OSPAR COMMISSION

# Liquid discharges from nuclear installations in 2009

Radioactive Substances Series

2011

### 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 Union 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 l’Union 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 and Mrs Ann-Christin Hägg, Sweden with the support of Ms Luisa Rodriguez Lucas and Ms Corinne Michel of the OSPAR Secretariat.

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# 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 – 2009. The discharges of tritium peaked in 2004.***

This annual report includes the data of 2009 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 19-year period. Although there was a very slight increase in the total alpha activity discharged in 2009 from nuclear installations relative to 2008, discharges still account less than one-tenth of the peak value in 1993. There was a 23% decrease compared to 2008 in alpha discharges from the fuel fabrication sub-sector at the Springfields site. However, there was a 22% increase of alpha discharges from the reprocessing plant at Sellafield compared to 2008. The figures for the reprocessing plant at La Hague showed a reduction of 18%. 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. Due to the increase in reprocessing throughput, tritium discharges also rose in 2009. Both La Hague and Sellafield registered an increase in discharges in 2009. Discharges of tritium from nuclear power stations contributed nearly 22% of the total tridium discharges, an increase by 34% compared to 2008.

**Total beta discharges** (excluding tritium) from all nuclear installations are dominated by discharges from the reprocessing plant which contributed approximately 70% of the overall discharges. There was a 30% increase in Tc-99 discharges in 2009 at Sellafield, representing 17% of total beta discharges from that site. However, total beta discharges from the fuel fabrication sub-sector at Springfields decreased by 29% compared to the 2008 figure. 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 2009. Les rejets de tritium ont atteint leur maximum en 2004.***

Le présent rapport annuel comporte les données de 2009 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** rejetée par toutes les installations nucléaires a diminué au cours des dix-neuf dernières années. Bien qu'on ait relevé une légère augmentation de l'activité d'alpha total en 2009 des installations nucléaires à comparer à 2008, les rejets d'activité alpha représentent un dixième du maximum enregistré en 1993. Par rapport à 2008, on note une réduction de 23 % des rejets d'activité alpha des usines de production de combustible nucléaire à Springfields et une augmentation de 22 % des usines de

retraitement de combustible nucléaire. On enregistre une réduction de 18 % des rejets de l'usine de retraitement à 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. En raison de l'augmentation du débit des usines de retraitement, les rejets totaux de tritirum ont également augmenté en 2009. On enregistre une hausse des rejets de La Hague et de Sellafield en 2009. Les rejets de tritium des centrales nucléaires contribuent presque 22 % des rejets totaux de tritium, une hausse de 34% par rapport à 2008.

Les **rejets totaux de total bêta** (à l'exclusion du tritium) émanant de toutes les installations nucléaires représentent pour la plupart les rejets des usines de retraitement, contribuyant environ 70% de l'ensemble des rejets. On relève une hausse de 30 % des rejets de Tc-99 de Sellafield, représentant 17 % des rejets de total bêta de cette usine. Toutefois, on note une diminution de 29 %  de l'usine de production de combustible nucléaire à Springfield par rapport à 2008.  Les rejets de total alpha 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 by the Ministerial Meeting of the OSPAR Commission at Bergen in 2010. The OSPAR Radioactive Substances Strategy thus now provides that:

“The OSPAR Commission's strategic objective with regard to radioactive substances is to prevent 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:

a. radiological impacts on man and biota;

b. legitimate uses of the sea;

c. technical feasibility.”

The Strategy further provides that:

“The Radioactive Substances Strategy will be implemented 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 Programme for More Detailed Implementation of the Strategy with regard to Radioactive Substances (the "RSS Implementation Programme" - OSPAR Agreement Number: 2001-03) 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:

PARCOM Recommendation 88/4 on Nuclear Reprocessing Plants;

PARCOM Recommendation 91/4 on Radioactive Discharges [3];

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

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

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

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

## 1.2 Annual reporting

In 1985, Contracting Parties to the former Paris Convention initiated reporting on liquid discharges from nuclear installations. These data have subsequently been submitted annually by Contracting Parties 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

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

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

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

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

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. The reporting format was last updated in 2010.

## 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 2009

## Introduction

Tables 1-3 summarise liquid radioactive discharges from nuclear installations for the period 1990 – 2009; data for 1990–2008 are taken from the previous 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 2009.

## Trends in total alpha discharges

Figure 1 shows a very slight increase in the total alpha activity discharged in 2009 from all nuclear installations relative to 2008. The position remains that discharges of alpha activity are still less than one-tenth of the peak value in 1993, and are still lower than 2006 and all previous years.

Fuel reprocessing sub-sector - in 2009 the total alpha discharge from Sellafield was 22% higher than the previous year (2005, 0.25TBq; 2006, 0.21TBq; 2007, 0.125TBq; 2008, 0.127TBq; 2009, 0.154TBq). The increase at Sellafield was offset to some degree as a result of reductions in discharges from the reprocessing plant at La Hague. The La Hague plant contributed only 0.013TBq (7%) to the overall total alpha discharge, which is a 23% reduction on 2008 (0.017TBq).

The decline in discharges from the fuel fabrication sub-sector continues, with the total alpha discharge from the Springfields site during 2009 some 23% lower than in 2008 (2005, 0.25TBq; 2006, 0.11TBq; 2007, 0.026TBq; 2008, 0.022TBq; 2009, 0.017TBq). This amounts to 7% of the overall total alpha discharge.

Discharges from research and development facilities continue to decline and for 2009 were only 72MBq in total, a 20% reduction on 2008. Total alpha discharges arising from decommissioning have been recorded separately since 2006, but do not contribute significantly to the overall total.

## Trends in tritium discharges

Figure 2 presents the discharges of tritium, in terms of activity. The 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, but rose by 11% in 2009 to 9130TBq. As mentioned in earlier reports, tritium discharges tend to follow trends in reprocessing throughput. The reprocessing plant at La Hague contributed 67% of the total tritium discharge from all sectors in 2009 (13593TBq).

The tritium discharges from Sellafield declined over the four-year period 2004-2007 to a low point of 628TBq in 2007, but increased in 2008 (778TBq) and increased further in 2009 to 1510TBq.

During 2009 nuclear power stations contributed nearly 22% of the total tritium discharges from the nuclear sector. The discharges of tritium from this sector increased by 34% in 2009 (2948TBq) ending a 6-year downward trend. The UK AGRs contributed 53% (1560TBq) of the tritium discharges from the nuclear power sub-sector; this is a rise of 8% (114TBq) over the previous year, but only accounts for 15% of the increase from this sector. 2008 will probably prove to have been an abnormally low year for tritium discharges from the nuclear power sub-sector.

The contribution to discharges from the research and development facilities (2.4TBq) is less than half the previous year (6TBQ). 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 2009 (1.9TBq) were only 17% of those reported in 2008 (11.2TBq).

## 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 19 years, from 491TBq (1990), down to 29.9TBq (2009). Historically, total beta discharges have been dominated by discharges from the reprocessing plant at Sellafield and the nuclear fuel plant at Springfields. The top three 2009 contributions were: Sellafield, 60%; La Hague, 12%; and Springfields, 11%. Reprocessing contributes approximately 70% of the overall discharges.

Prior to 2002 the high total beta discharges from Sellafield (2001, 123TBq) were mainly attributable to the radionuclide Technetium-99 (2001, 79TBq). The contribution from Technetium-99 to the total beta discharge at Sellafield has been reducing steadily over the period 2001-2008 (2001, 79TBq; 2002, 85TBq; 2003, 37TBq; 2004, 14TBq; 2005, 6.7TBq; 2006, 5.6TBq; 2007, 4.9TBq; 2008, 2.37TBq), but there was a 30% increase in Tc-99 discharges in 2009 (3.08TBq), but still accounts for only 17% of the total beta discharge from that site. The 7-year downward trend (to 2008) in total beta discharges from Sellafield (2001, 123TBq; 2002, 112TBq; 2003, 83TBq; 2004, 73TBq; 2005, 43TBq; 2006, 29TBq; 2007, 24.8TBq; 2008, 14.3TBq) ended in 2009 with a 24% rise relative to 2008, mostly due to radionuclides other than Tc-99.

