OSPAR COMMISSION

Liquid discharges from nuclear installations in 2007

Radioactive Substances Series

2009

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 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 – 2007. The discharges of tritium peaked in 2004.

This annual report includes the data of 2007 on liquid radioactive discharges from nuclear installations and temporal trends for the period 1990 - 2007. 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 17-year period. Discharges of alpha activity are at their lowest level during the period and are now less than one-tenth of the peak value in 1993. The alpha discharges from the reprocessing plant at Sellafield continue a four-year downward trend. There was also a three-fold decrease in alpha discharges from the fuel fabrication sub-sector, in particular from the Springfields site.

The **tritium** discharges from all installations have increased over the 17-year period, peaking in 2004, mainly as a result of discharges from La Hague. The reprocessing plant at La Hague contributed nearly 77% of the total tritium discharges in 2007. Discharges of tritium from Sellafield have declined over the four-year period 2004 – 2007. Discharges of tritium from nuclear power stations are relatively constant over the period, but are lower in 2007 than in 2006 and 2005. The contribution arising from the research and development facilities and from decommissioning and waste are low.

The discharges of **total beta** activity (excluding tritium) from all nuclear installations have decreased markedly over the past 17 years. 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 83% (2007) of the overall discharges, but this proportion is declining over time. The reduction of Sellafield's total-beta discharges from 2002 to 2007 is a result of the significant reduction in technetium-99 discharges. The most significant change is the decline in beta discharges from the fuel fabrication sub-sector, in particular from the Springfields site.

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 2007. Les rejets de tritium ont atteint leur maximum en 2004.

Le présent rapport annuel comporte les données de 2007 sur les rejets radioactifs liquides provenant des installations nucléaires et les tendances temporelles pour la période de 1990 à 2007. 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-sept dernières années. Les rejets d'activité alpha sont à leur niveau le plus bas au cours de cette période et sont maintenant inférieurs à un dixième de leur valeur de 1993. Les rejets d'alpha provenant de l'usine de retraitement de Sellafield continuent à révéler une tendance à la baisse sur quatre ans. 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.

Les rejets de **tritium** provenant de toutes les installations ont augmenté au cours des dix-sept dernières années, leur maximum étant en 2004, résultant principalement des rejets de la Hague. L'usine de retraitement de La Hague est responsable de presque 77% de l'ensemble des rejets de tritium en 2007. Les rejets de tritium provenant de Sellafield ont diminué entre 2004 et 2007. Les rejets de tritium provenant des centrales nucléaires sont relativement constants durant cette période mais ils sont plus faibles en 2007 qu'en 2006 et 2005. Les rejets provenant des installations de recherche et de développement et de la mise hors service et des déchets sont faibles.

Les rejets de l'activité de **bêta total** (à l'exclusion du tritium) provenant de toutes les installations nucléaires ont diminué sensiblement au cours des dix-sept dernières années. Historiquement, les rejets de bêta total sont dominés par les rejets provenant de l'usine de retraitement de Sellafield et de l'usine de Springfields. Ces deux usines contribuent ensemble à environ 83% (2007) de l'ensemble des rejets, mais ce pourcentage diminue dans le temps. La diminution des rejets de bêta total provenant de Sellafield, entre 2002 et 2007, résulte de la réduction significative des rejets de technetium-99. Le déclin des rejets de bêta provenant du sous-secteur de la production de combustible, en particulier du site de Springfields, représente le changement le plus significatif.

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:

- 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).

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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.
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).

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.

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 2007

2.1 Introduction

Tables 1 - 3 summarise liquid radioactive discharges from nuclear installations for the period 1990 – 2007; data for 1990 – 2006 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 terabecquerel per year (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 2007.

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 are now less than one-tenth of the peak value in 1993. The alpha discharge in 2007 from Sellafield was again lower than the previous year, continuing a four-year downward trend in alpha discharges from Sellafield (2003: 0.41 TBq; 2004: 0.29 TBq; 2005: 0.25 TBq; 2006: 0.21 TBq; 2007: 0.125 TBq).

