Radioactive Substances Series

Implementation Report of PARCOM Recommendation 91/4 by Switzerland

OSPAR Commission
2006

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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Introduction

This report relates to the fourth round of implementation reporting on PARCOM Recommendation 91/4 under which Switzerland was scheduled to report to OSPAR Radioactive Substances Committee in the year 2006. The report was produced on the basis of the OSPAR guidelines for the submission of information about the application of the best available technologies in nuclear facilities.

In first instance the OSPAR guidelines ask for general information on the national implementation of the Best Available Technology (BAT) / Best Environmental Practice (BEP) principles, discharge limits and monitoring programmes. This information is provided in the next chapter. The subsequent chapters 1 to 4 give an overview of site characteristics, discharges, environmental impact and radiation doses to the public due to the nuclear facilities in Switzerland. In this overview the relevant changes during the reporting period are documented and in chapter 5 a self assessment is given.

Detailed information and data on each of the four Swiss nuclear power plants and the Paul Scherrer Institute research facility are given in the Annexes A to E with chapters enumerated according to the OSPAR guidelines.

General Information

In this chapter general information on the national implementation of the Best Available Technology (BAT)/Best Environmental Practice (BEP) principles, discharge limits and monitoring programmes is provided.

Implementation of BAT/BEP in terms of the OSPAR Convention in national legislation

Since 1994 the Swiss Federal Act and Ordinance on Radiological Protection have been based on the recommendations of the ICRP Publication 60. Starting on January 1st, 2000 new dose factors have been introduced in compliance with IAEA Safety Series No. 115. In addition, the fundamental concepts of justification, optimization, radiation dose limitation and the 10 microSv per year concept, as described in the IAEA Safety Series 89 and the Euratom Treaty, are adopted by the Swiss legislation and by the Swiss Federal Nuclear Safety Inspectorate (in the following Inspectorate) in its regulatory guidelines (www.hsk.ch). In this context the BAT/BEP is implemented in the Swiss national legislation according to the terms of the OSPAR Convention. Further details are given in the Inspectorate's guidelines discussed below.

Dose constraints/limits for nuclear facilities

The Ordinance on Radiological Protection sets the dose limit for members of the public at 1 mSv of annual effective dose. According to the Inspectorate's Guideline R-11 as revised in May 2003 a source-related dose constraint is set for nuclear installations at 0,3 mSv per year and person as the sum of the doses due to radioactive emissions to the atmosphere, discharges to water and direct radiation. Further the R-11 Guideline sets a dose constraint for direct radiation at 0,1 mSv per year and person.

A nuclear facility has to be designed in such a way that the source-related dose constraints are not exceeded as a result of incidents with an occurrence greater than 0,01 per year and the dose limit for members of the public is not exceeded by incidents with an occurrence greater than 0,0001 per year.

Discharge limits

The discharge limits, as fixed in the licence for operation of each facility, are set so that the source-related dose constraint of 0,3 mSv per year and person will not be exceeded. The dose calculation model for a person of the critical group in the vicinity of a nuclear facility is defined in the Inspectorate Guideline R-41 of July 1997.

In the case of discharges to water, annual discharge limits are given for the releases of tritium and other nuclides. The released nuclides without tritium are normalized with a reference exemption limit of 200 Bq/kg as unit. Then a limit is set for the concentration of radioactivity in the discharged water: The concentration, calculated according to the summation rule for nuclide specific exemption limits given as specific activity LE in the Radiological Protection Ordinance, has to be lower than 100.

Monitoring programmes of radionuclide concentrations in the environment

For each facility the Inspectorate has issued discharge and environment monitoring regulations. These regulations contain requirements on the control of discharges and a complete program on environmental monitoring of radioactivity and direct radiation in the vicinity of the facility. The programme is drawn up by the Federal Office of Public Health (BAG) in co-operation with the Inspectorate, the National Emergency Operation Centre and the Cantons. It includes measurements of dose rate and integral dose as well as samplings and measurements of air, drinking water, rainwater, river water, river sediments, soil, plants and food. The program is reviewed annually and modified as necessary.

Environmental norms and standards (other than dose standards for humans)

The allowed concentration of radioactive substances in the atmosphere and water is limited. The Radiological Protection Ordinance defines immission limits as weekly mean values of the concentration in waters accessible to the public. The immission limits are defined as 2 % of the exemption limits (LE) defined for each nuclide in the Ordinance on Radiological Protection. By the way, for water the scope of the Ordinance is set to 1 % of the exemption limit.

The Swiss Ordinance on Foreign Substances and Ingredients defines limits and tolerance values for radioactivity in food as an additional constraint. The tolerance values basically fulfil the 10 microSv per year concept.

National authority responsible for supervision etc, of discharges

The Federal Office of Public Health (BAG) is responsible for the environmental radiation supervision in Switzerland.

The Swiss Federal Nuclear Safety Inspectorate (Inspectorate) is the national authority responsible for the supervision of emissions and discharges of radioactivity from nuclear facilities into air and water. In addition the Inspectorate monitors the ionising radiation in the vicinity of nuclear installations.

Nature of inspection and surveillance programmes

The Inspectorate's *regulations on radioactive discharges, monitoring of radioactivity and direct radiation in the vicinity of the nuclear facility* define the controlling of the emissions and discharges to be done by the nuclear facility. It further states that samples and measurements are cross-checked between the Inspectorate, the Federal Office of Public Health and the nuclear facility at least 4 times per year. In addition, the Inspectorate performs inspections of abatement systems and environmental surveillance. These inspections include all aspects of sampling, measurement (laboratories and equipment), data records, quality assurance and reporting. These regulations define the surveillance programmes and establish the location, frequency and methods of sampling and measurement, as well as the responsibility for conducting the tests. The Inspectorate itself operates a remote dose rate monitoring system as part of the environment surveillance programme.

1 Site Characteristics

In Switzerland there are four NPPs, one central interim storage facility, one research facility and two facilities used for teaching purposes. The locations of the Swiss nuclear facilities are given in figure 1. All but one Swiss nuclear facilities discharge to the catchment area of the Rhine river, the exception being a nuclear facility for education with no relevant discharges.

Figure 1. Location of the Swiss nuclear facilities. The sites of the NPPs are marked by triangles. Experimental and research installations are marked by stars. The nuclear waste management facility is marked by a square. Dots mark the major cities.

1.1 Nuclear Power Plants

The names of the NPPs are Beznau, Gösgen, Leibstadt, and Mühleberg. The Swiss NPPs are of four different reactor designs and were delivered by three different reactor suppliers. The main characteristics of the NPPs are compiled in table 1.

During the reporting period, the Leibstadt NPP has increased its thermal power from 3138 to 3600 MW(th) in four steps from the year 1998 to the year 2003.

Table 1. Main characteristics of the Swiss NPPs

Name of site	**Beznau I**	**Beznau II**	**Mühleberg**	**Gösgen**	**Leibstadt**
Receiving waters Licensed thermal power	Aare river 1130 MW_{th}	Aare river 1130 MW_{th}	Aare river 1097 MW_{th}	Aare river, Wet cooling tower 3002 MW_{th}	Rhine river, Wet cooling tower 3600 MW_{th}
Nominal net electrical power	365 MW_{el}	365 MW_{el}	355 MW_{el}	970 MW_{el}	1165 MW_{el}
Reactor type / supplier[1]	PWR / W	PWR / W	BWR / GE	PWR / KWU	BWR / GE
Site Licence	1964	1967	1965	1972	1969
Construction licence	1964	1967	1967	1973	1975
Commercial operation	1969	1971	1972	1979	1984
	First generation NPPs			Second generation NPPs	

1.2 Waste treatment plant

During the reporting period, a central interim storage facility including a waste treatment plant was put in operation step by step at the Würenlingen site. Its name is ZWILAG. The interim storage facility started operation in 2001. In 2004 after several inactive tests the incineration and melting plant started a series of tests with low-level radioactive waste. In the years from 2001 to 2004 the emissions to the air and discharges to the Aare river were very low and are therefore not reported any further. Switzerland will start reporting on the central interim storage facility ZWILAG to OSPAR with the 2005 annual report.

1.3 Research facilities and facilities for nuclear education

The Paul Scherrer Institute (PSI) research facility is an annex of the Swiss Federal Institute of Technology and is located between the villages of Villigen and Würenlingen in the North of Switzerland. The Paul Scherrer Institute is a multidisciplinary research institute for natural sciences and engineering. The nuclear installations include various laboratories, waste treatment plants, the BZL federal interim storage facility, and the PROTEUS research reactor, a zero power research reactor with a maximum thermal power of 1 kW(th). The treated waste waters of the institute are discharged into the Aare river that belongs to the catchment area of the Rhine.

Two research reactors of the institute are currently under decommissioning and the incineration plant mentioned in the last report is out of operation since the year 2002. Its decommissioning is in planning.

The two facilities for nuclear education at the University of Basel and at the Ecole Polytechnique Fédérale in Lausanne operate without relevant discharges and are therefore not reported further in detail.

