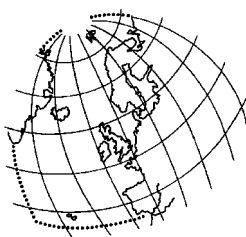


**Radioactive Substances Series**

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# **Liquid Discharges from Nuclear Installations in 2000**



**OSPAR Commission  
2002**

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

This annual report contains data on liquid radioactive discharges from nuclear installations for the period 1989 – 2000. 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 and covers total alpha activity, tritium and total beta activity excluding tritium in TBq/y for each nuclear installation sector and the ratio as a percentage of the total discharge from all installations. To facilitate comparison of the discharges year by year temporal trends are shown for total alpha, tritium and total beta excluding tritium for the period 1989 to 2000.

There is a downward trend of the total alpha activity discharged from all nuclear installations over the period 1989 to 2000. Overall, discharges of alpha activity in 2000 were significantly lower than in 1999. The most significant contributors to the summed discharges are from the fuel fabrication plant at Springfields and the reprocessing plant at Sellafield. Discharges from research and development facilities also reduced.

The tritium releases from all installations also decreased from 1999 to 2000 and is mainly due to the discharges from La Hague. The reprocessing plants in La Hague and Sellafield contribute in aggregate, approximately 80 % of the overall discharges. Discharges of tritium from nuclear power stations and research and development facilities show no pronounced trend over the time period 1996 – 2000.

The sum of total beta activity excluding tritium from all nuclear installations has fallen significantly over the period 1989 to 2000. Since 1995, there has been a year on year decrease in the overall total beta activity discharged into the OSPAR maritime area. When compared to 1999, the overall decrease in 2000 was mainly the result of reductions in discharges from both Springfields and the reprocessing plant at Sellafield, although this was partly offset by an increase in the total beta activity discharged from La Hague and mainly attributable to the radionuclides Ruthenium-106 and Rhodium-106. The discharge data in terms of total beta activity show a continuously downward trend for nuclear power plants and research and development facilities since 1997.

## RÉCAPITULATIF

Le présent rapport annuel contient des données sur les rejets radioactifs liquides des installations nucléaires pendant la période allant de 1989 à l'an 2000. Ces données constituent la base de l'évaluation des rejets des centrales nucléaires, des usines de retraitement du combustible nucléaire, des équipements de fabrication du combustible nucléaire et des équipements d'enrichissement ainsi que des installations de recherche et de développement. L'activité alpha totale, le tritium et l'activité bêta totale sans le tritium, exprimés en TBq/an pour chacun des secteurs nucléaires, ainsi que le ratio, en pourcentage, de l'ensemble des rejets de la totalité des installations ont été pris en compte. Pour faciliter la comparaison des rejets d'une année à l'autre, les tendances chronologiques d'alpha totale, du tritium et de bêta sans le tritium sont indiquées sur la période allant de 1989 à 2000.

On constate une tendance à la baisse de l'activité alpha totale rejetée par toutes les installations nucléaires pendant la période allant de 1989 à l'an 2000. Au total, les rejets d'activité alpha en l'an 2000 s'avèrent sensiblement inférieurs à ceux de 1999. Les contributeurs les plus importants à la somme des rejets sont l'usine de fabrication de combustibles de Springfields et l'usine de retraitement de Sellafield. Les rejets des équipements de recherche et de développement ont également baissé en l'an 2000.

Les émissions de tritium de toutes les installations ont baissé en 2000 par rapport à 1999. Cette diminution est pour l'essentiel due à la baisse des rejets de La Hague. Après regroupement, la contribution des usines de retraitement de La Hague et de Sellafield représente environ 80 % de l'ensemble des rejets. Les rejets de tritium des centrales nucléaires et des installations de recherche et de développement ne présentent aucune tendance prononcée sur la période allant de 1996 à l'an 2000.

La somme de l'activité bêta totale, à l'exclusion du tritium, rejetée par l'ensemble des installations nucléaires, a baissé significativement pendant la période allant de 1989 à l'an 2000. Depuis 1995, on constate une baisse d'année en année de l'ensemble de l'activité bêta totale rejetée dans la zone maritime d'OSPAR. Lorsque l'on compare à 1999, la baisse générale qui se manifeste en l'an 2000 résulte pour l'essentiel de la diminution des rejets de l'usine de Springfields et celle de retraitement de Sellafield, quoique cette baisse ait été en partie annulée par une augmentation de l'activité bêta totale rejetée par l'usine de La Hague, augmentation pour l'essentiel imputable aux radionucléides ruthénium-106 et rhodium-106. Les données des rejets en termes d'activité bêta totale présentent une tendance continue à la baisse dans le cas des centrales nucléaires et des installations de recherche et de développement, et ceci depuis 1997.

## 1. INTRODUCTION

### 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<sup>1</sup> are applicable under the OSPAR Convention:

- PARCOM Recommendation 88/4 on Nuclear Reprocessing Plants;
- PARCOM Recommendation 91/4 on Radioactive Discharges<sup>2</sup>;
- 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<sup>3</sup>;
- PARCOM Recommendation 94/9 Concerning the Management of Spent Nuclear Fuel<sup>4</sup>.
- 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.

In 1998, the Ministerial Meeting of the OSPAR Commission adopted the OSPAR Strategy with regard to Radioactive Substances (reference number: 1998-17). In 2000, the OSPAR Commission adopted, and in 2001 revised, the Programme for the More Detailed Implementation of the OSPAR with regard to Radioactive Substances (reference number: 2001-13). National reports to be submitted in 2002 under this more detailed programme will also contain information on liquid discharges from nuclear installations including, where available, forecasts on how these discharges would develop in order to move towards a situation by the year 2020 whereby discharges, emissions and losses of radioactive substances are reduced to levels where the additional concentrations in the marine environment above historic levels, resulting from such discharges, emissions and losses, are close to zero. Regular reporting is therefore required in order to review progress towards this target.

### 1.2 Annual reporting

In 1985, Contracting Parties to the former Paris Convention initiated reporting on liquid discharges from nuclear installations. These data were submitted by Contracting Parties and compiled by the Secretariat and, following examination by the relevant subsidiary bodies, published by the Commission in the form

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<sup>1</sup> All measures referred to in this chapter can be downloaded from the OSPAR website [www.ospar.org](http://www.ospar.org) (under "measures").

<sup>2</sup> 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: 1999-11). A summary report of the second round of implementation reporting on PARCOM Recommendation has been published for the first time by the OSPAR Commission in 1999.

<sup>3</sup> 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 MARINA II studies to be published by the European Commission; see website: <http://europa.eu.int/comm/environment/radprot/>.

<sup>4</sup> 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).

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 including a description of the trends from 1989 until the date of the 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 were regularly reviewed and updated in the light of ongoing work under the Commission as regards nuclear installations. With a view to harmonising the way in which data and information are being established and reported, the Programmes and Measures Committee (PRAM) of the OSPAR Commission adopted in 1996 the current reporting formats and procedures (reference number: 1996-2), which sets out the requirements for data and information to be provided by Contracting Parties.

### **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.

Total alpha represents the measured radioactivity of alpha particles that are composed of two protons and two neutrons. These particles are emitted as a result of the decay of certain radionuclides, the so-called  $\alpha$ -emitters. In the years 1985-2000, the total liquid discharges of  $\alpha$ -emitters from all nuclear sites represents mainly Pu-239 and Am-241 and, to a lesser extent, Th-230, Pu-238 and some other nuclides.<sup>5</sup>

Total beta represents the measured radioactivity of beta particles that are similar to electrons, except they originate from (processes within) the atomic nucleus. These particles are emitted as a result of the decay of other radionuclides, the so-called  $\beta$ -emitters. In the years 1985-2000, the total liquid discharges of  $\beta$ -emitters from all nuclear sites represents mainly Ru-106, Sr-90, Pu-241, Cs-137, Tc-99 and, to a lesser extent, some other nuclides. The breakdown for  $\beta$ -emitters since 1985 in liquid discharges from nuclear power plants comprises Cs-137 (39%), S-35 (20%), Sr-90 (11%), Co-60 (5%) and (for about 20 %) other radionuclides. Total beta in this report excludes tritium.

Tritium ( $^3\text{H}$ ) 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.

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<sup>5</sup> For abbreviations of radionuclides see chapter 3.

## **2. ASSESSMENT OF THE LIQUID RADIOACTIVE DISCHARGES FROM NUCLEAR INSTALLATIONS IN 2000**

The liquid radioactive discharges from nuclear installations in 2000 and for the period 1989 - 1999 are summarised in Table 1. The OSPAR Annual Reports for 1989 - 2000 on Liquid Discharges from Nuclear Installations form the basis for this assessment. Reported discharges from nuclear power stations, nuclear fuel reprocessing plants, nuclear fuel fabrication and enrichment plants and research and development facilities have been taken into account. Table 1 gives total alpha activity, tritium and total beta activity excluding tritium in TBq/y for each nuclear installation sector and the ratio as a percentage of the total discharge 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 period 1989 to 2000.

Both Table 1 and Figure 1 show a downward trend of the total alpha activity discharged from all nuclear installations for the period 1989 to 2000. Overall, discharges of alpha activity in 2000 were significantly lower than in 1999. The reason for this decline to 0,33 TBq/y is largely a result of lower total alpha releases from the nuclear fuel fabrication plant in Springfields, United Kingdom. The most significant contributors to the summed discharges are from the fuel fabrication plant at Springfields (0,17 TBq) and the reprocessing plant at Sellafield (0,12 TBq). Discharges from research and development facilities reduced in 2000 to 0,0019 TBq from the range 0,01 - 0,13 TBq over the period 1991 - 1998.

Figure 2 presents the discharges of tritium, in terms of activity. The tritium releases from all installations decreased from 18 870 TBq in 1999 to 15 911 TBq/y for 2000. This decrease is mainly due to the discharges from La Hague (1999: 12 900 TBq, 2000: 11 000 TBq). The reprocessing plants in La Hague and Sellafield contribute in aggregate, approximately 80,4 % of the overall discharges. Discharges of tritium from nuclear power stations and research and development facilities show no pronounced trend over the time period 1996 – 2000.

Figure 3 shows, that the sum of total beta activity excluding tritium from all nuclear installations has fallen significantly for the period 1989 to 2000, from 930 TBq (1989), 365 TBq (1995) down to 265 TBq (1998) and 171 TBq (2000). Since 1995, there has been a year on year decrease in the overall total beta activity discharged into the OSPAR maritime area. When compared to 1999, the overall decrease in 2000 was mainly the result of reductions in discharges from both Springfields (1999: 128 TBq, 2000: 71 TBq) and the reprocessing plant at Sellafield (1999: 110 TBq, 2000: 77 TBq), although this was partly offset by an increase in the total beta activity discharged from La Hague (1999: 15,8 TBq, 2000: 21 TBq), mainly attributable to the radionuclides Ruthenium-106 and Rhodium-106. The discharge data in terms of total beta activity show a continuously downward trend for nuclear power plants and research and development facilities since 1997.

## **EVALUATION DES REJETS RADIOACTIFS LIQUIDES DES INSTALLATIONS NUCLEAIRES EN L'AN 2000**

Les rejets radioactifs liquides des installations nucléaires en l'an 2000 ainsi que pendant la période allant de 1989 à 1999 sont résumés au tableau 1. Les rapports annuels OSPAR concernant la période de 1989 à l'an 2000, sur les rejets liquides des installations nucléaires, constituent la base de cette évaluation. Les rejets notifiés des centrales nucléaires, des usines de retraitement du combustible nucléaire, des équipements de fabrication du combustible nucléaire et des équipements d'enrichissement ainsi que des installations de recherche et de développement ont été pris en compte. Le tableau 1 indique l'activité alpha totale, le tritium et l'activité bêta totale sans le tritium, exprimés en TBq/an pour chacun des secteurs nucléaires, ainsi que le ratio, en pourcentage, de l'ensemble des rejets de la totalité des installations. Pour faciliter la comparaison des rejets d'une année à l'autre, les figures 1 à 3 illustrent les tendances chronologiques d'alpha totale, du tritium et de bêta totale sans le tritium pendant la période de 1989 à 2000.