There was also a three-fold decrease in alpha discharges from the fuel fabrication sub-sector since 2006, in particular from the Springfields site (2005: 0.25 TBq; 2006: 0.11 TBq; 2007: 0.026 TBq). During the first half of 2006 the Springfields site stopped processing raw uranium feedstock and started to buy pre-refined uranium, with a consequent reduction in alpha discharges. In addition, during 2006 Magnox fuel production ceased at Springfields.

The reprocessing plant at La Hague also contributes (0.021 TBq) to the overall alpha discharge. Discharges from research and development facilities continue to decline and for 2007 were less than 100 megabequerel (MBq) 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 8000 TBq/y during the period 1990 - 1992 to a peak of 20 634 TBq in 2004. This increase was mainly due to the discharges from La Hague (2001: 9650 TBq; 2002: 12 000 TBq; 2003: 11 900 TBq; 2004: 13 900 TBq). During the period 2005 to 2006 discharges of tritium from La Hague fell significantly (2005: 13 500 TBq; 2006: 11 100 TBq), but rose by 8% in 2007 (12 000 TBq). The reprocessing plant at La Hague contributed nearly 77% of the total tritium discharge from all sectors in 2007 (15 594 TBq). Tritium discharges from the reprocessing sub-sector are broadly proportional to throughput of fuel.

The tritium discharges from Sellafield have declined over the four-year period 2004 - 2007 (2003: 3900 TBq; 2004: 3170 TBq; 2005: 1570 TBq; 2006: 1090 TBq; 2007: 628 TBq). This is in part a consequence of reduced reprocessing throughput at Sellafield as a result of the limited operation of the THORP facility throughout 2007.

Discharges of tritium from nuclear power stations contribute virtually all of the remaining 19% and, though relatively constant, the discharges of tritium from this sector in 2007 (2936 TBq) were again lower than in 2006 (3304 TBq) and significantly lower than in 2005 (4160 TBq).

The contribution to discharges of the research and development facilities remains low (7 TBq). Tritium discharges arising from decommissioning have been recorded separately since 2006, and though a very minor contributor, discharges in 2007 (24 TBq) showed an increase of 42% on the previous year (16.9 TBq).

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 491 TBq (1990), down to 33.4 TBq (2007). 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 83% (2007) of the overall discharges, but this proportion is declining 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: 79 TBq; 2002: 85 TBq; 2003: 37 TBq; 2004: 14 TBq; 2005: 6.7 TBq; 2006: 5.6 TBq; 2007: 4.9 TBq) and now accounts for less than 20% of the total beta discharge from that site. Although the trend in total beta discharges (2001: 123 TBq; 2002: 112 TBq; 2003: 83 TBq; 2004: 73 TBq; 2005: 43 TBq; 2006: 29 TBq; 2007: 24.8 TBq) has largely followed the trend in Technetium-99 discharges, reductions in discharges of other radionuclides (e.g. Strontium-90) have been noted and these other radionuclides are now less than half the level they were before 2005.

The most significant change is the decline in beta discharges from the fuel fabrication sub-sector, in particular from the Springfields site (2005: 103 TBq; 2006: 20.7 TBq; 2007: 3 TBq). As mentioned above, during the first half of 2006 the Springfields site stopped processing raw uranium feedstock and started to buy pre-refined uranium, with a consequent reduction in beta, as well as alpha, discharges. In addition during 2006 Magnox fuel production ceased at Springfields. The full effect of these changes is evident in the figures for 2007.