In the 3 years prior to 2008, the most significant change noted in total beta discharges was the decline in beta discharges from the fuel fabrication sub-sector, in particular from the Springfields site (2005, 103TBq; 2006, 20.7TBq; 2007, 3TBq). However, in 2008 the total beta discharges from Springfields rose by 53% to 4.58TBq, but in 2009 there was a 29% reduction on the 2008 figure to 3.27TBq, which highlights the variability of these much reduced discharges.

**Table 1**. Total alpha discharges 1990-2009

TOTAL ALPHA

| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| All Nuclear Installations (TBq) | 2.43 | 2.43 | 1.84 | 2.88 | 1.36 | 0.68 | 0.57 | 0.38 | 0.43 | 0.41 | 0.33 | 0.41 | 0.61 | 0.62 | 0.54 | 0.52 | 0.34 | 0.19 | 0.17 | 0.19 |
| Reprocessing Plants (TBq) | 2.20 | 2.25 | 1.71 | 2.70 | 1.10 | 0.47 | 0.32 | 0.23 | 0.22 | 0.17 | 0.16 | 0.25 | 0.39 | 0.43 | 0.31 | 0.27 | 0.23 | 0.15 | 0.14 | 0.17 |
| % of all installations | 90.5 | 92.6 | 92.9 | 93.8 | 80.9 | 69.1 | 56.1 | 61.0 | 50.9 | 41.2 | 47.7 | 59.9 | 63.3 | 69.8 | 57.3 | 51.7 | 68.2 | 76.54 | 83.46 | 88.9 |
| Nuclear Power Plants (TBq) | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| % of all installations | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Nuclear Fuel Fabrication (TBq) | 0.21 | 0.15 | 0.10 | 0.08 | 0.16 | 0.12 | 0.12 | 0.12 | 0.20 | 0.24 | 0.17 | 0.16 | 0.22 | 0.18 | 0.23 | 0.25 | 0.11 | 0.04 | 0.02 | 0.02 |
| % of all installations | 8.6 | 6.2 | 5.4 | 2.8 | 11.8 | 17.6 | 21.1 | 31.8 | 46.1 | 58.1 | 51.7 | 39.7 | 36.3 | 29.5 | 42.5 | 48.1 | 31.6 | 23.09 | 12.84 | 9.1 |
| R&D Facilities (TBq) | 0.02 | 0.03 | 0.03 | 0.10 | 0.10 | 0.09 | 0.13 | 0.03 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| % of all installations | 0.8 | 1.2 | 1.6 | 3.5 | 7.4 | 13.2 | 22.8 | 7.2 | 3.0 | 0.7 | 0.5 | 0.4 | 0.3 | 0.7 | 0.2 | 0.2 | 0.0 | 0.06 | 0.05 | 0.03 |
| Decommissioning (TBq) | | | | | | | | | | | | | | | | | 0.00 | 0.00 | 0.01 | 0.00 |
| % of all installations | | | | | | | | | | | | | | | | | 0.2 | 0.31 | 3.65 | 1.9 |

