.86E-2													8.20E-5
UK13	Trawsfynydd (8)	Trawsfynydd	2 GCR	2.60E-3	1.18E-3						1.72E-4						8.00E-4			
UK18	Dounreay (9)	Pentland Firth	No reactors	9.61E-2		1.60E-4	1.99E-3				3.14E-2	2.10E-2					8.05E-3			
UK19	Harwell	River Thames	No reactors	1.17E-2		1.92E-5	3.42E-4		1.50E-6								2.24E-5			
UK20	Winfrith	Weymouth Bay	No reactors	9.86E+0	3.20E-2	4.12E-04											1.17E-01			

3.3 Endnotes to data tables 4 to 8

Table 4

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

(2) Value of "other radionuclides" (= total Beta-Gamma) reported as mentioned in the 'instructions for the reporting format for liquid discharges of radioactive substances from nuclear installations' (point 8)

(3) For Belgium, the nuclides included are:

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

(4) 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 2008, their net electrical output was 351 millions of MWh.

(6) Data from the producers EDF.

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

(8) Although José Cabrera nuclear power plant was shut down in 2006, its effluent data are reported in table 2 instead than in table 6 because the liquid effluents were produced during operations carried out prior to the dismantling of the plant. Other radionuclides for José Cabrera: Co-60.

(9) 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, Ba-140, La-140, Ce-141, Ce-144. Other radionuclides for Trillo: Cr-51, Mn-54, Fe-55, Co-58, Co-60, Ni-63, Zn-65, Nb-95, Zr-95, Ag-110m, Te-123m, Sb-124, Sb-125, Cs-137. Activities for Fe-55 and Ni-63 have been estimated from Co-60 using factors that have been obtained as a result of the 2008 compound samples analyses.

(10) Shut down in 2006.

(11) The value reported corresponds to the sum of individually assessed alpha emitting radionuclides

(12) For Ringhals unit 1 the following radionuclides were detected: Cr-51, Mn-54, Fe-59, Co-57, Co-58, Co-60, Zn-65, Zr-95, Nb-95, Ag-110m, Sn-113, Sb-124, Sb-125, Sr-90, Cs-137, Pu-238, Pu-239/240, Am-241, Cm-242, Cm-244

(13) For Ringhals unit 2 the following radionuclides were detected: Cr-51, Mn-54, Co-58, Co-60, As-76, Zr-95, Nb-95, Ag-108m, Ag-110m, Sn-113, Sb-124, Sb-125, Sr-90, Cs-137, Pu-238, Pu-239/240, Am-241, Cm-242, Cm-244

(14) For Ringhals unit 3 the following radionuclides were detected: Cr-51, Mn-54, Fe-59, Co-58, Co-60, Zr-95, Nb-95, Ag-110m, Sb-124, Sb-125, Sr-89, Cs-137, Pu-238, Pu-239/240, Am-241, Cm-242, Cm-244

(15) For Ringhals unit 4 the following radionuclides were detected: Cr-51, Mn-54, Fe-59, Co-58, Co-60, Zn-65, Zr-95, Nb-95, Ag-110m, S-113, Sb-124, Sr-89, Cs-137, Pu-238, Pu-239/240, Am-241, Cm-242, Cm-244

Table 5

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

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

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

Table 6

(1) For Juzbado Fuel Fabrication Plant the authorised capacity is 400 tonnes of uranium/year since 2006.

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 a substantial overestimate of the discharges of the two reactors (it is not possible to distinguish the discharges from each separate reactor). In all cases concentrations of α-emitters were lower than the detection limit, which is used for load calculations.

(6) Petten site refers to Research reactor of EU-JRC, the low-flux research reactor, Hot Cell Laboratories, Mo Production Facilities and Decontamination and Waste Treatment of NRG.

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

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

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

From IFE Halden, these radionuclides are: Ru-103, Fe-59

All these have been included in the total-beta or total-alpha.

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

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

Table 8

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

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

Additionally reporting required at discharges of Gross beta 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) 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 in 2005.

(5) Calder Hall permanently shut down in March 2003.

(6) Gross alpha and beta activity excluding tritium.

(7) Hunterston A gross alpha and beta activity excluding tritium. This value includes Pu-241 discharge limit 1 TBq, discharged 6.3E-05 TBq.

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

(9) The prototype fast reactor was shut down on 31 March 1994 and there is to be no further fuel reprocessing at Dounreay.

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

References

EC, 2003. Update of the MARINA Project on the radiological exposure of the European Community from radioactivity in North European marine waters. European Commission 2003.

OSPAR, 1998. Summary of the Report on Sources, Inputs and Temporal Trends on Radioactive Discharges from Nuclear Installations for the years 1989 to 1995. Publication 89/1998.ISBN 0 946955 85 9

OECD, 2000. A comparative study on Radiological Impacts of Spent Nuclear Fuel Management Options .ISBN 92 64 17657 8.

OSPAR, 2006. Revised First Periodic Evaluation of Progress towards the Objective of the OSPAR Radioactive Substances Strategy (JAMP product RA-1). Publication 302/2006. ISBN 1-905859-40-6. http://www.ospar.org/documents/dbase/publications/p00302_Revised First Periodic Evaluation.pdf

New Court
48 Carey Street
London WC2A 2JQ
United Kingdom

t: +44 (0)20 7430 5200
f: +44 (0)20 7430 5225
e: secretariat@ospar.org
www.ospar.org

OSPAR's vision is of a clean, healthy and biologically diverse North-East Atlantic used sustainably

ISBN 978-1-907390-56-2
Publication Number: 515/2010