Radioactive Substances Series

Liquid Discharges from Nuclear Installations in 2006, including exceptional discharges from decommissioning and management of legacy radioactive wastes

OSPAR Commission

2008

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.

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.

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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 – 2006. The discharges of tritium have increased over the period.

This annual report includes the data of 2006 on liquid radioactive discharges from nuclear installations and covers the period 1990-2006. 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 terrabequerel per year (TBq/y) for each type of nuclear installation. Temporal trends in discharges are shown for total alpha, tritium and total beta (excluding tritium) for the period 1990-2006.

There is a downward trend in the amount of **total alpha** activity discharged from all nuclear installations over the 16-year period. Discharges of alpha activity have now stabilised to the levels over the period 1997 – 2000. In 2006, the discharges from Sellafield were lower than those in 2005, continuing a three-year downward trend. It is expected that this downturn will continue. The most significant change is the decline in alpha discharges from the fuel fabrication plant at Springfields. The reason for this is that the site stopped processing raw uranium feedstock. Discharges from research and development facilities continue to decline. Total alpha discharges arising from decommissioning, recorded in 2006, contributed to only 0.2% of the total-alpha discharged.

The **tritium** releases from all installations have increased over the 16-year period, peaking in 2004, which was mainly due to discharges from La Hague. The reprocessing plants in La Hague contributed, to approximately 72 % of the overall discharges in 2006. Discharges of tritium from Sellafield have declined as a result of the suspension of operation of the THORP facility throughout 2006. Discharges of tritium from nuclear power stations and from the research and development facilities are lower than in 2005. The contribution arising from decommissioning and waste was recorded this year and is equivalent to 0.1% of the total.

The sum of **total beta activity (excluding tritium**) from all nuclear installations has fallen significantly over the past 16 years. Total discharges are dominated by discharges from the nuclear fuel plant at Springfields and to a lesser extent from the reprocessing plant at Sellafield, although discharges are declining over time. The two installations together contribute approximately 86 % of the overall discharges. The high, but decreasing total-beta discharges from Sellafield are mainly attributable to the radionuclide technetium-99. The reduction of Sellafield's total-beta discharges from 2002 to 2006 is a result of the significant reduction in technetium-99 discharges, due to the vitrification process, since 1994 for oxide fuels and 2003, for magnox fuels. The Springfields site stopped processing raw uranium feedstock during the first half of 2006. In addition, Magnox fuel production ceased at Springfields in 2006, resulting in a reduction in beta.

Récapitulatif

Les rejets des substances radioactives, mesurées en activité alpha totale et en bêta totale, excluant le tritium, émanant des installations nucléaires ont diminué durant la période de 1990 à 2006. Par contre, le tritium a augmenté durant la même période.

Le présent rapport annuel comprend les données 2006 des rejets radioactifs liquides des installations nucléaires, et couvre la période de 1990 à 2006. Sur cette base, les rejets des centrales nucléaires, des usines de retraitement du combustible nucléaire, des installations de fabrication et d'enrichissement du combustible nucléaire, ainsi que des équipements de recherche et développement ont été évalués. Les rejets sont exprimés en terrabequerel par an (TBq/an) pour les activités alpha totale, tritium et bêta totale (à l'exclusion du tritium) pour chacun des secteurs des installations nucléaires. Les tendances chronologiques des rejets d'activité alpha totale, du tritium et de bêta totale (à l'exclusion du tritium) sont mises en évidence pendant la période de 1990 à 2006.

On constate une tendance à la baisse de l'activité ***alpha totale*** *rejetée par toutes les installations nucléaires sur la période de 16 ans en cause. Toutefois, les rejets d'activité alpha se maintiennent au même niveau que la période couvrant 1997 – 2000. En 2006, les rejets de Sellafield étaient inférieurs à ceux de 2005, continuant une tendance à la baisse sur trois ans. On s'attend à ce que ce début de tendance à la baisse se poursuive. Le contributeur le plus important est le déclin des rejets d'activité alpha de l'installation de fabrication de combustible de Springfields. Ceci est dû à l'arrêt de la fabrication de la charge d'alimentation de l'uranium brut. Les rejets des équipements de recherche et de développement continuent à baisser. Les rejets d'activité alpha totale émanant du déclassement, notifiés en 2006, ont contribué à 0,2 % des rejets d'alpha totale.*

Les rejets de ***tritium*** *de toutes les installations ont augmenté sur la période de 16 ans en cause. Ils ont monté en pic en 2004, essentiellement dûs aux rejets de l'usine de La Hague. L'usine de retraitement de La Hague représente environ 72 % de l'ensemble des rejets en 2006. Les rejets de tritium de Sellafield ont diminué car les opérations de l'installation de THORP ont cessé au cours de 2006. Les rejets de tritium des centrales nucléaires et des equipements de recherche et de développement sont inférieurs à ceux de 2005. Les contributions du déclassement et des déchets ont été notées pour la première fois cette année et compte 0,1 % de l'ensemble du total.*

A l'exclusion du tritium, la somme d'activité ***bêta totale*** *de toutes les installations nucléaires a significativement baissé ces seize dernières années. Les émissions de l'usine de retraitement du combustible nucléaire à Sellafield, et, dans une moindre mesure, l'installation de fabrication et d'enrichissement du combustible nucléaire de Springfields constituent les rejets totaux pour l'essentiel bien que les rejets continuent à baisser au fil du temps. Conjointement, ces deux équipements représentent environ 86% de l'ensemble des rejets. Les rejets élevés, mais décroissants, de bêta totale de Sellafield sont surtout imputables au radionucléide technétium 99. La baisse des rejets de bêta totale de l'usine de Sellafield, telle que survenue pendant la période de 2002 à 2006, résulte d'une réduction significative des rejets de Technétium 99, due à la procédure de vitrication en vigueur depuis 1994 pour le combustible oxyde, et depuis 2003, pour le combustible Magnox. L'installation de Springfields a cessé la fabrication de la charge d'alimentation de l'uranium brut au cours de l'année 2006. En plus, la production du combustible Magnox a cessé à Springfields, donnant suite à une réduction de bêta.*

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 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];

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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).

- 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 [5];
- 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 (Publication number 302/2006).

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 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 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 (ISBN 0 946955 85 9).

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 (reference number: 1996-2).

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

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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; see website: http://europa.eu.int/comm/environment/radprot/.

5 At the request of the OSPAR Commission in this Recommendation, the OECD Nuclear Energy Agency published in 2000 a comparative study on Radiological Impacts of Spent Nuclear Fuel Management Options (ISBN 92 64 17657 8).

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 [6].

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.

