OSPAR COMMISSION

Implementation of PARCOM Recommendation 91/4 on radioactive discharges for 2010

Report from Switzerland

Radioactive Substances Series

2010

OSPAR Convention

The Convention for the Protection of the Marine Environment of the North-East Atlantic (the "OSPAR Convention") was opened for signature at the Ministerial Meeting of the former Oslo and Paris Commissions in Paris on 22 September 1992. The Convention entered into force on 25 March 1998. It has been ratified by Belgium, Denmark, Finland, France, Germany, Iceland, Ireland, Luxembourg, Netherlands, Norway, Portugal, Sweden, Switzerland and the United Kingdom and approved by the European Community and Spain.

Convention OSPAR

La Convention pour la protection du milieu marin de l'Atlantique du Nord-Est, dite Convention OSPAR, a été ouverte à la signature à la réunion ministérielle des anciennes Commissions d'Oslo et de Paris, à Paris le 22 septembre 1992. La Convention est entrée en vigueur le 25 mars 1998.
La Convention a été ratifiée par l'Allemagne, la Belgique, le Danemark, la Finlande, la France, l'Irlande, l'Islande, le Luxembourg, la Norvège, les Pays-Bas, le Portugal, le Royaume-Uni de Grande Bretagne et d'Irlande du Nord, la Suède et la Suisse et approuvée par la Communauté européenne et l'Espagne.

Contents

1. Introduction

This report relates to the fifth round of implementation reporting on PARCOM Recommendation 91/4 under which Switzerland was scheduled to report to OSPAR Radioactive Substances Committee in the year 2010. 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 programs. 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, the waste treatment and interim storage facility ZWILAG and the Paul Scherrer Institute research facility are given in the Annexes A to F with chapters enumerated according to the OSPAR guidelines.

2. 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 programs is provided.

2.1 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.ensi.ch).

In 2000 the ordinance for ratification of international resolution and recommendations came into force. This legislation requires that the PARCOM-recommendation 91/4 has to be considered by the execution of environmental protection regulations.

In 2005 new nuclear energy legislation came into force. The new legislation requires the performance of periodic safety reviews by the licensee of nuclear power plants in a time interval of ten years. The periodic safety reviews are evaluated by the Nuclear Safety Inspectorate. In the frame of the periodic safety review the licensee has to assess the liquid and gaseous discharges of his plant and at the request of the Inspectorate to benchmark against the corresponding discharges of similar European reactors. If the discharges of a nuclear power plant are higher than the benchmark, the licensee has to analyze the reasons and to make suggestions to reduce the discharges in the view of the appropriateness of the means.

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.

2.2 Dose guide values / dose 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 guide value is set for nuclear installations at 0.3 mSv per year and person as the sum of the doses due to radioactive emissions into the atmosphere, discharges into water and direct radiation. Further the Guideline R-11 sets a dose guide value 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 guide values are not exceeded as a result of the radioactive releases caused by 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.

2.3 Discharge limits

The discharge limits, as fixed in the licence for operation of each facility, are set so that the source-related dose guide value 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's Guideline G14 of February 2008.

In the case of discharges into 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. Supplementary 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. In this report only non normalized discharge data are reported.

2.4 Monitoring programs 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 program 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.

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

The allowed concentration of radioactive substances into 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 restriction. The tolerance values basically fulfill the 10 microSv per year concept.

2.6 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.

2.7 Nature of inspection and surveillance programs

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 programs 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 program.

3. Site Characteristics

In Switzerland there are four NPPs, a waste treatment and 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 river Rhine, 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 treatment and interim storage facility is marked by a square. Dots mark the major cities.*

3.1 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.

Table 1: Main characteristics of the Swiss NPPs

Name of site	Beznau I	Beznau II	Mühleberg	Gösgen	Leibstadt
Receiving waters	river Aare	river Aare	river Aare	river Aare, wet cooling tower	river Rhine, wet cooling tower
Licensed thermal power	1130 MW_{th}	1130 MW_{th}	1097 MW_{th}	3002 MW_{th}	3600 MW_{th}
Nominal net electrical power	365 MW_{el}	365 MW_{el}	390 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	

3.2 Waste treatment and interim storage facility

The waste treatment and interim storage facility ZWILAG in Würenlingen was put in operation step by step. First the interim storage facility started operation in 2001. In 2004 after several inactive tests the incineration and melting plant started with low-level radioactive waste. In the years from 2001 to 2004 the emissions into the air and discharges into the river Aare were very low and are therefore not reported. Switzerland started reporting on ZWILAG to OSPAR in 2005. Now in full operation the discharges increased significantly.