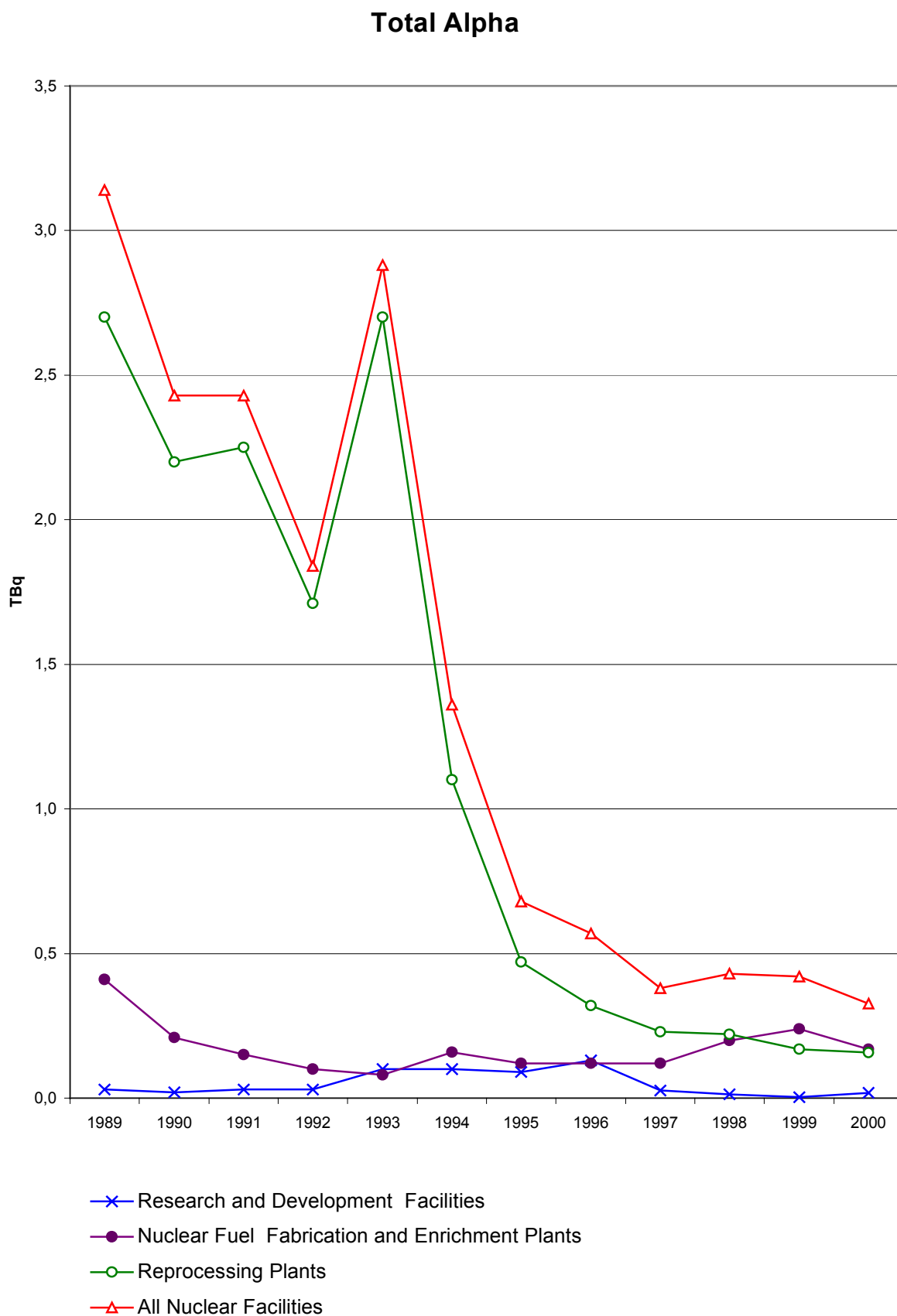
Le tableau 1 et la figure 1 mettent en évidence une tendance à la baisse de l'activité alpha totale rejetée par toutes les installations nucléaires pendant la période allant de 1989 à l'an 2000. Au total, les rejets d'activité alpha en l'an 2000 s'avèrent sensiblement inférieurs à ceux de 1999. Cette baisse, à 0,33 TBq/an, est due en grande partie à la diminution des émissions d'activité alpha totale de l'usine de fabrication de combustible nucléaire de Springfields au Royaume-Uni. Les contributeurs les plus importants à la somme des rejets sont l'usine de fabrication de combustibles de Springfields (0,17 TBq) et l'usine de retraitement de Sellafield (0,12 TBq). Les rejets des équipements de recherche et de développement ont baissé en l'an 2000 pour n'être plus que de 0,0019 TBq, alors qu'ils se situaient dans une fourchette de 0,01 à 0,13 TBq pendant la période de 1991 à 1998.

La figure 2 illustre les rejets de tritium en termes d'activité. Les émissions de tritium de toutes les installations ont baissé puisqu'ils sont passés de 18 870 TBq en 1999 à 15 911 TBq/an en l'an 2000. Cette diminution est pour l'essentiel due à la baisse des rejets de La Hague (1999 : 12 900 TBq, 2000 : 11 000 TBq). Après regroupement, la contribution des usines de retraitement de La Hague et de Sellafield représente environ 80,4% de l'ensemble des rejets. Les rejets de tritium des centrales nucléaires et des installations de recherche et de développement ne présentent aucune tendance prononcée sur la période allant de 1996 à l'an 2000.

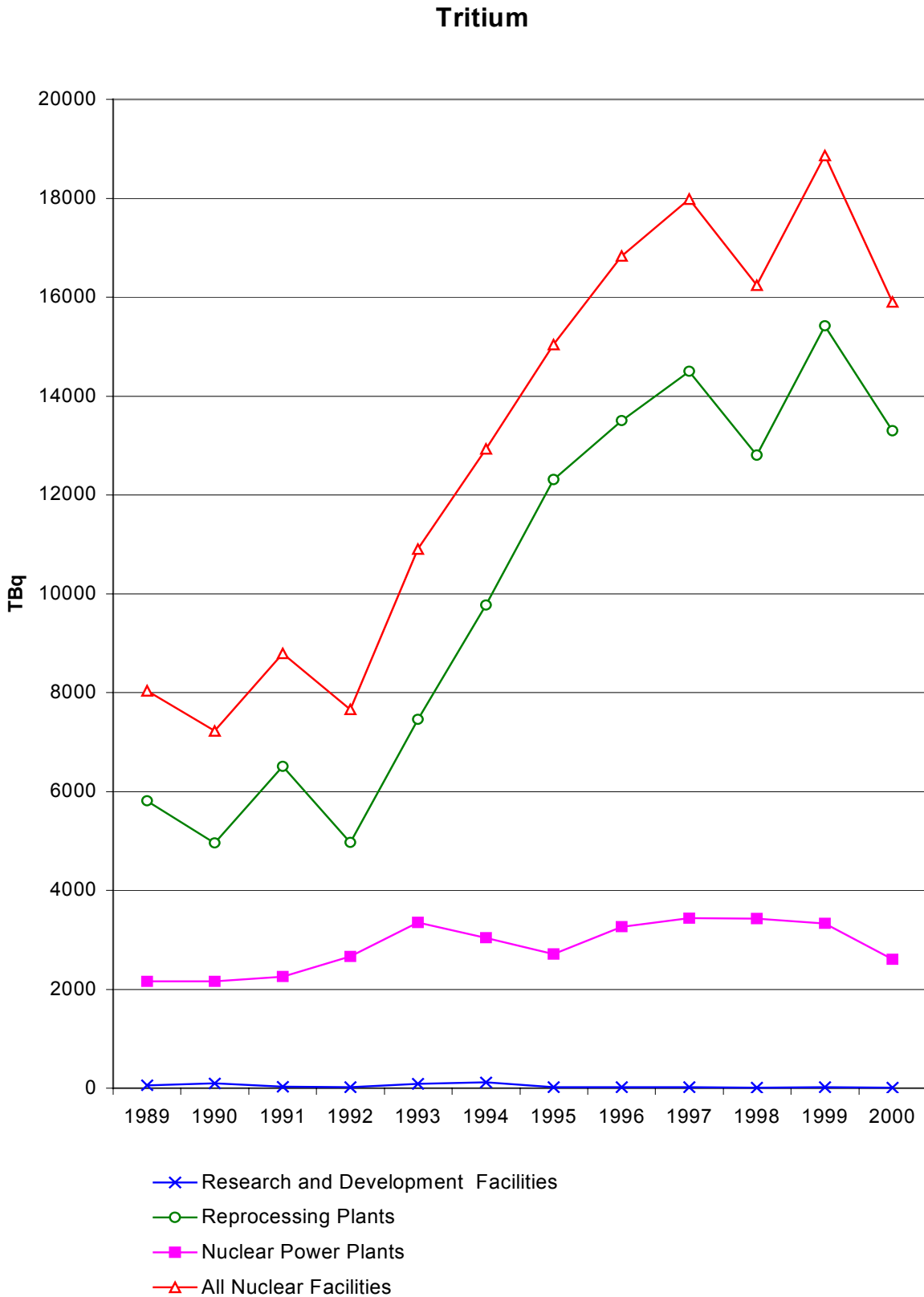
La figure 3 montre que la somme de l'activité bêta totale, à l'exclusion du tritium, rejetée par l'ensemble des installations nucléaires, a baissé significativement pendant la période allant de 1989 à l'an 2000, puisqu'elle est passée de 930 TBq (1989), à 365 TBq (1995) puis à 265 TBq (1998) et à 171 TBq (2000). Depuis 1995, on constate une baisse d'année en année de l'ensemble de l'activité bêta totale rejetée dans la zone maritime d'OSPAR. Lorsque l'on compare à 1999, la baisse générale qui se manifeste en l'an 2000 résulte pour l'essentiel de la diminution des rejets de l'usine de Springfields (1999 : 128 TBq, 2000 : 71 TBq) et de l'usine de retraitement de Sellafield (1999 : 110 TBq, 2000 : 77 TBq), quoique cette baisse ait été en partie annulée par une augmentation de l'activité bêta totale rejetée par l'usine de La Hague (1999 : 15,8 TBq, 2000 : 21 TBq), augmentation pour l'essentiel imputable aux radionucléides ruthénium-106 et rhodium-106. Les données des rejets en termes d'activité bêta totale présentent une tendance continue à la baisse dans le cas des centrales nucléaires et des installations de recherche et de développement, et ceci depuis 1997.

**Table 1 Summary of Liquid Radioactive Discharges of Nuclear Installations, 1989 - 2000**

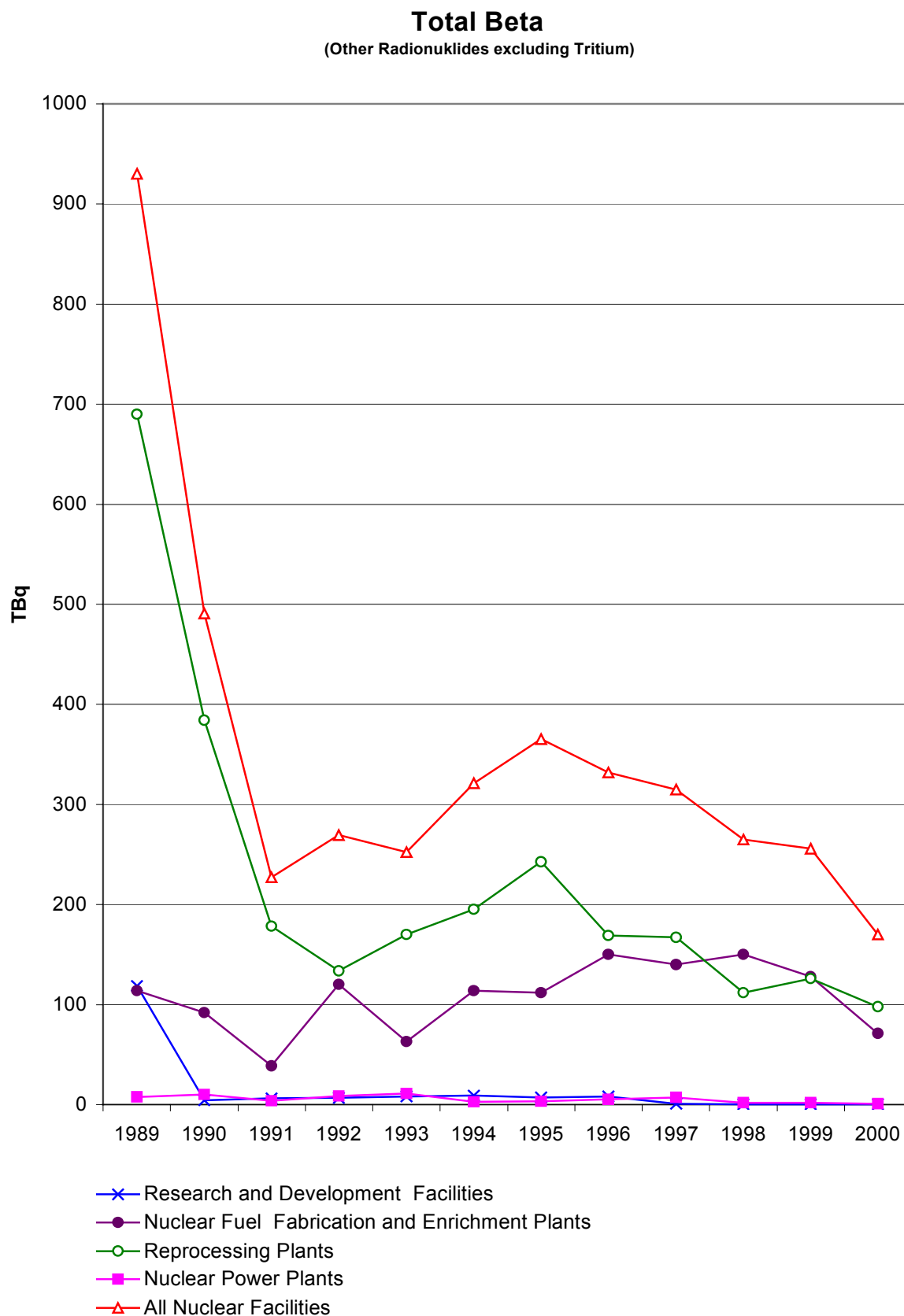
|                                                             | 1989 | 1990 | 1991 | 1992 | 1993  | 1994  | 1995  | 1996  | 1997  | 1998  | 1999  | 2000   |
|-------------------------------------------------------------|------|------|------|------|-------|-------|-------|-------|-------|-------|-------|--------|
| <b>TOTAL ALPHA</b>                                          |      |      |      |      |       |       |       |       |       |       |       |        |
| All Nuclear Installations (TBq)                             | 3,14 | 2,43 | 2,43 | 1,83 | 2,88  | 1,36  | 0,68  | 0,57  | 0,38  | 0,43  | 0,42  | 0,33   |
| Reprocessing Plants (TBq)                                   | 2,7  | 2,2  | 2,2  | 1,7  | 2,7   | 1,1   | 0,47  | 0,32  | 0,23  | 0,22  | 0,17  | 0,157  |
| % of all installations                                      | 86,0 | 90,6 | 90,6 | 93,0 | 93,7  | 80,9  | 69,1  | 56,1  | 60,5  | 51,2  | 41,6  | 47,7   |
| Nuclear Power Plants (TBq)                                  | -    | -    | -    | -    | -     | -     | -     | -     | -     | -     | -     | -      |
| % of all installations                                      | -    | -    | -    | -    | -     | -     | -     | -     | -     | -     | -     | -      |
| Nuclear Fuel Fabrication (TBq)                              | 0,41 | 0,21 | 0,15 | 0,10 | 0,08  | 0,16  | 0,12  | 0,12  | 0,12  | 0,20  | 0,24  | 0,17   |
| % of all installations                                      | 13,1 | 8,6  | 6,2  | 5,4  | 2,8   | 11,8  | 17,6  | 21,1  | 31,6  | 46,5  | 57,7  | 51,7   |
| Research and Development Facilities (TBq)                   | 0,03 | 0,02 | 0,03 | 0,03 | 0,1   | 0,1   | 0,09  | 0,13  | 0,03  | 0,01  | 0,003 | 0,0019 |
| % of all installations                                      | 0,9  | 0,8  | 1,2  | 1,6  | 3,5   | 7,3   | 13,3  | 22,8  | 7,9   | 2,3   | 0,7   | 0,6    |
| <b>TRITIUM</b>                                              |      |      |      |      |       |       |       |       |       |       |       |        |
| All Nuclear Installations (TBq)                             | 8036 | 7224 | 8797 | 7658 | 10902 | 12931 | 15040 | 16779 | 17991 | 16240 | 18871 | 16548  |
| Reprocessing Plants (TBq)                                   | 5814 | 4959 | 6513 | 4969 | 7460  | 9770  | 12310 | 13500 | 14500 | 12800 | 15420 | 13300  |
| % of all installations                                      | 72,4 | 68,6 | 74,0 | 64,9 | 68,4  | 75,6  | 81,9  | 80,5  | 80,6  | 78,8  | 82,1  | 80,4   |
| Nuclear Power Plants (TBq)                                  | 2161 | 2164 | 2252 | 2665 | 3354  | 3044  | 2713  | 3264  | 3440  | 3430  | 3335  | 3241   |
| % of all installations                                      | 26,9 | 30,0 | 25,6 | 34,8 | 30,8  | 23,3  | 18    | 19,5  | 19,1  | 21,1  | 17,8  | 19,6   |
| Nuclear Fuel Fabrication (TBq)                              | -    | -    | -    | -    | -     | -     | -     | -     | -     | -     | -     | -      |
| % of all installations                                      | -    | -    | -    | -    | -     | -     | -     | -     | -     | -     | -     | -      |
| Research and Development Facilities (TBq)                   | 61   | 101  | 32   | 23,7 | 87,9  | 117,5 | 16,7  | 15    | 16    | 14    | 16    | 7      |
| % of all installations                                      | 0,7  | 1,4  | 0,4  | 0,3  | 0,8   | 0,9   | 0,1   | 0,0   | 0,1   | 0,1   | 0,1   | 0,04   |
| <b>TOTAL BETA (OTHER RADIO-NUCLIDES EXCLUDING TRITIUM )</b> |      |      |      |      |       |       |       |       |       |       |       |        |
| All Nuclear Installations (TBq)                             | 930  | 491  | 227  | 269  | 252   | 321   | 365   | 332   | 315   | 265   | 256   | 171    |
| Reprocessing Plants (TBq)                                   | 690  | 384  | 178  | 134  | 170   | 195   | 243   | 169   | 167   | 112   | 126   | 98     |
| % of all installations                                      | 74,2 | 78,3 | 78,4 | 49,8 | 67,4  | 60,8  | 66,5  | 50,9  | 53,0  | 42,4  | 49,1  | 57,5   |
| Nuclear Power Plants (TBq)                                  | 7,6  | 10,3 | 3,8  | 8,8  | 11,1  | 2,8   | 3,4   | 5,2   | 7,4   | 2,0   | 2,0   | 1,2    |
| % of all installations                                      | 0,8  | 2,1  | 1,7  | 3,3  | 4,4   | 0,9   | 0,9   | 1,6   | 2,3   | 0,8   | 0,7   | 0,7    |
| Nuclear Fuel Fabrication (TBq)                              | 114  | 92   | 38,9 | 120  | 63    | 114   | 112   | 150   | 140   | 150   | 128   | 71     |
| % of all installations                                      | 12,2 | 18,7 | 17,1 | 44,6 | 25    | 35,5  | 30,7  | 45,1  | 44,4  | 56,6  | 50,0  | 41,6   |
| Research and Development Facilities (TBq)                   | 119  | 4,5  | 6,3  | 6,6  | 8,2   | 9,1   | 7,0   | 8,1   | 1     | 0,66  | 0,36  | 0,30   |
| % of all installations                                      | 12,8 | 0,9  | 2,8  | 2,4  | 3,2   | 2,8   | 1,9   | 2,4   | 0,3   | 0,2   | 0,1   | 0,2    |