**Table 2.** Tritium discharges 1990-2009

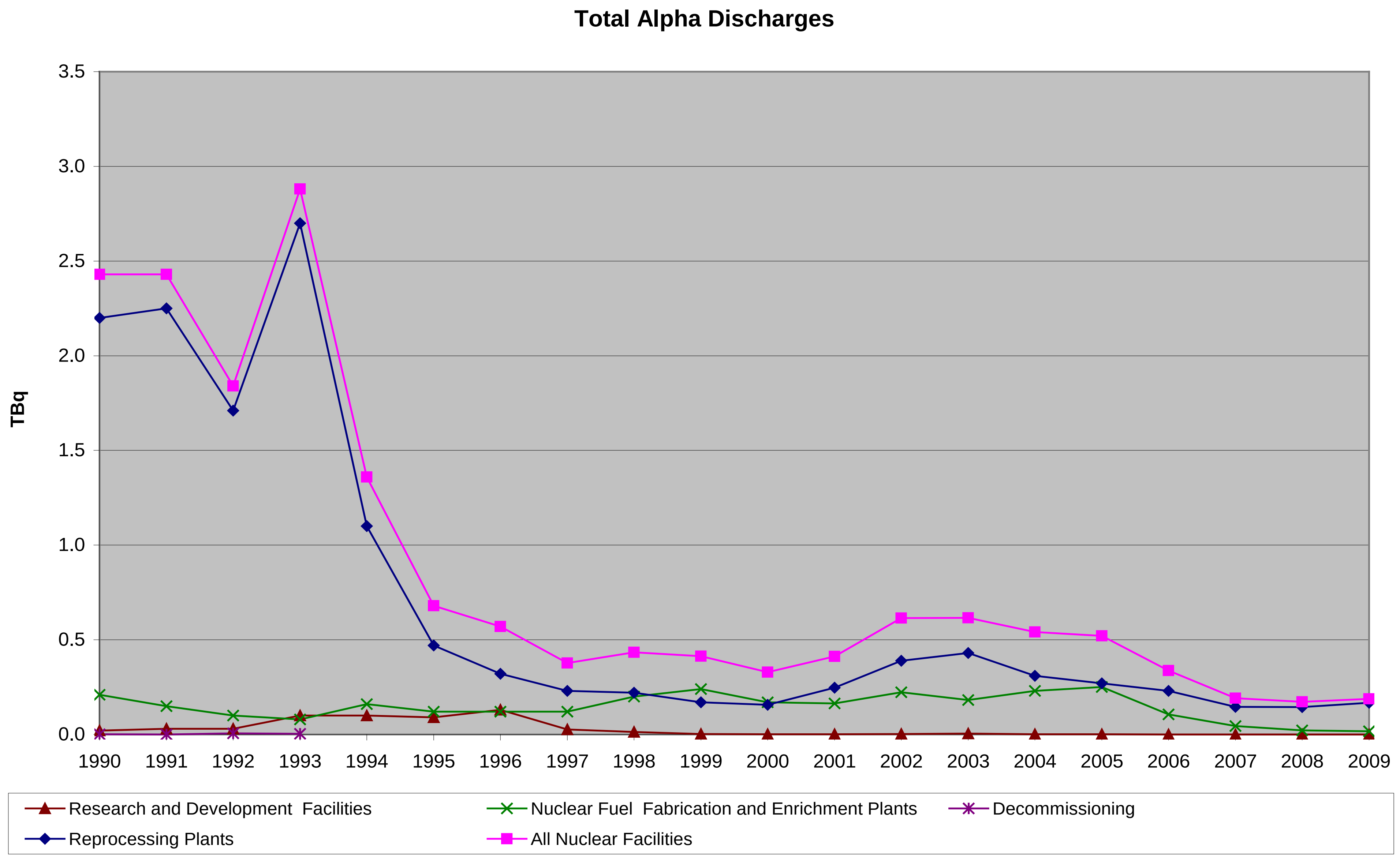
**TRITIUM**

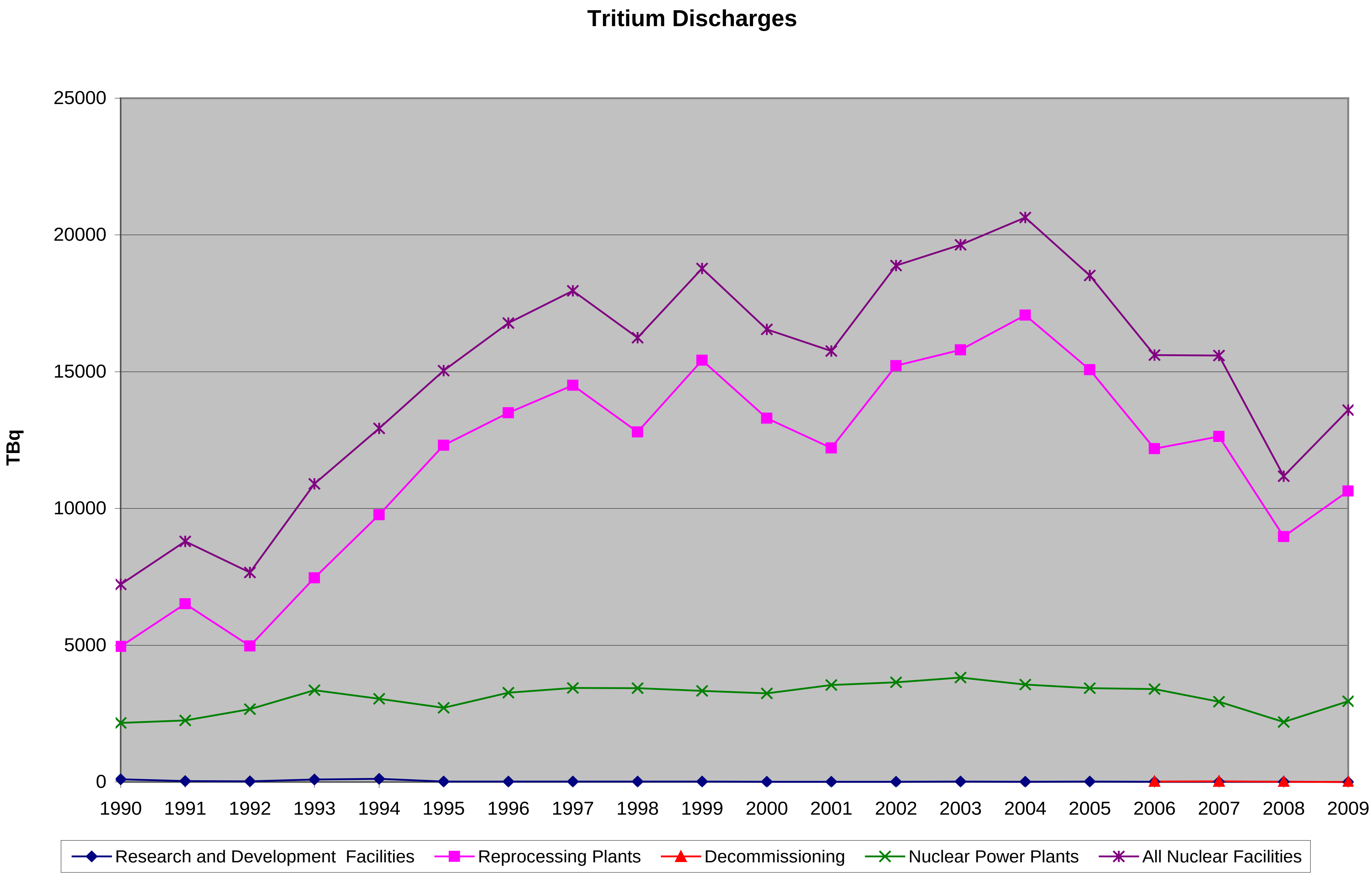
| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| All Nuclear Installations (TBq) | 7224 | 8798 | 7658 | 10902 | 12931 | 15040 | 16779 | 17956 | 16244 | 18771 | 16548 | 15759 | 18880 | 19637 | 20637 | 18517 | 15607 | 15594 | 11178 | 13593 |
| Reprocessing Plants (TBq) | 4959 | 6513 | 4969 | 7460 | 9770 | 12310 | 13500 | 14500 | 12800 | 15420 | 13300 | 12210 | 15220 | 15800 | 17070 | 15070 | 12190 | 12628 | 8968 | 10640 |
| % of all installations | 68.6 | 74.0 | 64.9 | 68.4 | 75.6 | 81.8 | 80.5 | 80.8 | 78.8 | 82.1 | 80.4 | 77.5 | 80.6 | 80.5 | 82.7 | 81.4 | 78.6 | 81.0 | 80.2 | 78.3 |
| Nuclear Power Plants (TBq) | 2164 | 2252 | 2666 | 3354 | 3044 | 2713 | 3264 | 3440 | 3430 | 3335 | 3241 | 3543 | 3648 | 3819 | 3560 | 3429 | 3394 | 2936 | 2193 | 2948 |
| % of all installations | 30.0 | 25.6 | 34.8 | 30.8 | 23.5 | 18.0 | 19.5 | 19.2 | 21.1 | 17.8 | 19.6 | 22.5 | 19.3 | 19.4 | 17.3 | 18.5 | 21.7 | 18.8 | 19.6 | 21.7 |
| Nuclear Fuel Fabrication (TBq) | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| % of all installations | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| R&D Facilities (TBq) | 101 | 32 | 24 | 88 | 118 | 17 | 15 | 16 | 14 | 16 | 7 | 6 | 12 | 18 | 7 | 18 | 5 | 6 | 6 | 2.40 |
| % of all installations | 1.4 | 0.4 | 0.3 | 0.8 | 0.9 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.0 | 0.0 | 0.1 | 0.1 | 0.0 | 0.1 | 0.0 | 0.0 | 0.1 | 0.0 |
| Decommissioning (TBq) | | | | | | | | | | | | | | | | | 16.90 | 25.07 | 11.18 | 1.90 |
| % of all installations | | | | | | | | | | | | | | | | | 0.1 | 0.16 | 0.10 | 0.0 |