3.3 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 federal interim storage facility BZL, 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 river Aare 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 third report is out of operation since the year 2002. Its decommissioning is analyzed.

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.

[1] Westinghouse 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

3.4 Liquid Discharges

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

Figure 2 presents the discharges of radioactive substances without tritium from the nuclear facilities in Switzerland. The total sum of the discharges of all nuclear facilities shows a downward trend over the last 10 years.

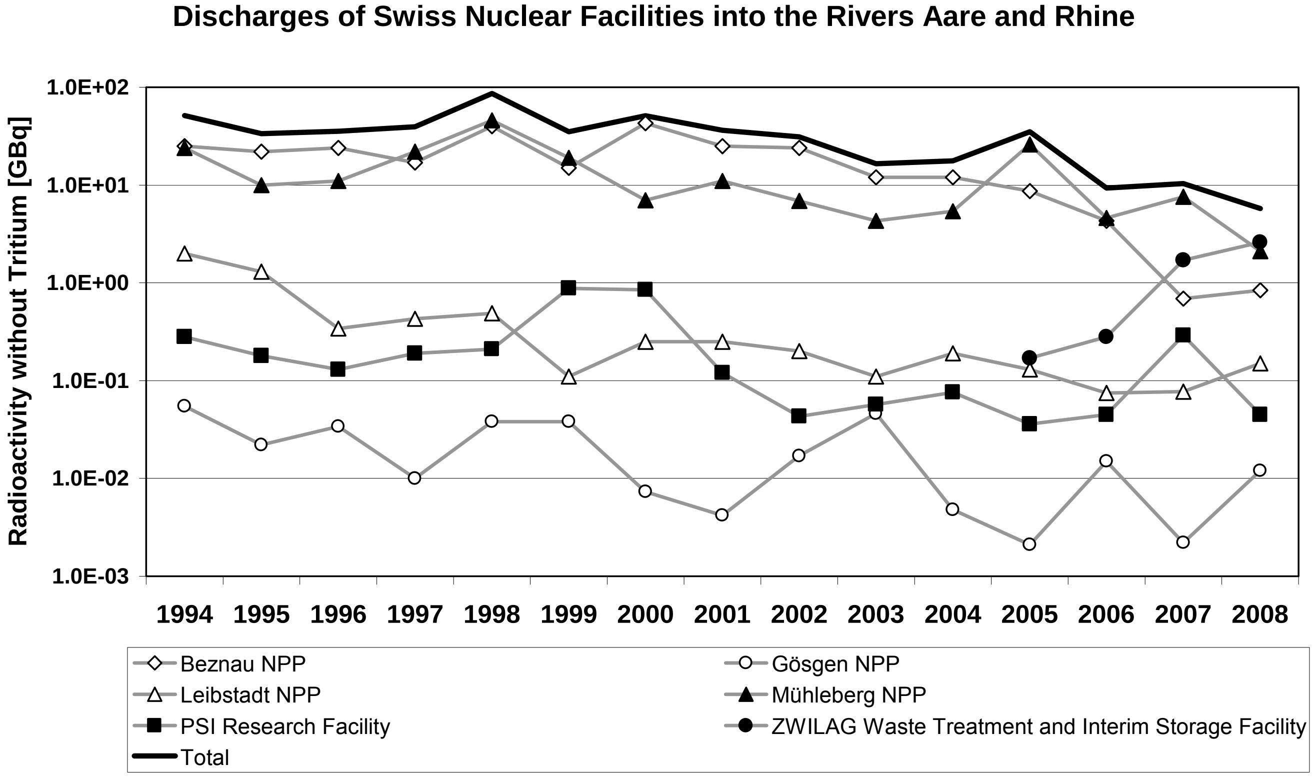

Figure 2: Discharges of radioactive substances by Swiss nuclear facilities 1994 to 2008: Beznau NPP, Gösgen NPP, Leibstadt NPP, Mühleberg NPP, PSI research facility, ZWILAG waste treatment and interim storage facility and the total sum of the discharges of all Swiss nuclear facilities.