**Figure 1 Annual releases of Total Alpha in liquid discharges from all nuclear installations of Contracting Parties to the OSPAR Convention, 1989 - 2000**



**Figure 2 Annual releases of Tritium in liquid discharges from all nuclear installations of Contracting Parties to the OSPAR Convention, 1989 - 2000**



**Figure 3 Annual releases of Total Beta in liquid discharges from all nuclear installations of Contracting Parties to the OSPAR Convention, 1989 - 2000**

### 3. 2000 DATA AND INFORMATION

In this part of the report, data and information about liquid discharges from nuclear installations draining into the OSPAR maritime area is presented for each Contracting Party as follows:

- 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.

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

The column headings and abbreviations (e.g. for plants) used in the tables correspond to the reporting requirements set out in the current formats. 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.

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.

The abbreviations used in the tables for radionuclides are the following:

|     |           |     |              |     |            |
|-----|-----------|-----|--------------|-----|------------|
| 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  |

## Locations of nuclear installations

The following map give an overview of the locations of the type of installations below:

| Country / Code | Name installation                       | Type  | Discharging into                 |
|----------------|-----------------------------------------|-------|----------------------------------|
| <b>Belgium</b> |                                         |       |                                  |
| B1             | Doel                                    | NPS   | Schelde                          |
| B2             | Tihange                                 | NPS   | Meuse                            |
| B3             | Mol                                     | RDF   | River Mol-Neet                   |
|                |                                         |       |                                  |
| <b>Denmark</b> |                                         |       |                                  |
| DK1            | Risø                                    | RDF   | Kattegat through Roskilde Fjord  |
|                |                                         |       |                                  |
| <b>France</b>  |                                         |       |                                  |
| F1             | Belleville                              | NPS   | Loire                            |
| F2             | Cattenom                                | NPS   | Mosel                            |
| F3             | Chinon                                  | NPS   | Loire                            |
| F4             | Chooz                                   | NPS   | Meuse                            |
| F5             | Civaux                                  | NPS   | Vienne                           |
| F6             | Dampierre en-Burly                      | NPS   | Loire                            |
| F7             | Fessenheim                              | NPS   | Rhine                            |
| F8             | Flamanville                             | NPS   | Channel                          |
| F9             | Fontenay-aux- Roses                     | RDF   | Seine                            |
| F10            | Golfech (5)                             | NPS   | Garonne                          |
| F11            | Gravelines                              | NPS   | North Sea                        |
| F12            | Le Blayais                              | NPS   | Gironde Estuary                  |
| F13            | La Hague                                | NFRP  | English Channel                  |
| F14            | Nogent-sur-Seine                        | NPS   | Seine                            |
| F15            | Paluel                                  | NPS   | Channel                          |
| F16            | Penly                                   | NPS   | Channel                          |
| F17            | Saclay                                  | RDF   | Etang de Saclay                  |
| F18            | Saint Laurent                           |       | Loire                            |
|                |                                         |       |                                  |
| <b>Germany</b> |                                         |       |                                  |
| D1             | Biblis A/Biblis B                       | NPS   | Rhine                            |
| D2             | Brokdorf                                | NPS   | Elbe                             |
| D3             | Brunsbüttel                             | NPS   | Elbe                             |
| D4             | Grafenrheinfeld                         | NPS   | Main                             |
| D5             | Grohnde/Emmerthal                       | NPS   | Weser                            |
| D6             | Hamm-Uentrop                            | NPS   | Lippe                            |
| D7             | Kahl                                    | NPS   | Main                             |
| D8             | Krümmel/Geesthacht                      | NPS   | Elbe                             |
| D8             | Geesthacht                              | RDF   | Elbe                             |
| D9             | Lingen/Emsland                          | NPS   | Ems                              |
| D9             | Lingen                                  | NFFEP | Ems - via municipal sewer system |
| D10            | Mülheim-Kärlich                         | NPS   | Rhine                            |
| D11            | Neckar- westheim 1/Neckar-<br>wesheim 2 | NPS   | Neckar                           |
| D12            | Obrigheim                               | NPS   | Neckar                           |
| D13            | Philippsburg KKP1/<br>Philippsburg KKP2 | NPS   | Rhine                            |
| D14            | Rheinsberg                              | NPS   | Havel                            |

|                        |                         |       |                                   |
|------------------------|-------------------------|-------|-----------------------------------|
| D15                    | Stade                   | NPS   | Elbe                              |
| D16                    | Rodenkirchen-Unterweser | NPS   | Weser                             |
| D17                    | Würgassen/Beverungen    | NPS   | Weser                             |
| D18                    | Karlsruhe               | RDF   | Rhine                             |
| D19                    | Gronau                  | NFFEP | Vechte, IJsselmeer                |
| D20                    | Hanau                   | NFFEP | Main - via municipal sewer system |
| D21                    | Karlstein               | NFFEP | Main - via municipal sewer system |
| D22                    | HMI Berlin              | RDF   | Havel                             |
| D23                    | Jülich                  | RDF   | Rur                               |
| D24                    | Rosendorf               | RDF   | Elbe                              |
|                        |                         |       |                                   |
| <b>The Netherlands</b> |                         |       |                                   |
| NL1                    | Borssele                | NPS   | Scheldt Estuary                   |
| NL2                    | Doodewaard              | NPS   | Waal                              |
| NL3                    | Almelo                  | NFFEP | Municipal sewer system            |
| NL4                    | Delft                   | RDF   | Sewage system                     |
| NL5                    | Petten                  | RDF   | North Sea                         |
|                        |                         |       |                                   |
| <b>Norway</b>          |                         |       |                                   |
| N1                     | Halden                  | RDF   | River Tista (Skagerrak)           |
| N2                     | Kjeller                 | RDF   | River Nitelva (Skagerrak)         |
|                        |                         |       |                                   |
| <b>Portugal</b>        |                         |       |                                   |
| P1                     | Campus de Sacavém       | RDF   | Tagus River                       |
|                        |                         |       |                                   |
| <b>Spain</b>           |                         |       |                                   |
| E1                     | Almaraz                 | NPS   | Tagus                             |
| E2                     | José Cabrera            | NPS   | Tagus                             |
| E3                     | Trillo                  | NPS   | Tagus                             |
| E4                     | Juzbado                 | NFFEP | River Tormes - Duero              |
|                        |                         |       |                                   |
| <b>Sweden</b>          |                         |       |                                   |
| S1                     | Barsebäck               | NPS   | Öresund                           |
| S2                     | Ringhals 1-4            | NPS   | Kattegat                          |
|                        |                         |       |                                   |
| <b>Switzerland</b>     |                         |       |                                   |
| CH1                    | Beznau                  | NPS   | Aare                              |
| CH2                    | Gösgen                  | NPS   | Aare                              |
| CH3                    | Leibstadt               | NPS   | Rhine                             |
| CH4                    | Mühleberg               | NPS   | Aare                              |
| CH5                    | Paul Scherrer Institute | RDF   | Aare                              |
|                        |                         |       |                                   |
| <b>United Kingdom</b>  |                         |       |                                   |
| GB1                    | Berkeley                | NPS   | Severn Estuary                    |
| GB2                    | Bradwell                | NPS   | North Sea                         |
| GB3                    | Calder Hall             | NPS   | Irish Sea                         |
| GB4                    | Chapelcross             | NPS   | Solway Firth                      |
| GB5                    | Dungeness A/Dungeness B | NPS   | English Channel                   |
| GB6                    | Hartlepool              | NPS   | North Sea                         |
| GB7                    | Heysham 1 / Heysham 2   | NPS   | Morecambe Bay                     |

|      |                                 |       |                                                |
|------|---------------------------------|-------|------------------------------------------------|
| GB8  | Hinkley Point A/Hinkley Point B | NPS   | Severn Estuary                                 |
| GB9  | Hunterston A/Hunterston B       | NPS   | Firth of Clyde                                 |
| GB10 | Oldbury                         | NPS   | Severn Estuary                                 |
| GB11 | Sizewell A/Sizewell B           | NPS   | North Sea                                      |
| GB12 | Torness                         | NPS   | North Sea                                      |
| GB13 | Trawsfynydd                     | NPS   | Trawsfynydd lake                               |
| GB14 | Wylfa                           | NPS   | Irish Sea                                      |
| GB15 | Sellafield                      | NFRP  | Irish Sea                                      |
| GB16 | Capenhurst                      | NFFEP | Irish Sea via Rivacre Brook and Mersey Estuary |
| GB17 | Springfields                    | NFFEP | Irish Sea via River Ribble                     |
| GB18 | Dounreay                        | RDF   | Pentland Firth                                 |
| GB19 | Harwell                         | RDF   | River Thames                                   |
| GB20 | Winfrith                        | RDF   | Weymouth Bay (English Channel)                 |