2 Discharges

Detailed information and data on each of the four nuclear power plants and the research facility are given in the Annexes A to E in chapters enumerated according to the OSPAR guidelines for the site-specific information. In the following a summary is given.

[1] **W**estinghouse Co; **GE**neral Electric Co (now Global Nuclear Fuel); **KWU,** Kraftwerk-Union (now Framatome ANP);
BWR: Boiling **W**ater **R**eactor; **PWR: P**ressurised **W**ater **R**eactor

2.1 Boiling water reactors (BWRs)

Figure 2 presents the discharges of radioactive substances (without tritium) from the boiling water reactors at Leibstadt and Mühleberg. A clear downward trend parallel to the median of European BWRs can be observed. This is due to the optimisation of the waste water management.

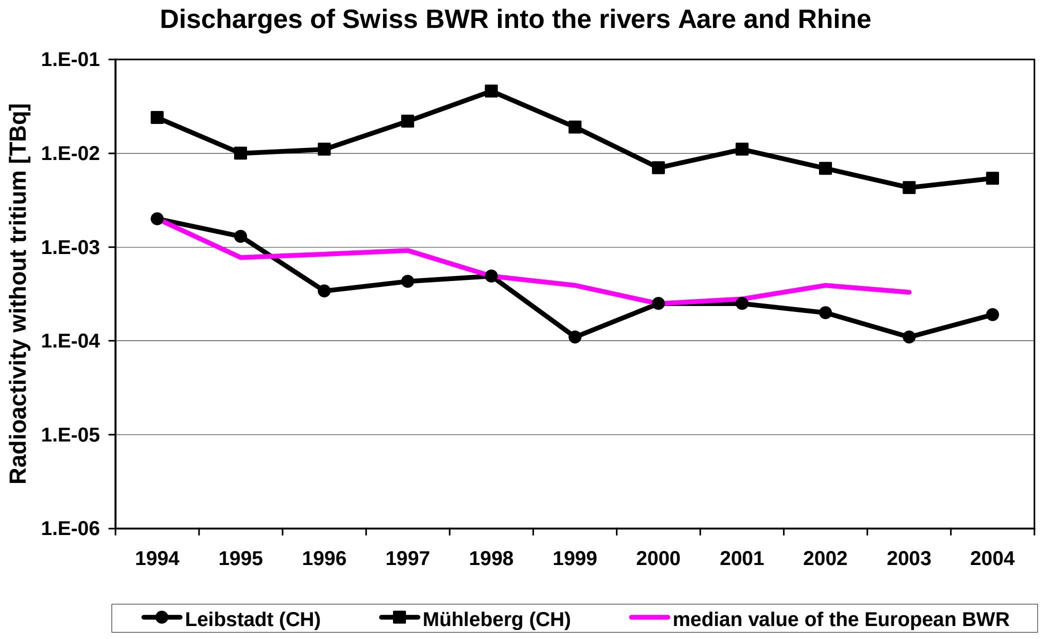

Figure 2. Discharges of radioactive substances by BWRs from 1994 to 2004: Leibstadt NPP, Mühleberg NPP and the median value of European BWRs.

2.2 Pressurized water reactors (PWRs)

The discharges of radioactive substances (without tritium) are presented in figure 3 for the pressurized water reactors at Gösgen and Beznau (two units). If compared with the previous reporting period, the curves for the Swiss PWRs show no clear downward trend. The median of European PWRs is also indicated in the figure and shows a definite downward trend. In 2003 the median value was 0,9 GBq.

As explanation of this behavior it should be noted that the discharges of the Gösgen NPP are very low, so that no downward trend can be expected.

At the Beznau NPP the liquid or aqueous radioactive waste of both units is treated in common abatement systems and discharged from there to the river. The licensee of Beznau had performed a periodical safety review for both units in 2002. The Inspectorate has assessed this review in depth. As a result the Inspectorate has formulated the following requirement: "The licensee has to continue his efforts to reduce significantly the activity without tritium in the liquid discharges. Until 2007 the activity shall be reduced to less then the median value of the European pressurized water reactors." To reach this aim, the licensee of Beznau has started a project to reduce the radioactive discharges by nanofiltration.

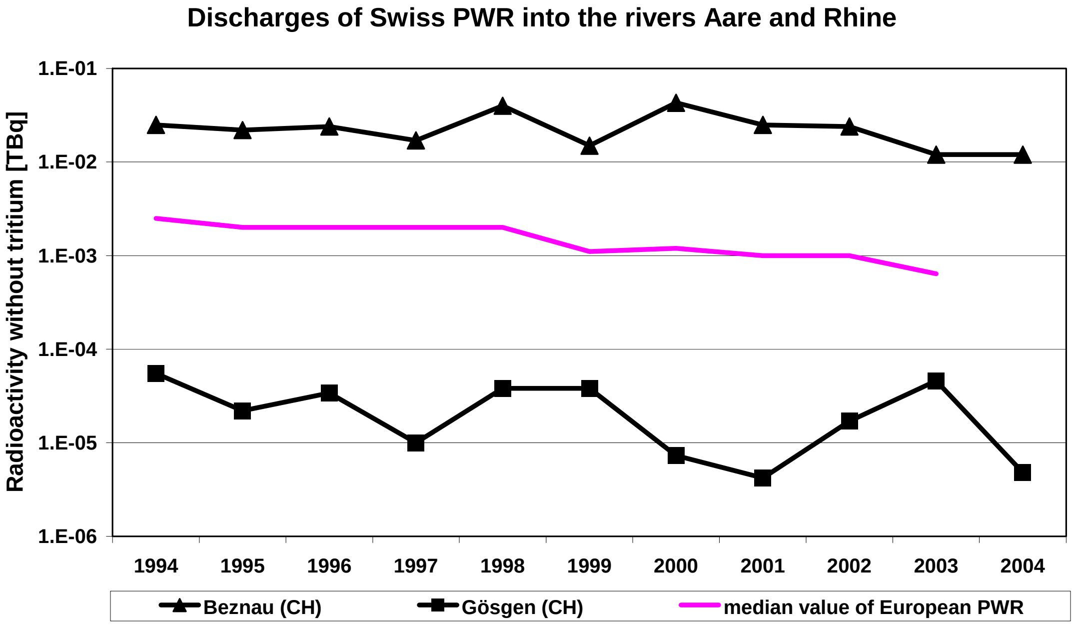

Figure 3. Discharges of radioactive substances by PWRs from 1994 to 2004: Beznau NPP, Gösgen NPP and the median value of European PWRs.

2.3 Research facility

At the Paul Scherrer Institute (PSI) the discharges of radioactive substances (without tritium) show a downward trend form 1999 to 2004 of one order of magnitude and are now below 10^{-4} TBq per year.

3 Environmental Impact

All Swiss nuclear facilities release their liquid discharges into the Rhine catchment area. Three of the NPPs and the Paul Scherrer Institute research facility are located on the Aare river, which flows into the Rhine river. One plant (Leibstadt) is located on the Rhine river. As a result of this fact the environmental monitoring data can be traced back to a single discharge source only partially.

3.1 Concentration of radioisotopes of concern in environmental samples

The results of gamma spectroscopy measurements of sediment in the Rhine river near Basel are reported in table 2 for the period from 1999 to 2004. Radionuclides originating from nuclear facilities, like for example Mn-54, Co-58, Co-60, Zn-65, Cs-134 and Cs-137, were observed in traces. The highest concentration values observed are 15 Bq/kg for Co-58, due to discharges from the Beznau NPP, and for Cs-137 predominantly due to historic fallout.

3.2 Environmental monitoring programme

There are three locations downstream of the NPPs where samples of river water and sediments are taken permanently. The samples are analysed in a laboratory on a monthly basis.

The first sampling location is at the Hagneck dam. It is located on the Aare river downstream of the Mühleberg NPP. The second location is at the Klingnau dam. It is located on the Aare river downstream of the Paul Scherrer Institute and the Beznau, Gösgen und Mühleberg NPPs. Most of the radioactivity measured in this location is due to the liquid discharges of the Beznau NPP which is the closest to the sampling point. The liquid discharges of the Gösgen NPP and the Paul

Scherrer Institute are so small that their contribution to the radioactivity in the sample is not relevant. The Mühleberg NPP on the other hand is more than 100 km upstream of this sampling point.

The third location is near Basel. It lies on the Rhine river and it is downstream of all the mentioned Swiss nuclear facilities. The radioactivity measured at this location is dominated by the liquid discharges of the Beznau NPP.

3.3 System for quality assurance of environmental monitoring

No formal quality assurance system is applied but annual quality checks are done.

3.4 Any relevant information not covered by the requirements specified above

There is no relevant information which is not covered in the previous sections.

3.5 Explanations for lack of data or failure to meet BAT/BEP indicators, ongoing and planned activities

The submitted data are complete.