3.5 Pressurized water reactors (PWRs)

When compared with the previous reporting period, the curve for Beznau NPP shows a clear downward trend. The licensee of Beznau had performed a periodical safety review for both units in 2002. The Inspectorate has evaluated this review and convinced the licensee of reducing the activity without tritium in the liquid discharges to less then the median value of the European pressurized water reactors of the year 2002. To reach this aim, the licensee of Beznau has started a project to reduce the radioactive discharges by cross flow nanofiltration. Since 2007 the nanofiltration is in full operation and the liquid discharges were reduced below 1 GBq per year.

The liquid discharges of Gösgen NPP are the lowest among the European pressurized water reactors. Nevertheless from 1994 up to now the Gösgen NPP has reduced discharges by a factor of 5.

3.6 Boiling water reactors (BWRs)

The discharges of radioactive substances without tritium from the boiling water reactors at Leibstadt NPP and Mühleberg NPP show a downward trend. This is due to the optimization of the waste water management.

The licensee of Mühleberg had performed a periodical safety review in 2005. The Inspectorate has evaluated this review. As a result the licensee is reducing the activity without tritium in the liquid discharges to a target setting of 1 GBq per year until 2010. To reach this aim, the licensee of Mühleberg has studied possibilities to reduce the quantity of waste water as well as separating different qualities of waste water for specific treatment. This work has resulted in a decrease of the activity released by 40 % compared to data from the previous evaluation in 2004.

3.7 Waste treatment and interim storage facility

Since 2005 when the incineration and melting plant of the waste treatment and interim storage facility ZWILAG was put in operation the discharges of radioactive substances without tritium of this facility increased up to a value of 2.6 GBq in 2008. In January 2009 as a result of an inspection the Inspectorate has required the licensee to study the possibilities to reduce the liquid discharges. As a result of this study in 2010 the licensee will reduce the Cs-137 content in the liquid discharges by sorption with an inorganic ion exchange powder.

3.8 Research facility

At the Paul Scherrer Institute (PSI) the discharges of radioactive substances without tritium show a downward trend from 1999 to 2008 of one order of magnitude and are now below 10^{-1} GBq per year.

3.9 Environmental Impact

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

3.9.1 Concentration of radioisotopes of concern in environmental samples

The results of gamma spectroscopy measurements of sediment in the river Rhine near Basel are reported in table 2 for the period from 2005 to 2008. 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 6.3 Bq/kg for Co-58, due to discharges from the Beznau NPP, and for Cs-137 predominantly due to historic fallout.

3.9.2 Environmental monitoring program

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

The first sampling location is at the Hagneck dam, located on the river Aare downstream of the Mühleberg NPP. The second location is at the Klingnau dam, located on the river Aare downstream of the Paul Scherrer Institute, the ZWILAG facility 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 river Rhine and it is downstream of all the mentioned Swiss nuclear facilities. Since 2006 the radioactivity measured at this location is less dominated by the liquid discharges of the Beznau NPP (see table 2).

3.9.3 System for quality assurance of environmental monitoring

No formal quality assurance system is applied but annual quality checks are done. In the reporting period the testing laboratory for analyses in the field of environmental radioactivity of the BAG and the testing laboratory for radioactivity and dose rate measurements of the ENSI are accredited in accordance with ISO/IEC 17025:2005.