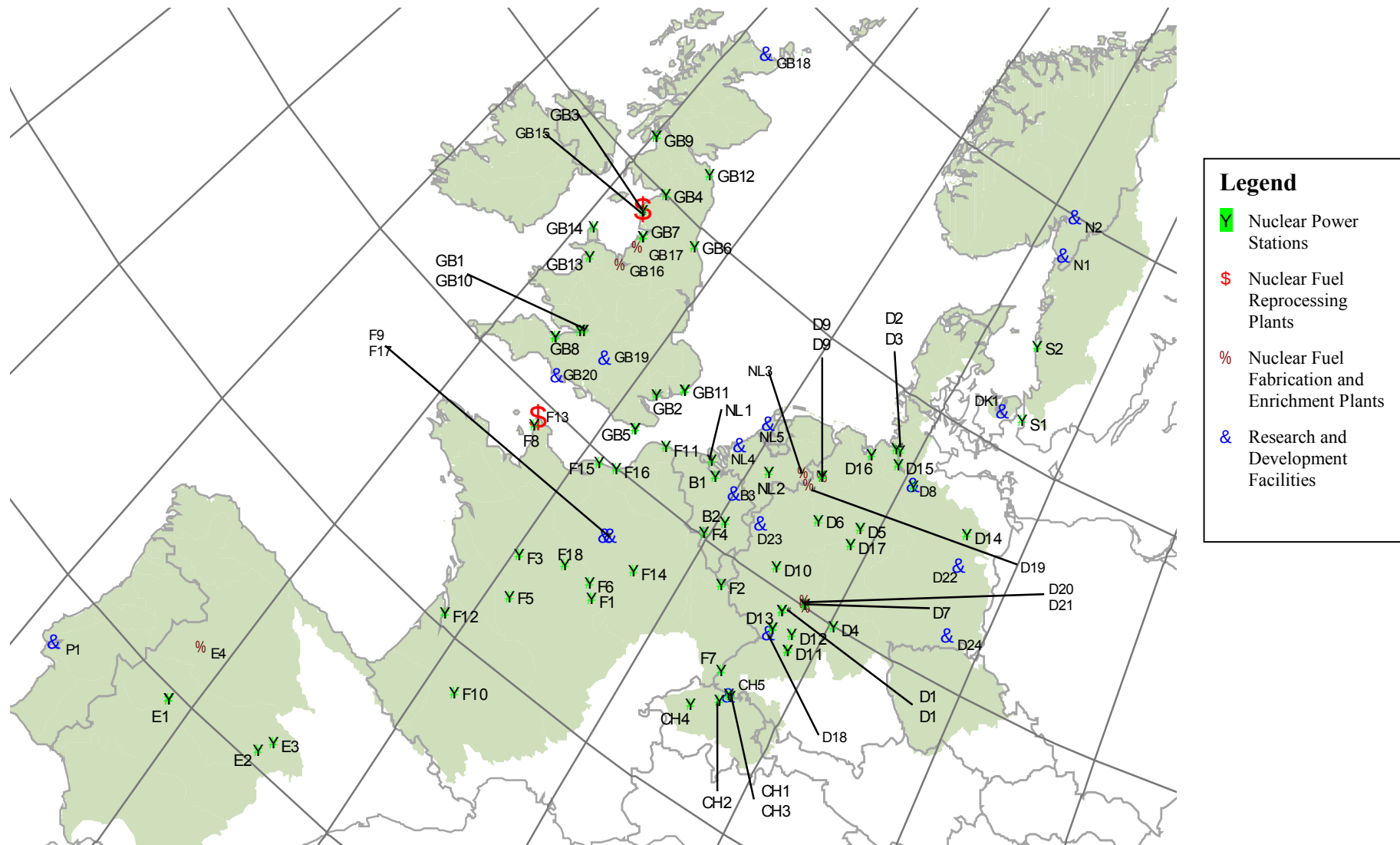
NPS: Nuclear Power Stations

RDF: Research and Development Facilities

NFRP: Nuclear Fuel Reprocessing Plants

NFFEP: Nuclear Fuel Fabrication and Enrichment Plants

## Location of nuclear installations



# Table 2 Nuclear Power Stations

| Map Ref. | Country Site       | Discharges to   | Reactors Number and Type | Installed Capacity MW (e) 2000 | Net Electrical Out-put MW (e) a 2000 | Discharge limits (upper row value) and releases (lower row value) of radioactive substances (1) in 2000 (TBq) |                          |                        |                                   |         |         |         |         |          |         |         |         |         |         |         |  |
|----------|--------------------|-----------------|--------------------------|--------------------------------|--------------------------------------|---------------------------------------------------------------------------------------------------------------|--------------------------|------------------------|-----------------------------------|---------|---------|---------|---------|----------|---------|---------|---------|---------|---------|---------|--|
|          |                    |                 |                          |                                |                                      | Tritium                                                                                                       | other (2) radio-nuclides | Specific radionuclides |                                   |         |         |         |         |          |         |         |         |         |         |         |  |
|          |                    |                 |                          |                                |                                      |                                                                                                               |                          | gross (2) α activity   | gross (2) β-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  |  |
|          | Belgium            |                 |                          |                                |                                      |                                                                                                               |                          |                        |                                   |         |         |         |         |          |         |         |         |         |         |         |  |
| B1       | Doel               | Schelde         | 4 PWR                    | 390 / 390<br>900 / 1000        | 1. 392,5                             | 1,0E+02                                                                                                       | 1,5E+00                  |                        |                                   |         |         |         |         |          |         |         |         |         |         |         |  |
|          |                    |                 |                          |                                | 2. 392,5                             | 3,1E+01                                                                                                       | 1,5E-02                  | 0,0E+00                | 1,4E-04                           | 5,2E-03 | 1,4E-03 | 0,0E+00 | 1,3E-04 | 0,0E+00  | 0,0E+00 | 5,2E-04 | 2,1E-03 | 6,6E-04 | 3,5E-03 | 0,0E+00 |  |
|          |                    |                 |                          |                                | 3. 1006                              |                                                                                                               |                          |                        |                                   |         |         |         |         |          |         |         |         |         |         |         |  |
|          |                    |                 |                          |                                | 4. 985                               |                                                                                                               |                          |                        |                                   |         |         |         |         |          |         |         |         |         |         |         |  |
| B2       | Tihange            | Meuse           | 3 PWR                    | 900 / 900<br>1000              | 1. 962                               | 1,5E+02                                                                                                       | 8,9E-01                  | 2,0E-03                |                                   |         |         |         |         |          |         |         |         |         |         |         |  |
|          |                    |                 |                          |                                | 2. 960                               | 3,3E+01                                                                                                       | 1,6E-02                  | 7,1E-07                | 0,0E+00                           | 8,3E-03 | 3,8E-03 | 0,0E+00 | 0,0E+00 | 4,7E-05  | 0,0E+00 | 8,4E-04 | 2,7E-04 | 5,1E-05 | 3,5E-04 | 0,0E+00 |  |
|          |                    |                 |                          |                                | 3. 1015                              |                                                                                                               |                          |                        |                                   |         |         |         |         | 1,9E-04  |         |         |         |         |         |         |  |
|          | France (3)         |                 |                          |                                |                                      |                                                                                                               |                          |                        |                                   |         |         |         |         |          |         |         |         |         |         |         |  |
| F1       | Belleville         | Loire           | 2 PWR                    | 2600                           |                                      | 8,0E+01                                                                                                       | 1,1E+00                  |                        |                                   |         |         |         |         |          |         |         |         |         |         |         |  |
|          |                    |                 |                          |                                |                                      | 3,9E+01                                                                                                       | 1,7E-03                  |                        |                                   | 3,2E-04 | 6,3E-04 |         |         |          | 4,3E-04 | 8,2E-05 | 4,7E-05 | 6,5E-05 |         |         |  |
| F2       | Cattenom           | Mosel           | 4 PWR                    | 5200                           |                                      | 1,6E+02                                                                                                       | 2,2E+00                  |                        |                                   |         |         |         |         |          |         |         |         |         |         |         |  |
|          |                    |                 |                          |                                |                                      | 8,6E+01                                                                                                       | 1,4E-03                  |                        |                                   | 5,6E-04 | 3,6E-04 |         |         |          | 1,8E-04 | 3,8E-05 | 2,4E-05 | 8,3E-05 |         |         |  |
| F3       | Chinon             | Loire           | 4 PWR                    | 3600                           |                                      | 1,1E+02                                                                                                       | 1,5E+00                  |                        |                                   |         |         |         |         |          |         |         |         |         |         |         |  |
|          |                    |                 |                          |                                |                                      | 3,8E+01                                                                                                       | 1,0E-03                  |                        |                                   | 8,6E-05 | 1,1E-04 |         |         |          | 1,8E-04 | 7,9E-05 | 5,4E-05 | 7,8E-05 |         |         |  |
| F4       | Chooz (4)          | Meuse           | 2 PWR                    | 2900                           |                                      | 8,0E+01                                                                                                       | 2,2E-01                  |                        |                                   |         |         |         |         |          |         |         |         |         |         |         |  |
|          |                    |                 |                          |                                |                                      | 3,7E+01                                                                                                       | 3,2E-03                  |                        |                                   | 3,0E-04 | 1,5E-04 |         |         |          | 1,3E-03 |         | 3,4E-05 | 1,3E-03 |         |         |  |
| F5       | Civaux             | Vienne          | 2 PWR                    | 2900                           |                                      | 8,0E+01                                                                                                       | 2,2E-01                  |                        |                                   |         |         |         |         |          |         |         |         |         |         |         |  |
|          |                    |                 |                          |                                |                                      | 2,6E+01                                                                                                       | 1,3E-03                  |                        |                                   | 8,7E-04 | 2,4E-05 |         |         |          | 2,3E-04 |         | 1,9E-05 | 2,3E-05 |         |         |  |
| F6       | Dampierre-en-Burly | Loire           | 4 PWR                    | 3600                           |                                      | 1,1E+02                                                                                                       | 1,5E+00                  |                        |                                   |         |         |         |         |          |         |         |         |         |         |         |  |
|          |                    |                 |                          |                                |                                      | 3,2E+01                                                                                                       | 3,1E-03                  |                        |                                   | 1,1E-03 | 7,1E-04 |         |         |          | 6,6E-04 | 1,3E-04 | 1,8E-05 | 1,2E-04 |         |         |  |
| F7       | Fessenheim         | Rhine           | 2 PWR                    | 1800                           |                                      | 7,5E+01                                                                                                       | 9,3E-01                  |                        |                                   |         |         |         |         |          |         |         |         |         |         |         |  |
|          |                    |                 |                          |                                |                                      | 1,8E+01                                                                                                       | 2,1E-03                  |                        |                                   | 8,4E-04 | 1,9E-04 |         |         |          | 7,2E-04 |         | 3,0E-05 | 5,2E-05 |         |         |  |
| F8       | Flamanville        | Channel         | 2 PWR                    | 2600                           |                                      | 8,0E+01                                                                                                       | 1,1E+00                  |                        |                                   |         |         |         |         |          |         |         |         |         |         |         |  |
|          |                    |                 |                          |                                |                                      | 4,7E+01                                                                                                       | 2,4E-03                  |                        |                                   | 6,7E-04 | 8,2E-04 |         |         |          | 2,8E-04 | 1,8E-04 | 5,7E-05 | 2,3E-04 |         |         |  |
| F10      | Golfech (5)        | Garonne         | 2 PWR                    | 2600                           |                                      | 8,0E+01                                                                                                       | 1,1E+00                  |                        |                                   |         |         |         |         |          |         |         |         |         |         |         |  |
|          |                    |                 |                          |                                |                                      | 2,7E+01                                                                                                       | 6,2E-04                  |                        |                                   | 1,7E-04 | 2,1E-04 |         |         |          | 3,5E-05 | 8,0E-06 | 3,0E-05 | 8,5E-05 |         |         |  |
| F11      | Gravelines         | North Sea       | 6 PWR                    | 5400                           |                                      | 1,7E+02                                                                                                       | 2,2E+00                  |                        |                                   |         |         |         |         |          |         |         |         |         |         |         |  |
|          |                    |                 |                          |                                |                                      | 4,7E+01                                                                                                       | 3,2E-03                  |                        |                                   | 1,6E-03 | 6,6E-04 |         |         |          | 5,8E-04 | 5,8E-05 | 1,4E-05 | 9,7E-05 |         |         |  |
| F12      | Le Blayais         | Gironde Estuary | 4 PWR                    | 3600                           |                                      | 1,1E+02                                                                                                       | 1,5E+00                  |                        |                                   |         |         |         |         |          |         |         |         |         |         |         |  |
|          |                    |                 |                          |                                |                                      | 3,6E+01                                                                                                       | 3,5E-03                  |                        |                                   | 1,0E-03 | 7,6E-04 |         |         |          | 9,0E-04 | 1,1E-04 | 2,8E-05 | 1,4E-04 |         |         |  |
| F14      | Nogent-sur-Seine   | Seine           | 2 PWR                    | 2600                           |                                      | 8,0E+01                                                                                                       | 1,1E+00                  |                        |                                   |         |         |         |         |          |         |         |         |         |         |         |  |
|          |                    |                 |                          |                                |                                      | 6,2E+01                                                                                                       | 1,5E-03                  |                        |                                   | 5,0E-04 | 6,0E-04 |         |         |          | 1,2E-04 | 2,7E-05 | 1,4E-05 | 5,2E-05 |         |         |  |
| F15      | Paluel             | Channel         | 4 PWR                    | 5200                           |                                      | 1,6E+02                                                                                                       | 2,2E+00                  |                        |                                   |         |         |         |         |          |         |         |         |         |         |         |  |
|          |                    |                 |                          |                                |                                      | 1,1E+02                                                                                                       | 4,1E-03                  |                        |                                   | 1,5E-03 | 7,8E-04 |         |         |          | 3,1E-04 | 5,3E-04 | 6,8E-05 | 4,0E-04 |         |         |  |
| F16      | Penly              | Channel         | 2 PWR                    | 2600                           |                                      | 8,0E+01                                                                                                       | 1,1E+00                  |                        |                                   |         |         |         |         |          |         |         |         |         |         |         |  |
|          |                    |                 |                          |                                |                                      | 3,5E+01                                                                                                       | 1,2E-03                  |                        |                                   | 4,9E-04 | 3,2E-04 |         |         |          | 3,2E-05 | 2,4E-05 | 4,1E-05 | 1,6E-04 |         |         |  |
| F18      | Saint Laurent (6)  | Loire           | 2 PWR                    | 1800                           |                                      | 4,5E+01                                                                                                       | 3,3E-01                  |                        |                                   |         |         |         |         |          |         |         |         |         |         |         |  |
|          |                    |                 |                          |                                |                                      | 2,4E+01                                                                                                       | 1,9E-03                  |                        |                                   | 8,5E-04 | 3,6E-04 |         |         |          | 2,6E-04 | 8,7E-05 | 2,9E-05 | 8,6E-05 |         |         |  |