Table 2. Radioactivity in the sediment in the Rhein river at Pratteln near Basel, downstream of all Swiss nuclear facilities in the catchment area

Start of sampling	End of sampling	Be-7 [Bq/kg]	K-40 [Bq/kg]	Mn-54 [Bq/kg]	Co-58 [Bq/kg]	Co-60 [Bq/kg]	Zn-65 [Bq/kg]	Cs-134 [Bq/kg]	Cs-137 [Bq/kg]	Pb-210 [Bq/kg]
07.01.99	03.02.99	33 ± 5	338 ± 22	≤ 0,7	1,6 ± 0,5	0,7 ± 0,3	≤ 1,8	≤ 0,6	6,8 ± 0,7	17 ≤ 4
03.02.99	03.03.99	20 ± 2	339 ± 15	0,2 ± 0,1	0,8 ± 0,1	0,6 ± 0,1	≤ 0,5	≤ 0,2	9,0 ± 0,4	19 ± 9
03.03.99	30.03.99	9 ± 2	314 ± 17	≤ 0,3	0,4 ± 0,2	0,5 ± 0,1	≤ 1,0	≤ 0,3	5,4 ± 0,4	12 ± 3
30.03.99	05.05.99	23 ± 4	408 ± 22	≤ 0,5	≤ 0,6	0,7 ± 0,2	≤ 1,2	≤ 0,4	7,3 ± 0,5	≤ 45
05.05.99	04.06.99	18 ± 3	353 ± 19	≤ 0,5	≤ 0,6	≤ 0,4	≤ 1,0	≤ 0,4	8,0 ± 0,6	15 ± 4
04.06.99	30.06.99	4 ± 1	321 ± 15	0,2 ± 0,1	≤ 0,2	≤ 0,2	≤ 0,4	≤ 0,1	4,7 ± 0,3	10 ± 2
30.06.99	03.08.99	5 ± 1	333 ± 16	≤ 0,2	≤ 0,2	0,2 ± 0,1	≤ 0,4	≤ 0,1	5,0 ± 0,3	10 ± 2
03.08.99	31.08.99	100 ± 6	373 ± 19	≤ 0,4	≤ 0,5	0,6 ± 0,2	≤ 0,9	≤ 0,3	9,6 ± 0,6	29 ± 5
31.08.99	06.10.99	98 ± 6	369 ± 18	0,3 ± 0,1	0,7 ± 0,2	0,8 ± 0,2	≤ 0,9	≤ 0,3	8,9 ± 0,5	25 ± 4
06.10.99	03.11.99	46 ± 4	359 ± 19	0,3 ± 0,2	≤ 0,7	≤ 0,4	≤ 1,1	0,7 ± 0,2	7,8 ± 0,6	21 ± 4
03.11.99	02.12.99	101 ± 8	376 ± 34	≤ 0,9	0,6 ± 0,5	0,8 ± 0,3	≤ 2,1	≤ 0,8	14,0± 1,0	≤ 100
02.12.99	05.01.00	54 ± 2	411 ± 10	0,2 ± 0,1	0,2 ± 0,1	0,5 ± 0,1	≤ 1,0	≤ 0,4	10,1± 0,3	26 ± 8
05.01.00	01.02.00	21 ± 4	392 ± 23	0,4 ± 0,3	1,7 ± 0,5	0,6 ± 0,3	≤ 1,7	≤ 0,6	6 ± 0,6	≤ 76
01.02.00	29.02.00	24 ± 3	340 ± 17	0,2 ± 0,1	1,5 ± 0,3	0,7 ± 0,1	0,4 ≤ 0,3	≤ 0,3	7 ± 0,4	17 ± 3
29.02.00	04.04.00	49 ± 3	346 ± 16	≤ 0,3	0,9 ± 0,2	0,3 ± 0,1	≤ 0,6	≤ 0,2	9 ± 0,5	≤ 8
04.04.00	02.05.00	63 ± 8	344 ± 43	0,2 ± 0,1	1,2 ± 0,3	0,9 ± 0,2	≤ 0,8	≤ 0,3	10 ± 1,1	30 ± 4
02.05.00	02.06.00	67 ± 8	339 ± 41	≤ 0,6	0,7 ± 0,3	0,7 ± 0,2	≤ 1,4	≤ 0,5	10 ± 1,1	≤ 94
02.06.00	04.07.00	113 ± 12	362 ± 43	0,2 ± 0,1	0,9 ± 0,2	0,5 ± 0,1	≤ 0,6	≤ 0,3	11 ± 1,3	≤ 137
04.07.00	02.08.00	135 ± 15	361 ± 45	≤ 0,3	0,6 ± 0,2	0,5 ± 0,1	≤ 0,8	≤ 0,3	9 ± 1,1	18 ± 5
02.08.00	28.08.00	79 ± 9	364 ± 44	≤ 0,7	1,3 ± 0,4	≤ 0,8	≤ 1,8	≤ 0,6	8 ± 0,9	≤ 141
28.08.00	02.10.00	123 ± 14	356 ± 44	0,5 ± 0,3	14,0 ±1,6	0,8 ± 0,3	≤ 2,0	≤ 0,8	11 ± 1,3	≤ 159
02.10.00	30.10.00	151 ± 17	384 ± 48	1,0 ± 0,4	7,1 ± 1,0	1,9 ± 0,4	≤ 2,4	≤ 0,9	13 ± 1,5	≤ 195
30.10.00	28.11.00	97 ± 12	339 ± 42	0,4 ± 0,3	3,0 ± 0,7	0,8 ± 0,3	≤ 2,3	≤ 0,8	10 ± 1,2	≤ 170
28.11.00	03.01.00	49 ± 7	401 ± 48	≤ 0,8	5,8 ± 0,9	0,8 ± 0,3	≤ 2,0	≤ 0,7	8 ± 0,9	≤ 171
05.01.00	01.02.00	21 ± 4	392 ± 23	0,4 ± 0,3	1,7 ± 0,5	0,6 ± 0,3	≤ 1,7	≤ 0,6	6 ± 0,6	≤ 76
01.02.00	29.02.00	24 ± 3	340 ± 17	0,2 ± 0,1	1,5 ± 0,3	0,7 ± 0,1	0,4 ≤ 0,3	≤ 0,3	7 ± 0,4	17 ± 3
29.02.00	04.04.00	49 ± 3	346 ± 16	≤ 0,3	0,9 ± 0,2	0,3 ± 0,1	≤ 0,6	≤ 0,2	9 ± 0,5	≤ 8
04.04.00	02.05.00	63 ± 8	344 ± 43	0,2 ± 0,1	1,2 ± 0,3	0,9 ± 0,2	≤ 0,8	≤ 0,3	10 ± 1,1	30 ± 4
02.05.00	02.06.00	67 ± 8	339 ± 41	≤ 0,6	0,7 ± 0,3	0,7 ± 0,2	≤ 1,4	≤ 0,5	10 ± 1,1	≤ 94