**Table 3.** Total beta (excl tritium) discharges 1990-2009

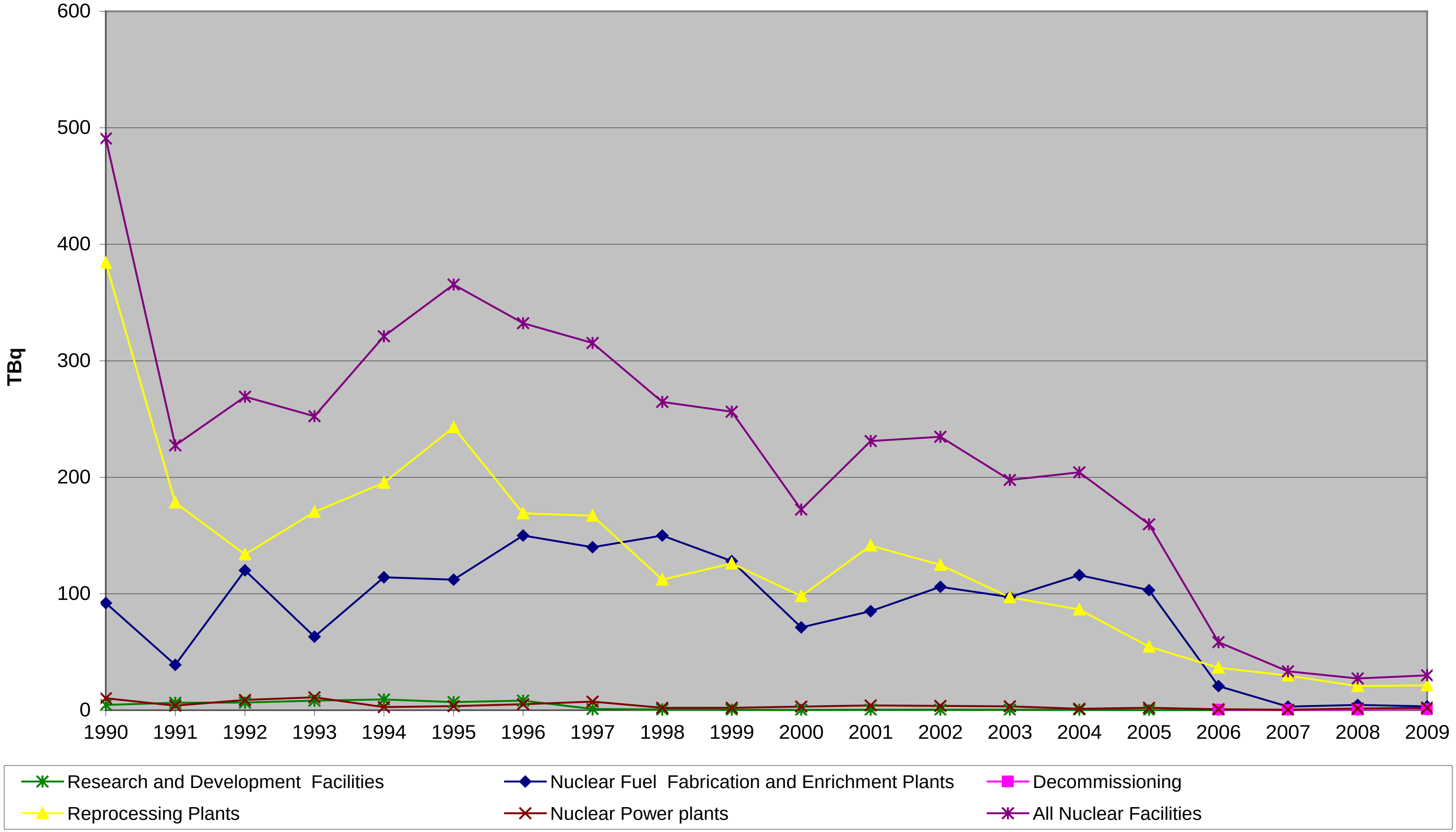
**TOTAL BETA** **(OTHER RADIONUCLIDES EXCLUDING TRITIUM)**

| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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 | 29.81 |
| Reprocessing Plants (TBq) | 384 | 178 | 134 | 170 | 195 | 243 | 169 | 167 | 112 | 126 | 98 | 141 | 125 | 97 | 86 | 54 | 37 | 29.61 | 20.67 | 21.34 |
| % 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 | 71.6 |
| Nuclear Power Plants (TBq) | 10.3 | 3.8 | 8.9 | 11.1 | 2.8 | 3.4 | 5.2 | 7.4 | 2.0 | 2.0 | 3.0 | 4.2 | 3.6 | 3.2 | 1.3 | 2.0 | 0.75 | 0.46 | 1.53 | 2.1 |
| % of all installations | 2.1 | 1.7 | 3.3 | 4.4 | 0.9 | 0.9 | 1.6 | 2.3 | 0.8 | 0.8 | 1.7 | 1.8 | 1.5 | 1.6 | 0.6 | 1.9 | 1.3 | 1.4 | 5.6 | 7 |
| Nuclear Fuel Fabrication (TBq) | 92 | 39 | 120 | 63 | 114 | 112 | 150 | 140 | 150 | 128 | 71 | 85 | 106 | 97 | 116 | 103 | 21 | 3 | 5 | 3 |
| % 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 | 11 |
| R&D Facilities (TBq) | 4.5 | 6.3 | 6.6 | 8.2 | 9.1 | 7.0 | 8.1 | 1.0 | 0.66 | 0.36 | 0.30 | 0.46 | 0.46 | 0.44 | 0.47 | 0.09 | 0.06 | 0.13 | 0.07 | 2.31 |
| % 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 | 7.7 |
| Decommissioning (TBq) | | | | | | | | | | | | | | | | | 0.40 | 0.04 | 0.38 | 0.80 |
| % of all installations | | | | | | | | | | | | | | | | | 0.0 | 0.1 | 1.4 | 2.7 |


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
2009
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
2009
Research and Development  Facilities
Reprocessing Plants
Decommissioning
Nuclear Power Plants
All Nuclear Facilities

## Total Beta Discharges



# 3. 2009 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. |

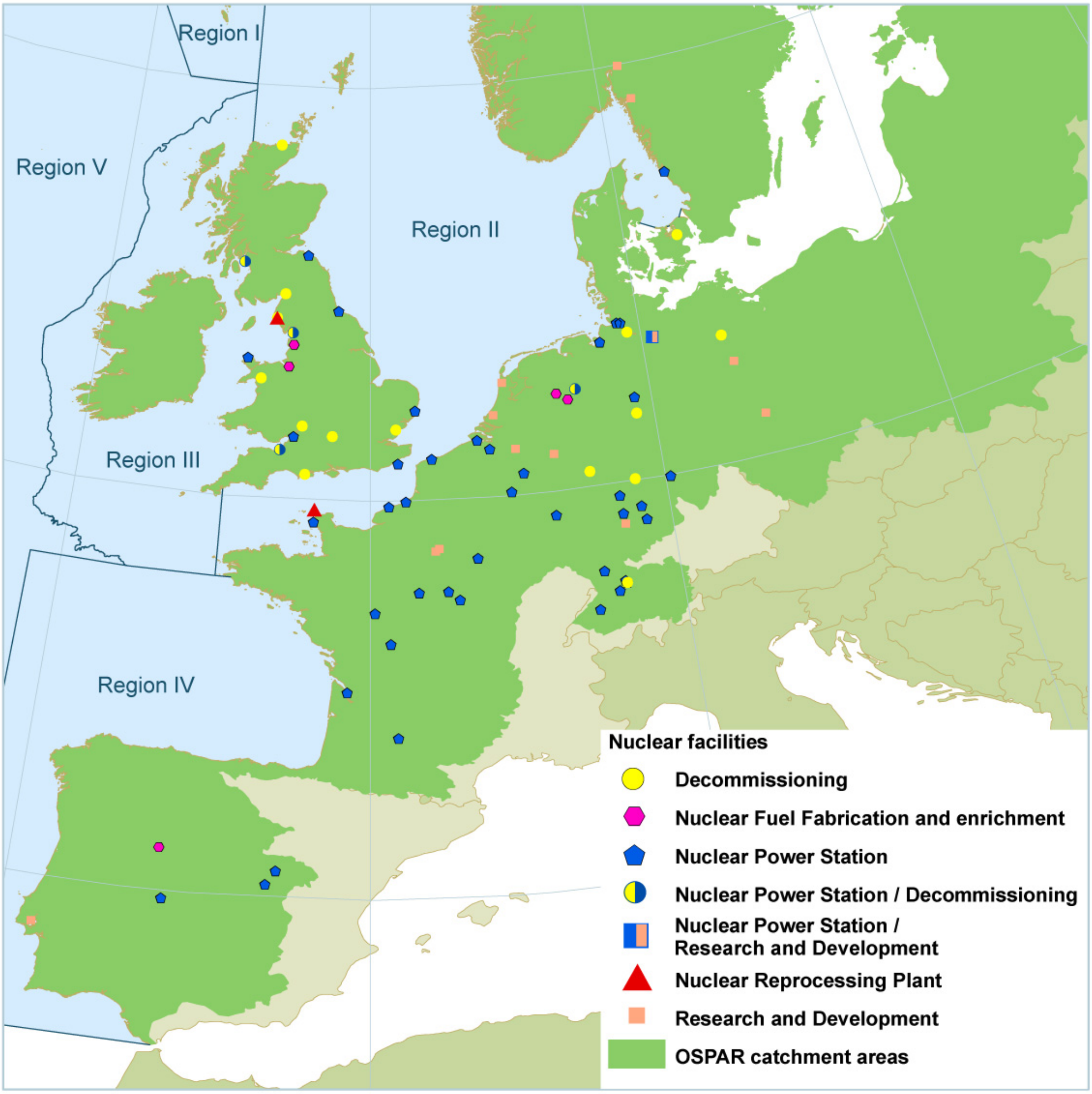
*For radionuclides:*

| | | | | | |
|---|---|---|---|---|---|
| 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** | | | |
| DE1a | Biblis A | NPS | Rhine |
| DE1b | 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 – Shut down |
| DE22 | HMI Berlin | RDF | Havel |
| DE23 | Jülich | RDF | Rur |
| DE24 | Rossendorf | RDF | Elbe – Shut down |