**Table 2, cont. Nuclear Power Stations**

| Map Ref. | Country Site           | Discharges to | Reactors Number and Type | Installed Capacity MW (e) 2000 | Net Electrical Out-put MW (e) a 2000 | Discharge limits (upper row value) and releases (lower row value) of radioactive substances (1) in 2000 (TBq) |                          |                        |                                    |         |         |         |         |          |        |         |         |         |         |        |
|----------|------------------------|---------------|--------------------------|--------------------------------|--------------------------------------|---------------------------------------------------------------------------------------------------------------|--------------------------|------------------------|------------------------------------|---------|---------|---------|---------|----------|--------|---------|---------|---------|---------|--------|
|          |                        |               |                          |                                |                                      | Tritium                                                                                                       | other (2) radio-nuclides | Specific radionuclides |                                    |         |         |         |         |          |        |         |         | Cs 134  | Cs 137  | Ce 144 |
|          |                        |               |                          |                                |                                      |                                                                                                               |                          | gross (2) α activity   | gross (2) β-activity (ex. Tritium) | Co 58   | Co 60   | Zn 65   | Sr 90   | Zr/Nb 95 | Ru 106 | Ag 110m | Sb 125  |         |         |        |
|          | Germany                |               |                          |                                |                                      |                                                                                                               |                          |                        |                                    |         |         |         |         |          |        |         |         |         |         |        |
| D1       | Biblis A               | Rhine         | 1 PWR                    | 1225                           | 881                                  | 3,0E+01<br>1,6E+01                                                                                            | 1,1E-01<br>1,6E-04       |                        |                                    | 1,7E-06 | 5,8E-05 | 1,1E-07 |         |          |        | 4,4E-07 | 1,7E-06 | 1,7E-06 | 5,9E-06 |        |
| D1       | Biblis B               | Rhine         | 1 PWR                    | 1300                           | 1060                                 | 3,0E+01<br>1,5E+01                                                                                            | 1,1E-01<br>2,0E-04       |                        |                                    | 9,9E-07 | 1,5E-05 |         |         | 7,2E-08  |        | 4,8E-07 | 2,9E-06 | 1,3E-07 | 2,3E-06 |        |
| D2       | Brokdorf               | Elbe          | 1 PWR                    | 1440                           | 1332                                 | 3,5E+01<br>2,1E+01                                                                                            | 5,5E-02<br>4,0E-06       |                        |                                    |         | 2,1E-06 |         |         |          |        |         | 4,4E-08 | 6,7E-07 | 1,2E-06 |        |
| D3       | Brunsbüttel            | Elbe          | 1 BWR                    | 806                            | 740                                  | 3,7E+01<br>3,5E-01                                                                                            | 1,9E-01<br>2,1E-04       |                        |                                    | 8,1E-06 | 7,8E-05 | 2,7E-05 | 3,7E-07 | 3,8E-08  |        | 1,3E-07 |         | 5,7E-08 | 3,0E-05 |        |
| D4       | Grafenrheinfeld        | Main          | 1 PWR                    | 1345                           | 1005                                 | 4,1E+01<br>1,6E+01                                                                                            | 5,5E-02<br>4,5E-05       |                        |                                    | 2,7E-06 | 3,1E-05 |         |         | 2,9E-07  |        | 1,0E-07 | 4,3E-07 | 1,2E-06 | 9,0E-07 |        |
| D5       | Grohnde/<br>Emmerthal  | Weser         | 1 PWR                    | 1430                           | 1350                                 | 4,8E+01<br>1,7E+01                                                                                            | 5,5E-02<br>3,7E-05       |                        |                                    | 4,5E-07 | 8,9E-06 |         | 1,3E-05 | 9,7E-07  |        |         |         |         | 9,4E-08 |        |
| D6       | Hamm-<br>Uentrop       | Lippe         | 1 THTR                   | 296                            | (7)                                  | 3,7E+01<br>-                                                                                                  | 1,9E-02<br>-             |                        |                                    |         |         |         |         |          |        |         |         |         |         |        |
| D7       | Kahl                   | Main          | 1 BWR                    | 16                             | (8)                                  | 1,5E-01<br>1,6E-03                                                                                            | 4,4E-03<br>1,3E-05       |                        |                                    |         | 8,5E-06 |         | 5,4E-08 |          |        |         |         |         | 2,8E-06 |        |
| D8       | Krümmel/<br>Geesthacht | Elbe          | 1 BWR                    | 1316                           | 1251                                 | 1,9E+01<br>5,0E-01                                                                                            | 5,0E-02<br>1,9E-06       |                        |                                    |         | 9,8E-07 |         |         |          |        |         |         |         |         |        |
| D9       | Lingen/<br>Emsland     | Ems           | 1 PWR                    | 1363                           | 1292                                 | 3,5E+01<br>1,3E+01                                                                                            | 3,7E-02<br>1,1E-07       |                        |                                    | 3,0E-08 |         |         |         |          |        |         | 3,2E-08 |         |         |        |
| D9       | Lingen                 | Ems           | 1 BWR                    | 268                            | (9)                                  | 2,5E-02<br>7,1E-06                                                                                            | 2,5E-05<br>4,6E-07       | 1,6E-08                |                                    |         | 1,6E-07 |         | 2,1E-08 |          |        |         |         |         | 1,4E-07 |        |
| D10      | Mülheim-<br>Kärlich    | Rhine         | 1 PWR                    | 1302                           | (8)                                  | 5,0E+01<br>1,1E-01                                                                                            | 6,0E-02<br>8,1E-06       |                        |                                    |         | 8,1E-06 |         |         |          |        |         |         |         |         |        |
| D11      | Neckar-<br>westheim 1  | Neckar        | 1 PWR                    | 840                            | 720                                  | 1,9E+01<br>8,7E+00                                                                                            | 1,9E-02<br>1,8E-06       |                        |                                    |         | 6,5E-08 |         |         |          |        |         |         |         |         |        |
| D11      | Neckar-<br>westheim 2  | Neckar        | 1 PWR                    | 1365                           | 1279                                 | 7,0E+01<br>1,1E+01                                                                                            | 6,0E-02<br>5,0E-06       |                        |                                    | 1,2E-07 | 1,9E-06 |         |         | 1,3E-07  |        |         | 1,4E-06 |         | 1,8E-07 |        |
| D12      | Obrigheim              | Neckar        | 1 PWR                    | 357                            | 338                                  | 1,9E+01<br>5,5E+00                                                                                            | 1,9E-01<br>7,3E-04       |                        |                                    | 4,2E-05 | 1,8E-04 | 1,4E-06 | 4,2E-07 |          |        | 5,5E-05 |         | 2,8E-05 | 6,6E-05 |        |
| D13      | Philippsburg<br>KKP1   | Rhine         | 1 BWR                    | 926                            | 825                                  | 1,9E+01<br>4,8E-01                                                                                            | 1,5E-01<br>1,6E-04       |                        |                                    | 7,3E-06 | 7,7E-05 | 2,2E-05 |         |          |        | 1,6E-07 |         |         | 4,7E-06 |        |
| D13      | Philippsburg<br>KKP2   | Rhine         | 1 PWR                    | 1424                           | 1338                                 | 4,8E+01<br>1,8E+01                                                                                            | 5,5E-02<br>3,5E-04       |                        |                                    | 4,3E-06 | 5,0E-05 | 1,7E-07 |         | 1,6E-06  |        | 5,0E-06 | 1,7E-06 | 2,9E-05 | 1,3E-04 |        |
| D14      | Rheinsberg             | Havel         | 1 PWR                    | 70                             | (10)                                 | 2,0E+00                                                                                                       | 2,0E-03<br>9,0E-06       | 5,9E-08                |                                    |         | 1,7E-06 |         | 4,1E-07 |          |        |         |         |         | 2,1E-06 |        |

**Table 2, cont. Nuclear Power Stations**

| Map Ref.             | Country Site                      | Discharges to   | Reactors Number and Type | Installed Capacity MW (e) 2000 | Net Electrical Out-put MW (e) a 2000 | Discharge limits (upper row value) and releases (lower row value) of radioactive substances (1) in 2000 (TBq) |                          |                        |        |         |         |        |         |         |  |         |         |         |         |  |
|----------------------|-----------------------------------|-----------------|--------------------------|--------------------------------|--------------------------------------|---------------------------------------------------------------------------------------------------------------|--------------------------|------------------------|--------|---------|---------|--------|---------|---------|--|---------|---------|---------|---------|--|
|                      |                                   |                 |                          |                                |                                      | Tritium                                                                                                       | other (2) radio-nuclides | Specific radionuclides |        |         |         |        |         |         |  |         |         |         |         |  |
| gross (2) α activity | gross (2) β-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  |  |         |         |         |         |  |
|                      | Germany cont.                     |                 |                          |                                |                                      |                                                                                                               |                          |                        |        |         |         |        |         |         |  |         |         |         |         |  |
| D15                  | Stade                             | Elbe            | 1 PWR                    | 672                            | 556                                  | 4,8E+01<br>2,4E+00                                                                                            | 1,9E-01<br>3,8E-05       |                        |        | 4,5E-06 | 9,3E-06 |        | 7,9E-08 | 3,7E-07 |  | 3,4E-06 |         |         | 5,5E-06 |  |
| D16                  | Rodenkirchen-Unterweser           | Weser           | 1 PWR                    | 1350                           | 975                                  | 3,5E+01<br>1,6E+01                                                                                            | 7,4E-02<br>7,7E-04       |                        |        | 1,1E-05 | 1,4E-04 |        |         | 8,2E-08 |  | 1,9E-05 | 7,0E-06 | 2,0E-05 | 8,8E-05 |  |
| D17                  | Würgassen /Beverungen             | Weser           | 1 BWR                    | 640                            | (11)                                 | 1,0E+01<br>8,0E-04                                                                                            | 6,0E-02<br>4,3E-05       |                        |        |         | 2,6E-05 |        |         |         |  |         |         |         | 1,7E-05 |  |
|                      | The Netherlands                   |                 |                          |                                |                                      |                                                                                                               |                          |                        |        |         |         |        |         |         |  |         |         |         |         |  |
| NL1                  | Borssele                          | Scheldt Estuary | 1 PWR                    | 485                            | 411                                  | 3,0E+01<br>7,7E+00                                                                                            | 0,2(11a)<br>3,3E-04      | 2,0E-04<br>6,0E-08     |        |         |         |        |         |         |  |         |         |         |         |  |
| NL2                  | Doodewaard                        | Waal            | 1 BWR                    | 58                             | (11b)                                | 2,0E+00<br>1,4E-03                                                                                            | 0,1(11c)<br>6,7E-04      |                        |        |         |         |        |         |         |  |         |         |         |         |  |
|                      | Spain                             |                 |                          |                                |                                      |                                                                                                               |                          |                        |        |         |         |        |         |         |  |         |         |         |         |  |
| E1                   | Almaraz                           | Tagus           | 2 PWR                    | 1956                           | 1698                                 | (12)<br>6,7E+01                                                                                               | (12,13)<br>1,2E-02       |                        |        |         |         |        |         |         |  |         |         |         |         |  |
| E2                   | José Cabrera                      | Tagus           | 1 PWR                    | 160                            | 126                                  | (12)<br>4,0E+00                                                                                               | (12,13)<br>3,2E-04       |                        |        |         |         |        |         |         |  |         |         |         |         |  |
| E3                   | Trillo                            | Tagus           | 1 PWR                    | 1066                           | 937                                  | (12)<br>1,6E+01                                                                                               | (12,13)<br>6,6E-04       |                        |        |         |         |        |         |         |  |         |         |         |         |  |
|                      | Sweden                            |                 |                          |                                |                                      |                                                                                                               |                          |                        |        |         |         |        |         |         |  |         |         |         |         |  |
| S1                   | Barsebäck (14)                    | Öresund         | 1 BWR                    | 600                            | 338                                  | (15)<br>4,0E-01                                                                                               | (16, 16a)<br>2,5E-02     |                        |        |         |         |        |         |         |  |         |         |         |         |  |
| S2                   | Ringhals 1-4                      | Kattegat        | BWR                      | 835                            | 372                                  | (15)<br>5,1E-01                                                                                               | (16, 16b)<br>1,1E-02     |                        |        |         |         |        |         |         |  |         |         |         |         |  |
|                      |                                   |                 | PWR                      | 875                            | 593                                  | (15)<br>1,1E+01                                                                                               | (16, 16c)<br>8,2E-03     |                        |        |         |         |        |         |         |  |         |         |         |         |  |
|                      |                                   |                 | PWR                      | 915                            | 709                                  | (15)<br>9,0E+00                                                                                               | (16, 16d)<br>1,1E-02     |                        |        |         |         |        |         |         |  |         |         |         |         |  |
|                      |                                   |                 | PWR                      | 915                            | 467                                  | (15)<br>5,7E+00                                                                                               | (16, 16e)<br>5,6E-03     |                        |        |         |         |        |         |         |  |         |         |         |         |  |