***Table 1**. Total alpha discharges 1990 - 2007*

Total alpha	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
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**	**0.62**	**0.62**	**0.54**	**0.52**	**0.34**	**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**
% 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**	**78.9**
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**
% 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**	**21.0**
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**
% 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**	**0.0**
Decommissioning (TBq)																	**0.00**	**0.00**
% of all installations																	**0.2**	**0.0**

***Table 2.** Tritium discharges 1990 - 2007*

Tritium	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
All Nuclear Installations (TBq)	7224	8798	7658	**10902**	**12931**	**15040**	**16779**	**17956**	**16244**	**18771**	**16548**	**15759**	18880	19637	20637	19248	**15514**	**15594**
Reprocessing Plants (TBq)	4959	6513	4969	**7460**	**9770**	**12310**	**13500**	**14500**	**12800**	**15420**	**13300**	**12210**	15220	15800	17070	15070	**12190**	**12628**
% 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	78.3	**78.6**	**81.0**
Nuclear Power Plants (TBq)	2164	2252	2666	**3354**	**3044**	**2713**	**3264**	**3440**	**3430**	**3335**	**3241**	**3543**	3648	3819	3560	4160	**3304**	**2936**
% 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	21.6	**21.3**	**18.8**
Nuclear Fuel Fabrication (TBq)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**0.03**
% of all installations	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**0.0**
Research and Development Facilities (TBq)	101	32	24	**88**	**118**	**17**	**15**	**16**	**14**	**16**	**7**	**6**	12	18	7	18	**5**	**7**
% 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**
Decommissioning (TBq)																	**16.90**	**24**
% of all installations																	**0.1**	**0.15**

Table 3. *Total beta (excl tritium) discharges 1990 - 2007*

Total beta excluding tritium)	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
All Nuclear Installations (TBq)	491	227	269	252	321	365	332	315	265	256	172	231	235	198	204	160	58	33.42
Reprocessing Plants (TBq)	384	178	134	170	195	243	169	167	112	126	98	141	125	97	86	54	37	29.6
% 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	34.1	62.5	88.6
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
% 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	1.3	1.3	1.4
Nuclear Fuel Fabrication (TBq)	92	39	120	63	114	112	150	140	150	128	71	85	106	97	116	103	21	2.99
% 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	64.5	35.4	8.9
Research and Development Facilities (TBq)	4.5	6.3	6.6	8.2	9.1	7.0	8.1	1.0	0.66	0.36	0.30	0.46	0.46	0.44	0.47	0.09	0.06	0.13
% 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
Decommissioning (TBq)																	0.40	0.22
% of all installations																	0.7	0.7