| 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 | 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) 2009 | Net Electrical Output MW (e).h 2009 | Operational discharges of radioactive substances in 2009 (TBq) | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Specific radionuclides | | | | | | | | | | | | | |
| | | | | | | Tritium | other (1) radio-nuclides | Total-α activity | Total-β activity (excluding tritium) | Co 58 | Co 60 | Zn 65 | Sr 90 | Zr/Nb 95 | Ru 106 | Ag 110m | Sb 125 | Cs 134 | Cs 137 | Ce 144 | S 35 |
| | **Belgium (2)** | | | | | | | | | | | | | | | | | | | | |
| BE1 | Doel | Schelde | 4 PWR | 392,5 | 2 868 181,0 | 5,31E+01 | 7,00E-04 | 0,00E+00 | 3,53E-03 | 5,69E-04 | 8,63E-04 | 4,60E-06 | 0,00E+00 | 2,94E-05 | 3,22E-05 | 4,95E-04 | 4,04E-04 | 2,10E-06 | 3,59E-04 | 0,00E+00 | 0,00E+00 |
| | | | | 433,0 | 3 464 167,0 | | | | | | | | | 6,95E-05 | | | | | | | |
| | | | | 1006,0 | 7 974 081,0 | | | | | | | | | | | | | | | | |
| | | | | 1013,4 | 6 860 377,0 | | | | | | | | | | | | | | | | |
| BE2 | Tihange | Meuse | 3 PWR | 962,0 | 8 264 928,8 | 5,34E+01 | 3,91E-04 | 1,27E-09 | 5,53E-03 | 9,09E-04 | 3,49E-03 | 0,00E+00 | 0,00E+00 | 1,58E-05 | 0,00E+00 | 2,57E-04 | 4,19E-06 | 1,06E-04 | 3,08E-04 | 0,00E+00 | 0,00E+00 |
| | | | | 1008,0 | 7 714 471,1 | | | | | | | | | 5,42E-05 | | | | | | | |
| | | | | 1040,5 | 7 694 304,4 | | | | | | | | | | | | | | | | |
| | **France (3)** | | | | 3.22E-08 MWh (4) | | | | | | | | | | | | | | | | |
| FR1 | Belleville | Loire | 2 PWR | 2600 | | 5,35E+1 | 3,69E-04 | | | 1,38E-04 | 6,79E-05 | | | | | 2,32E-05 | 4,89E-05 | 1,01E-05 | 3,44E-05 | | |
| FR2 | Cattenom | Mosel | 4 PWR | 5200 | | 8,26E+1 | 7,94E-4 | | | 1,66E-4 | 2,74E-4 | | | | | 4,05E-5 | 5,48E-5 | 3,10E-05 | 9,01E-5 | | |
| FR3 | Chinon | Loire | 4 PWR | 3600 | | 5,11E+1 | 3,00E-4 | | | 5,43E-5 | 9,24E-5 | | | | | 3,43E-5 | 3,84E-5 | 1,33E-5 | 1,67E-5 | | |
| FR4 | Chooz | Meuse | 2 PWR | 2900 | | 4,17E+1 | 5,38E-4 | | | 4,48E-5 | 1,77E-4 | | | | | 2,47E-5 | 1,30E-4 | 1,26E-5 | 4,40E-5 | | |
| FR5 | Civaux | Vienne | 2 PWR | 2900 | | 3,92E+1 | 2,43E-4 | | | 1,11E-5 | 4,06E-5 | | | | | 1,14E-4 | 1,54E-5 | 5,48E-6 | 8,10E-6 | | |
| FR6 | Dampierre- | Loire | 4 PWR | 3600 | | 4,22E+1 | 6,45E-4 | | | 1,42E-4 | 7,71E-5 | | | 1,98E-7 | | 2,50E-4 | 5,12E-5 | 1,99E-5 | 2,53E-5 | | |
| FR7 | Fessenheim | Rhine | 2 PWR | 1800 | | 2,43E+1 | 3,26E-4 | | | 8,29E-5 | 3,70E-5 | | | | | 1,49E-4 | 1,49E-5 | 4,89E-6 | 1,03E-5 | | |
| FR8 | Flamanville | North Sea | 2 PWR | 2600 | | 5,70E+1 | 2,74E-4 | | | 7,22E-5 | 8,98E-5 | | | | | 1,19E-5 | 3,18E-5 | 1,10E-5 | 1,30E-5 | | |
| FR10 | Golfech | Garonne | 2 PWR | 2600 | | 5,73E+1 | 1,77E-4 | | | 5,69E-5 | 4,65E-5 | | | | | 8,06E-6 | 1,84E-5 | 6,63E-6 | 9,60E-6 | | |
| FR11 | Gravelines | North Sea | 6 PWR | 5400 | | 7,07E+1 | 8,58E-4 | | | 7,15E-5 | 3,02E-4 | | | | | 1,84E-4 | 6,96E-5 | 2,66E-5 | 1,07E-4 | | |
| FR12 | Le Blayais | Gironde | 4 PWR | 3600 | | 3,62E+1 | 7,44E-4 | | | 1,60E-4 | 2,40E-4 | | | | | 1,71E-4 | 3,98E-5 | 1,58E-5 | 2,30E-5 | | |
| FR14 | Nogent- | Seine | 2 PWR | 2600 | | 4,53E+1 | 2,40E-4 | | | 8,30E-5 | 3,48E-5 | | | | | 1,27E-5 | 3,00E-5 | 1,28E-5 | 1,71E-5 | | |
| FR15 | Paluel | North Sea | 4 PWR | 5200 | | 8,62E+1 | 1,10E-3 | | | 3,91E-4 | 2,80E-4 | | | | | 4,61E-5 | 1,07E-4 | 3,85E-5 | 5,08E-5 | | |
| FR16 | Penly | North Sea | 2 PWR | 2600 | | 5,66E+1 | 4,03E-4 | | | 8,36E-5 | 1,43E-4 | | | | | 3,67E-5 | 3,05E-5 | 9,33E-6 | 1,28E-5 | | |
| FR18 | Saint Laurent | Loire | 2 PWR | 1800 | | 2,20E+1 | 2,67E-4 | | | 8,11E-5 | 5,55E-5 | 7,36E-7 | | 2,90E-6 | | 1,91E-5 | 1,84E-5 | 7,31E-6 | 8,76E-6 | | |
| | **Federal Republic of Germany** | | | | | | | | | | | | | | | | | | | | |
| DE1a | Biblis A | Rhine | 1 PWR | 1225 | 1098261 | 1,1E+01 | 8,6E-05 | | | 1,3E-06 | 4,0E-05 | | | | | 8,6E-06 | 7,3E-06 | 2,6E-07 | 3,0E-06 | | |
| DE1b | Biblis B | Rhine | 1 PWR | 1300 | 1614042 | 8,8E+00 | 1,0E-04 | | | 7,0E-06 | 1,5E-05 | | | | | 7,6E-07 | 1,9E-05 | 1,5E-06 | 8,9E-06 | | |
| DE2 | Brokdorf | Elbe | 1 PWR | 1440 | 12050357 | 2,0E+01 | | | | | | | | | | | | | | | |
| DE3 | Brunsbüttel | Elbe | 1 BWR | 806 | 0 | 1,7E-02 | 4,6E-05 | | | | 1,9E-05 | 1,2E-05 | 6,6E-08 | | | | | | 6,3E-06 | | |
| DE4 | Grafenrheinfeld | Main | 1 PWR | 1345 | 11056120 | 2,7E+01 | 2,4E-05 | | | 1,1E-06 | 1,2E-05 | | | 1,6E-07 | | 9,0E-08 | | | 5,4E-08 | | |
| DE5 | Grohnde/Emme | Weser | 1 PWR | 1430 | 11505158 | 2,4E+01 | 1,9E-05 | | | | 8,6E-06 | | | | | | | | | | |
| DE8a | Krümmel/Geest | Elbe | 1 BWR | 1402 | 349362 | 6,5E-02 | 4,5E-07 | | | | 3,3E-07 | 1,2E-07 | | | | | | | | | |
| DE9a | Lingen/Emsland | Ems | 1 PWR | 1400 | 11429673 | 1,5E+01 | | | | | | | | | | | | | | | |
| DE11a | Neckar-Westhe | Neckar | 1 PWR | 840 | 4825484 | 7,8E+00 | | | | | | | | | | | | | | | |
| DE11b | Neckar-Westhe | Neckar | 1 PWR | 1400 | 11515750 | 2,7E+01 | | | | | | | | | | | | | | | |
| DE13a | Philippsburg 1 | Rhine | 1 BWR | *926* | 6448081 | 4,6E-01 | 9,1E-05 | | | 2,7E-06 | 3,3E-05 | 3,1E-05 | | | | 8,5E-07 | | 1,5E-07 | 5,4E-06 | | |
| DE13b | Philippsburg 2 | Rhine | 1 PWR | 1458 | 11582804 | 1,7E+01 | 3,9E-05 | | | 4,3E-06 | 7,0E-06 | | | 1,1E-06 | | | | 1,1E-07 | 1,7E-05 | | |
| DE16 | Rodenkirchen/U | Weser | 1 PWR | 1410 | 10542429 | 1,9E+01 | 8,6E-05 | | | 3,4E-06 | 6,7E-05 | | | | | | | | | | |
| | **The Netherlands** | | | | | | | (5) | | | | | | | | | | | | | |
| NL1 | Borssele | Westerscheld | 1 PWR | 520 | 4,02E+6 | 7,49E+0 | NI | 3,42E-7 | 1,76E-4 | 1,15E-6 | 5,45E-5 | <MDA | 2,27E-6 | 2,14E-6 | 4,40E-7 | 8,02E-6 | <MDA | 8,60E-7 | 1,15E-5 | 2,30E-7 | NI |