**Table 2, cont. Nuclear Power Stations**

| Map Ref.             | Country Site                      | Discharges to   | Reactors Number and Type | Installed Capacity MW (e) 2000 | Net Electrical Out-put MW (e) a 2000 | Discharge limits (upper row value) and releases (lower row value) of radioactive substances (1) in 2000 (TBq) |                          |                        |         |         |         |         |         |         |  |         |         |         |         |         |
|----------------------|-----------------------------------|-----------------|--------------------------|--------------------------------|--------------------------------------|---------------------------------------------------------------------------------------------------------------|--------------------------|------------------------|---------|---------|---------|---------|---------|---------|--|---------|---------|---------|---------|---------|
|                      |                                   |                 |                          |                                |                                      | Tritium                                                                                                       | other (2) radio-nuclides | Specific radionuclides |         |         |         |         |         |         |  |         |         |         |         |         |
| gross (2) α activity | gross (2) β-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  |  |         |         |         |         |         |
|                      | Switzerland                       |                 |                          |                                |                                      |                                                                                                               |                          |                        |         |         |         |         |         |         |  |         |         |         |         |         |
| CH1                  | Beznau                            | Aare            | 2 PWR                    | 380/380                        | 290/351                              | 7,0E+01                                                                                                       | 4,0E-01                  |                        |         |         |         |         |         |         |  |         |         |         |         |         |
|                      |                                   |                 |                          |                                |                                      | 8,3E-04                                                                                                       | 4,3E-02                  |                        |         | 3,0E-02 | 3,1E-03 | 1,3E-05 | 1,8E-05 | 4,5E-05 |  | 1,3E-04 | 3,0E-03 | 5,6E-04 | 1,7E-03 | 2,0E-06 |
| CH2                  | Gösgen                            | Aare            | 1 PWR                    | 1015                           | 891                                  | 7,0E+01                                                                                                       | 2,0E-01                  |                        |         |         |         |         |         |         |  |         |         |         |         |         |
|                      |                                   |                 |                          |                                |                                      | 1,4E+01                                                                                                       | 7,3E-06                  | 1,0E-07                |         |         | 2,6E-06 |         |         |         |  |         |         |         |         |         |
| CH3                  | Leibstadt                         | Rhine           | 1 BWR                    | 1200                           | 1007                                 | 2,0E+01                                                                                                       | 4,0E-01                  |                        |         |         |         |         |         |         |  |         |         |         |         |         |
|                      |                                   |                 |                          |                                |                                      | 1,7E+00                                                                                                       | 2,5E-04                  | 1,3E-06                |         | 3,2E-06 | 1,3E-04 | 3,2E-06 |         | 9,1E-07 |  |         |         | 2,6E-05 | 5,3E-05 |         |
| CH4                  | Mühleberg                         | Aare            | 1 BWR                    | 372                            | 321                                  | 2,0E+01                                                                                                       | 4,0E-01                  |                        |         |         |         |         |         |         |  |         |         |         |         |         |
|                      |                                   |                 |                          |                                |                                      | 1,4E-01                                                                                                       | 7,0E-03                  |                        |         | 2,6E-04 | 1,7E-03 | 5,3E-04 | 9,1E-07 |         |  |         |         |         | 3,3E-03 |         |
|                      | United Kingdom                    |                 |                          |                                |                                      |                                                                                                               |                          |                        |         |         |         |         |         |         |  |         |         |         |         |         |
| GB1                  | Berkeley                          | Severn Estuary  | 2 GCR                    | 0                              | (17)                                 | 8,0E+00                                                                                                       | 4,0E-01                  |                        |         |         |         |         |         |         |  |         |         |         | 2,0E-01 |         |
|                      |                                   |                 |                          |                                |                                      | 6,4E-03                                                                                                       | 2,2E-02                  |                        |         |         |         |         |         |         |  |         |         |         | 1,8E-02 |         |
| GB2                  | Bradwell                          | North Sea       | 2 GCR                    | 245                            | 64 MWa                               | 3,0E+01                                                                                                       | 1,0E+00                  |                        |         |         |         |         |         |         |  |         |         |         | 7,5E-01 |         |
|                      |                                   |                 |                          |                                |                                      | 6,5E-01                                                                                                       | 1,7E-01                  |                        |         |         |         |         |         |         |  |         |         |         | 4,9E-01 |         |
| GB3                  | Calder Hall                       | Irish Sea       | 4 GCR                    | 198                            | 159 MWa                              |                                                                                                               | (18)                     |                        |         |         |         |         |         |         |  |         |         |         |         |         |
|                      |                                   |                 |                          |                                |                                      |                                                                                                               | (18)                     |                        |         |         |         |         |         |         |  |         |         |         |         |         |
| GB4                  | Chapelcross                       | Solway Firth    | 4 GCR                    | 192                            | 1.5 TWHrs                            | 5,5E+00                                                                                                       |                          | 1,0E-01                | 2,5E+01 |         |         |         |         |         |  |         |         |         |         |         |
|                      |                                   |                 |                          |                                |                                      | 5,5E-01                                                                                                       |                          | 6,3E-04                | 1,9E-01 |         |         |         |         |         |  |         |         |         |         |         |
| GB5                  | Dungeness A (19)                  | English Channel | 2 GCR                    | 440                            | 343 MWa                              | 3,5E+01                                                                                                       | 1,4E+00                  |                        |         |         |         |         |         |         |  |         |         |         | 1,2E+00 |         |
|                      |                                   |                 |                          |                                |                                      | 1,1E+00                                                                                                       | 4,4E-01                  |                        |         |         |         |         |         |         |  |         |         |         | 1,3E-01 |         |
| GB5                  | Dungeness B (19)                  | English Channel | 2 AGR                    | 1110                           | 257 MWa                              | 6,5E+02                                                                                                       | 2,5E-01                  |                        |         |         | 3,0E-02 |         |         |         |  |         |         |         |         |         |
|                      |                                   |                 |                          |                                |                                      | 1,2E+02                                                                                                       | 1,7E-02                  |                        |         |         | 1,5E-03 |         |         |         |  |         |         |         |         |         |
| GB6                  | Hartlepool (20)                   | North Sea       | 2 AGR                    | 1210                           | 1026 MWa                             | 1,2E+03                                                                                                       | 3,0E-01                  |                        |         |         | 3,0E-02 |         |         |         |  |         |         |         |         |         |
|                      |                                   |                 |                          |                                |                                      | 4,1E+02                                                                                                       | 1,9E-03                  |                        |         |         | 3,3E-03 |         |         |         |  |         |         |         |         |         |
| GB7                  | Heysham 1 (21)                    | Morecambe Bay   | 2 AGR                    | 1150                           | 1026 MWa                             | 1,2E+03                                                                                                       | 3,0E-01                  |                        |         |         | 3,0E-02 |         |         |         |  |         |         |         |         |         |
|                      |                                   |                 |                          |                                |                                      | 4,4E+02                                                                                                       | 1,4E-02                  |                        |         |         | 1,1E-03 |         |         |         |  |         |         |         |         |         |
| GB7                  | Heysham 2 (22)                    | Morecambe Bay   | 2 AGR                    | 1250                           | 1116 MWa                             | 1,2E+03                                                                                                       | 3,0E-01                  |                        |         |         | 3,0E-02 |         |         |         |  |         |         |         |         |         |
|                      |                                   |                 |                          |                                |                                      | 3,4E+02                                                                                                       | 1,5E-02                  |                        |         |         | 3,7E-04 |         |         |         |  |         |         |         |         |         |
| GB8                  | Hinkley Point A (23)              | Severn Estuary  | 2 GCR                    | 0                              | (23)                                 | 2,5E+01                                                                                                       | 1,0E+00                  |                        |         |         |         |         |         |         |  |         |         |         | 1,5E+00 |         |
|                      |                                   |                 |                          |                                |                                      | 1,3E+00                                                                                                       | 1,2E-01                  |                        |         |         |         |         |         |         |  |         |         |         | 3,0E-01 |         |
| GB8                  | Hinkley Point B (24)              | Severn Estuary  | 2 AGR                    | 1220                           | 952 MWa                              | 6,2E+02                                                                                                       | 2,4E-01                  |                        |         |         | 3,0E-02 |         |         |         |  |         |         |         |         |         |
|                      |                                   |                 |                          |                                |                                      | 3,5E+02                                                                                                       | 1,7E-02                  |                        |         |         | 3,0E-04 |         |         |         |  |         |         |         |         |         |
| GB9                  | Hunterston A                      | Firth of Clyde  | 2 CGR                    | 0                              | 0                                    | 5,0E+00                                                                                                       | 2 (25)                   |                        |         |         |         |         |         |         |  |         |         |         |         |         |
|                      |                                   |                 |                          |                                |                                      | 2,8E-03                                                                                                       | 1,4E-01                  |                        |         |         |         |         |         |         |  |         |         |         |         |         |

Table 2, cont. Nuclear Power Stations

| Map Ref. | Country Site          | Discharges to    | Reactors Number and Type | Installed Capacity MW (e) 2000 | Net Electrical Out-put MW (e) a 2000 | Discharge limits (upper row value) and releases (lower row value) of radioactive substances (1) in 2000 (TBq) |                          |                        |                                    |       |         |       |         |          |        |         |        |        |         |         |
|----------|-----------------------|------------------|--------------------------|--------------------------------|--------------------------------------|---------------------------------------------------------------------------------------------------------------|--------------------------|------------------------|------------------------------------|-------|---------|-------|---------|----------|--------|---------|--------|--------|---------|---------|
|          |                       |                  |                          |                                |                                      | Tritium                                                                                                       | other (2) radio-nuclides | Specific radionuclides |                                    |       |         |       |         |          |        |         |        |        |         |         |
|          |                       |                  |                          |                                |                                      |                                                                                                               |                          | gross (2) α activity   | gross (2) β-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  |
|          | United Kingdom, cont. |                  |                          |                                |                                      |                                                                                                               |                          |                        |                                    |       |         |       |         |          |        |         |        |        |         |         |
| GB9      | Hunterston B          | Firth of Clyde   | 2 AGR                    | 1150                           | 8.03 TWHrs                           | 8,0E+02                                                                                                       | 1,0E+01                  | 1,0E-03                | 4,5E-01                            |       | 3,0E-02 |       |         |          |        |         |        |        |         |         |
|          |                       |                  |                          |                                |                                      | 3,3E+02                                                                                                       | 1,6E+00                  | 6,0E-06                | 3,6E-03                            |       | 4,6E-04 |       |         |          |        |         |        |        |         |         |
| GB10     | Oldbury               | Severn Estuary   | 2 GCR                    | 434                            | 410 MWa                              | 2,5E+01                                                                                                       | 1,3E+00                  |                        |                                    |       |         |       |         |          |        |         |        |        | 7,0E-01 |         |
|          |                       |                  |                          |                                |                                      | 3,5E-01                                                                                                       | 1,5E-01                  |                        |                                    |       |         |       |         |          |        |         |        |        |         | 6,4E-02 |
| GB11     | Sizewell A            | North Sea        | 2 GCR                    | 420                            | 315 MWa                              | 3,5E+01                                                                                                       | 7,0E-01                  |                        |                                    |       |         |       |         |          |        |         |        |        | 1,0E+00 |         |
|          |                       |                  |                          |                                |                                      | 1,6E+00                                                                                                       | 1,7E-01                  |                        |                                    |       |         |       |         |          |        |         |        |        |         | 1,4E-01 |
| GB11     | Sizewell B            | North Sea        | 1 PWR                    | 1175                           | 976 MWa                              | 8,0E+01                                                                                                       | 2,0E-01                  |                        |                                    |       |         |       |         |          |        |         |        |        |         |         |
|          |                       |                  |                          |                                |                                      | 5,3E+01                                                                                                       | 6,0E-02                  |                        |                                    |       |         |       |         |          |        |         |        |        |         |         |
| GB12     | Torness               | North Sea        | 2 AGR                    | 1264                           | 8.25 TWHrs                           | 8,0E+02                                                                                                       | 1,0E+01                  | 1,0E-03                | 4,5E-01                            |       | 3,0E-02 |       |         |          |        |         |        |        |         |         |
|          |                       |                  |                          |                                |                                      | 2,3E+02                                                                                                       | 1,9E-02                  | 1,3E-05                | 2,8E-03                            |       | 3,5E-04 |       |         |          |        |         |        |        |         |         |
| GB13     | Trawsfynydd           | Trawsfynydd lake | 2 GCR                    | 0                              | (24)                                 | 1,2E+01                                                                                                       | 7,2E-01                  |                        |                                    |       |         |       | 8,0E-02 |          |        |         |        |        | 5,0E-02 |         |
|          |                       |                  |                          |                                |                                      | 5,3E-03                                                                                                       | 2,7E-03                  |                        |                                    |       |         |       | 1,5E-03 |          |        |         |        |        | 1,8E-03 |         |
| GB14     | Wylfa                 | Irish Sea        | 2 GCR                    | 950                            | 216 MWa                              | 4,0E+01                                                                                                       | 1,5E-01                  |                        |                                    |       |         |       |         |          |        |         |        |        |         |         |
|          |                       |                  |                          |                                |                                      | 4,0E+00                                                                                                       | 2,9E-02                  |                        |                                    |       |         |       |         |          |        |         |        |        |         |         |

Table 3

## Nuclear Fuel Reprocessing Plants

| Location (Map Ref.)                        | La Hague (F 13)                     |                                | Sellafield (GB 15)                                               |                                 |
|--------------------------------------------|-------------------------------------|--------------------------------|------------------------------------------------------------------|---------------------------------|
| Discharges to                              | English Channel                     |                                | Irish Sea                                                        |                                 |
| Type of Fuel Reprocessed<br>Capacity (t/y) | PWR + BWR<br>NI<br>NI               |                                | Magnox, AGR, LWR<br>1600 te/yr Magnox<br>1200 te/yr U oxide (25) |                                 |
| Radionuclide                               | Discharge Limit in<br>TBq per annum | TBq released<br>per annum (43) | Discharge Limit in<br>TBq per annum (26,27,40)                   | TBq released<br>in 2000 (27,40) |
| Tritium                                    | 3,7E+04                             | 1,1E+04                        | 2,5E+04                                                          | 2,3E+03                         |
| Total- $\alpha$                            | 1,7E+00                             | 3,7E-02                        | 1,0E+00                                                          | 1,2E-01                         |
| Total- $\beta$                             | 1,7E+03                             | 2,1E+01                        | 4,0E+02                                                          | 7,7E+01                         |
| C 14                                       |                                     | 8,5E+00                        | 2,1E+01                                                          | 4,6E+00                         |
| S 35                                       |                                     |                                | ND                                                               | ND                              |
| Mn 54                                      |                                     | 9,0E-03                        | ND                                                               | ND                              |
| Fe 55                                      |                                     |                                | ND                                                               | ND                              |
| Co 57                                      |                                     | 3,6E-04                        | ND                                                               | ND                              |
| Co 58                                      |                                     | 9,3E-04                        | ND                                                               | ND                              |
| Co 60                                      |                                     | 3,0E-01                        | 1,3E+01                                                          | 1,2E+00                         |
| Ni 63                                      |                                     | 6,8E-02                        | ND                                                               | ND                              |
| Zn 65                                      |                                     | 1,2E-04                        | ND                                                               | ND                              |
| Sr 89                                      |                                     | 1,2E-02                        | ND                                                               | ND                              |
| Sr 90                                      |                                     | 5,2E-01                        | 4,8E+01                                                          | 2,0E+01                         |
| (Sr 90 + Cs 137)                           | 2,2E+02                             | 1,4E+00                        | 1,2E+02                                                          | 2,7E+01                         |
| (Zr + Nb 95)                               |                                     | ND                             | 9,0E+00                                                          | 1,9E-01                         |
| Tc 99                                      |                                     | 3,9E-01                        | 9,0E+01                                                          | 4,4E+01                         |
| Ru 103                                     |                                     | ND                             | ND                                                               | ND                              |
| Ru 106                                     |                                     |                                | 6,3E+01                                                          | 2,7E+00                         |
| (Ru + Rh) 106                              |                                     | 2,1E+01                        | ND                                                               | ND                              |
| Ag 110m                                    |                                     | ND                             | ND                                                               | ND                              |
| Sb 124                                     |                                     | ND                             | ND                                                               | ND                              |
| Sb 125                                     |                                     | 3,5E-01                        | ND                                                               | ND                              |
| I 129                                      |                                     | 1,4E+00                        | 1,6E+00                                                          | 4,7E-01                         |
| Cs 134                                     |                                     | 4,7E-02                        | 6,6E+00                                                          | 2,3E-01                         |
| Cs 137                                     |                                     | 8,7E-01                        | 7,5E+01                                                          | 6,9E+00                         |
| Ce 144                                     |                                     |                                | 8,0E+00                                                          | 5,5E-01                         |
| (Ce + Pr) 144                              |                                     | 1,8E-03                        | ND                                                               | ND                              |
| Pm 147                                     |                                     | ND                             | ND                                                               | ND                              |
| Eu 152                                     |                                     | ND                             | ND                                                               | ND                              |
| Eu 154                                     |                                     | 8,3E-04                        | ND                                                               | ND                              |
| Eu 155                                     |                                     | 1,9E-04                        | ND                                                               | ND                              |
| Np 237                                     |                                     | 1,2E-03                        | ND                                                               | ND                              |
| Plutonium-a                                |                                     | 1,4E-02                        | 7,0E-01                                                          | 1,2E-01                         |
| Pu 241                                     |                                     | 2,8E-01                        | 2,7E+01                                                          | 3,2E+00                         |
| Am 241                                     |                                     | 7,3E-03                        | 3,0E-01                                                          | 3,0E-02                         |
| Cm 242                                     |                                     | 9,9E-05                        | ND                                                               | ND                              |
| Cm 243+244                                 |                                     | 1,5E-03                        | ND                                                               | ND                              |
|                                            |                                     |                                |                                                                  |                                 |
| Uranium (kg)                               |                                     |                                | 2,0E+03                                                          | 6,1E+02                         |
|                                            |                                     |                                |                                                                  |                                 |