3.9.4 Any relevant information not covered by the requirements specified above

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

3.9.5 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 river Rhein 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]
22.12.04	26.01.05	134 ± 13	413 ± 48	0.5 ± 0.3	6.3 ± 0.8	1.1 ± 0.3	≤ 1.3	≤ 0.5	10 ± 1.0	138 ± 42
26.01.05	22.02.05	93 ± 10	403 ± 47	0.5 ± 0.3	2.0 ± 0.4	0.5 ± 0.4	≤ 1.2	≤ 0.5	8 ± 0.9	62 ± 37
22.02.05	30.03.05	111 ± 11	402 ± 47	0.4 ± 0.2	1.2 ± 0.4	0.7 ± 0.4	≤ 1.2	≤ 0.5	10 ± 1.1	62 ± 36
30.03.05	26.04.05	93 ± 9	367 ± 42	0.2 ± 0.2	0.4 ± 0.2	0.8 ± 0.2	≤ 0.9	≤ 0.4	8 ± 0.8	87 ± 30
26.04.05	31.05.05	212 ± 20	374 ± 43	0.4 ± 0.2	0.5 ± 0.3	1.2 ± 0.3	≤ 1.1	≤ 0.5	9 ± 1.0	47 ± 41
31.05.05	23.06.05	235 ± 24	379 ± 46	0.5 ± 0.2	0.2 ± 0.1	0.5 ± 0.1	≤ 0.9	≤ 0.4	10 ± 1.1	75 ± 11
23.06.05	26.07.06	362 ± 34	414 ± 48	0.6 ± 0.1	3.2 ± 0.4	0.7 ± 0.4	≤ 1.1	≤ 0.5	13 ± 1.3	231 ± 45
26.07.05	24.08.05	180 ± 17	423 ± 49	0.1 ± 0.1	1.4 ± 0.3	≤ 0.5	≤ 1.1	≤ 0.5	9 ± 1.0	53 ± 30
24.08.05	29.08.05	8 ± 2	377 ± 43	0.1 ± 0.1	≤ 0.4	≤ 0.3	≤ 0.8	≤ 0.3	3 ± 0.4	≤ 41
29.09.05	26.10.05	25 ± 3	384 ± 44	0.1 ± 0.1	≤ 0.4	0.3 ± 0.1	≤ 0.7	≤ 0.3	4 ± 0.5	≤ 39
26.10.05	24.11.05	22 ± 3	384 ± 44	0.2 ± 0.1	≤ 0.4	0.3 ± 0.1	≤ 0.7	≤ 0.3	5 ± 0.5	≤ 37
24.11.05	21.12.05	14 ± 2	36 ± 41	≤ 0.3	≤ 0.3	≤ 0.3	≤ 0.7	≤ 0.3	4 ± 0.4	≤ 37
21.12.05	25.01.06	33 ± 4	386 ± 44	0.2 ± 0.2	≤ 0.5	≤ 0.4	≤ 0.9	≤ 0.3	5 ± 0.5	≤ 41
25.01.06	22.02.06	61 ± 7	380 ± 44	0.3 ± 0.2	≤ 0.7	≤ 0.6	≤ 1.3	≤ 0.5	7 ± 0.8	63 ± 32
22.02.06	29.03.06	23 ± 3	368 ± 45	0.4 ± 0.1	≤ 0.3	0.3 ± 0.1	≤ 0.6	≤ 0.2	5 ± 0.6	23 ± 6
29.03.0.6	26.04.06	7 ± 2	382 ± 44	≤ 0.3	≤ 0.4	≤ 0.3	≤ 0.8	≤ 0.3	3 ± 0.0	≤ 43
26.04.06	30.05.06	28 ± 4	382 ± 44	≤ 0.4	≤ 0.5	≤ 0.4	≤ 0.9	≤ 0.3	3 ± 0.4	≤ 45
30.05.06	28.06.06	15 ± 3	371 ± 43	≤ 0.4	≤ 0.5	≤ 0.4	≤ 0.9	≤ 0.3	3 ± 0.3	≤ 43
28.06.06	24.07.06	149 ± 14	413 ± 47	≤ 0.4	1.0 ± 0.2	0.6 ± 0.2	≤ 0.9	≤ 0.3	7 ± 0.7	≤ 48
24.07.06	30.08.06	270 ± 25	423 ± 49	0.3 ± 0.1	≤ 0.5	≤ 0.5	≤ 1.0	≤ 0.4	9 ± 1.0	67 ± 33
30.08.06	27.09.06	52 ± 5	371 ± 42	≤ 0.4	≤ 0.4	≤ 0.4	≤ 0.8	≤ 0.3	4 ± 1.0	30 ± 21