| Location Ref. | Country Site | Discharges to | Reactors Number and Type | Installed Capa-city MW (e) 2009 | Net Electrical Output MW (e).h 2009 | Operational discharges of radioactive substances in 2009 (TBq) | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Specific radionuclides | | | | | | | | | | | | | |
| | | | | | | Tritium | other (1) radio-nuclides | Total-α activity | Total-β activity (excluding tritium) | Co 58 | Co 60 | Zn 65 | Sr 90 | Zr/Nb 95 | Ru 106 | Ag 110m | Sb 125 | Cs 134 | Cs 137 | Ce 144 | S 35 |
| | **Spain (6) (7) (8)** | | | | | | | | | | | | | | | | | | | | |
| ES1 | Almaraz | Tagus | 2 PWR | 1 957 | 13 744 681 | 2,74E+1 | 1,09E-2 | ND | | 1,49E-3 | 1,67E-3 | 3,45E-5 | 1,29E-4 | 2,04E-3 | ND | 5,06E-4 | 1,63E-4 | 1,85E-5 | 2,27E-4 | 8,17E-5 | ND |
| ES2 | José | Tagus | 1 PWR | (9) | - - | 2,57E-1 | 6,73E-5 | ND | | ND | 6,73E-5 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| ES3 | Trillo | Tagus | 1 PWR | 1 066 | 7 197 095 | 2,02E+1 | 9,53E-4 | ND | | 1,82E-5 | 2,28E-4 | ND | ND | 2,66E-5 | ND | 2,18E-5 | 9,91E-6 | ND | 1,88E-5 | ND | ND |
| | **Sweden** | | | | | | | (9) | | | | | | | | | | | | | |
| SE2 | Ringhals 1-4 | Kattegatt (11 | BWR | 855 | | 3,60E-1 | 3,25E-4 | 4,36E-7 | 8,22E-3 | 7,20E-4 | 6,80E-3 | 2,20E-6 | 5,50E-6 | 6,50E-5 | | 4,10E-5 | 4,60E-5 | | 2,20E-4 | | |
| | | 12 | PWR | 815 | | 1,10E+1 | 1,02E-5 | 7,32E-7 | 1,47E-4 | 7,70E-6 | 2,80E-5 | | 4,90E-7 | 4,80E-7 | | 8,70E-5 | 8,40E-6 | | 5,80E-6 | | |
| | | 13 | PWR | 1080 | | 2,50E+1 | 3,02E-5 | 7,95E-7 | 2,12E-4 | 4,10E-5 | 7,50E-5 | | | 1,37E-5 | | 4,00E-5 | 1,20E-5 | | 6,80E-7 | | |
| | | 14 | PWR | 951 | | 9,00E+0 | 7,11E-5 | 5,82E-8 | 5,68E-4 | 4,30E-4 | 3,80E-5 | | | 2,66E-5 | | 6,10E-7 | 1,20E-6 | | 7,40E-7 | | |
| | **Switzerland** | | | | | | | | | | | | | | | | | | | | |
| CH1 | Beznau | Aare | 2 PWR | 380/380 | 6 001 300 | 1,10E+1 | | 3,20E-8 | 5,30E-4 | 1,40E-4 | 4,30E-5 | | 1,20E-6 | | | 2,20E-6 | 1,50E-5 | 2,90E-6 | 1,60E-4 | | |
| CH2 | Gösgen | Aare | 1 PWR | 1020 | 8 179 500 | 1,50E+1 | | <1.3E-7 | 7,00E-6 | | 1,30E-6 | | | | | | | | | | |
| CH3 | Leibstadt | Rhine | 1 BWR | 1220 | 9 385 000 | 2,90E+0 | | 2,70E-7 | 6,40E-5 | 5,60E-6 | 5,00E-5 | 2,10E-6 | | | | | | | 6,60E-7 | | |
| CH4 | Mühleberg | Aare | 1 BWR | 390 | 2 977 700 | 1,40E-1 | | 6,00E-8 | 1,30E-3 | 1,10E-4 | 7,10E-4 | 3,40E-5 | 7,10E-7 | | | | | | 3,10E-5 | | |
| | **United Kingdom** | | | | | | | | | | | | | | | | | | | | |
| UK5b | Dungeness B | English | 2 AGR | | | 2,25E+2 | 4,11E-3 | | | | 1,95E-3 | | | | | | | | 1,52E-3 | | 1,99E-01 |
| UK6 | Hartlepool | North Sea | 2 AGR | | | 2,68E+2 | 2,09E-3 | | | | 1,40E-4 | | | | | | | | 1,42E-3 | | 3,63E-01 |
| UK7a | Heysham 1 | Morecambe | 2 AGR | | | 2,77E+2 | 4,88E-3 | | | | 9,80E-5 | | | | | | | | 2,40E-3 | | 2,20E-01 |
| UK7b | Heysham 2 | Morecambe | 2 AGR | | | 3,22E+2 | 1,09E-2 | | | | 5,40E-5 | | | | | | | | 1,27E-3 | | 7,73E-02 |
| UK8b | Hinkley Point B | Severn | 2 AGR | | | 1,05E+2 | 6,96E-3 | | | | 3,83E-4 | | | | | | | | 4,48E-3 | | 2,16E-01 |
| UK9b | Hunterston B | Firth of Clyde | 2 AGR | 1150 | | 1,53E+2 | | 5,71E-5 | 1,24E-2 | | 2,70E-4 | | | | | | | | | | 5,60E-01 |
| UK10 | Oldbury | Severn | 2 GCR | | | 1,52E-1 | 9,07E-2 | | | | | | | | | | | | 1,99E-1 | | |
| UK11b | Sizewell B | North Sea | 1 PWR | | | 5,27E+1 | 2,20E-2 | | | | | | | | | | | | 5,00E-3 | | |
| UK12 | Torness | North Sea | 2 AGR | 1264 | | 3,64E+2 | | 6,71E-6 | 2,67E-3 | | 1,16E-4 | | | | | | | | | | 2,21E-02 |
| UK14 | Wylfa | Irish Sea | 2 GCR | | | 1,91E+0 | 9,48E-3 | | | | | | | | | | | | | | |