6 For abbreviations of radionuclides see Chapter 3.

2. Assessment of the liquid radioactive discharges from nuclear installations in 2006

2.1 Introduction

Table 1 summarises liquid radioactive discharges from nuclear installations for the time period 1990 – 2006; data 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 and for the first time in 2006 discharges from decommissioning are reported separately. For each type of nuclear installation, Table 1 gives total alpha activity, tritium and 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 temporal trends of total alpha, tritium and total beta (excluding tritium) for the time period 1990 to 2006.

2.2 Trends in total alpha discharges

There was a decrease of the total alpha activity discharged from all nuclear installations over the 16-year period (Table 1 and Figure 1). Discharges of alpha activity have in 2006 returned to the levels recorded over the period 1997 – 2000, that is before the increase in discharges in the period 2001- 2003 which were largely a result of higher total alpha releases from the reprocessing plant at Sellafield. The alpha discharge in 2006 from Sellafield was lower than 2005, continuing a three-year downward trend in alpha discharges from Sellafield (2003, 0.41TBq; 2004, 0.29TBq; 2005, 0.25TBq; 2006, 0.21TBq). The most significant change is the decline in alpha discharges from the fuel fabrication sub-sector, in particular from the Springfields site (2005, 0.25TBq; 2006, 0.11TBq). 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 (0.025TBq) also contributes to the overall alpha discharge. Discharges from research and development facilities continue to decline and for 2006 were only 100MBq in total. Total alpha discharges arising from decommissioning were recorded separately for the first time in 2006, and at 0.6 GBq contributed only 0.2 % of the total.

2.3 Trends in tritium discharges

There was an increase in discharges of tritium discharged from all nuclear installations over the 16-year period (Table 2 and Figure 2). 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). From 2005 onwards discharges of tritium from La Hague have been reduced (2005, 13500TBq; 2006, 11100TBq); the trend is dependent on throughput and fuel burn-up, with throughput being the principal influence. Despite this downward trend the reprocessing plant at La Hague still contributed nearly 72% of the total tritium discharge from all sectors of 15,514TBq, in 2006.

The tritium discharges from Sellafield have also declined over the three years 2004-2006 (2003, 3900TBq; 2004, 3170TBq; 2005, 1570TBq; 2006, 1090TBq). This is in part a consequence of reduced reprocessing throughput at Sellafield as a result of the suspension of operation of the THORP facility throughout 2006. Discharges of tritium from nuclear power stations contribute virtually all of the remaining 21% and, though relatively constant, the discharges of tritium from this sector in 2006 (3304TBq) were significantly lower than in 2005 (4160TBq). The contribution of the research and development facilities has decreased to 3TBq in 2006. Tritium discharges arising from decommissioning were recorded separately for the first time in 2006, and amounted to a total of 16.9TBq, equivalent to 0.1% of the total.

2.4 Trends in total beta discharges

Figure 3 shows that the sum of total beta activity (excluding tritium) discharged from all nuclear installations has decreased markedly over the past 16 years, from 491TBq (1990), down to 58TBq (2006). 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 86% (2006) of the overall discharges, but this proportion is declining over time.

Prior to 2002 the high total beta discharges from Sellafield (2001, 123TBq; 2002, 112TBq; 2003, 83TBq; 2004, 73TBq; 2005, 43TBq; 2006, 29TBq) were mainly attributable to the radionuclide Technetium-99 (2001, 79TBq; 2002, 85TBq; 2003, 37TBq; 2004, 14TBq; 2005, 6.7TBq; 2006, 5.6TBq). The contribution from Technetium-99 to the total beta discharge at Sellafield has been reducing steadily and now accounts for less than 20% of the total beta discharge from that site. The reduction of technetium-99 discharges is due to the diversion of the Medium Active Concentrate waste stream to vitrification and the use of tetrophenylphosphonium bromide (TPP) to remove technetium-99 from the waste stream at the Enhanced Actinide Removal Plant (EARP). The decrease in Sellafield's beta discharges in 2006, relative to 2005, was mainly attributable to reduced strontium-90 discharges as a result of the completion of the programme of processing of stored Medium Active Concentrate through EARP.

The most significant change is the decline in beta discharges from the fuel fabrication sub-sector, in particular from the Springfields site (2005, 103TBq; 2006, 20.7TBq). 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.

Table 1: Summary of discharges from nuclear installations from 1990-2006

a) Total alpha	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
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
% 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
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
% 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
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
% 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
Decommissioning (TBq)																	0.00
% of all installations																	0.2

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

c) Total Beta (Other radionuclides excluding tritium)	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
All Nuclear Installations (TBq)	491	227	269	252	321	365	332	315	265	256	172	231	235	198	204	160	58
Reprocessing Plants (TBq)	384	178	134	170	195	243	169	167	112	126	98	141	125	97	86	54	37
% 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
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
% 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
Nuclear Fuel Fabrication (TBq)	92	39	120	63	114	112	150	140	150	128	71	85	106	97	116	103	21
% 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
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
% 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
Decommissioning (TBq)																	0.40
% of all installations																	0.7