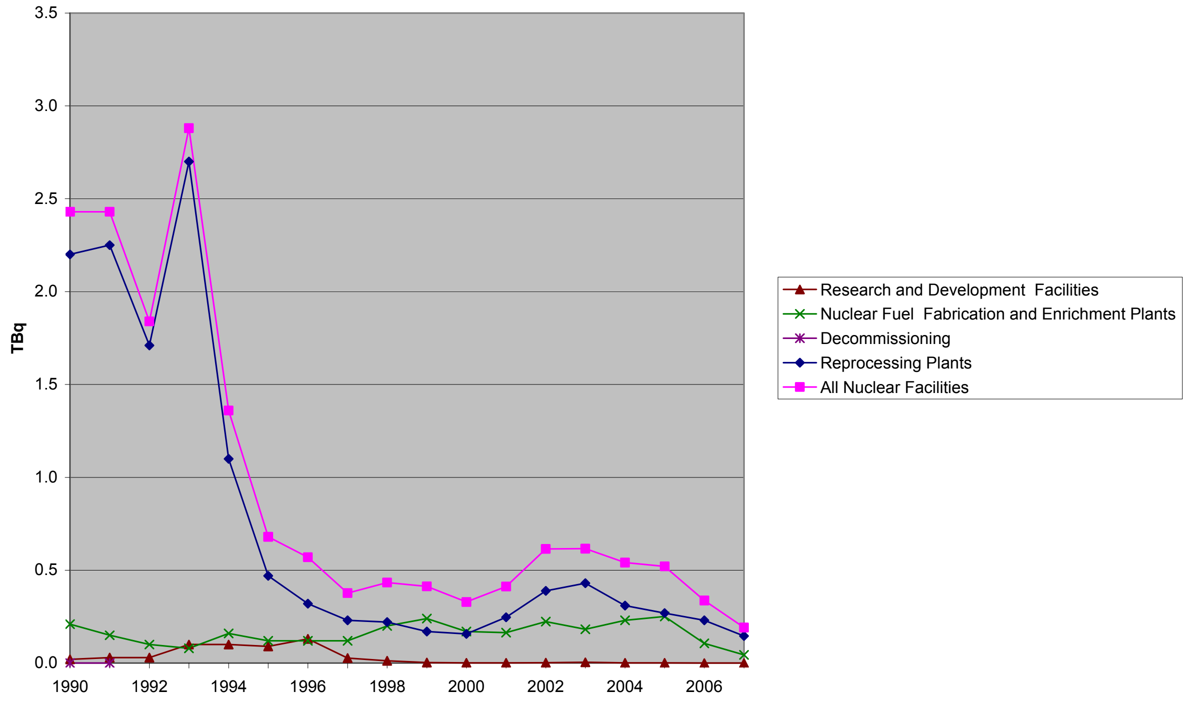


***Figure 1**: Discharges of total alpha*

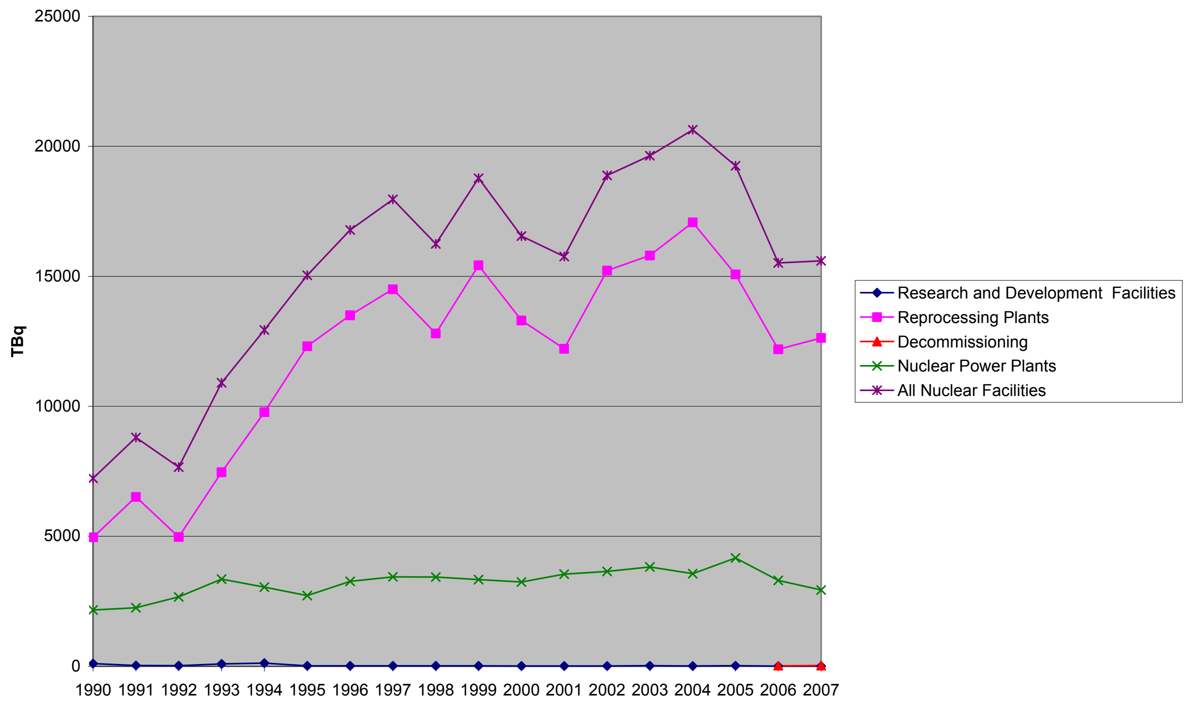


***Figure 2:** Discharges of tritirum*