## Table 5  Nuclear Fuel Reprocessing Plants

| Location ref | La Hague (FR13) | | Sellafield (UK15) |
|---|---|---|---|
| Discharges to | English Channel | | Irish Sea |
| Type of Fuel Reprocessed Capacity (t/y) | PWR + BWR | | Magnox, AGR, LWR |
| Radionuclide | TBq released per annum (1) | Normed releases in TBq per GWye (32,3 GWye in 2009) | TBq released in 2009 (2) (3) |
| Tritium | 9,13E+3 | | 1,51E+3 |
| Total-α | 1,32E-2 | 4,09E-4 | 1,54E-1 |
| Total-β | 3,54 | 1,10E-1 | 1,78E+1 |
| C 14 | 6,12 | | 8,19E+0 |
| S 35 | | | |
| Mn 54 | 1,83E-3 | | |
| Fe 55 | | | |
| Co 57 | 3,93E-5 | | |
| Co 58 | 6,92E-5 | | |
| Co 60 | 8,57E-2 | | 8,25E-2 |
| Ni 63 | 5,06E-2 | | |
| Zn 65 | ND | | |
| Sr 89 | ND | | |
| Sr 90 | 1,01E-1 | | 2,86E+0 |
| (Sr 90 + Cs 137) | | | |
| (Zr + Nb 95) | ND | | 1,93E-1 |
| Tc 99 | 5,16E-2 | | 3,08E+0 |
| Ru 103 | ND | | |
| Ru 106 | 1,58 | | 3,16E+0 |
| (Ru + Rh) 106 | 3,16 | | |
| Ag 110m | ND | | |
| Sb 124 | ND | | |
| Sb 125 | 1,37E-1 | | |
| I 129 | 1,07 | | 2,53E-1 |
| Cs 134 | 6,89E-2 | | 1,41E-1 |
| Cs 137 | 9,41E-1 | | 4,27E+0 |
| Ce 144 | 1,14E-4 | | 4,98E-1 |
| (Ce + Pr) 144 | 2,28E-4 | | |
| Pm 147 | | | |
| Eu 152 | | | |
| Eu 154 | 4,24E-4 | | |
| Eu 155 | 6,47E-5 | | |
| Np 237 | 5,22E-5 | | 5,21E-2 |
| Pu 239+240 | 1,27E-3 | | 1,20E-1 |
| Pu 241 | 1,05E-1 | | 2,87E+0 |
| Am 241 | 1,86E-3 | | 4,63E-2 |
| Cm 242 | 7,13E-6 | | |
| Cm 243+244 | 9,08E-4 | | 4,52E-3 |
| Uranium (in kg) | 19,6 | | 4,09E+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 in 2009 |
|---|---|---|---|---|---|---|---|
| | **Federal Republic of Germany** | | | | | | |
| DE19 | Gronau | Vechte, IJsselmeer | Uranium enrichment | | | total - α | 4,6E-09 |
| | **Netherlands** | | | | | | |
| NL3 | Urenco, Almelo | Municipal sewer system | Uranium enrichment | 4950 | 4078 | total - α | 2,00E-7 |
| | | | | | | total - β (β- & γ- emitting rn) | 2,40E-6 |
| | **Spain** | | | | | | |
| ES4 | Juzbado (6) | River Tormes - Duero | PWR, BWR | 400 | 368,7 | total - α | 2,09E-5 |
| | **United Kingdom** | | | | | | |
| UK16 | Capenhurst | Irish Sea via | Uranium enrichment | | | Uranium - α | 8,00E-5 |
| | | Rivacre Brook and | | | | Uranium daughters | 1,00E-5 |
| | | Mersey Estuary | | | | other - α | 2,00E-5 |
| | | | | | | Tc 99 | 1,00E-5 |
| | | | | | | Tritium | |
| UK17 | Springfields | Irish Sea via | GCR, AGR, PWR | | | total - α | 1,70E-2 |
| | | River Ribble | fuel fabrication | | | total - β | 3,27E+0 |
| | | | | | | Tc 99 | 5,35E-3 |
| | | | | | | Th 230 | 4,05E-3 |
| | | | | | | Th 232 | 2,05E-4 |
| | | | | | | Uranium α | 1,09E-2 |
| | | | | | | Np 237 | 2,23E-4 |

## Table 7 Research and Development Facilities

| Location Ref. | Country/ site | Discharges to | Reactors Number & Type | Installed Capacity | Radionuclides | TBq released per annum in 2009 |
|---|---|---|---|---|---|---|
| | **Belgium** | | | (1) | | |
| BE3 | **Mol** | River Mol-Neet | 2 | 129MW (th) | Total α | 1,60E-05 |
| | | | | | Total β | 1,88E-04 |
| | | | | | H-3 | 2,29E+00 |
| | | | | | Sr-90/Y-90 | 2,05E-05 |
| | | | | | Co-60 | 9,00E-06 |
| | | | | | Cs-134 | 0,00E+00 |
| | | | | | Cs-137 | 9,60E-05 |
| | | | | | Total activitiy | 2,29E+00 |
| | **France** | | | | | |
| FR17 | Saclay | Etang | Centre de recherches du | | α | <4,35E-05 |
| | | de Saclay | Commissariat à l'énergie | | other radionuclides | 4,71E-04 |
| | | | atomique | | Tritium | 1,26E-02 |
| | **Germany** | | | | | |
| DE8b | Geesthacht | Elbe | 1 | | Tritium | 3,3E-05 |
| | | | | | β/γ – emitting radionuclides | 8,3E-06 |
| DE18 | Karlsruhe | Rhine | No reactors | | Tritium | 7,5E-02 |
| | | | | | β/γ – emitting radionuclides | 2,0E-05 |
| DE22 | HZ Berlin | Havel | 1 | | Tritium | 3,6E-04 |
| | | | | | β/γ – emitting radionuclides | 1,2E-07 |
| DE23 | Jülich | Rur | 1 | | Tritium | 1,9E-01 |
| | | | | | β/γ – emitting radionuclides | 1,1E-04 |
| | **Netherlands** | | | | | |
| NL4 | Delft (2) (3) (4) | Sewage system | 1 Research reactor | 2 MWth | α – emitting radionuclides | 1,0E-07 |
| | | | | | β – emitting radionuclides including tritium | 2,0E-06 |
| | | | | | γ – emitting radionuclides | 1,0E-06 |
| | | | | | total | |
| NL5 | Petten (5) (6) (7) | North Sea | 1 high flux Research reactor | 50 MWth | Tritium | 6,69E-02 |
| | | | | | α - emitting radionuclides | 2,40E-06 |
| | | | 1 low flux Research reactor | 30kWth | β/γ – emitting radionuclides | 1,47E-02 |
| | | | | | total | 8,55E-02 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | **Norway (8)** | | | | | |
| NO1 | Halden (9) | River Tista (Skagerrak) | 1 BWR D2O as moderator | (10) | Tritium | 1,80E+00 |
| | | | | | Total α | ND |
| | | | | | Total β | 2,11E-04 |
| | | | | | Ag-110m | 2,10E-06 |
| | | | | | Cr-51 | 4,30E-05 |
| | | | | | Mn-54 | 4,50E-07 |
| | | | | | Mn-56 | NA |
| | | | | | Co-58 | 3,90E-06 |
| | | | | | Co-60 | 4,00E-05 |
| | | | | | Sr-90 | 1,00E-06 |
| | | | | | Zr-95 | 3,90E-06 |
| | | | | | Nb-95 | 9,00E-06 |
| | | | | | Sb-125 | 2,50E-08 |
| | | | | | Cd-109 | ND |
| | | | | | I-131 | 2,40E-06 |
| | | | | | Cs-134 | 8,10E-06 |
| | | | | | Cs-137 | 9,10E-05 |
| | | | | | Ce-141 | 5,70E-07 |
| | | | | | Ce-144 | 4,90E-06 |
| NO2 | Kjeller (9) | River Nitelva (Skagerrak) | 1 JEEP II, heavy water and cooled Research Reactor | (10) | Tritium | 4,00E-04 |
| | | | | | Total-α | 2,66E-08 |
| | | | | | Total-β | 2,73E-05 |
| | | | | | Co 58 | ND |
| | | | | | Co 60 | 1,56E-06 |
| | | | | | Zn 65 | 0,00E+00 |
| | | | | | Sr 90 | 3,56E-07 |
| | | | | | Zr/Nb 95 | ND |
| | | | | | Ru 103 | ND |
| | | | | | Ru 106 | ND |
| | | | | | Ru/Rh 106 | ND |
| | | | | | Ag 110m | ND |
| | | | | | Sb 125 | ND |
| | | | | | I 125 | 2,50E-05 |
| | | | | | I 131 | 5,45E-09 |
| | | | | | Cs 134 | ND |
| | | | | | Cs 137 | 3,98E-07 |
| | | | | | Ce 144 | ND |
| | | | | | Pu 238 | 1,11E-10 |
| | | | | | Pu 239/240 | 1,41E-08 |
| | | | | | Am 241 | 2,21E-09 |
| | | | | | Pu 241 | NA |
| | **Portugal** | | | | | |
| PT1 | Campus de Sacavém | Residual Water Treatment Municipal Plant | 1 Research Swimming Pool Reactor | | Total-β | 5,0E-04 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | **Switzerland** | | | | | |
| CH5 | Paul Scherrer Institute | Aare | 1 research reactor | | Tritium | 2,50E-01 |
| | | | | | Total-β | 1,70E-04 |
| | | | | | other radionuclides | |
| | | | | | β– and γ– emitting radionuclides | |
| | | | | | Be-7 | 1,50E-04 |
| | | | | | Na-22 | 4,90E-08 |
| | | | | | S-35 | 4,10E-06 |
| | | | | | Sc-46 | 8,00E-08 |
| | | | | | Mn-52 | 2,30E-08 |
| | | | | | Mn-54 | 4,90E-06 |
| | | | | | Co-56 | 1,20E-07 |
| | | | | | Co-57 | 2,60E-07 |
| | | | | | Co-58 | 2,40E-07 |
| | | | | | Co-60 | 4,90E-07 |
| | | | | | Sr/Y-90 | 1,50E-06 |
| | | | | | Sb-124 | 3,10E-07 |
| | | | | | I-125 | 5,00E-07 |
| | | | | | I-131 | 1,50E-06 |
| | | | | | Cs-134 | 1,90E-07 |
| | | | | | Cs-137 | 3,00E-06 |
| | | | | | Lu-177 | 2,40E-06 |
| | | | | | α - emitting radionuclides | |
| | | | | | U-234/238 | 1,00E-07 |
| | | | | | Pu-238/Am-241 | 1,40E-08 |
| | | | | | Pu-239/240 | 2,20E-08 |