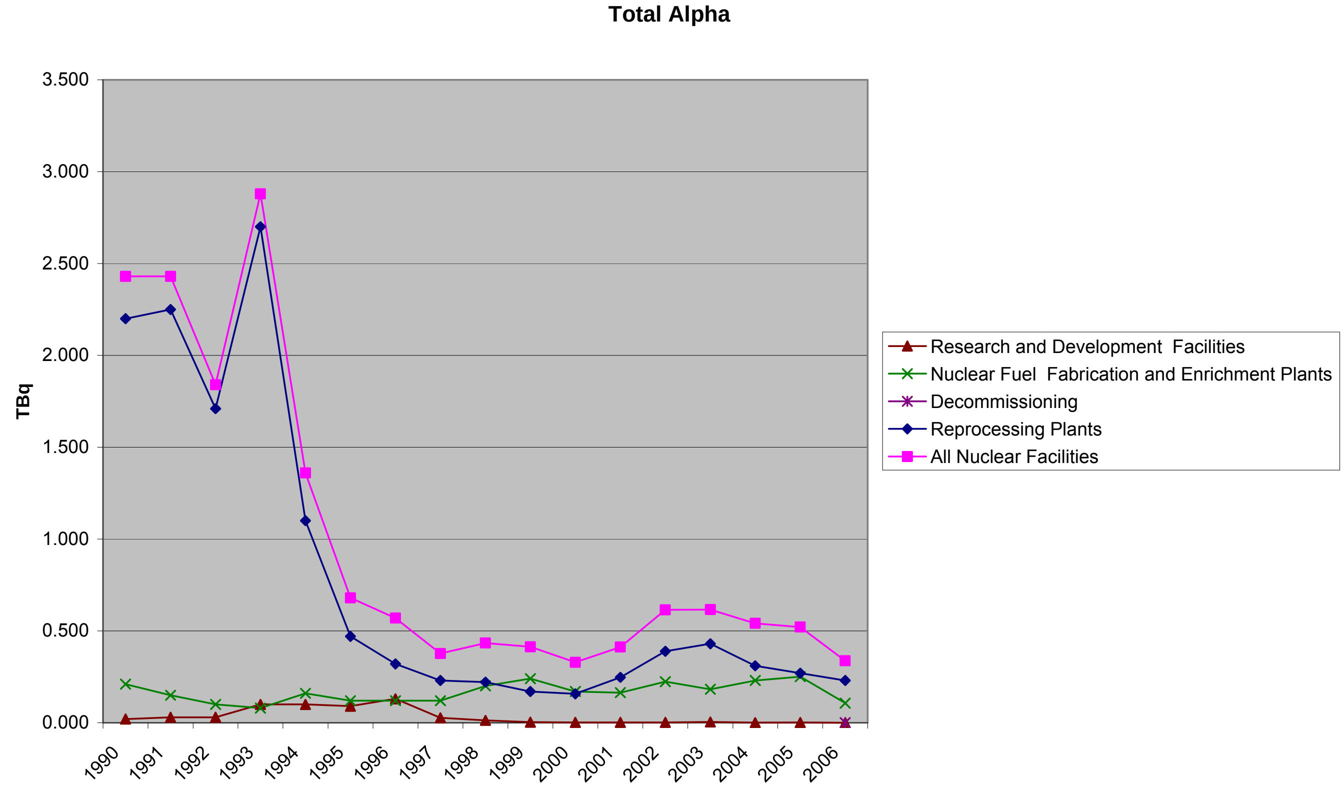


Figure 1: Discharges of total alpha from nuclear installations from 1990-2006

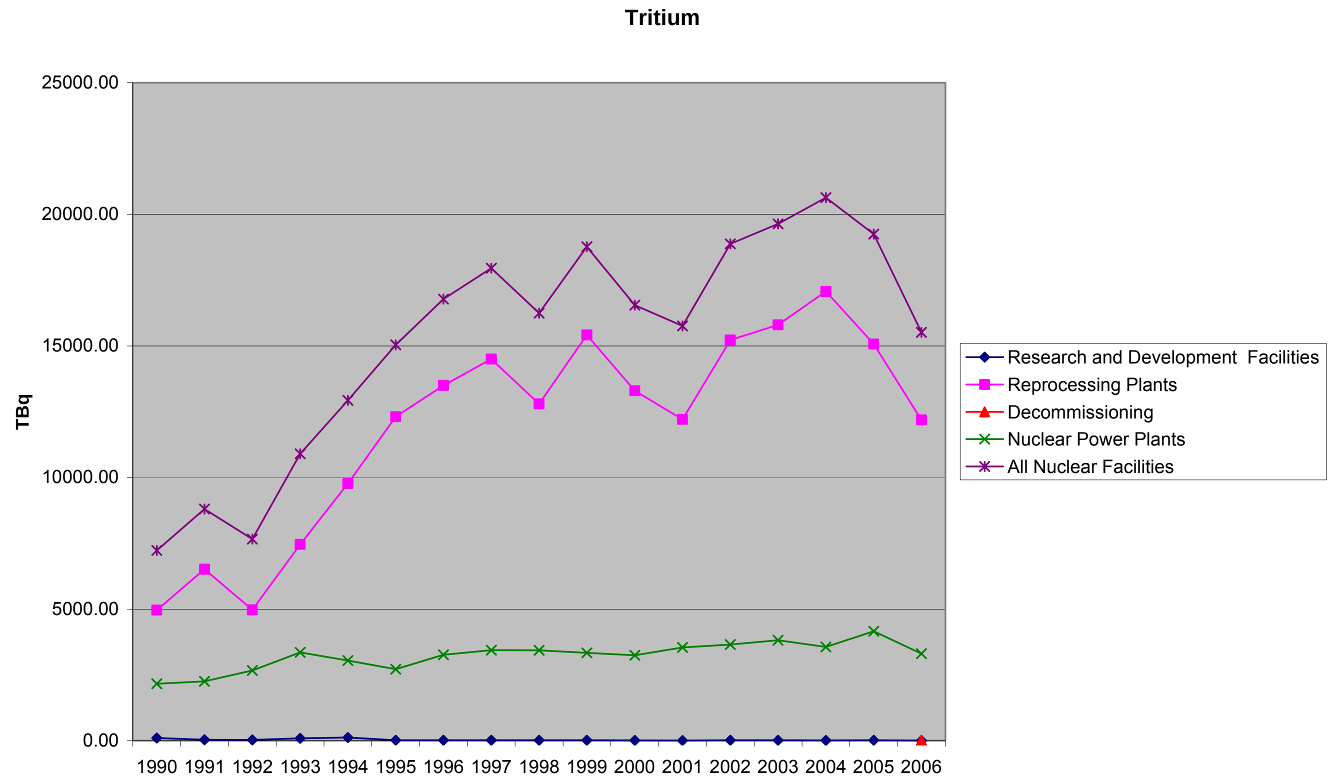


Figure 2: Discharges of tritium from nuclear installations from 1990-2006

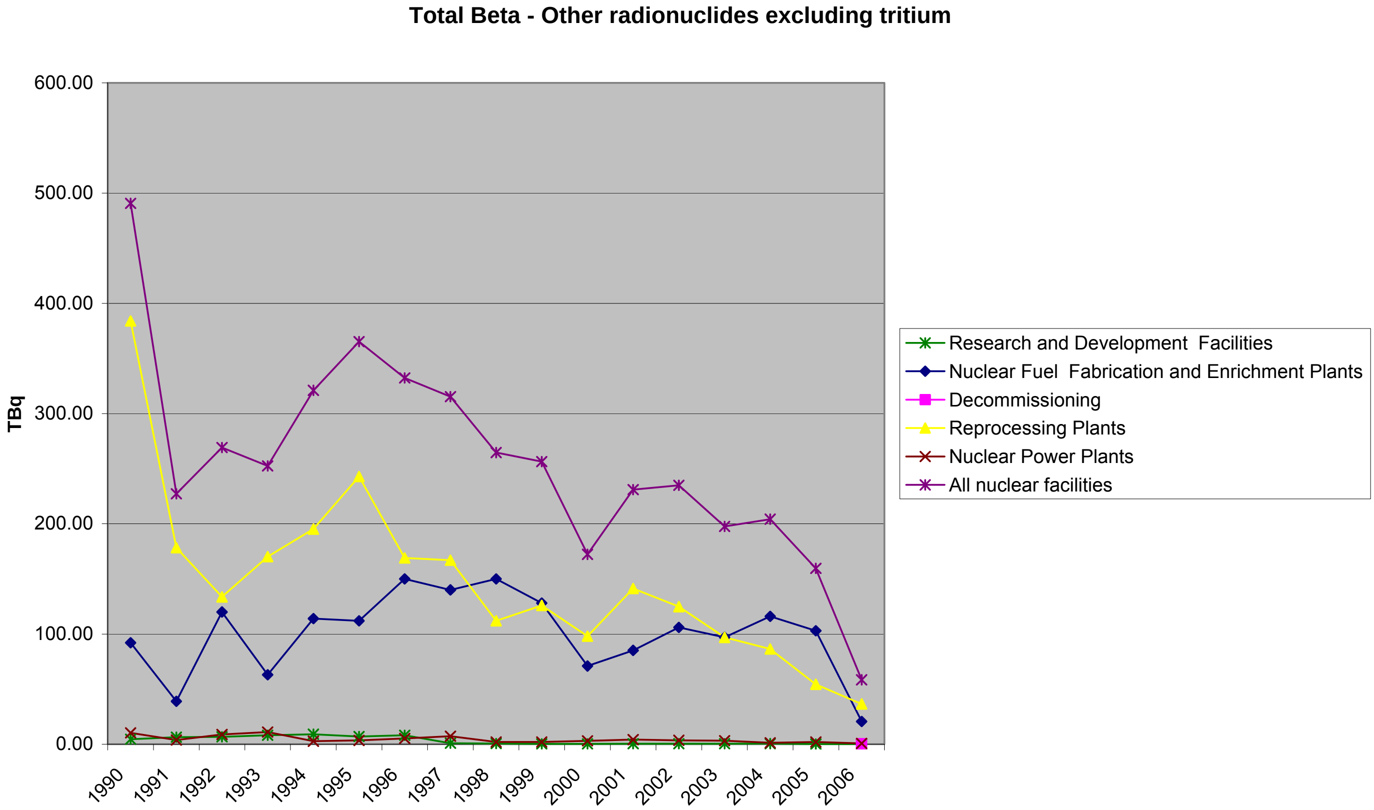


Figure 3: Discharges of radioactivity for other nuclides (excluding tritium) measured as total beta from 1990-2006

3. 2006 data and information

In this chapter of the report, data and information on liquid discharges is presented for each Contracting Party under the following categories of nuclear installations draining into the OSPAR maritime area:

Table 2:	Nuclear Power Stations;
Table 3:	Nuclear Fuel reprocessing Plants;
Table 4:	Nuclear Fuel Fabrication and Enrichment Plants;
Table 5:	Research and Development Facilities;
Table 6:	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. The following abbreviations are used in the tables:

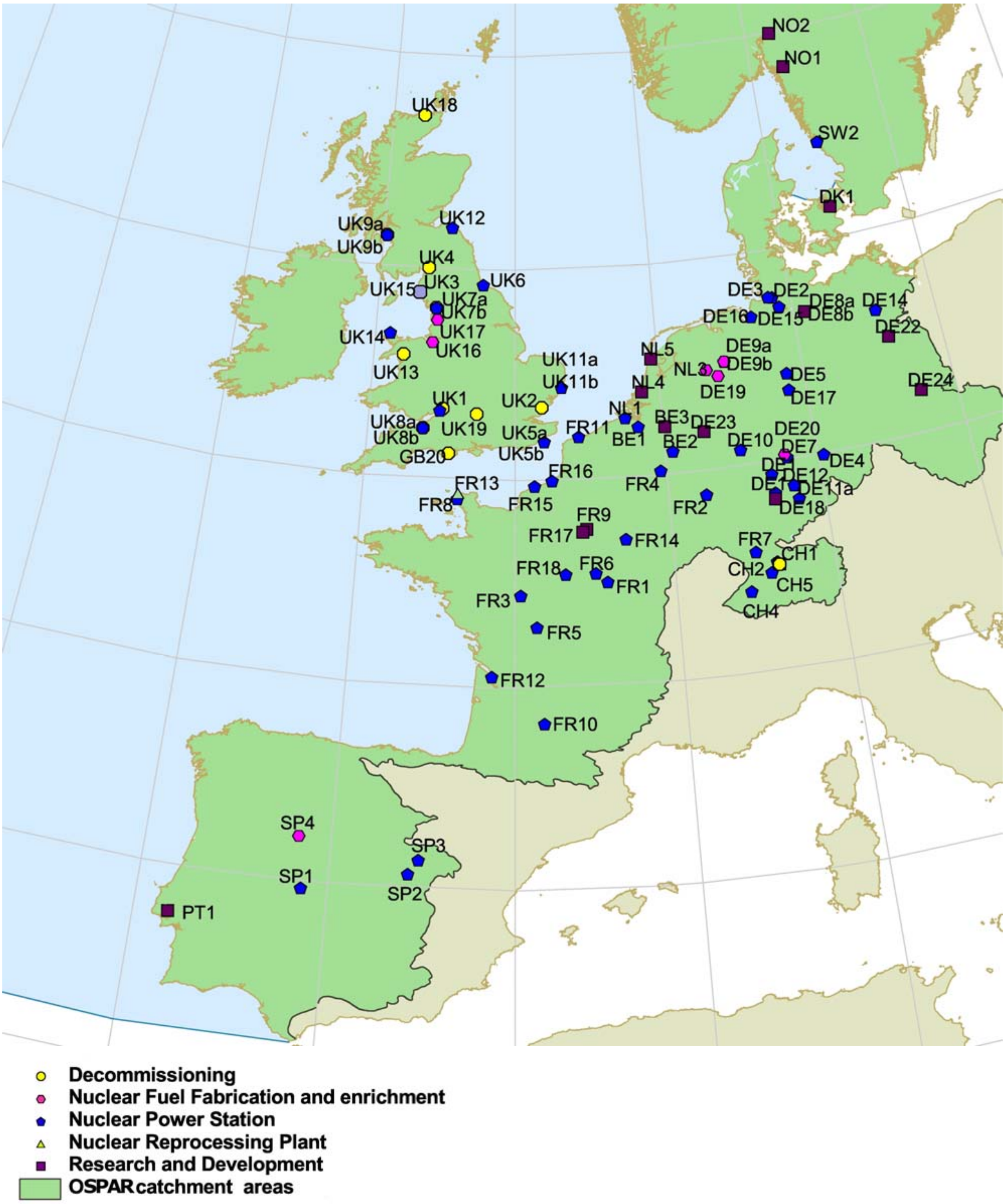
AGR:	Advanced Gas Cooled Reactor;
GCR:	Gas Cooled Reactor;
UNGG:	Natural Uranium Gas Graphite (French equivalent for GCR);
PWR:	Pressurised Water Reactor;
THTR:	Thorium High Temperature Reactor;
BWR:	Boiling Water Reactor;
NA:	Not applicable;
NI:	No information;
ND:	Not detectable.