Start of sampling	End of sampling	Be-7 [Bq/kg]	K-40 [Bq/kg]	Mn-54 [Bq/kg]	Co-58 [Bq/kg]	Co-60 [Bq/kg]	Zn-65 [Bq/kg]	Cs-134 [Bq/kg]	Cs-137 [Bq/kg]	Pb-210 [Bq/kg]
02.06.00	04.07.00	113 ±12	362 ± 43	0,2 ± 0,1	0,9 ± 0,2	0,5 ± 0,1	≤ 0,6	≤ 0,3	11 ± 1,3	≤ 137
04.07.00	02.08.00	135 ±15	361 ± 45	≤ 0,3	0,6 ± 0,2	0,5 ± 0,1	≤ 0,8	≤ 0,3	9 ± 1,1	18 ± 5
02.08.00	28.08.00	79 ± 9	364 ± 44	≤ 0,7	1,3 ± 0,4	≤ 0,8	≤ 1,8	≤ 0,6	8 ± 0,9	≤ 141
28.08.00	02.10.00	123 ±14	356 ± 44	0,5 ± 0,3	14,0 ±1,6	0,8 ± 0,3	≤ 2,0	≤ 0,8	11 ± 1,3	≤ 159
02.10.00	30.10.00	151 ±17	384 ± 48	1,0 ± 0,4	7,1 ± 1,0	1,9 ≤ 0,4	≤ 2,4	≤ 0,9	13 ± 1,5	≤ 195
30.10.00	28.11.00	97 ± 12	339 ± 42	0,4 ± 0,3	3,0 ± 0,7	0,8 ± 0,3	≤ 2,3	≤ 0,8	10 ± 1,2	≤ 170
28.11.00	03.01.00	49 ± 7	401 ± 48	≤ 0,8	5,8 ± 0,9	0,8 ± 0,3	≤ 2,0	≤ 0,7	8 ± 0,9	≤ 171
03.01.01	31.01.01	71 ± 10	356 ± 41	≤ 0,4	1,0 ± 0,4	0,6 ± 0,2	≤ 0,9	≤ 0,4	10 ± 1,0	≤ 174
31.01.01	28.02.01	70 ± 11	421 ± 54	≤ 0,7	1,6 ± 0,5	1,6 ± 0,4	≤ 1,5	≤ 0,5	9 ± 1,2	39 ± 6
28.02.01	04.04.01	14 ± 4	348 ± 41	≤ 0,5	1,0 ± 0,4	0,2 ± 0,1	≤ 1,1	≤ 0,4	6 ± 0,8	≤ 217
04.04.01	02.05.01	13 ± 2	321 ± 38	≤ 0,2	0,4 ± 0,3	0,3 ± 0,1	≤ 0,5	≤ 0,2	5 ± 0,6	≤ 125
02.05.01	06.06.01	28 ± 4	303 ± 38	0,2 ± 0,1	0,5 ± 0,2	0,3 ± 0,1	≤ 0,9	≤ 0,3	6 ± 0,7	≤ 15
06.06.01	05.07.01	19 ± 3	355 ± 47	≤ 0,5	1,1 ± 0,3	0,2 ± 0,1	≤ 1,2	≤ 0,5	5 ± 0,7	≤ 46
05.07.01	31.07.01	36 ± 6	349 ± 50	≤ 0,6	4,4 ± 0,8	≤ 0,6	≤ 1,3	≤ 0,5	6 ± 0,9	18 ± 10
31.07.01	30.08.01	64 ± 8	358 ± 37	≤ 0,6	2,5 ± 0,4	≤ 0,6	≤ 1,5	≤ 0,5	6 ± 0,7	26 ± 19
30.08.01	02.10.01	83 ± 9	393 ± 48	≤ 0,4	3,1 ± 0,5	0,5 ± 0,2	≤ 1,2	≤ 0,4	8 ± 0,9	27 ± 14
02.10.01	01.11.01	87 ± 10	387 ± 49	≤ 0,4	0,7 ± 0,2	≤ 0,5	≤ 1,1	≤ 0,4	7 ± 0,9	33 ± 5
01.11.01	29.11.01	33 ± 4	343 ± 43	≤ 0,4	0,3 ± 0,1	0,4 ± 0,1	≤ 0,9	≤ 0,3	5 ± 0,7	21 ± 4
29.11.01	20.12.01	35 ± 4	386 ± 47	0,3 ± 0,1	≤ 0,3	0,4 ± 0,1	≤ 0,9	≤ 0,3	6 ± 0,7	22 ± 12
20.12.01	23.01.02	40 ± 7	455 ± 66	≤ 0,6	1,0 ± 0,4	0,5 ± 0,2	≤ 1,5	≤ 0,5	9 ± 1,4	43 ± 15
23.01.02	20.02.02	60 ± 10	504 ± 73	≤ 0,7	1,6 ± 0,5	≤ 0,6	≤ 1,6	≤ 0,5	10 ± 1,6	63 ± 15
20.02.02	26.03.02	72 ± 12	499 ± 72	0,3 ± 0,2	1,0 ± 0,4	0,7 ± 0,2	≤ 1,3	≤ 0,5	10 ± 1,6	72 ± 16
26.03.02	23.04.02	37 ± 7	487 ± 71	≤ 0,6	0,4 ± 0,3	≤ 0,6	≤ 1,2	≤ 0,5	8 ± 1,3	52 ± 14
23.04.02	29.05.02	104 ± 16	465 ± 67	0,5 ± 0,2	0,5 ± 0,2	0,8 ± 0,2	≤ 1,0	≤ 0,4	11 ± 1,7	98 ± 17
29.05.02	26.06.02	72 ± 11	466 ± 67	0,4 ± 0,2	1,1 ± 0,3	0,5 ± 0,2	≤ 0,8	≤ 0,3	9 ± 1,3	72 ± 13
26.06.02	31.07.02	144 ± 21	503 ± 72	0,4 ± 0,2	4,4 ± 0,8	0,5 ± 0,2	≤ 1,1	≤ 0,5	11 ± 1,8	97 ± 18
31.07.02	29.08.02	49 ± 6	376 ± 46	≤ 0,3	2,5 ± 0,4	≤ 0,3	≤ 0,7	≤ 0,2	5 ± 0,6	28 ± 6
29.08.02	25.09.02	57 ± 7	399 ± 50	0,3 ± 0,2	3,1 ± 0,5	0,5 ± 0,2	≤ 1,0	≤ 0,4	7 ± 0,9	32 ± 9
25.09.02	30.10.02	31 ± 4	424 ± 52	≤ 0,3	0,7 ± 0,2	≤ 0,4	≤ 0,8	≤ 0,3	5 ± 0,6	22 ± 6
30.10.02	27.11.02	19 ± 3	401 ± 49	0,2 ± 0,1	0,3 ± 0,1	≤ 0,3	≤ 0,6	≤ 0,2	4 ± 0,5	19 ± 5
27.11.02	18.12.02	8 ± 2	403 ± 49	0,2 ± 0,1	≤ 0,3	≤ 0,3	≤ 0,6	≤ 0,2	3 ± 0,4	14 ± 4
18.12.02	22.01.03	11 ± 2	366 ± 47	0,1 ± 0,1	≤ 0,3	≤ 0,3	≤ 0,6	≤ 0,3	4 ± 0,5	≤ 24
22.01.03	19.02.03	20 ± 3	375 ± 49	0,2 ± 0,1	≤ 0,4	≤ 0,3	≤ 0,7	≤ 0,3	5 ± 0,6	≤ 26
19.02.03	19.03.03	13 ± 2	350 ± 46	0,2 ± 0,1	≤ 1,4	≤ 0,3	≤ 0,7	≤ 0,3	5 ± 0,6	≤ 24
19.03.03	23.04.03	12 ± 2	351 ± 46	0,2 ± 0,1	≤ 0,3	≤ 0,3	≤ 0,6	≤ 0,2	4 ± 0,5	≤ 23
23.04.03	21.05.03	181 ± 19	391 ± 52	0,1 ± 0,1	0,7 ± 0,2	1,0 ± 0,2	≤ 0,9	≤ 0,4	9 ± 1,1	30 ± 17
21.05.03	25.06.03	134 ± 14	453 ± 56	0,4 ± 0,2	1,0 ± 0,2	0,7 ± 0,2	≤ 0,8	≤ 0,3	9 ± 1,1	48 ± 8
25.06.03	23.07.03	168 ± 18	412 ± 53	0,3 ± 0,2	5,0 ± 0,2	0,6 ± 0,2	≤ 1,2	≤ 0,5	11 ± 1,3	≤ 47
23.07.03	27.08.03	309 ± 32	440 ± 57	1,0 ± 0,3	14,9± 1,8	1,5 ± 0,3	≤ 1,4	≤ 0,5	12 ± 1,5	71 ± 24
27.08.03	24.09.03	197 ± 21	403 ± 53	0,4 ± 0,2	5,8 ± 0,8	0,9 ± 0,2	≤ 1,4	≤ 0,5	11 ± 1,2	29 ± 21
24.09.03	22.10.03	141 ± 15	393 ± 51	0,7 ± 0,2	2,2 ± 0,5	0,8 ± 0,2	≤ 1,2	≤ 0,5	9 ± 1,1	94 ± 26
22.10.03	19.11.03	36 ± 5	385 ± 50	0,1 ± 0,1	0,9 ± 0,3	0,4 ± 0,1	≤ 0,9	≤ 0,3	6 ± 0,7	21 ± 19
19.11.03	17.12.03	50 ± 6	374 ± 49	0,2 ± 0,1	0,7 ± 0,3	0,5 ± 0,2	≤ 1,1	≤ 0,4	7 ± 0,9	55 ± 19
17.12.03	21.01.04	34 ± 5	430 ± 53	0,2 ± 0,2	0,2 ± 0,2	0,2 ± 0,2	≤ 0,9	≤ 0,3	7 ± 0,8	32 ± 8
21.01.04	18.02.04	24 ± 3	417 ± 51	0,2 ± 0,1	0,2 ± 0,1	0,3 ± 0,1	≤ 0,5	≤ 0,2	5 ± 0,6	22 ± 4
18.02.04	24.03.04	42 ± 5	411 ± 54	0,4 ± 0,2	0,4 ± 0,2	0,4 ± 0,2	≤ 1,2	≤ 0,4	6 ± 0,8	20 ± 10
24.03.04	29.04.04	63 ± 7	393 ± 48	0,5 ± 0,2	1,4 ± 0,3	0,5 ± 0,2	≤ 1,4	≤ 0,5	8 ± 0,9	29 ± 18
29.04.04	02.06.04	173 ± 18	403 ± 49	0,5 ± 0,2	4,0 ± 0,6	0,9 ± 0,2	≤ 0,9	≤ 0,4	10 ± 1,1	72 ± 11