27.09.06	25.10.06	71 ± 7	355 ± 41	≤ 0.5	≤ 0.5	≤ 0.4	≤ 1.0	≤ 0.4	5 ± 0.6	≤ 56
25.10.06	21.11.06	71 ± 7	364 ± 42	≤ 0.5	≤ 0.5	≤ 0.5	≤ 1.0	≤ 0.4	5 ± 0.6	≤ 57
21.11.06	19.12.06	139 ± 14	369 ± 43	≤ 0.4	≤ 0.7	≤ 0.5	≤ 1.4	≤ 0.6	8 ± 1.0	≤ 43
19.12.06	23.01.07	132 ± 13	412 ± 48	0.7 ± 0.3	≤ 0.6	≤ 0.7	≤ 1.5	≤ 0.6	10 ± 0.9	83 ± 40
23.01.07	20.02.07	138 ± 14	411 ± 47	0.5 ± 0.3	≤ 0.7	≤ 0.6	≤ 1.3	≤ 0.5	10 ± 0.8	58 ± 34
20.02.07	23.03.07	63 ± 7	380 ± 44	≤ 0.4	≤ 0.5	0.3 ± 0.1	≤ 0.9	≤ 0.4	6 ± 0.6	≤ 53
23.03.07	25.04.07	96 ± 10	391 ± 45	0.6 ± 0.2	≤ 0.7	≤ 0.6	≤ 1.7	≤ 0.7	8 ± 0.7	155 ± 41
25.04.07	30.05.07	211 ± 20	395 ± 46	≤ 0.7	≤ 0.8	≤ 0.7	≤ 2.1	≤ 1.0	9 ± 0.6	181 ± 49
30.05.07	27.06.07	101 ± 11	397 ± 46	≤ 0.6	≤ 0.7	≤ 0.5	≤ 1.3	≤ 0.5	6 ± 0.7	174 ± 43
27.06.07	25.07.07	64 ± 8	392 ± 45	≤ 0.5	≤ 0.6	≤ 0.6	≤ 1.5	≤ 0.5	4 ± 0.5	≤ 48
25.07.07	23.08.07	48 ± 5	397 ± 46	≤ 0.4	≤ 0.5	≤ 0.4	≤ 0.9	≤ 0.4	4 ± 0.4	≤ 53
23.08.07	26.09.07	[1)]	[1)]	[1)]	[1)]	[1)]	[1)]	[1)]	[1)]	[1)]
26.09.07	31.10.07	83 ± 8	402 ± 46	0.3 ± 0.2	≤ 0.5	≤ 0.4	≤ 0.9	≤ 0.3	5 ± 0.5	< 49
31.10.07	28.11.07	10 ± 2	367 ± 42	≤ 0.3	≤ 0.4	≤ 0.3	≤ 0.7	≤ 0.3	3 ± 0.6	42 ± 20
28.11.07	18.12.07	35 ± 4	386 ± 44	0.3 ± 0.2	≤ 0.4	≤ 0.4	≤ 0.9	≤ 0.3	4 ± 0.6	≤ 40
18.12.07	23.01.08	102 ± 10	411 ± 47	≤ 0.6	≤ 0.7	≤ 0.6	≤ 1.3	≤ 0.5	8 ± 0.9	45 ± 28
23.01.08	27.02.08	105 ± 11	425 ± 25	0.2 ± 0.4	≤ 0.5	0.5 ± 0.2	≤ 0.9	≤ 0.4	8 ± 1.0	42 ± 9
27.02.08	27.03.08	167 ± 16	443 ± 51	≤ 0.7	≤ 0.8	≤ 0.6	≤ 1.4	≤ 0.6	11 ± 1.1	129 ± 35
27.03.08	29.04.08	46 ± 5	400 ± 46	≤ 0.4	≤ 0.5	≤ 0.4	≤ 0.9	≤ 0.4	5 ± 0.6	51 ± 18
29.04.08	29.05.08	100 ± 10	419 ± 49	≤ 0.3	≤ 0.4	≤ 0.4	≤ 0.8	≤ 0.3	5 ± 0.6	42 ± 8
29.05.08	26.06.08	72 ± 8	407 ± 47	≤ 0.5	≤ 0.6	≤ 0.5	≤ 1.1	≤ 0.4	5 ± 0.6	71 ± 25
26.06.08	30.07.08	156 ± 14	422 ± 49	0.2 ± 0.5	≤ 0.4	≤ 0.3	≤ 0.8	≤ 0.3	6 ± 0.6	40 ± 18
30.07.08	26.08.08	195 ± 22	392 ± 45	≤ 0.4	≤ 0.5	≤ 0.4	≤ 0.9	≤ 0.4	6 ± 0.7	≤ 256
26.08.08	30.09.08	152 ± 17	376 ± 43	0.5 ± 0.2	≤ 0.4	≤ 0.3	≤ 0.7	≤ 0.3	5 ± 0.6	≤ 213
30.09.08	30.10.08	111 ± 13	373 ± 42	0.3 ± 0.1	≤ 0.3	≤ 0.3	≤ 0.6	≤ 0.3	5 ± 0.6	≤ 168