For radionuclides:

Ag:	Silver	Gd:	Gadolinium	Rh:	Rhodium
Am:	Americum	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



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	RDF	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

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
UK			
UK1	Berkeley	DMLRW	Severn Estuary
UK2	Bradwell	DMLRW	North Sea
UK3	Calder Hall	DMLRW	Irish Sea
UK4	Chapelcross	DMLRW	Solway Firth
UK5	Dungeness A/Dungeness B	NPS	English Channel
UK6	Hartlepool	NPS	North Sea
UK7	Heysham 1 / Heysham 2	NPS	Morecambe Bay
UK8	Hinkley Point A	DMLRW	Severn Estuary
UK8	Hinkley Point B	NPS	Severn Estuary
UK9	Hunterston A	DMLRW	Firth of Clyde
UK9	Hunterston B	NPS	Firth of Clyde
UK10	Oldbury	NPS	Severn Estuary
UK11	Sizewell A/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
DMLRW: Decommissiong and Management of Legacy Radioactive Wastes
NFRP: Nuclear Fuel Reprocessing Plants
NFFEP: Nuclear Fuel Fabrication and Enrichment Plants

Table 2 Nuclear Power Stations

Location Ref.	Country Site	Discharges to	Reactors Number and Type	Installed Capa-city MW (e) 2006	Net Electrical Output MW (e).h 2006	Operational discharges of radioactive substances in 2006 (TBq)															
								Specific radionuclides													
						Tritium	other (1) radio-nuclides	gross a-activity	gross b-activity (ex.Tritium)	Co 58	Co 60	Zn 65	Sr 90	Zr/Nb 95	Ru 106	Ag 110m	Sb 125	Cs 134	Cs 137	Ce 144	S 35
	Belgium (2) (3)																				
BE1	Doel	Schelde	4 PWR	392,5	3 095 560.0	4.61E+01	1.71E-03	0.00E+00	6.60E-06	0.00E+00	2.84E-04	1.20E-06	6.60E-06	8.00E-07	3.57E-05	1.78E-04	4.19E-04	8.60E-06	1.01E-04	0.00E+00	X
				433	3 393 954.0									4.11E-05							
				1006	7 694 710.0																
				1008	7 443 052.0																
BE2	Tihange	Meuse	3 PWR	962	8182631	4.41E+01	2.41E-02	1.71E-09	0.00E+00	7.36E-03	1.02E-02	0.00E+00	0.00E+00	3.36E-05	2.47E-05	7.85E-04	6.72E-04	1.05E-03	2.03E-03	2.90E-05	X
				1008	7 193 585.0									1.67E-04							
				1015	7 221 087.0																
	France (4) (5)				339E+06 (6)																
FR1	Belleville	Loire	2 PWR	2600		5.3E+01	2.75E-04			6.9E-05	4.5E-05					1.1E-05	6.6E-05	1.1E-05	1.5E-05		
FR2	Cattenom	Mosel	4 PWR	5200		1.31E+2	1.17E-3			2.29E-4	6.03E-4					2.60E-5	6.30E-5	4.10E-5	7.70E-5		
FR3	Chinon	Loire	4 PWR	3600		4.22E+1	3.61E-4			8.80E-5	9.80E-5					3.00E-5	4.60E-5	1.60E-5	1.90E-5		
FR4	Chooz	Meuse	2 PWR	2900		4.92E+1	4.30E-4			4.60E-5	1.51E-4					8.10E-5	4.90E-5	1.50E-5	1.80E-5		
FR5	Civaux	Vienne	2 PWR	2900		5.39E+1	2.74E-4			3.50E-5	3.60E-5					6.50E-5	3.70E-5	1.30E-5	1.60E-5		
FR6	Dampierre-	Loire	4 PWR	3600		3.14E+1	8.00E-4			1.30E-4	1.40E-4					2.70E-4	4.60E-5	2.00E-5	4.40E-5		
FR7	Fessenhein	Rhine	2 PWR	1800		2.79E+1	5.13E-4			2.50E-4	3.30E-5					1.40E-4	2.60E-5	7.00E-6	1.50E-5		
FR8	Flamanville	North Sea	2 PWR	2600		5.17E+1	3.96E-4			1.15E-4	8.00E-5					3.00E-5	5.80E-5	1.80E-5	2.20E-5		
FR10	Golfech	Garonne	2 PWR	2600		5.35E+1	1.77E-4			3.50E-5	4.00E-5					1.80E-5	2.20E-5	8.00E-6	1.30E-5		
FR11	Gravelines	North Sea	6 PWR	5400		4.44E+1	2.20E-3			3.40E-4	9.55E-4			1.31E-6		4.90E-4	9.90E-5	4.60E-5	9.40E-5		
FR12	Le Blayais	Gironde	4 PWR	3600		5.05E+1	8.60E-4			1.89E-4	2.00E-4					2.10E-4	4.70E-5	1.90E-5	3.70E-5		
FR14	Nogent-	Seine	2 PWR	2600		6.67E+1	3.83E-4			1.49E-4	8.10E-5					3.20E-5	3.10E-5	1.40E-5	2.50E-5		
FR15	Paluel	North Sea	4 PWR	5200		1.09E+2	1.19E-3			3.50E-4	3.40E-4					9.90E-5	1.10E-4	4.00E-5	5.10E-5		
FR16	Penly	North Sea	2 PWR	2600		6.59E+1	1.02E-3			4.10E-4	2.50E-4					2.30E-5	8.40E-5	3.50E-5	6.90E-5		
FR18	Saint Laure	Loire	2 PWR	1800		2.23E+1	1.71E-4			1.00E-5	8.70E-5					1.30E-5	1.80E-5	7.00E-6	9.00E-6		
	Federal Republic of Germany																				
DE1	Biblis A	Rhine	1 PWR	1225		1.77E+1	2.43E-4			3.18E-6	4.85E-5					1.70E-5	1.48E-5	4.31E-6	7.72E-6		
DE1	Biblis B	Rhine	1 PWR	1300		1.41E+1	4.27E-5			2.65E-8	4.02E-6					5.39E-8	8.79E-6		6.64E-7		
DE2	Brokdorf	Elbe	1 PWR	1440		1.62E+1	1.80E-7												1.80E-7		
DE3	Brunsbüttel	Elbe	1 BWR	806		2.86E-1	1.90E-4			4.31E-6	6.80E-5	4.91E-5	1.32E-7	8.49E-7		3.34E-8			1.62E-5		
DE4	Grafenrhein	Main	1 PWR	1345		1.52E+1	1.57E-5			4.70E-7	1.49E-5										
DE5	Grohnde/	Weser	1 PWR	1430		2.01E+1	1.97E-7				1.97E-7										
DE7	Kahl	Main	1 BWR	16	(7)	1.88E-6	1.05E-7				4.42E-8								1.86E-8		
DE8	Krümmel/	Elbe	1 BWR	1316		5.60E-1	1.10E-5			2.50E-7	4.70E-6	1.16E-6					6.30E-7		1.10E-7		
DE9	Lingen/	Ems	1 PWR	1363		1.80E+1															
DE9	Lingen	Ems	1 BWR	268	(8)	4.45E-4	7.78E-6	5.94E-9			1.15E-7								7.66E-6		
DE10	Mülheim-	Rhine	1 PWR	1302	(7)	8.92E-5	5.02E-6				2.00E-6										
DE11	Neckar-	Neckar	1 PWR	1365		1.22E+1															
DE11	Neckar-	Neckar	1 PWR	357		2.12E+1															
DE12	Obrigheim	Neckar	1 PWR	357	(9)	8.16E-2	1.68E-4			2.42E-6	3.48E-5		9.46E-9			3.27E-6	8.90E-7		7.11E-6		
DE13	Philippsbur	Rhine	1 BWR	926		3.80E-1	2.36E-4			6.08E-6	5.20E-5	8.23E-5				2.00E-7			2.54E-6		
DE13	Philippsbur	Rhine	1 PWR	1424		1.37E+1	9.62E-5			2.2E-06	2.1E-05	7.4E-08		5.7E-07		8.5E-07	8.6E-08	5.0E-06	3.3E-05		
DE14	Rheinsberg	Havel	1 PWR	70	(10)		6.19E-6				6.70E-7		2.30E-7						1.47E-6		