Start of sampling	End of sampling	Be-7 [Bq/kg]	K-40 [Bq/kg]	Mn-54 [Bq/kg]	Co-58 [Bq/kg]	Co-60 [Bq/kg]	Zn-65 [Bq/kg]	Cs-134 [Bq/kg]	Cs-137 [Bq/kg]	Pb-210 [Bq/kg]
02.06.04	01.07.04	52 ± 6	367 ± 42	0,1 ± 0,1	1,1 ± 0,3	0,1 ± 0,1	≤ 0,9	≤ 0,4	5 ± 0,6	38 ± 22
01.07.04	28.07.04	225 ± 21	395 ± 46	0,4 ± 0,2	2,1 ± 0,4	0,1 ± 0,1	≤ 1,4	≤ 0,6	11 ± 1,1	96 ± 40
28.07.04	25.08.04	400 ± 40	430 ± 52	0,6 ± 0,2	3,3 ± 0,4	0,9 ± 0,2	≤ 0,7	≤ 0,3	14 ± 1,7	79 ± 11
25.08.04	30.09.04	247 ± 25	438 ± 53	0,9 ± 0,3	2,4 ± 0,4	1,2 ± 0,2	≤ 1,0	≤ 0,4	11 ± 1,2	80 ± 12
30.09.04	27.10.04	375 ± 38	428 ± 52	0,7 ± 0,2	2,8 ± 0,5	0,7 ± 0,2	≤ 1,1	≤ 0,4	15 ± 1,6	103 ± 15
27.10.04	24.11.04	191 ± 20	405 ± 49	0,8 ± 0,2	1,9 ± 0,4	1,1 ± 0,2	≤ 0,9	≤ 0,4	10 ± 1,2	97 ± 12
24.11.04	22.11.04	209 ± 20	434 ± 51	0,6 ± 0,3	2,3 ± 0,5	1,2 ± 0,3	≤ 1,6	≤ 0,6	15 ± 1,5	98 ± 49

4 Radiation doses to the public

4.1 Annual effective doses to the reference group caused by liquid discharges

The annual effective doses to a member of the reference group due to liquid discharges of the nuclear power plants and the research facility in Switzerland were below 1 microSv for the last 6 years, as evaluated with the models of the Inspectorate's Guideline R-41.

4.2 Total exposure (including doses from historic discharges)

The table below shows the yearly doses calculated for individual members of the population in the vicinity of the Swiss nuclear facilities. The calculated exposures to the reference group due to nuclear power plants are dominated by the C-14 emission. The reported values lie well below the source-related dose constraint of 0,3 mSv per year. Articles 5 and 6 of the Swiss Radiation Protection Ordinance state that activities which result in an effective dose of less than 10 microSv per year for the persons concerned are deemed to be justified and optimised. This means that according to the Swiss legislation no further efforts are necessary to reduce radioactive releases and the resulting doses for the population.

Table 3. Total effective dose (including doses from historic emissions) for a person of the reference group living in the vicinity of a Swiss nuclear facilities in microSv per year and person, as evaluated with the models of the Inspectorate's Guideline R-41.

μSv/a	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
Beznau NPP	*< 2,5*	*< 2,5*	*< 2,5*	*< 2,5*	*< 2,5*	*< 2,5*
Gösgen NPP	< 2	< 2	< 5	< 5	< 4	< 2
Leibstadt NPP	< 6	< 5	< 5	< 8	< 6	< 5
Mühleberg NPP	< 7	< 6	< 6	< 6	< 6	< 6
Paul Scherrer Institute	< 5	< 5	< 5	< 6	< 4	< 4

4.3 Critical group definition

The dose calculations are performed for an individual who is living and working at the place with the highest total dose resulting from immersion, inhalation, ground radiation and ingestion. It is assumed that food e.g. fruits, vegetables, milk and meat which an individual consumes is produced locally also. The individual is assumed to cover his drinking water needs and his fish consumption from the river downstream of the facility.

4.4 Considered exposure pathways

The following pathways are considered: Immersion from the plume, inhalation, ground radiation and ingestion of fruits, vegetables, milk, meat, fish as well as water drinking from the river downstream of the facility.

4.5 Methodology to assess doses

The methodology to estimate the dose is laid down in the Inspectorate's Guideline-R-41. The models and parameters used in this guideline are taken or derived from international recommendations, e.g. IAEA, ICRP, or regulations from other countries, e.g. the German guideline (Allgemeine Verwaltungs-vorschrift).

4.6 Site specific factors to estimate the dose

Site specific factors to estimate the dose are the dispersion factor for the emissions and the mean value of the water flow. The dispersion factor for the emissions is determined by a statistical analysis of the weather parameters measured at the meteorological tower near the facility.

4.7 Site specific target annual effective dose

The source related dose constraint for a nuclear site is 0,3 mSv per year. In case of relevant superposition of the immission of facilities owned by different licencees, a target annual effective dose is defined, for example, the Paul Scherrer Institute has a target dose of 0,25 mSv per year and the interim storage and waste treatment facility ZWILAG has a target dose of 0,05 mSv per year.

4.8 System for quality assurance of processes involved in dose estimates

No formal quality assurance system is applied.

4.9 Any relevant information not covered by the requirements specified above

There is no relevant information which is not covered in the previous sections.

4.10 Explanations for lack of data or failure to meet BAT/BEP indicators, ongoing and planned activities

The submitted data are complete.

5 Summary Evaluation

This report has been produced for the Radioactive Substances Committee of the OSPAR Commission according the guidelines for the submission of information about the application of the BAT principles in nuclear facilities. As a self-assessment the Inspectorate summarizes the following evaluation:

(0) The national legislation defines dose constraints/limits, discharge limits, environmental monitoring programmes, as well as the national authority responsible for the supervision and the nature of inspection and surveillance. The Federal Act and Ordinance on Radiological Protection, for example, limit the concentration of radioactive substances in the atmosphere and water at locations accessible to the public, requiring that the weekly mean value of the concentration be below the immission limits. The Ordinance on Foreign Substances and Ingredients defines limits and, as an additional constraint, tolerance values for radioactivity in food and drinking water. The tolerance values fulfil the 10 microSv per year concept.

(1) All but one Swiss nuclear facilities are in the catchment area of the Rhine river, the exception being a nuclear facility for education with no relevant discharges. During the reporting period an incineration facility was taken out of operation and a nuclear waste treatment facility was step by step put into operation.

(2) The liquid discharges of radioactive substances (without tritium) from the Mühleberg and Leibstadt boiling water reactors show a downward trend. The discharges (without tritium) from the Gösgen and Beznau pressurized water reactors show no clear downward trend. At the Gösgen NPP the discharges of radioactive substances (without tritium) are the lowest

among the European pressurized water reactors and therefore no downward trend is realistically to be expected. The licensee of the Beznau NPP has performed a periodic safety review for both units. The Inspectorate has assessed this review in depth and as one result formulated a requirement, upon which the licensee has initiated a project to reduce the discharges of radioactive substances without tritium below the median value of European pressurized water reactors. At the Paul Scherrer Institute research facility the discharges of radioactive substances (without tritium) show a downward trend.

(3) The environmental monitoring programme allows the sampling and detection of concentrations well below the limits for food and drinking water and provides for an independent surveillance of discharges by the federal authorities. Radionuclides originating from nuclear facilities were observed in traces.

(4) The annual effective dose to a member of the critical group caused by the liquid discharges was below 1 microSv for all Swiss nuclear facilities during the years investigated. At the nuclear power plants the total effective doses caused by liquid discharges and emissions are dominated by C-14 emissions, at the Paul Scherrer Institute research facility by the emissions from the accelerator. All dose values were below the 10 microSv criterion during the last years.

Based on the above information, the Inspectorate concludes that the BAT/BEP principles are implemented in the Swiss legislation and regulatory practices. Furthermore progress has been made in the application of such principles in the Swiss nuclear facilities with the clearly stated objective of reducing discharges according to the OSPAR strategy on radioactive substances.

Appendix A

A Beznau Nuclear Power Plant (KKB)

A.1 Site Characteristics

The Beznau nuclear power plant (KKB) is owned by the Nordostschweizerische Kraftwerke AG.

The nuclear power plant consists of two virtually identical dual-loop pressurized water reactor units (KKB 1 and KKB 2) built by Westinghouse. KKB 1 started commercial operation in 1969 and KKB 2 in 1971.

The Beznau nuclear power plant is located in Döttingen in the canton Aargau in the North of Switzerland. The Beznau nuclear power plant is cooled by water from the Aare river and it also releases its liquid discharges into the Aare river which belongs to the catchment area of the Rhine.

Each unit has a thermal power of 1130 MW(th). As a result of different backfitting measures, the power of both units has improved in the years and the net electrical output in August 2005 was 365 MW(e) for each unit.

Table A-1. Annual net electrical output 1999-2004 [GWa]

	1999	2000	2001	2002	2003	2004
KKB 1	0,324	0,290	0,353	0,332	0,350	0,320
KKB 2	0,253	0,351	0,293	0,344	0,333	0,354
Beznau total	0,577	0,641	0,646	0,676	0,683	0,674

Other relevant information

In 2002 the licensee of KKB 1 and KKB 2 has performed a periodic safety review for both units. The Inspectorate has assessed this review in depth. As result the Inspectorate has formulated the following requirement: "The licensee has to continue his efforts to reduce significantly the activity without tritium in the liquid discharges. Until 2007 the activity shall be reduced to less then the median value of the European pressurized water reactors."