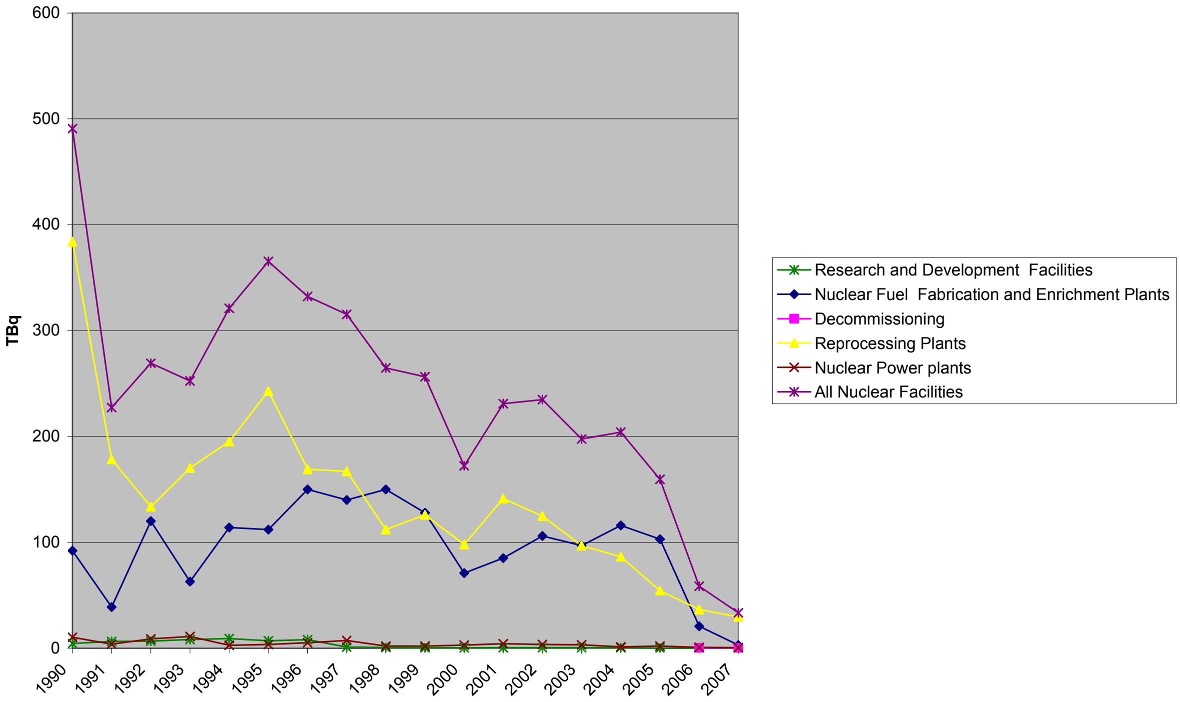


Figure 3: *Discharges of total beta, excluding tritium*

3. 2007 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.