**Table 4 Nuclear Fuel Fabrication and Enrichment Plants**

| Map Ref. | Country/site          | Discharges to                                  | Type of Fuel                   | Capacity (t/y)     | Production | Activity                                  | Discharge limit in TBq per annum | TBq released in 2000 |
|----------|-----------------------|------------------------------------------------|--------------------------------|--------------------|------------|-------------------------------------------|----------------------------------|----------------------|
|          | <b>Germany</b>        |                                                |                                |                    |            |                                           |                                  |                      |
| D9       | Lingen                | Ems - via municipal sewer system               | LWR                            | 400                |            | Uranium                                   |                                  |                      |
| D19      | Gronau                | Vechte, IJsselmeer                             | Uranium enrichment             | 760                |            | total - $\alpha$                          |                                  | 1,0E-08              |
| D20      | Hanau                 | Main - via municipal sewer system              | PWR, MOX                       | 1 350              |            | total - $\alpha$                          |                                  | 1,7E-04              |
| D21      | Karlstein             | Main - via municipal sewer system              | BWR                            | 400                |            | total - $\alpha$                          |                                  |                      |
|          | <b>Netherlands</b>    |                                                |                                |                    |            |                                           |                                  |                      |
| NL3      | Almelo                | Municipal sewer system                         | Uranium enrichment             | 2 500              | 1 440      | total - $\alpha$                          | 2,0E-05                          | 3,4E-06              |
|          |                       |                                                |                                |                    |            | $\beta$ - & $\gamma$ - emitting radionuc. | 2,0E-04                          | 8,5E-06              |
|          | <b>Spain</b>          |                                                |                                |                    |            |                                           |                                  |                      |
| E4       | Juzbado               | River Tormes - Duero                           | PWR, BWR                       | 500                | 229        | total - $\alpha$                          | 1,2E-02                          | 3,5E-05              |
|          | <b>United Kingdom</b> |                                                |                                |                    |            |                                           |                                  |                      |
| GB16     | Capenhurst            | Irish Sea via Rivacre Brook and Mersey Estuary | Uranium enrichment             | NI                 |            | Uranium - $\alpha$                        | 2,0E-02                          | 1,2E-03              |
|          |                       |                                                |                                |                    |            | Uranium daughters                         | 2,0E-02                          | 2,4E-03              |
|          |                       |                                                |                                |                    |            | other - $\alpha$                          | 3,0E-03                          | 3,5E-05              |
|          |                       |                                                |                                |                    |            | Tc 99                                     | 1,0E-01                          | 1,5E-03              |
| GB17     | Springfields          | Irish Sea via River Ribble                     | GCR, AGR, PWR fuel fabrication | 10000 te/yr as UOC |            | total - $\alpha$                          | 4,0E+00                          | 1,7E-01              |
|          |                       |                                                |                                |                    |            | total - $\beta$                           | 2,4E+02                          | 7,1E+01              |
|          |                       |                                                |                                |                    |            | Tc 99                                     | 6,0E-01                          | 3,5E-02              |
|          |                       |                                                |                                |                    |            | Th 230                                    | 2,0E+00                          | 6,9E-02              |
|          |                       |                                                |                                |                    |            | Th 232                                    | 2,0E-01                          | 9,0E-04              |
|          |                       |                                                |                                |                    |            | Uranium $\alpha$                          | 1,5E-01                          | 5,9E-02              |
|          |                       |                                                |                                |                    |            | Np 237                                    | 4,0E-02                          | 5,0E-04              |

**Table 5 Research and Development Facilities**

| Map Ref. | Country/site       | Discharges to                   | Reactors Number & Type                                    | Installed Capacity       | Radionuclides                | Discharge limit in TBq per annum | TBq released per annum in 2000 |
|----------|--------------------|---------------------------------|-----------------------------------------------------------|--------------------------|------------------------------|----------------------------------|--------------------------------|
|          | <b>Belgium</b>     |                                 |                                                           |                          |                              |                                  |                                |
| B3       | Mol                | River Mol-Neet                  | 1                                                         | 40 MW (th)               | weighted activity            | 2,0E+00                          | 6,0E-03                        |
|          | <b>France</b>      |                                 |                                                           |                          |                              |                                  |                                |
| F9       | Fontenay-aux-Roses | Seine                           | Centre de recherches du Commissariat à l'énergie atomique |                          | α                            | 1,0E-03                          | 3,6E-06                        |
|          |                    |                                 |                                                           |                          | β (other than tritium)       | 4,0E-02                          | 2,3E-06                        |
|          |                    |                                 |                                                           |                          | Tritium                      | 2,0E-01                          | 1,2E-04                        |
| F17      | Saclay             | Etang de Saclay                 | Centre de recherches du Commissariat à l'énergie atomique |                          | α                            | 7,4E-04                          | 1,6E-04                        |
|          |                    |                                 |                                                           |                          | β (other than tritium)       | 3,7E-02                          | 1,5E-03                        |
|          |                    |                                 |                                                           |                          | Tritium                      | 7,8E+00                          | 7,8E-02                        |
|          | <b>Denmark</b>     |                                 |                                                           |                          |                              |                                  |                                |
| DK1      | Risø               | Kattegat through Roskilde Fjord | 1                                                         | 10 MW (th)               | Tritium                      | (28)                             | 9,6E-01                        |
|          |                    |                                 |                                                           |                          | gross β                      | (29)                             | 1,5E-04                        |
|          | <b>Germany</b>     |                                 |                                                           |                          |                              |                                  |                                |
| D8       | Geesthacht         | Elbe                            | 1                                                         | 5 MW                     | Tritium                      | 5,6E-02                          | 2,8E-03                        |
|          |                    |                                 |                                                           |                          | other radionuclides          | 1,9E-02                          | 1,9E-04                        |
| D18      | Karlsruhe          | Rhine                           | No reactors                                               | None                     | Tritium                      | 1,5E+02                          | 1,5E+00                        |
|          |                    |                                 |                                                           |                          | other radionuclides          | 3,2E-01                          | 2,7E-05                        |
| D22      | HMI Berlin         | Havel                           | 1                                                         | 10 MW                    | Tritium                      | -                                | 5,8E-05                        |
|          |                    |                                 |                                                           |                          | other radionuclides          | -                                | 5,1E-07                        |
| D23      | Jülich             | Rur                             | 1                                                         | 23 MW                    | Tritium                      | 1,1E+01                          | 1,4E-01                        |
|          |                    |                                 |                                                           |                          | other radionuclides          | 7,6E-03                          | 1,3E-04                        |
| D24      | Rosendorf          | Elbe                            | No reactors                                               | None                     | Tritium                      | 4,0E-01                          | 8,1E-04                        |
|          |                    |                                 |                                                           |                          | other radionuclides          | 2,3E-04                          | 3,5E-06                        |
|          | <b>Portugal</b>    |                                 |                                                           |                          |                              |                                  |                                |
| P1       | Campus de Sacavém  | Tagus River                     | 1 Research Swimming Pool Reactor                          | 1 MW                     | total - β                    | 4,0E-02                          | 9,0E-04                        |
|          | <b>Netherlands</b> |                                 |                                                           |                          |                              |                                  |                                |
| NL4      | Delft (30)         | Sewage system                   | 1                                                         | 6 MW (th)                | α - emitting radionuclides   |                                  | < 4,0E-07                      |
|          |                    |                                 |                                                           |                          | β - emitting radionuclides   |                                  | 9,6E-06                        |
|          |                    |                                 |                                                           |                          | γ - emitting radionuclides   |                                  | < 3,8E-06                      |
|          |                    |                                 |                                                           |                          | total                        | 20 gew Re,ing (31)               |                                |
| NL5      | Petten (32)        | North Sea                       | 1 HFR for material testing<br>1 LFR                       | 60 MW (th)<br>30 MW (th) | Tritium                      |                                  | 2,8E-01                        |
|          |                    |                                 |                                                           |                          | α - emitting radionuclides   |                                  | 6,0E-07                        |
|          |                    |                                 |                                                           |                          | β/γ - emitting radionuclides |                                  | 7,8E-02                        |
|          |                    |                                 |                                                           |                          | total                        | 2000 gew Re,ing (31)             |                                |
|          | <b>Norway</b>      |                                 |                                                           |                          |                              |                                  |                                |
| N1       | Halden (33)        | River Tista (Skagerrak)         | 1 BWR<br>D2O as moderator                                 | 25 MW                    | Tritium                      | 4,0E+02                          | 5,2E-01                        |
|          |                    |                                 |                                                           |                          | Cr 51                        | 4,0E+00                          | 6,1E-04                        |
|          |                    |                                 |                                                           |                          | Mn 54                        | 4,0E-03                          | 1,7E-05                        |
|          |                    |                                 |                                                           |                          | Co 58                        | 3,0E-01                          | 1,4E-05                        |
|          |                    |                                 |                                                           |                          | Co 60                        | 8,0E-02                          | 5,3E-04                        |
|          |                    |                                 |                                                           |                          | Nb 95                        | 8,0E-02                          | 3,8E-05                        |
|          |                    |                                 |                                                           |                          | Zr 95                        | 8,0E-02                          | 2,1E-05                        |
|          |                    |                                 |                                                           |                          | Sb 124                       | 5,0E-02                          | 1,2E-06                        |
|          |                    |                                 |                                                           |                          | Cs 134                       | 1,0E-02                          | 1,5E-05                        |
|          |                    |                                 |                                                           |                          | Cs 137                       | 1,0E-02                          | 2,9E-04                        |
|          |                    |                                 |                                                           |                          | I 131                        | 4,0E-03                          | 4,0E-07                        |
|          |                    |                                 |                                                           |                          | Sb 125                       | 1,5E-02                          | 1,2E-04                        |