Location Ref.	Country Site	Discharges to	Reactors Number and Type	Installed Capa-city MW (e) 2006	Net Electrical Output MW (e).h 2006	Operational discharges of radioactive substances in 2006 (TBq)															
								Specific radionuclides													
						Tritium	other (1) radio-nuclides	gross a-activity	gross b-activity (ex.Tritium)	Co 58	Co 60	Zn 65	Sr 90	Zr/Nb 95	Ru 106	Ag 110m	Sb 125	Cs 134	Cs 137	Ce 144	S 35
DE15	Stade	Elbe	1 PWR	672	(11)	1.93E+0	1.59E-5	4.05E-8			6.10E-6					1.03E-7	2.55E-7		3.90E-7		
DE16	Rodenkirch	Weser	1 PWR	1350		1.32E+1	3.42E-5			2.53E-6	2.30E-5			2.51E-8			3.03E-7		6.05E-7		
DE17	Würgassen	Weser	1 BWR	640	(12)	2.00E-1	5.16E-5				1.59E-5		2.30E-6						3.34E-5		
	The Netherlands																				
NL1	Borssele	Westerscheld	1 PWR	485	3269622	8.86E+0	N I	(13)	4.74E-4	1.36E-5	1.20E-4	<MDA	9.40E-6	3.38E-5	4.70E-6	3.60E-6	4.00E-7	1.12E-5	2.76E-5	1.15E-5	NA
	Spain																				
ES1	Almaraz	Tagus	2 PWR	1957	14402 534.0	45.95 (14)	0.00361 (14)	(15)		8.44E-4	1.04E-3	5.84E-6	1.24E-5	4.77E-4		4.87E-4	1.04E-4	6.52E-6	1.41E-4		
ES2	José	Tagus	1 PWR	150,05 (16)	391568	11.19 (14)	0.000176 (14)	(15)		8.28E-7	4.26E-5							8.59E-7	4.67E-5		
ES3	Trillo	Tagus	1 PWR	1 066	7687802	18.27 (14)	0.000588 (14)	(15)		2.19E-5	3.00E-4			8.69E-6		3.25E-5	3.97E-5	9.17E-6	1.53E-4		
										8.66E-4	1.38E-3	5.84E-6	1.24E-5	4.86E-4	0.00E+0	5.20E-4	1.44E-4	1.65E-5	3.40E-4	3.43E-3	
	Sweden							(17)													
SE2	Ringhals 1-	Kattegat (18)	BWR	857	742	1.20E+0	1.91E-3	4.54E-7		2.80E-4	9.20E-4	1.20E-6	8.70E-7	6.80E-5	Nd	5.70E-5	2.40E-5	Nd	1.10E-4	Nd	Nd
		(19)	PWR	867	776	1.60E+1	3.48E-4	2.34E-7		1.50E-4	3.80E-5	Nd	7.90E-6	2.23E-5	Nd	7.10E-5	5.70E-6	3.10E-6	1.60E-5	Nd	Nd
		(20)	PWR	1040	753	1.30E+1	1.51E-3	6.89E-8		6.10E-4	2.50E-4	4.60E-6	1.10E-7	1.22E-4	Nd	1.40E-4	4.50E-5	Nd	3.80E-6	4.30E-7	Nd
		(21)	PWR	907	810	1.50E+1	4.08E-3	1.89E-8		3.60E-3	1.00E-4	7.90E-7	1.50E-7	1.13E-4	Nd	2.30E-6	1.90E-6	Nd	2.40E-6	Nd	Nd
	Switzerland																				
CH1	Beznau	Aare	2 PWR	380/380	2,95E6/3,07E6	1.10E+1	4.30E-3	6.90E-7		2.80E-3	4.10E-4		8.60E-6	3.20E-6		2.50E-5	1.30E-4	7.60E-6	3.20E-4		
CH2	Gösgen	Aare	1 PWR	1020	8026000	1.30E+1	1.50E-5	<9,10E-8			2.20E-6								4.00E-8		
CH3	Leibstadt	Rhine	1 BWR	1220	9367000	7.00E-1	7.50E-5	<2,60E-7		4.50E-6	5.80E-5							1.60E-6	5.40E-6		
CH4	Mühleberg	Aare	1 BWR	372	2883000	1.90E-1	4.60E-3	2.20E-7		2.10E-4	2.50E-3	1.20E-4	9.10E-6						7.70E-5		
	United Kingdom																				
UK5	Dungeness A	English	2 GCR	440		2.70E+0	9.08E-2												7.89E-2		
UK5	Dungeness B (28)	English	2 AGR	1110		2.64E+2	2.13E-2				3.56E-3										2.49E-01
UK6	Hartlepool	North Sea	2 AGR	1210		2.38E+2	1.00E-2				2.08E-4										2.75E-01
UK7	Heysham 1	Morecambe	2 AGR	1150		3.51E+2	1.76E-2				3.58E-4										2.84E-01
UK7	Heysham 2	Morecambe	2 AGR	1250		3.21E+2	1.24E-2				7.74E-5										1.07E-01
UK8	Hinkley Point B	Severn	2 AGR	1220		3.09E+2	1.19E-2				1.35E-4										3.81E-01
UK9	Hunterston B	Firth of CLYDE	2 AGR	1150		3.15E+2		5.94E-5	6.01E-3		5.30E-4										5.82E-01
UK10	Oldbury	Severn	2 GCR	434		1.54E-1	1.15E-1												3.96E-1		
UK11	Sizewell A	North Sea	2 GCR	420		9.16E-1	3.98E-1												5.69E-1		
UK11	Sizewell B	North Sea	1 PWR	1175		5.51E+1	2.17E-2														
UK12	Torness	North Sea	2 AGR	1264		2.73E+2		1.44E-5	2.17E-3		2.46E-4										1.41E-03
UK14	Wylfa	Irish Sea	2 GCR	950		3.27E+0	1.70E-2														