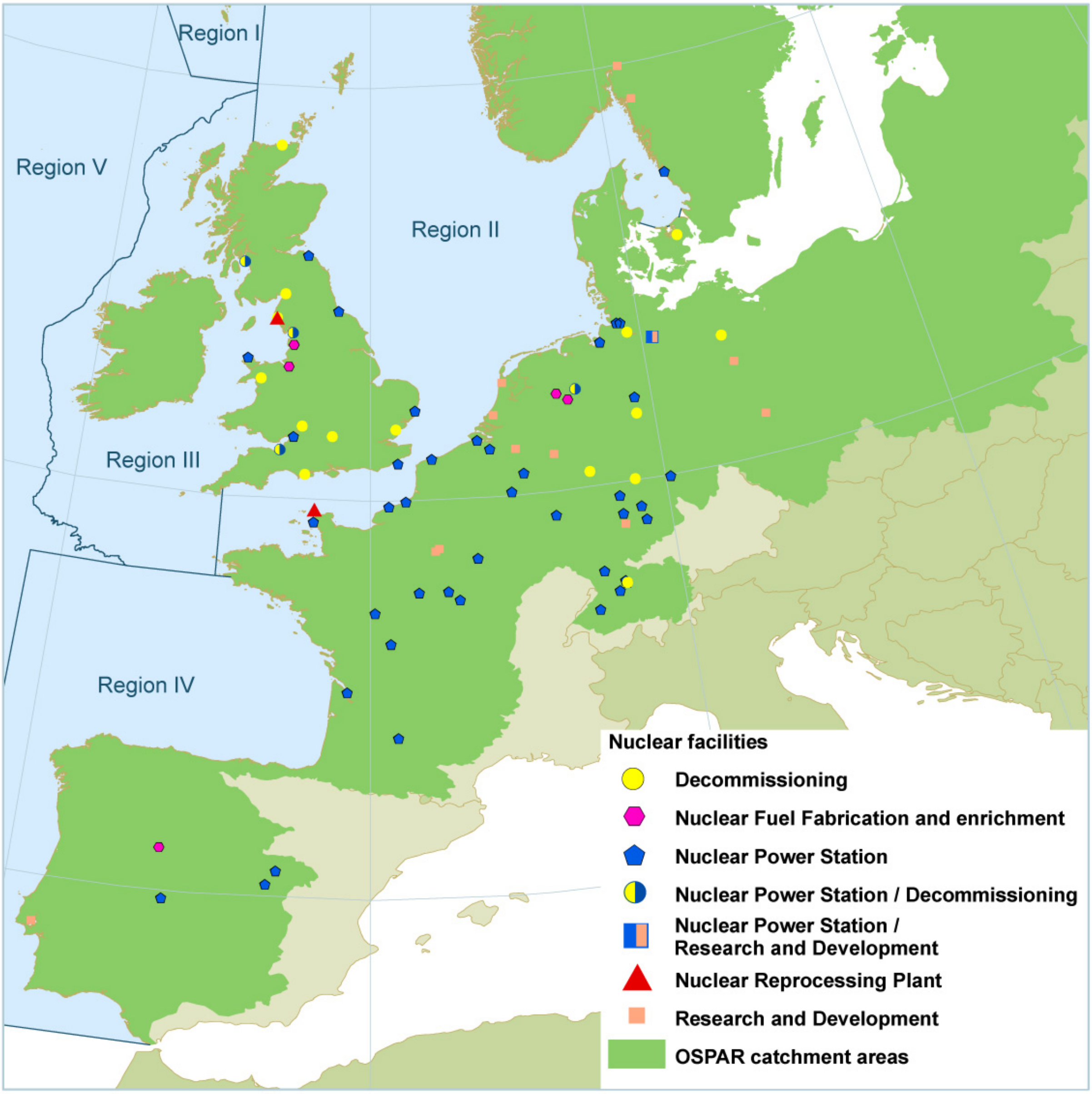
For radionuclides:

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	NPS	Main
DE8	Krümmel/Geesthacht	NPS	Elbe
DE8	Geesthacht	RDF	Elbe
DE9	Lingen/Emsland	NPS	Ems
DE9	Lingen	NFFEP	Ems - via municipal sewer system
DE10	Mülheim-Kärlich	NPS	Rhine
DE11	Neckar-westheim 1/Neckar-wesheim 2	NPS	Neckar
DE12	Obrigheim	NPS	Neckar
DE13	Philippsburg KKP1/Philippsburg KKP2	NPS	Rhine
DE14	Rheinsberg	NPS	Havel
DE15	Stade	NPS	Elbe
DE16	Rodenkirchen-Unterweser	NPS	Weser
DE17	Würgassen/Beverungen	NPS	Weser
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
NL3	Almelo	NFFEP	Municipal sewer system
NL4	Delft	RDF	Sewage system
NL5	Petten	RDF	North Sea