A.2 Discharges

A.2.1 Abatement systems

The waste water is collected and treated in batches. The radioactivity in the waste water is reduced by centrifugation and, if necessary, by chemical precipitation. The waste water cleaned this way is sampled, measured and, if the concentration criterions are fulfilled, discharged. In addition, during the discharge the activity concentration is monitored by total gamma counters and if concentration limits are exceeded, the discharge is automatically stopped. The radioactive waste by-products are solidified in the radioactive waste treatment system of the plant.

In the year 2004 the licensee decided to improve the abatement system by nanofiltration which is planned to go into operation in the year 2007.

A.2.2 Efficiency of systems

The chemical precipitation system reduces the concentration of radioactivity in the discharged water by a factor of up to 1000. The tritium discharges are not reduced by the abatement systems.

A.2.3 Annual liquid discharges

Beside gamma spectrometry the Beznau NPP determines the activity of tritium in each batch. Sr-90 is checked analysing monthly samples and alpha-emitters in four samples a year (since the end of 2004). The absolute values of the liquid discharges from both units are shown in tables A-2, A-3 and A-4, the normalised liquid discharges for the last six years can be read in table A-5.

In figure 3 of the main report the discharges of radioactive substances (without tritium) are plotted as a function of time. For the liquid discharges without tritium a downward trend can be observed in the last five years. On the other hand, if the previous reporting period is also taken into account no clear downward trend can be read. As mentioned above, under 'Other relevant information', the licensee has to improve the abatement system by the year 2007. For the liquid discharges of tritium, no up or downward trend can be observed.

Table A-2. Liquid discharges without tritium in GBq from Beznau NPP, both units: Isotops

Isotope	1999	2000	2001	2002	2003	2004
Co-58	1,0E+01	3,0E+01	2,0E+01	2,2E+01	9,3E+00	1,0E+01
Co-60	1,7E+00	3,1E+00	1,6E+00	1,3E+00	8,5E-01	6,3E-01
Zn-65		1,3E-02		5,2E-04	7,5E-04	
Sr-90	9,7E-03	1,8E-02	2,2E-02	8,7E-03	9,3E-03	7,2E-03
Zr/Nb-95	6,4E-02	4,5E-02	4,9E-02	1,9E-02	1,8E-02	1,4E-02
Ag-110m	1,3E-2	1,3E-01	1,8E-01	4,6E-02	1,1E-01	4,4E-02
Sb-125	3,0E-1	3,0E+00	6,8E-01	2,2E-01	5,0E-01	1,9E-01
Cs-134	7,6E-2	5,6E-01	2,3E-01	3,6E-02	2,7E-02	1,9E-03
Cs-137	1,3E+00	1,7E+00	8,7E-01	3,3E-01	2,4E-01	1,4E-01
Ce-144		2,0E-03	6,6E-04	1,3E-03	3,0E-03	1,2E-03
Other isotopes	1,8E+00	4,4E+00	1,4E+00	4,0E-02	9,4E-01	9,7E-01

Table A-3. Liquid discharges without tritium in GBq from Beznau NPP, both units: Total activity without tritium

	1999	2000	2001	2002	2003	2004
Total activity without tritium	1,5E+01	4,3E+01	2,5E+01	2,4E+01	1,2E+01	1,2E+01

Table A-4. Liquid tritium discharges in TBq from KKB 1 and KKB 2

	1999	2000	2001	2002	2003	2004
Tritium	8,8E+00	8,3E+00	1,1E+01	9,9E+00	1,1E+01	1,1E+01

Table A-5. Normalised liquid discharges from KKB 1 and KKB 2

	1999	2000	2001	2002	2003	2004
Total activity without tritium [GBq/GW(e)a]	2,6E+01	6,7E+01	3,9E+01	3,6E+01	1,8E+01	1,8E+01
Tritium [TBq/GW(e)a]	1,5E+01	1,3E+01	1,7E+01	1,5E+01	1,6E+01	1,6E+01

A.2.4 Emissions to air relevant for the marine compartment

Measurements of releases of I-129 to air are not requested by the Inspectorate. Likewise, emissions of C-14 and tritium to air are not routinely measured. The emissions of C-14 are estimated on the basis of measurements done over a period of several months in the 1980s and during the year 2004. For both units together a C-14 emission of 4,0E+10 Bq per year is estimated.

A.2.5 Quality assurance of retention/data management

The data management system of the Beznau NPP is certified in accordance with ISO 9001:2000 and ISO 14001:1996.

A.2.6 Site specific target discharge data

The Beznau NPP site specific target for liquid discharge (without Tritium) is to be below 1% of the discharge limit given in the licence.

A.2.7 Any relevant information not covered by the requirements specified above

There is no relevant information which is not covered by the previous sections.

A.2.8 Explanations for lack of data or failure to meet BAT/BEP indicators, ongoing and planned activities

The submitted data are complete.

An ongoing activity at the Beznau NPP is the project to reduce the activity without tritium in the liquid discharges at least to the median value of the European pressurized water reactors by nanofiltration.

A.3 Environmental Impact

The information is given in chapter 3 of the main report.

A.4 Radiation Doses to the Public

The information is given in chapter 4 of the main report.

Appendix B

B Gösgen Nuclear Power Plant (KKG)

B.1 Site Characteristics

The Gösgen nuclear power plant is owned by the Kraftwerk Gösgen-Däniken AG.

The nuclear power plant is a 3-loop pressurized water reactor, built by Kraftwerkunion (KWU, now Framatome ANP). The plant started commercial operation in 1979.

The Gösgen nuclear power plant is located in Daeniken in the canton Solothurn in the North of Switzerland. The plant has a wet cooling tower and releases its liquid discharges into the Aare river which belongs to the catchment area of the Rhine river.

The Gösgen NPP has a thermal power of 3002 MW(th) and a net electrical output of 970 MW(e).

Table B-1. Annual net electrical output 1999-2004 [GWa]

	1999	2000	2001	2002	2003	2004
Gösgen NPP	0,86	0,89	0,90	0,90	0,91	0,92

Other relevant information

At Gösgen NPP site, a building for the wet storage of spent fuel elements has been licensed and it is now under construction. The waste water system belonging will be integrated to the existing discharge system.

B.2 Discharges

B.2.1 Abatement systems

The waste water is collected and treated in batches. The radioactivity in the waste water is reduced by evaporation. The condensate is sampled, measured and, if the concentration criterions are fulfilled, discharged in batches. In addition, during the discharge the concentration of radioactivity is monitored by total gamma counters and, if concentration limits are exceeded, the discharge is automatically stopped. The residues are conditioned with bitumen in the radioactive waste treatment system of the plant.

B.2.2 Efficiency of systems

The water evaporation reduces the concentration of radioactivity in the discharged water by a factor of 100 up to 10'000. The tritium discharges are not reduced by the abatement system.

B.2.3 Annual liquid discharges

Beside gamma spectrometry KKG determines the activity of tritium, Sr-90 and alpha-emitters by analysing monthly samples. The absolute values of the liquid discharges from KKG are shown in tables B-2, B-3, B-4 and the normalised liquid discharges for the last six years in table B-5.

In the figures 3 in the main report, the discharges of radioactive substances (without tritium) are plotted as a function of time. At the Gösgen NPP the discharges of radioactive substances without tritium are the lowest among the European pressurized water reactors and therefore no downward trend is to be expected. For the liquid discharges of tritium, no up or downward trend can be observed.

Table B-2. Liquid discharges without tritium in GBq from KKG

Isotope	1999	2000	2001	2002	2003	2004
Co-58					1,8E-04	
Co-60	1,1E-03	2,6E-03	1,1E-03	6,0E-03	7,5E-03	2,7E-03
Zr/Nb-95			1,8E-04	1,3E-03		2,4E-04
Sb-125	5,6E-03			1,1E-03	2,0E-03	
Cs-134						
Cs-137			8,2E-05			
Other isotopes	3,1E-02	4,7E-03	2,9E-03	8,6E-03	3,6E-02	1,9E-03
Total activity without tritium	3,8E-02	7,3E-3	4,2E-03	1,7E-02	4,6E-02	4,8E-03

Table B-3. Liquid tritium discharges in TBq from KKG

	1999	2000	2001	2002	2003	2004
Tritium	1,4E+01	1,4E+01	1,2E+01	1,4E+01	1,4E+01	1,4E+01

Table B-4. Liquid alpha discharges in GBq from KKG

	1999	2000	2001	2002	2003	2004
Alpha total	5,8E-04	1,0E-04	2,8E-05	3,9E-05	5,4E-05	3,1E-05

Table B-5. Normalised liquid discharges from KKG

	1999	2000	2001	2002	2003	2004
Total activity without tritium [GBq/GW(e)a].	4,4E-02	8,2E-03	4,7E-03	1,9E-02	5,1E-02	5,2E-03
Tritium [TBq/GW(e)a]	1,6E+01	1,6E+01	1,3E+01	1,6E+01	1,5E+01	1,5E+01

B.2.4 Emissions to air relevant for the marine compartment

Measurements of actual releases of I-129 to air are not requested by the Inspectorate. Likewise, emissions to air of C-14 and tritium are not routinely measured. The emissions of C-14 are estimated on the basis of measurements done over a period of several months in the 1980s and during the year 2004. A C-14 emission of 1,0E+11 Bq per year is estimated.