Table 3 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 1700 t/y		Magnox, AGR, LWR 1750 te/yr Magnox 1200 te/yr U oxide
Radionuclide	TBq released per annum (1)	Normed releases in TBq per GWye (39,0 GWye in 2006)	TBq released in 2006 (2) (3)
Tritium	1.11E+4		1.09E+3
Total-a	2.50E-2	6.42E-4	2.05E-1
Total-b	7.55E+0	1.94E-1	2.90E+1
C 14	7.46E+0		1.09E+1
S 35			
Mn 54	7.52E-3		
Fe 55			
Co 57	2.80E-4		
Co 58	4.48E-4		
Co 60	2.10E-1		1.40E-1
Ni 63	6.18E-2		
Zn 65	4.24E-5		
Sr 89	ND		
Sr 90	2.16E-1		4.96E+0
(Sr 90 + Cs 137)			
(Zr + Nb 95)	ND		1.55E-1
Tc 99	4.47E-2		5.62E+0
Ru 103	ND		
Ru 106	4.80E+0		3.51E+0
(Ru + Rh) 106	9.59E+0		
Ag 110m	ND		
Sb 124	ND		
Sb 125	9.64E-2		
I 129	1.32E+0		1.98E-1
Cs 134	6.05E-2		1.54E-1
Cs 137	6.23E-1		5.93E+0
Ce 144	5.45E-4		5.53E-1
(Ce + Pr) 144	1.09E-3		
Pm 147			
Eu 152			
Eu 154	1.55E-3		
Eu 155	4.56E-4		
Np 237	6.86E-5		5.48E-2
Pu 239+240	1.75E-3		1.47E-1
Pu 241	1.48E-1		3.64E+0
Am 241	3.03E-3		5.18E-2
Cm 242	2.42E-5		
Cm 243+244	2.55E-3		2.15E-3
Uranium (in kg)	3.20E+1		4.39E+2

ND: not detectable

Table 4 Nuclear Fuel Fabrication and Enrichment Plants

Location Ref.	Country/ site	Discharges to	Type of Fuel	Capacity (t/y)	Production	Activity	TBq released in 2006
	Federal Republic of Germany						
DE9	Lingen	Ems - via municipal sewer system	LWR	400		Uranium	2.3E-09
DE19	Gronau	Vechte, IJsselmeer	Uranium enrichment	760		total - α	
DE20	Hanau	Main - via municipal sewer system	PWR, MOX	1350		total - α	
	Netherlands						
NL3	Almelo	URENCO Nederland B.V. -	Uranium enrichment	3700	3210	total - a	2.20E-6
		Municipal sewer system				total - b (b- & g- emitting rn)	1.74E-5
	Spain						
ES4	Juzbado	River Tormes - Duero	PWR, BWR	400	267.4	total - α	3.70E-5
	United Kingdom						
UK16	Capenhurst	Irish Sea via	Uranium enrichment	NI		Uranium - a	9.50E-5
		Rivacre Brook and				Uranium daughters	1.78E-4
		Mersey Estuary				other - a	2.07E-5
						Tc 99	8.50E-5
						Tritium	3.25E-6
UK17	Springfields	Irish Sea via	GCR, AGR, PWR	10000 te/yr		total - a	8.00E-2
		River Ribble	fuel fabrication	as UOC		total - b	2.07E+1
						Tc 99	6.50E-2
						Th 230	1.19E-2
						Th 232	3.10E-4
						Uranium a	2.60E-2
						Np 237	1.58E-3

Table 5 Research and Development Facilities

Location Ref.	Country/ site	Discharges to	Reactors Number & Type	Installed Capacity	Radionuclides	TBq released per annum in 2006
	Belgium			(1)		
BE3	**Mol**	River Mol-Neet	2	129MW (th)	weighted activity	2.88E-04
	Denmark			(2) (3)		
DK1	Risø	Kattegat through Roskilde Fjord	No reactors		Tritium	9.77E-01
					Gross beta	1.45E-04
	France					
FR9	Fontenay-aux-Roses	Seine	Centre de recherches du Commissariat à l'énergie atomique		α	5.71E-06
					other radionuclides	2.09E-05
					Tritium	2.19E-04
FR17	Saclay	Etang de Saclay	Centre de recherches du Commissariat à l'énergie atomique		α	<1.01E-04
					other radionuclides	1.11E-03
					Tritium	4.84E-02
	Germany					
DE8	Geesthacht	Elbe	1	5 MW	Tritium	3.60E-04
					Total β	2.30E-05
DE18	Karlsruhe	Rhine	No reactors	None	Tritium	1.60E+00
					Total β	2.00E-05
DE22	HMI Berlin	Havel	1	10 MW	Tritium	
					Total β	
DE23	Jülich	Rur	1	23 MW	Tritium	6.60E-01
					Total β	8.20E-05
DE24	Rossendorf	Elbe	No reactors	None	Tritium	1.80E-03
					Total β	4.40E-06
	Netherlands					
NL4	Delft (4) (5) (6)	Sewage system	1	2 MW (th)	α – emitting radionuclides	<2E-07
					β – emitting radionuclides including tritium	7.97E-06
					γ – emitting radionuclides	3.53E-6
					total	
NL5	Petten (7) (8) (9)	North Sea	1 HFR for material testing	50 MW (th)	Tritium	3.38E-01
			1 LFR		α – emitting radionuclides	8.91E-06
				30 kW (th)	β/γ – emitting radionuclides	6.10E-02
					total	
	Norway (10)					
NO1	Halden (11)	River Tista (Skagerrak)	1 BWR D2O as moderator	(12)	Tritium	3.00E-01
					Total α	NA
					Total β	5.87E-04
					Ag-110m	2.10E-07
					Cr-51	2.40E-04
					Mn-54	1.10E-06
					Mn-56	NA