**Table 5, cont. Research and Development Facilities**

| Ref  | Country site                                  | Discharges to             | Reactors Number & Type                             | Installed Capacity | Radionuclides                                        | Discharge limit in TBq per annum | TBq released per annum 2000 |
|------|-----------------------------------------------|---------------------------|----------------------------------------------------|--------------------|------------------------------------------------------|----------------------------------|-----------------------------|
| N2   | Kjeller (33)                                  | River Nitelva (Skagerrak) | 1 JEEP II, heavy water and cooled Research Reactor | 2 MW               | Tritium                                              | 4,8E+02                          | 4,0E-01                     |
|      |                                               |                           |                                                    |                    | S 35                                                 | 8,0E-02                          | 1,4E-04                     |
|      |                                               |                           |                                                    |                    | Co 60                                                | 1,1E-03                          | 8,6E-06                     |
|      |                                               |                           |                                                    |                    | Zn 65                                                | 1,7E-03                          | 8,5E-07                     |
|      |                                               |                           |                                                    |                    | Sr 90                                                | 4,8E-03                          | 5,3E-06                     |
|      |                                               |                           |                                                    |                    | I 125                                                | 2,5E-02                          | 7,8E-05                     |
|      |                                               |                           |                                                    |                    | I 131                                                | 1,3E-02                          | 2,5E-05                     |
|      |                                               |                           |                                                    |                    | Cs 134                                               | 1,5E-04                          | 3,2E-07                     |
|      |                                               |                           |                                                    |                    | Cs 137                                               | 2,7E-04                          | 6,0E-06                     |
|      |                                               |                           |                                                    |                    | Gd 153                                               |                                  |                             |
|      |                                               |                           |                                                    |                    | Pu 239                                               | 2,0E-02                          | 1,4E-07                     |
| CH5  | <b>Switzerland</b><br>Paul Scherrer Institute | Aare                      | 1 research reactor                                 | zero power         |                                                      |                                  |                             |
|      |                                               |                           |                                                    |                    | Tritium                                              | 2,0E+01                          | 1,0E-02                     |
|      |                                               |                           |                                                    |                    | other radionuclides                                  | 2,0E-01                          | 8,5E-04                     |
|      |                                               |                           |                                                    |                    | $\beta$ - and $\gamma$ - emitting radionuclides      |                                  |                             |
|      |                                               |                           |                                                    |                    | Be 7                                                 |                                  | 9,5E-06                     |
|      |                                               |                           |                                                    |                    | Na 22                                                |                                  | 9,0E-07                     |
|      |                                               |                           |                                                    |                    | S 35                                                 |                                  | 1,8E-06                     |
|      |                                               |                           |                                                    |                    | Mn 54                                                |                                  | 7,1E-07                     |
|      |                                               |                           |                                                    |                    | Co 57                                                |                                  | 4,3E-07                     |
|      |                                               |                           |                                                    |                    | Co 58                                                |                                  | 4,7E-07                     |
|      |                                               |                           |                                                    |                    | Co 60                                                |                                  | 1,3E-04                     |
|      |                                               |                           |                                                    |                    | Zn 65                                                |                                  | 1,6E-06                     |
|      |                                               |                           |                                                    |                    | Sr 90                                                |                                  | 1,8E-04                     |
|      |                                               |                           |                                                    |                    | Sb 124                                               |                                  | 3,0E-06                     |
|      |                                               |                           |                                                    |                    | Sb 125                                               |                                  | 3,8E-05                     |
|      |                                               |                           |                                                    |                    | I 125                                                |                                  | 2,5E-04                     |
|      |                                               |                           |                                                    |                    | Ba 133                                               |                                  | 7,4E-06                     |
|      |                                               |                           |                                                    |                    | Cs 134                                               |                                  | 1,3E-05                     |
|      |                                               |                           |                                                    |                    | Cs 137                                               |                                  | 1,9E-04                     |
|      |                                               |                           |                                                    |                    | Eu 152                                               |                                  | 2,0E-06                     |
|      |                                               |                           |                                                    |                    | Eu 154                                               |                                  | 1,8E-05                     |
|      |                                               |                           |                                                    |                    | $\alpha$ - emitting radionuclides                    |                                  |                             |
|      |                                               |                           |                                                    |                    | U 234/238                                            |                                  | 3,0E-05                     |
|      |                                               |                           |                                                    |                    | Pu 238/Am 242                                        |                                  | 6,2E-07                     |
|      |                                               |                           |                                                    |                    | Pu 239/240                                           |                                  | 2,5E-06                     |
|      |                                               |                           |                                                    |                    | Cm 244                                               |                                  | 2,4E-07                     |
| GB18 | <b>United Kingdom</b><br>Dounreay (34)        | Pentland Firth            | 1 prototype fast reactor                           | None (34)          |                                                      |                                  |                             |
|      |                                               |                           |                                                    |                    | $\alpha$ - emitting radionuclides (excluding Cm 242) | 2,7E-01                          | 1,6E-03                     |
|      |                                               |                           |                                                    |                    | $\beta$ - emitting radionuclides (excluding Tritium) | 4,9E+01                          | 3,0E-01                     |
|      |                                               |                           |                                                    |                    | Tritium                                              | 3,1E+01                          | 8,8E-02                     |
|      |                                               |                           |                                                    |                    | Co 60                                                | 4,6E-01                          | 7,1E-04                     |
|      |                                               |                           |                                                    |                    | Sr 90                                                | 7,7E+00                          | 1,6E-01                     |
|      |                                               |                           |                                                    |                    | Zr 95 + Nb 95                                        | 4,0E-01                          | 7,3E-04                     |
|      |                                               |                           |                                                    |                    | Ru 106                                               | 4,1E+00                          | 1,8E-03                     |
|      |                                               |                           |                                                    |                    | Ag 110m                                              | 1,3E-01                          | 2,7E-04                     |
|      |                                               |                           |                                                    |                    | Cs 137                                               | 2,3E+01                          | 1,4E-02                     |
|      |                                               |                           |                                                    |                    | Ce 144                                               | 4,2E-01                          | 1,1E-03                     |
|      |                                               |                           |                                                    |                    | Pu 241                                               | 2,3E+00                          | 3,0E-03                     |
|      |                                               |                           |                                                    |                    | Cm 242                                               | 4,0E-02                          | 2,6E-06                     |

**Table 5, cont. Research and Development Facilities**

| Ref  | Country site  | Discharges to                  | Reactors Number & Type | Installed Capacity | Radionuclides    | Discharge limit in TBq per annum | TBq released per annum 2000 |
|------|---------------|--------------------------------|------------------------|--------------------|------------------|----------------------------------|-----------------------------|
| GB19 | Harwell (41)  | River Thames                   | No reactors            | None               | total - $\alpha$ | 1,0E-03                          | 1,3E-05                     |
|      |               |                                |                        |                    | total - $\beta$  | 2,0E-02                          | 1,5E-03                     |
|      |               |                                |                        |                    | Tritium          | 4,0E+00                          | 6,5E-02                     |
|      |               |                                |                        |                    | Co 60            | 7,0E-03                          | 7,9E-05                     |
|      |               |                                |                        |                    | Cs 137           | 7,0E-03                          | 1,7E-04                     |
| GB20 | Winfrith (42) | Weymouth Bay (English Channel) | No reactors            | None               | total - $\alpha$ | 3,0E-01                          | 1,4E-04                     |
|      |               |                                |                        |                    | Tritium          | 6,5E+02                          | 4,3E+00                     |
|      |               |                                |                        |                    | Co 60            | 1,0E+01                          | 1,1E-02                     |
|      |               |                                |                        |                    | Zn 65            | 6,0E+00                          | 3,2E-04                     |
|      |               |                                |                        |                    | others           | 8,0E+01                          | 7,4E-02                     |

## FOOTNOTES TO TABLES 2-5

- (1) Discharge limits are given in row above the actual releases.
- (2) Where the value indicated corresponds to the sum of individually assessed nuclides, please indicate the nuclides included.  
For Belgium:  
  
β-Activity for Tihange: Sr-89, Sr-90. β-Activity for Doel: Sr-89, Sr-90. Other radionuclides for Tihange: Na-24, Cr-51, Mn-54, Co-57, Co-58, Co-60, Fe-59, Zn-65, Zr-95, Nb-95, Mo-99, Tc-99m, Ru-103, Ru-106, Ag-110m, Sb-122, Te-123m, Sb-124, Sb-125, I-131, Cs-134, Cs-136, Cs-137, Ba-140, La-140, Ce-141, Ce-144. Other radionuclides for Doel: Cr-51, Mn-54, Co-57, Co-58, Co-60, Fe-59, Zn-65, Zr-95, Nb-95, Ru-103, Ru-106, Ag-110m, Te-123m, Sb-124, Sb-125, I-131, Cs-134, Cs-137, Ba-140, La-140, Ce-141, Ce-144
- (3) French statement, cf. Appendix.
- (4) Chooz A ceased to operate on 30.10.1992, Chooz B1 was connected to the grid on 30.8.1996.
- (5) Second reactor was connected to the grid on 28.5.1993.
- (6) Ceased to operate on 27.5.1992.
- (7) Shut down in 1988.
- (8) Shut down in 1986.
- (9) Shut down in 1977.
- (10) Shut down in 1990.
- (11) Shut down in 1994.
- (11a) Total β- and γ-activity excluding Tritium. In 2000 for Borssele the detected radionuclides were: Cr-51; Mn-54; Fe-55; Co-58; Co-60; Ni-63; Zr-95; Nb-95; Ag-110m; Sb-124; I-131; Xe-133; Cs-134; Cs-137.
- (11b) Dodewaard shut down 26 March 1997.
- (11c) Total β- and γ-activity excluding Tritium. For the year 2000 no specific nuclides were indicated for Dodewaard.
- (12) Each facility has to comply with an authorised total effective dose equivalent limit of 100 μSv/y (ALARA dose limit), which is distributed between liquid and gaseous effluents in accordance with the criteria established in the Offsite Dose Calculation Manual. The relation between discharges and dose is calculated according to a methodology developed in the above document, based on the USNRC-Regulatory Guide 1.109 methodology with dose conversion factors for internal exposition taken from the NRPS-GS7 publication, using local or national parameters.
- (13) Total β- and γ-activity excluding Tritium and dissolved gases.
- (14) Discharges into the Øresund (HELCOM area adjacent to the OSPAR Maritime Area). Data provided for information only.
- (15) Discharges from Swedish nuclear facilities are regulated on the basis of dose to critical group. During normal operation the annual effective dose to individuals of the critical group shall not exceed 0,1 mSv. The 2000 discharges to the marine environment from the Ringhals and Barsebäck Nuclear Power Plants correspond to annual effective doses of 0,04 μSv and 0,05 μSv, respectively.
- (16) Total α-, β- and γ-activity excluding Tritium.
- (16a) In 2000 the detected radionuclides for Barsebäck were: Cr-51, Mn-54, Co-58, Co-60, Zn-65, Sr-90, Nb-95, Zr-95, Ag-110m, Sb-124, Sb-125, Cs-134, Cs-137, La-140, Pu-238, Pu-239, Am-241, Cm-242, Cm-244.
- (16b) For Ringhals unit 1, 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, Sb-122, Sb-124, Sb-125, Cs-134, Cs-137, La-140, Pu-238, Pu-239/240, Am-241, Cm-242, Cm-244, I-131.

- (16c) For Ringhals unit 2, 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, Ru-106, Ag-110m, Sn-113, Sb-122, Sb-124, Sb-125, Cs-137, Pu-239/240, Am-241, Cm-242, Cm-244.
- (16d) For Ringhals unit 3, the detected radionuclides were: Cr-51, Mn-54, Co-57, Co-58, Co-60, Fe-59, Zn-65, As-76, Nb-95, Zr-95, Ru-106, Ag-110m, Sn-113, Sb-124, Sb-125, Cs-134, Cs-137, Ce-141, Ce-144, Pu-238, Pu-239/240, Am-241, Cm-242, Cm-244.
- (16e) For Ringhals unit 4, the detected radionuclides were: Cr-51, Mn-54, Co-57, Co-58, Co-60, Fe-59, Zn-65, Nb-95, Zr-95, Ag-110m, Sn-113, Sb-124, Sb-125, Cs-137, Ce-143, Ce-144, Pu-238, Pu-, 239/240, Am-241, Cm-242, Cm-244.
- (17) Shut down in 1989, reactors decommissioned. Combined discharge data for Berkeley Power Station and Technology Centre.
- (18) Discharges from Calder Hall power station are included in the data for Sellafield (cf. Table 3).
- (19) New authorised discharge limits came into effect on 1 July 1994. Dungeness B also discharges sulphur-35 in a liquid form. The discharge limits and values for 2000 for sulphur-35 have not been included in the 'other radionuclides' category in the table and are as follows: limit 2 TBq; discharge 0,117 TBq.
- (20) Hartlepool also discharges sulphur-35 in a liquid form. The discharge limits and values for 2000 for sulphur-35 have not been included in the 'other radionuclides' category in the table and are as follows: limit 3 TBq; discharge 1,22 TBq.
- (21) Heysham 1 also discharges sulphur-35 in a liquid form. The discharge limits and values for 2000 for sulphur-35 have not been included in the 'other radionuclides' category in the table and are as follows: limit 2,8 TBq; discharge 0,121 TBq.
- (22) Heysham 2 also discharges sulphur-35 in a liquid form. The discharge limits and values for 2000 for sulphur-35 have not been included in the 'other radionuclides' category in the table and are as follows: limit 2,3 TBq; discharge 0,0375 TBq.
- (23) Hinkley A is shut down. No power output in 2000.
- (24) Hinkley B also discharges sulphur-35 in a liquid form. The discharge limits and values for 2000 for sulphur-35 have not been included in the 'other radionuclides' category in the table and are as follows: limit 5 TBq; discharge 0,347 TBq.
- (25) Total alpha and beta emitting radionuclides (excluding tritium).
- (26) Shut down in 1991, reactors decommissioned.
- (27) The reprocessing of uranium oxide fuel began in 1994.
- (28) The discharges of the Centre de Stockage de la Manche (low and intermediate level waste disposal site) are included in the La Hague discharges.
- (29) New authorisation for discharges from Sellafield came into force on 17 January 1994.
- (30) Discharges from Calder Hall Nuclear Power Station are included in the discharges from Sellafield.
- (31) Discharges and limits are listed for the Sellafield sea pipelines only.
- (32) Reporting obligation at discharge 10 times above average level.
- (33) The discharge limit is 0,4 Bq/ml gross- $\beta$  in the sewage from the plant. The average sewage discharge is  $77,5 \times 10^9$  ml per annum. The discharge limit per annum can thus be calculated to 0,03 TBq gross- $\beta$ .
- (34) 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. At the end of 1996 the permit regarding discharges to sewage were changed into a maximum value of 20 weighted Re,ing per year.

- (35) Depending on the half life of the individual radionuclides, 1 weighted Re,ing corresponds with the following amounts of radioactivity expressed in ICRP-61 Annual Limit Intake (ALI) -units:

|        |     |     |                 |               |     |      |
|--------|-----|-----|-----------------|---------------|-----|------|
| 0,5    | ALI | for | $t_{1/2} > 250$ | year          |     |      |
| 5      | ALI | for | 250 year        | $> t_{1/2} >$ | 25  | year |
| 50     | ALI | for | 25 year         | $> t_{1/2} >$ | 15  | days |
| 500    | ALI | for | 15 days         | $> t_{1/2} >$ | 7,5 | days |
| 5 000  | ALI | for | 7,5 days        | $> t_{1/2} >$ | 5   | days |
| 50 000 | ALI | for | 5 days          | $> t_{1/2}$   |     |      |

- (36) 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 distinct the discharges from each separate reactor). In all cases concentrations of  $\alpha$ -emitters were lower than the detection limit, which is used for load calculations. The discharge limits for Petten have been changed into 2000 weighted Re,ing per year.
- (37) Annual discharge data of gaseous effluents are also available.
- (38) The prototype fast reactor was shut down on 31 March 1994. Fuel reprocessing was being carried out at the UK research and development facility "Dounreay".
- (39) Discharges and limits are listed for the pipeline into the River Thames only.
- (40) Combined discharges and limits are listed for the Inner Pipeline and the Outer Pipeline for UKAEA Winfrith.

## Appendix

### RADIOACTIVE EFFLUENT AND THE PRODUCTION OF ELECTRICITY

#### *Explanatory text to footnote 5 (submitted by France)*

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.