B.2.5 Quality assurance of retention/data management

The data management system of KKG is certified in accordance with ISO 9001:2000, ISO 14001:1996 and OHSAS 18001:1999.

B.2.6 Site specific target discharge data

KKG has formulated as internal goal that of keeping the environmental impact below 0,01 mSv per year and person.

B.2.7 Any relevant information not covered by the requirements specified above

There is no relevant information which is not covered by the previous sections.

B.2.8 Explanations for lack of data or failure to meet BAT/BEP indicators, ongoing and planned activities

The submitted data are complete.

B.3 Environmental Impact

The information is given in chapter 3 of the main report.

B.4 Radiation Doses to the Public

The information is given in chapter 4 of the main report.

Appendix C

C Leibstadt Nuclear Power Plant (KKL)

C.1 Site Characteristics

The Leibstadt nuclear power plant is owned by the Kraftwerk Leibstadt AG

The nuclear power plant is a boiling water reactor (BWR), built by General Electric. KKL started commercial operation in 1984.

The Leibstadt nuclear power plant is located in the Leibstadt village in the canton Aargau in the North of Switzerland on the German border. The plant has a wet cooling tower and releases its liquid discharges into the Rhine river.

KKL has a thermal power of 3600 MW(th) and a net electrical output of 1165 MW(e).

Table C-1. Annual net electrical output 1999-2004 [GWa]

	1999	2000	2001	2002	2003	2004
Leibstadt NPP	0,95	1,01	1,04	1,05	1,06	0,99

Other relevant information

From 1998 to 2003 Leibstadt NPP had increased the thermal power from 3138 to 3600 MW(th) in four steps.

C.2 Discharges

C.2.1 Abatement systems

The waste water is collected and treated in batches. The radioactivity in the waste water is reduced by centrifugation and evaporation. The distillate is sampled, measured and, if the concentration criterions are fulfilled, discharged in batches. In addition, during the discharge the concentration of radioactivity is monitored by total gamma counters and, if concentration limits are exceeded, the discharge is automatically stopped.

C.2.2 Efficiency of systems

The decontamination factor of the evaporator is of the order of 1'000 up to 10'000 (ratio of concentration in feed liquid to that of the distillate). The tritium discharges are not reduced by the abatement system.

C.2.3 Annual liquid discharges

Beside gamma spectrometry, KKL determines the activity of tritium, Sr-90 and alpha-emitters by analysing quarterly samples. The absolute values of the liquid discharges from KKL are shown in tables C-2, C-3, C-4 and the normalised liquid discharges for the last six years in table C-5.

In figure 2 in the main report, the discharges of radioactive substances (without tritium) are plotted as a function of time. At the Leibstadt NPP a downward trend can be observed and the discharges of radioactive substances without tritium are low compared to the group of the European boiling water reactors. For the liquid discharges of tritium, no up or downward trend can be observed.

Table C-2. Liquid discharges without tritium in GBq from KKL

Isotope	1999	2000	2001	2002	2003	2004
Co-58	1,6E-03	3,2E-03	3,2E-03	3,0E-04	2,3E-03	8,3E-03
Co-60	5,0E-02	1,3E-01	1,3E-01	4,6E-02	5,8E-02	1,0E-01
Zn-65	3,4E-03	3,2E-03				
Zr/Nb-95		9,1E-04				
Cs-134	9,1E-03	2,6E-02	2,8E-02	4,6E-02	8,2E-03	1,2E-02
Cs-137	2,3E-02	5,3E-02	4,0E-02	9,4E-02	2,4E-02	1,5E-02
Other isotopes	2,6E-02	3,8E-02	4,8E-02	9,4E-03	1,6E-02	5,3E-02
Total activity without tritium	1,1E-01	2,5E-01	2,5E-01	2,0E-01	1,1E-01	1,9E-01

Table C-3. Liquid tritium discharges in TBq from KKL

	1999	2000	2001	2002	2003	2004
Tritium	7,0E-01	1,7E+00	1,1E+00	1,6E+00	2,2E+00	1,9E+00

Table C-4. Liquid alpha discharges in GBq from KKL

	1999	2000	2001	2002	2003	2004
Alpha total	2,5E-04	1,3E-03	6,5E-04	6,3E-04	4,6E-04	4,6E-04

Table C-5. Normalised liquid discharges from KKL

	1999	2000	2001	2002	2003	2004
Total activity without tritium [GBq/GW(e)a]	1,2E-01	2,5E-01	2,4E-01	1,9E-01	1,0E-01	1,9E-01
Tritium [TBq/GW(e)a]	7,4E-01	1,7E+00	1,1E+00	1,5E+00	2,1E+00	1,9+00

C.2.4 Emissions to air relevant for the marine compartment

Measurements of actual releases of I-129 to the air are not requested by the Inspectorate. The table C-6 shows the C-14 and tritium emissions to atmosphere by KKL.

Table C-6. C-14 and tritium emission to air from KKL

	1999	2000	2001	2002	2003	2004
C-14 [TBq]	6,5E-01	5,1E-01	4,5E-01	7,5E-01	6,0E-01	4,5E-01
Tritium [TBq]	4,7E-01	1,3E+00	8,2E-01	1,3E+00	1,6E+00	1,4E+00

C.2.5 Quality assurance of retention/data management

The data management system of KKL is certified in accordance with ISO 9001:2000.

C.2.6 Site specific target discharge data

KKL has set as the site specific target for liquid discharges to be below the limits given in the licence.

C.2.7 Any relevant information not covered by the requirements specified above

There is no relevant information which is not covered by the previous sections.

C.2.8 Explanations for lack of data or failure to meet BAT/BEP indicators, ongoing and planned activities

The submitted data are complete.

C.3 Environmental Impact

The information is given in chapter 3 of the main report.

C.4 Radiation Doses to the Public

The information is given in chapter 4 of the main report.

Appendix D

D Mühleberg Nuclear Power Plant (KKM)

D.1 Site Characteristics

The Mühleberg nuclear power plant is owned by the BKW FMB Energie AG.

The Mühleberg nuclear power plant is a boiling water reactor, built by General Electric. It started commercial operation in 1972.

The Mühleberg nuclear power plant is located in the Mühleberg village in the canton Bern. The Mühleberg NPP is cooled by water from the Aare river and it releases its liquid discharges into the Aare river which belongs to the catchment area of the Rhine.

KKM has a thermal capacity of 1'097 MW(th) and a net electrical output of 355 MW(e).

Table D-1. Annual net electrical output 1999-2004 [GWa]

	1999	2000	2001	2002	2003	2004
Mühleberg NPP	0,31	0,32	0,32	0,32	0,31	0,33

Other relevant information

There is no other relevant information.

D.2 Discharges

D.2.1 Abatement systems

The waste water is collected and treated in batches. The radioactivity in the waste water is reduced by centrifugation and ion exchange. The waste water cleaned by this means is sampled, measured and, if the concentration criterions are fulfilled, discharged in batches. In addition, during the discharge the concentration of radioactivity is monitored by total gamma counters and if concentration limits are exceeded, the discharge is automatically stopped. The radioactive waste by-products are solidified in the radioactive waste treatment system of the plant.

D.2.2 Efficiency of systems

The centrifugation and ion exchange system reduces the concentration of radioactivity in the discharged water by a factor of 100. The tritium discharges are not reduced by the abatement system.

D.2.3 Annual liquid discharges

Beside gamma spectrometry Mühleberg NPP determines the activity of tritium, Sr-90 and since 2002 alpha-emitters by analysing quarterly samples. The absolute values of the liquid discharges from KKM are shown in tables D-2, D-3, D-4 and the normalised liquid discharges for the last six years in table D-5.

In figure 2 in the main report, the discharges of radioactive substances (without tritium) are plotted as a function of time. At the Mühleberg NPP a downward trend can be observed.