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]
30.10.08	26.11.08	142 ± 16	364 ± 41	0.4 ± 0.2	≤ 0.4	0.3 ± 0.1	≤ 0.7	≤ 0.3	8 ± 0.9	≤ 204
26.11.08	18.12.08	139 ± 16	408 ± 46	0.2 ± 0.1	≤ 0.4	≤ 0.3	≤ 0.8	≤ 0.4	9 ± 1.0	≤ 215

1) The sampling trap was lost.

3.10 Radiation Doses to the Public

3.10.1 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, the waste treatment and interim storage facility 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 G14.

3.10.2 Total exposure (including doses from historic emissions)

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 guide value 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 optimized. 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 G-14.

microSv/a	2003	2004	2005	2006	2007	2008
Beznau NPP	*< 2.5*	*< 2.5*	*< 3*	*< 4*	*< 2*	*< 2*
Gösgen NPP	< 4	< 2	< 1	< 1	*< 1*	*< 1*
Leibstadt NPP	< 6	< 5	< 4	< 4	*< 5*	*< 5*
Mühleberg NPP	< 6	< 6	< 6	< 6	*< 6*	*< 5*
Paul Scherrer Institute	< 4	< 4	< 4	< 6	*< 8*	*< 5*
ZWILAG			*< 1*	*< 1*	*< 1*	*< 1*

3.10.3 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.

3.10.4 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.

3.10.5 Methodology to assess doses

The methodology to estimate the dose is laid down in the Inspectorate's Guideline-G14. 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 administrative regulation (allgemeine Verwaltungsvorschrift) for the determination of the radiation exposure caused by radioactive emissions from nuclear facilities.

3.10.6 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.

3.10.7 Site specific target annual effective dose

The source related dose guide value for a nuclear site is 0.3 mSv per year. In case of relevant superposition of the immission of facilities owned by different licensees, 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.

3.10.8 System for quality assurance of processes involved in dose estimates

No formal quality assurance system is applied.

3.10.9 Any relevant information not covered by the requirements specified above

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

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

The submitted data are complete.

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 guide values/ dose limits, discharge limits, environmental monitoring programs, 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, limits the concentration of radioactive substances into 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 restriction, tolerance values for radioactivity in food and drinking water. The tolerance values fulfill the 10 microSv per year concept. In 2000 the ordinance for ratification of international resolution and recommendations come into force. This legislation requires that the PARCOM-recommendation 91/4 has to be considered at the execution of environmental protection regulations. In 2005 new nuclear energy legislation came into force. The new legislation requires the performance of periodic safety reviews by the licensee of nuclear power plants in a time interval of ten years. The periodic safety reviews are evaluated by the Inspectorate. In the frame of the periodic safety review the licensee has to assess the liquid and gaseous discharges of his plant and at the request of the Inspectorate to benchmark against the corresponding discharges of similar European reactors. If the discharges of a nuclear power plant are higher than the benchmark, the licensee has to analyze the reasons and to make suggestions to reduce the discharges in the view of the appropriateness of the means.

(1) All Swiss nuclear facilities with one exception are in the catchment area of the river Rhine. The exception is a nuclear facility for education with no relevant discharges.

(2) The total sum of the liquid discharges of radioactive substances without tritium from the nuclear facilities in Switzerland shows over the last 10 years a downward trend. The liquid discharges without tritium from the Beznau pressurized water reactors show when compared to the previous reporting period a clear downward trend. In the frame of the evaluation of a periodic safety review the Inspectorate required in 2002 the reduction of the activity of a value of less than 1 GBq per year in the liquid discharges in addition without tritium. To reach this aim the licensee of Beznau NPP started to clean the liquid discharges by nanofiltration. Since 2007 the nanofiltration is in full operation and the Licensee has reached the aim. At the Gösgen pressurized water reactor the discharges of radioactive substances without tritium are the lowest among the European pressurized water reactors. Nevertheless from 1994 up to now the Gösgen NPP has reduced discharges by a factor of 5. The liquid discharges of radioactive substances without tritium from the Mühleberg and Leibstadt boiling water reactors show a downward trend. The licensee of Mühleberg had performed a periodical safety review in 2005. The Inspectorate has evaluated this review in depth. As a result the Inspectorate required the licensee to reduce the activity without tritium in the liquid discharges to a target setting of