Location Ref.	Country/ site	Discharges to	Reactors Number & Type	Installed Capacity	Radionuclides	TBq released per annum in 2006
					Co-58	4.00E-06
					Co-60	8.60E-05
					Sr-90	4.40E-06
					Zr-95	3.80E-06
					Nb-95	8.30E-06
					Sb-125	6.40E-09
					Cd-109	NA
					I-131	2.10E-05
					Cs-134	2.50E-05
					Cs-137	1.90E-04
					Ce-141	2.50E-07
					Ce-144	3.00E-06
NO2	Kjeller (11)	River Nitelva (Skagerrak)	1 JEEP II, heavy water and cooled Research Reactor		Tritium	1.43E+00
					Total-α	6.53E-08
					Total-β	1.91E-04
					Co 58	3.0E-07
					Co 60	7.40E-05
					Zn 65	0.00E+00
					Sr 90	1.20E-06
					Zr/Nb 95	5.00E-07
					Ru 103	2.0E-08
					Ru 106	0.0E+00
					Ru/Rh 106	
					Ag 110m	4.00E-07
					Sb 125	7.0E-07
					I 125	4.28E-05
					I 131	4.20E-06
					Cs 134	5.30E-06
					Cs 137	5.36E-05
					Ce 144	2.70E-06
					Pu 238	3.00E-09
					Pu 239/240	4.00E-08
					Am 241	6.00E-09
					Pu 241	NA
	Portugal					
PT1	Campus de Sacavém	Residual Water Treatment Municipal Plant	1 Research Swimming Pool Reactor	1 MW	Total-β	9.60E-5
	Switzerland					
CH5	Paul Scherrer Institute	Aare	1 research reactor	zero power	Tritium	3.80E-02
					Total-β	
					other radionuclides	3.90E-5
					β– and γ– emitting radionuclides	
					Be-7	6.20E-07
					Na-22	2.80E-07
					Mn-54	1.50E-07
					Co-57	2.90E-07
					Co-58	6.40E-07
					Co-60	3.60E-06

Location Ref.	Country/ site	Discharges to	Reactors Number & Type	Installed Capacity	Radionuclides	TBq released per annum in 2006
					Zn-65	6.10E-08
					Sr-85	9.40E-08
					Sr/Y-90	5.70E-06
					I-125	7.10E-07
					Cs-134	8.40E-07
					Cs-137	2.30E-05
					Ce-141	7.00E-08
					Eu-152	1.30E-07
					Eu-154	3.40E-08
					Lu-172	9.30E-08
					α - emitting radionuclides	
					Pu-238/Am-241	1.40E-06
					Pu-239/240	1.20E-06
					Cm-243/244	8.60E-08

Table 6 - Discharges from decommissioning and treatment/recovery of old radioactive waste in 2006

Location Ref.	Country Site	Discharges to	Reactors Number and Type	Exceptional discharges of radioactive substances in 2006 (TBq)																
						Specific radionuclides														
				Tritium	other (1) radio-nuclides	gross a-activity	gross b-activity (ex.Tritium)	Co 58	Co 60	Zn 65	Sr 90	Na22	Ru 106	Ag 110m	Sb 125	Cs 134	Cs 137	Ce 144	S 35	Pu-241
	Switzerland																			
CH6	ZWILAG (2)	Aare		8.50E-4	2.90E-4	1.40E-8			2.40E-6					5.60E-9	1.20E-5	1.10E-5	2.60E-4			
	United Kingdom																			
UK1	Berkeley	Severn	2 GCR	2.34E-4	6.36E-4												7.20E-4			
UK2	Bradwell	North Sea	2 GCR	2.55E-1	2.63E-1												1.73E-1			
UK3	Calder Hall (3)	Irish Sea	4 GCR	Reported with Sellafield's discharges																
UK4	Chapelcross (4)	Solway Firth	4 GCR	1.13E-2		1.06E-5	3.60E-3													
UK8	Hinkley Point A	Severn	2 GCR	2.80E-1	1.30E-1												1.40E-1			
UK9	Hunterston A (5)	Firth of Clyde	2 CGR	5.30E-4		8.72E-5	4.55E-2													6.30E-5
UK13	Trawsfynydd (6)	Trawsfynydd	2 GCR	3.32E-3	1.81E-3						3.20E-4						1.92E-3			
UK18	Dounreay (7)	Pentland Firth	No reactors	3.36E-1		4.17E-4	9.70E-4				9.63E-2	1.91E-2					1.17E-2			
UK19	Harwell	River Thames	No reactors	8.91E-3		1.54E-5	2.41E-4		1.74E-6								2.98E-5			
UK20	Winfrith	Weymouth Bay	No reactors	16.00513	4.26E-3	1.32E-4											3.30E-03			

4. Footnotes to tables 2 to 6

Table 2

(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, 51Cr. 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 2006, their net electrical output was 339E+06 MW(e)h.

(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) During normal operation, each facility has to comply with a discharge limit of 0,1 mSv/year effective dose to individuals of the critical group, which is distributed between liquid and gaseous effluents in accordance with the criteria established in the Offsite Dose Calculation Manual.

(15) In 2006, the detected radionuclides for Almaraz were: Cr-51, Mn-54, Co-58, Fe-59, Co-60, Zn-65, Sr-89, Sr-90, Nb-95, Zr-95, Ag-110m, Te-123m, Sb-124, Sb-125, I-131, Cs-134, Cs-137. The detected radionuclides for José Cabrera were: Mn-54, Co-58, Co-60, I-131, I-132, I-133, I-135, Cs-134, Cs-137. The detected radionuclides for Trillo were: Cr-51, Mn-54, Co-58, Co-60, Nb-95, Zr-95, Ag-110m, Sb-122, Te-123m, Sb-124, Sb-125, Cs-134, Cs-137.

(16) José Cabrera Nuclear Power Plant has been shut down on 30th April 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 3

(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 4

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

Table 5

(1) The installed capacity is the maximum value. The reactors function in a discontinuous way, often at a fraction of their maximum.

(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) The data represent the total emissions/discharges from the Interfaculty Research Institute (IRI) complex, including the IRI-Higher Research Reactor (HOR) and different laboratories (it is not possible to make a distinction between the various sources). The discharges from the IRI-HOR are substantially lower than the values reported.

(5) Delft site refers to Research reactor of Technical University Delft.

(6) "Total-β" value represents all β-emitting nuclides, including tritium.

(7) 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.

(8) Petten site refers to Research reactor of EU-JRC.

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

(10) 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.

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

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

Table 6

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

(2) 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.

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

(4) Gross alpha and beta activity excluding tritium.

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

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

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