## Table 8 Discharges from decommissioning and treatment/recovery of old radioactive waste in 2009

| Location Ref. | Country Site | Discharges to | Reactors Number and Type | Exceptional discharges of radioactive substances in 2009 (TBq) | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Specific radionuclides | | | | | | | | | | | | | | |
| | | | | Tritium | other (1) radio-nuclides | Total-α activity | Total-β activity (excluding 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 | No reactors | 1,21E-01 | | | 7,06E-05 | | | | | | | | | | | | | |
| | | Roskilde Fjord | | | | | | | | | | | | | | | | | | |
| | **France** | | **Type of fuel reprocessed** | | | | | | | | | | | | | | | | | |
| FR4 | Chooz (4) | Meuse | 1 PWR | 8,3E-04 | 4,1E-04 | | | 1,7E-06 | 6,0E-06 | | | | | 1,9E-06 | 5,9E-06 | 1,8E-06 | 3,8E-04 | | | |
| FR9 | Fontenay-aux-Roses | Seine | No reactor | 5,5E-06 | 1,0E-05 | 1,6E-06 | | | | | | | | | | | | | | |
| FR13 | La Hague | English Channel | PWR + BWR | | | 3,0E-03 | 1,6E-01 | | 3,0E-03 | | 1,4E-02 | | | | | | 9,9E-02 | | | |
| | **Federal Republic of Germany** | | | | | | | | | | | | | | | | | | | |
| DE9b | Lingen | Ems | 1 BWR | 9,2E-07 | 2,6E-06 | | | | 5,7E-08 | | 2,2E-09 | | | | | | 2,4E-06 | | | |
| DE10 | Mülheim-Kärlich | Rhine | 1 PWR | 2,0E-04 | 7,2E-06 | | | | 2,9E-06 | | | | | | | | | | | |
| DE12 | Obrigheim | Neckar | 1 PWR | 1,2E-02 | 3,8E-04 | | | | 6,9E-05 | | 7,7E-08 | | | | | | 6,2E-06 | | | |
| DE14 | Rheinsberg | Havel | 1 PWR | 7,3E-04 | 5,8E-06 | | | | 7,8E-07 | | 5,0E-07 | | | | | | 8,1E-07 | | | |
| DE15 | Stade | Elbe | 1 PWR | 6,5E-02 | 7,4E-06 | 6,3E-08 | | | 1,5E-06 | | | | | | | | 7,2E-07 | | | |
| DE17 | Würgassen/Beverungen | Weser | 1 BWR | 2,9E-03 | 6,7E-06 | | | | 2,9E-06 | | 1,9E-07 | | | | | | 2,6E-06 | | | |
| | **Switzerland** | | | | | | | | | | | | | | | | | | | |
| CH6 | ZWILAG (5) | Aare | | 1,0E-01 | | 6,4E-08 | 3,5E-03 | | 1,2E-05 | | | 1,4E-06 | 4,2E-06 | | 1,1E-05 | 3,9E-05 | 3,4E-03 | | | |
| | **United Kingdom** | | | | | | | | | | | | | | | | | | | |
| UK1 | Berkeley | Severn | 2 GCR | 2,0E-03 | 1,9E-03 | | | | | | | | | | | | 1,1E-03 | | | |
| UK2 | Bradwell | North Sea | 2 GCR | 2,4E-02 | 8,2E-02 | | | | | | | | | | | | 8,2E-02 | | | |
| UK3 | Calder Hall (6) | Irish Sea | 4 GCR | | | REPORTED WITH SELLAFIELD DISCHARGES | | | | | | | | | | | | | | |
| UK4 | Chapelcross (7) | Solway Firth | 4 GCR | 2,4E-02 | | 7,7E-05 | 7,4E-04 | | | | | | | | | | | | | |
| UK5a | Dungeness A | English | 2 GCR | 7,7E-02 | 5,5E-03 | | | | | | | | | | | | 1,6E-02 | | | |
| UK8a | Hinkley Point A | Severn | 2 GCR | 2,3E-01 | 3,7E-01 | | | | | | | | | | | | 6,3E-02 | | | |
| UK9a | Hunterston A (8) | Firth of Clyde | 2 GCR | 3,9E-04 | | 2,1E-04 | 2,3E-02 | | | | | | | | | | | | | 1,0E-04 |
| UK11a | Sizewell A | North Sea | 2 GCR | 5,3E-02 | 6,0E-02 | | | | | | | | | | | | 1,2E-01 | | | |
| UK13 | Trawsfynydd (9) | Trawsfynydd | 2 GCR | 5,7E-03 | 1,0E-03 | | | | | | 2,2E-05 | | | | | | 5,4E-04 | | | |
| UK18 | Dounreay (10) | Pentland Firth | No reactors | 1,0E-01 | | 2,6E-04 | 6,0E-04 | | | | 3,1E-02 | 1.19r-5 | | | | | 6,2E-03 | | | |
| UK19 | Harwell | River Thames | No reactors | 7,9E-03 | | 9,3E-06 | 2,5E-04 | | 7,2E-07 | | | | | | | | 4,4E-05 | | | |
| UK20 | Winfrith | Weymouth Bay | No reactors | 1,1E+00 | 8,2E-03 | 5,6E-05 | | | | | | | | | | | 4,9E-02 | | | |

## 3.3 Endnotes to data tables 4 to 8

### Table 4

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

(2) For Belgium, the nuclides included are:

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

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

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

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

In order to eliminate the variability associated with specific operating conditions of each reactor, it is more appropriate for a given year to consider the total amount of electricity generated by the French facilities in the OSPAR area. In 2009, their net electrical output was 322 millions of MWh.

(4) Data from the producers EDF.

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

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

(7) 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.

(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, 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, Nb-95, Zr-95, Ag-110m, Te-123m, Sb-124, Sb-125, I-131, 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 2009 compound samples analyses.

(9) Shut down in 2006.

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

(11) 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, Sb-124, Sb-125, Sr-89, Sr-90, Cs-137, H-3, Pu-238, Pu-239/240, Am-241, Cm-242, Cm-244

(12) For Ringhals unit 2 the following radionuclides were detected: Cr-51, Mn-54, Co-58, Co-60, Zr-95, Nb-95, Ag-108m, Ag-110m, Sb-124, Sb-125, Sr-89, Sr-90, Cs-137, H-3, Pu-238, Pu-239/240, Am-241, Cm-242, Cm-244

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

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

(5) 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.

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

(7) Gross alpha and beta activity excluding tritium.

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

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

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

# References

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