Country / Code	Name of installation	Type	Discharging into
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
RDF: Research and Development Facilities
NFRP: Nuclear Fuel Reprocessing Plants
NFFEP: Nuclear Fuel Fabrication and Enrichment Plants
DMLRW: Decommissiong and Management of Legacy Radioactive Wastes

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 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) 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 2007, their net electrical output was 349 millions of MWh.

(6) Data from the producers EDF.

(7) Shut down in 1986.

(8) Shut down in 1977.

(9) Shut down in 2005.

(10) Shut down in 1990.

(11) Shut down in 2003.

(12) Shut down in 1994.

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

(14) Although José Cabrera nuclear power plant was shut down in 2006, its effluent data are reported in table 4 instead than in table 8 because the liquid effluents were produced during operations carried out prior to the dismantling of the plant.

(15) Other radionuclides for Almaraz: Ag-110-m, Ce-141, Co-58, Co-60, Cr-51, Cs-134, Cs-136, Cs-137, Fe-59, Mn-54, Na-24, Nb-95, Ru-106, Sb-122, Sb-124, Sb-125, Sr-89, Sr-90, Te-123m, Zn-65, Zr-95. Other radionuclides for José Cabrera: Co-58, Co-60, Cs-137. Other radionuclides for Trillo: Ag-110m, Co-58, Co-60, Cr-51, Cs-134, Cs-137, Mn-54, Nb-95, Sb-124, Sb-125, Te-123m, Zr-95.

(16) Shut down in 2006.

(17) The value reported corresponds to the sum of individually assessed alpha emitting readionuclides.

(18) For Ringhals unit 1 the detected radionuclides were: Cr-51, Mn-54, Fe-59, Co-57, Co-58, Co-60, Zn-65, Sr-90, Nb-95, Zr-95, Ag-110m, Sb-124, Sb-125, Cs-137.

(19) For Ringhals unit 2 the detected radionuclides were: Cr-51, Mn-54, Co-57, Co-58, Co-60, Sr-90, Nb-95, Zr-95, Ag-110m, Sb-122, Sb-124, Sb-125, Cs-137, La-140, Ce-144Pu-238, Pu-239, Am-241, Cm-242, Cm-244.

(20) For Ringhals unit 3 the detected radionuclides were: Cr-51, Mn-54, Co-57, Co-58, Co-60, Fe-59, Zn-65, As-76, Sr-89, Sr-90, Nb-95, Zr-95, Tc-99m, Ag-110m, Sn-113, Sb-122, Sb-124, Sb-125, Cs-134, Cs-137, Pu-238, Pu-239, Am-241, Cm-242, Cm-244, I-131.

(21) For Ringhals unit 4 the detected radionuclides were: Cr-51, Mn-54, Co-57, Co-58, Co-60, Fe-59, Zn-65, Sr-89, Sr-90, Nb-95, Zr-95, Ag-110m, Sn-113, Sb-124, Sb-125, Cs-137, Pu-238, Pu-239, Am-241, Cm-242, Cm-244, I-131.

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) Since July 2006, the authorised capacity is 400 tonnes of uranium/year.

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 (most have been reported as "less than" values) by IFE are not included as specific nuclides in the spreadsheet.

From IFE Kjeller, these radionuclides are: Mn-54, Cr-51, Fe-59, Sb-124 U-234, U-235, U-238 and Cm-244

From IFE Halden, these radionuclides are: Ru-103, Zn-65

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.

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OSPAR COMMISSION

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

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