Table D-2. Liquid discharges without tritium in GBq from KKM

Isotope	1999	2000	2001	2002	2003	2004
Co-58	4,2E-01	2,6E-01	3,8E-01	6,9E-01	2,8E-01	5,5E-01
Co-60	2,0E+00	1,7E+00	5,1E+00	3,2E+00	2,4E+00	2,2E+00
Zn-65	1,2E+00	5,3E-01	8,6E-01	4,2E-01	2,3E-01	2,1E-01
Sr-90	2,4E-02	9,1E-04	6,3E-03	3,4E-03	1,1E-02	2,0E-02
Zr/Nb-95	1,5E-02	6,2E-03	8,1E-03	5,4E-03	5,9E-03	7,3E-03
Sb-125				1,7E-03	7,4E-03	
Cs-134			6,9E-02	1,5E-02	5,6E-03	2,3E-03
Cs-137	1,1E+01	3,3E+00	3,2E+00	1,3E+00	6,9E-01	3,8E-01
Other isotopes	4,7E+00	1,2E+00	1,2E+00	1,3E+00	6,6E-01	2,0E+00
Total activity without tritium	1,9E+01	7,0E+00	1,1E+01	6,9E+00	4,3E+00	5,4E+00

Table D-3. Liquid tritium discharges in TBq from KKM

	1999	2000	2001	2002	2003	2004
Tritium	1,7E-01	1,4E-01	2,0E-01	2,4E-01	1,7E-01	1,5E-01

Table D-4. Liquid alpha discharges in GBq from KKM

	2002	2003	2004
Alpha total	1,6E-03	2,8E-04	1,9E-04

Table D-5. Normalised liquid discharges from KKM

	1999	2000	2001	2002	2003	2004
Total activity without tritium [GBq/GW(e)a]	6,1E+01	2,2E+01	3,4E+01	2,2E+01	1,4E+01	1,6E+01
Tritium [TBq/GW(e)a]	5,5E-01	4,4E-01	6,3E-01	7,5E-01	5,5E-01	4,5-01

D.2.4 Emissions to air relevant for the marine compartment

Measurements of actual releases of I-129 to the air are not requested by the Inspectorate. Likewise, emissions of C-14 and tritium are not routinely measured. The emissions of C-14 are estimated on the basis of measurements done over a period of several months in the 1980s. A C-14 emission of 2,0E+11 Bq per year is estimated.

D.2.5 Quality assurance of retention/data management

The data management system of KKM is certified in accordance with ISO 9001:2000 and ISO 14001:2004 and OHSAS 18001:1999.

D.2.6 Site specific target discharge data

KKM has set as site specific target for liquid discharges to be below the limits given in the licence.

D.2.7 Any relevant information not covered by the requirements specified above

There is no relevant information which is not covered by the previous sections.

D.2.8 Explanations for lack of data or failure to meet BAT/BEP indicators, ongoing and planned activities

The submitted data are complete.

D.3 Environmental Impact

The information is given in chapter 3 of the main report.

D.4 Radiation Doses to the Public

The information is given in chapter 4 of the main report.

Appendix E

E Paul Scherrer Institute (PSI)

E.1 Site Characteristics

The Paul Scherrer Institute research facility founded in 1956 is a multidisciplinary research institute for natural sciences and engineering covering fields of interest in the areas of elementary particle physics, biological sciences, solid state research, materials science, nuclear and non-nuclear energy research, as well as environmental research related to the production and use of energy. The installation includes various laboratories, facilities for the medical application of radiation, the accelerator installations with the SINQ spallation neutron source and the synchrotron light source. The laboratories with hotcells, waste treatment facilities, the federal interim storage facility BZL and three research reactors, named PROTEUS, DIORIT and SAPHIR (the last two currently being decommissioned) all are falling under the regime of the nuclear energy legislation.

The Paul Scherrer Institute is located between the villages of Villigen and Würenlingen in the canton Aargau in the North of Switzerland. The PSI released its liquid discharges into the Aare river which belongs to the catchment area of the Rhine.

The PROTEUS research reactor has a maximum thermal capacity of 1 kW(th).

Other relevant information

In 2002 the incineration plant, mentioned in the last implementation report, was taken out of service and its decommissioning is under study.

E.2 Discharges

E.2.1 Abatement systems

The waste water is collected and treated continuously. The radioactivity in the waste water is reduced by diffusion through membranes due to pressure difference. The waste water cleaned in this way is sampled and analyzed for gamma and total alpha and discharged in batches. In addition, during discharge the concentration of radioactivity is monitored by total gamma counters and, if concentration limits are exceeded, the discharge is automatically stopped. The radioactive waste by-products are solidified at the radioactive waste treatment system of the institute.

E.2.2 Efficiency of systems

The described system reduces the concentration of the radioactivity in the discharged water at least by a factor of 1'000. The tritium discharges are not reduced by the abatement system.

E.2.3 Annual liquid discharges

Beside gamma spectrometry the PSI has to determine the activity of Tritium, Sr-90 and alpha-emitters by analysing quarterly samples. The absolute values of the liquid discharges from PSI are shown for the last six years in the tables E-1 and E-2. The discharges of radioactive substances (without tritium) show a downward trend form 1999 to 2004 of one order of magnitude.

Table E-1. Liquid discharges without tritium in TBq from PSI

Isotope	1999	2000	2001	2002	2003	2004
Be-7		9,5E-06	1,2E-07	4,1E-07		3,0E-07
Na-22	5,3E-06	9,0E-07	4,3E-07	1,3E-06	5,1E-06	3,4E-06
S-35	7,6E-06	1,8E-06	1,8E-05		3,9E-06	4,6E-06
Mn-54	3,4E-06	7,1E-07	1,9E-08	2,9E-07	2,3E-07	6,3E-07
Co-56				7,5E-09		1,3E-07
Co-57	7,9E-07	4,3E-07	7,5E-09	1,9E-07	4,0E-08	7,3E-07
Co-58	2,0E-06	4,7E-07	9,5E-09	1,7E-07	4,8E-09	2,5E-06
Co-60	9,5E-05	1,3E-04	9,6E-06	4,4E-06	1,0E-05	8,5E-06
Zn-65	6,6E-06	1,6E-06	2,3E-08	3,6E-08		
Sr-85					3,9E-09	2,4E-07
Sr/Y-90	4,4E-04	1,8E-04	4,4E-05	1,0E-06		3,3E-07
Sb-122	1,8E-06					
Sb-124		3,0E-06		5,1E-09		
Sb-125	1,8E-06	3,8E-05	2,9E-05	3,4E-07	1,4E-07	
Te-123m	9,2E-07					
I-125	7,9E-05	2,5E-04		1,9E-05	7,1E-06	1,1E-05
I-126	7,3E-05					
I-131	5,6E-06		1,8E-06	1,7E-06	5,0E-06	3,1E-06
I-133					3,9E-08	
Ba-133		7,4E-06		3,3E-09	4,6E-08	9,2E-08
Cs-134	3,2E-05	1,3E-05	5,9E-07	4,1E-07	4,4E-07	1,1E-06
Cs-137	1,1E-04	1,9E-04	1,8E-05	1,3E-05	2,3E-05	2,1E-05
Ce-141				1,3E-08		
Eu-152		2,0E-06			7,2E-08	2,8E-06
Eu-154		1,8E-05	9,8E-08			
Lu-177					1,3E-08	8,6E-07
Po-210				4,3E-09		5,4E-06
U-234/238	7,6E-06	3,0E-05	4,8E-07	4,0E-07	1,1E-07	
Pu-238/Am-241	4,0E-06	6,2E-07	2,0E-07	4,0E-08	4,5E-07	3,5E-06
Pu-239/240	8,0E-06	2,5E-06	3,8E-08	1,4E-07	1,6E-06	5,3E-06
Cm-244	5,0E-07	2,4E-07		1,3E-09	7,4E-09	
Total activity without tritium	8,8E-04	8,8E-04	1,2E-04	4,3E-05	5,7E-05	7,6E-05

Table E-2: Liquid tritium discharges in TBq from PSI

	1999	2000	2001	2002	2003	2004
Tritium	2,1E-01	1,0E-02	1,3E-01	2,7E-01	3,3E-01	6,6E-01

E.2.4 Emissions to air relevant for the marine compartment

Measurements of actual releases of I-129 to air are not requested by the Inspectorate. Table E-3 shows the tritium emissions from PSI. Further radioisotopes with short half lives produced by the accelerators as side effect, like C-11, N-13, O-15 are monitored during the release to the atmosphere.

Table E-3: Tritium emissions to air from PSI for the last six years

	1999	2000	2001	2002	2003	2004
Tritium [TBq]	7,8E-01	1,0E+00	3,6E+00	1,7E+00	1,1E+00	8,9E-01

E.2.5 Quality assurance of retention/data management

The data management system of PSI is accredited in accordance with ISO 17025.

E.2.6 Site specific target discharge data

PSI has set as site specific target for liquid discharges to be below the limits given in the licence.

E.2.7 Any relevant information not covered by the requirements specified above

There is no relevant information which is not covered by the previous sections.

E.2.8 Explanations for lack of data or failure to meet BAT/BEP indicators, ongoing and planned activities

The submitted data are complete.

E.3 Environmental Impact

The information is given in chapter 3 of the main report.

E.4 Radiation Doses to the Public

The information is given in chapter 4 of the main report.