1 GBq per year until 2010. To reach this aim, the licensee of Mühleberg has studied the possibilities to reduce the quantity of waste water and the possibilities to separate the waste water paths and processing plants. In a first action the gaskets and bearings of axle shafts were optimized to reduce losses of lock water. Since 2005 when the incineration and melting plant of the waste treatment and interim storage facility ZWILAG was put into operation the discharges of radioactive substances without tritium of this facility increased significantly. In January 2009 as a result of an inspection the Inspectorate has required the licensee to study the possibilities to reduce the liquid discharges. As a result of this study in 2010 the licensee will reduce the Cs-137 content in the liquid discharges by sorption with an inorganic ion exchange powder. At the Paul Scherrer Institute research facility the discharges of radioactive substances without tritium show a downward trend.

(3) The environmental monitoring program 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 - 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 river Aare and it also releases its liquid discharges into the river Aare 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_{el} for each unit.

Table A-1: Annual net electrical output 2003-2008 [$GW_{el}h$]

	2003	2004	2005	2006	2007	2008
KKB 1	3061.8	2800.0	3096.0	2950.7	3081.3	2956.6
KKB 2	2920.3	3099.4	2799.9	3073.2	2911.6	3073.4
Beznau total	5982.1	5899.4	5895.9	6023.9	5992.9	6030.0

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 in agreement with the licensee 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 in 2002."

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. In the year 2004 the licensee decided to improve the abatement system by nanofiltration which has gone into operation in the year 2007. The radioactive waste by-products are solidified in the radioactive waste treatment system of the plant.

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. With the cross flow nanofiltration system the concentration is additionally reduced by a factor up to 100. 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 analyzing 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.
In figure 2 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 clear downward trend can be observed in the last five years. Since 2007 the nanofiltration is in full operation and the liquid discharges are reduced below 1 GBq per year. 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

Isotope	2003	2004	2005	2006	2007	2008
Co-58	9.3E+00	1.0E+01	7.6E+00	2.8E+00	1.8E-01	1.9E-01
Co-60	8.5E-01	6.3E-01	4.4E-01	4.1E-01	1.2E-01	7.8E-02
Zn-65	7.5E-04		2.6E-04			
Sr-90	9.3E-03	7.2E-03	7.9E-03	8.6E-03	2.0E-03	1.7E-03
Zr/Nb-95	1.8E-02	1.4E-02	3.8E-03	3.2E-03	3.6E-04	1.4E-04
Ag-110m	1.1E-01	4.4E-02	1.3E-02	2.5E-02	1.2E-03	
Sb-125	5.0E-01	1.9E-01	9.9E-02	1.3E-01	3.0E-02	5.6E-02
Cs-134	2.7E-02	1.9E-03	3.0E-03	7.6E-03	8.5E-03	1.7E-03
Cs-137	2.4E-01	1.4E-01	1.5E-01	3.2E-01	1.5E-01	1.3E-01
Ce-144	3.0E-03	1.2E-03				
Other isotopes	9.4E-01	9.7E-01	3.3E-01	7.0E-01	1.9E-01	3.8E-01
Total Beta/Gamma without tritium	1.2E+01	1.2E+01	8.7E+00	4.3E+00	6.9E-01	8.4E-01

Table A-3: Liquid tritium discharges in TBq from KKB 1 and KKB 2

	2003	2004	2005	2006	2007	2008
Tritium	1.1E+01	1.1E+01	1.1E+01	1.1E+01	1.1E+01	1.2E+01

Table A-4: Liquid alpha discharges in GBq from KKB 1 and KKB 2

	2005	2006	2007	2008
Pu-239/Pu-240	4.7E-05	2.0E-04	1.0E-5	1.1E-05
Pu-238/Am-241	1.0E-04	2.9E-04	1.2E-5	3.8E-05
Cm-242	3.6E-05	1.4E-04	2.1E-6	5.5E-06
Cm-243/Cm-244	3.9E-05	6.2E-05	1.2E-6	5.8E-06
Total Alpha	2.2E-04	6.9E-04	2.5E-5	6.0E-5

A.2.4 Emissions into air relevant for the marine compartment

Measurements of actual releases of I-129 into the air are not requested by the Inspectorate. Since 2004 the C-14 and tritium emissions into the atmosphere are measured. Before 2004 the emissions of C-14 have been estimated on the basis of measurements done over a period of several months in the 1980s. The table A-5 shows the C-14 and tritium emissions into the atmosphere by KKB 1 and KKB 2.

Table A-5: C-14 and tritium emission into air in TBq from KKB 1 and KKB 2

	2004	2005	2006	2007	2008
C-14 (CO_2)	5.6E-02	5.0E-02	5.8E-02	3.4E-02	2.6E-02
Tritium	5.4E-01	5.7E-01	5.6E-01	6.0E-01	5.3E-01

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 license.

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.

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 - Gösgen Nuclear Power Plant (KKG)

B.1 Site Characteristics

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

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

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

The Gösgen NPP has a thermal power of 3002 MW_{th} and a net electrical output of 970 MW_{el}.

Table B-1: Annual net electrical output 2003-2008 [$GW_{el}h$]

	2003	2004	2005	2006	2007	2008
Gösgen NPP	7988,7	8015,6	7582,9	8099,1	8158,9	7964,0

Other relevant information

At Gösgen NPP site, a building for the wet storage of spent fuel elements is in operation since 2008. The waste water system of the new storage building is 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 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. 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 analyzing monthly samples. The absolute values of the liquid discharges from KKG are shown in tables B-2, B-3 and B-4.

In the figures 2 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. Nevertheless from 1994 up to now the Gösgen NPP has reduced discharges by a factor of 5. 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	2003	2004	2005	2006	2007	2008
Co-58	1.8E-04		5.8E-04		1.0E-4	
Co-60	7.5E-03	2.7E-03	1.1E-03	2.2E-03	9.3E-4	3.0E-03
Zr/Nb-95		2.4E-04	9.4E-05		1.7E-4	
Sb-125	2.0E-03					
Cs-134						
Cs-137				4.0E-05		
Other isotopes	3.6E-02	1.9E-03	3.7E-04	1.3E-02	1.0E-3	9.0E-03
Total Beta/Gamma without tritium	4.6E-02	4.8E-03	2.1E-03	1.5E-02	2.2E-3	1.2E-02

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

	2003	2004	2005	2006	2007	2008
Tritium	1.4E+01	1.4E+01	1.3E+01	1.3E+01	1.6E+01	1.7E+01

Table B-4 Liquid alpha discharges in GBq from KKG

	2003	2004	2005	2006	2007	2008
Total Alpha	< 1.3E-04	< 1.1E-04	< 1.3E-04	< 9.1E-05	< 7.3E-05	< 1.5E-04

B.2.4 Emissions into air relevant for the marine compartment

Measurements of actual releases of I-129 into the air are not requested by the Inspectorate. Since 2004 the C-14 and tritium emissions into the atmosphere are measured. Before 2004 the emissions of C-14 have been estimated on the basis of measurements done over a period of several months in the 1980s. The table B-5 shows the C-14 and tritium emissions into the atmosphere by KKG.

Table B-5: C-14 and tritium emission into air in TBq from KKG

	2004	2005	2006	2007	2008
C-14 (CO_2)	8.4E-02	6.3E-2	4.6E-02	5.0E-02	6.2E-02
Tritium	4.5E-01	4.7E-01	5.7E-01	7.1E-01	4.7E-01

B.2.5 Quality assurance of retention/data management

The data management system of KKG is certified in accordance with ISO 9001:2000, ISO 14001:2004 and OHSAS 18001:2007.

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 - 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 river Rhine.

KKL has a thermal power of 3600 MW_{th} and a net electrical output of 1165 MW_{el}.

Table C-1: Annual net electrical output 2003-2008 [$GW_{el}h$]

	2003	2004	2005	2006	2007	2008
Leibstadt NPP	9309.3	8692.0	5738.5	9367,0	9436.8	9307.7

Other relevant information

From 1998 to 2003 Leibstadt NPP had increased the thermal power from 3138 to 3600 MW_{th} in four steps. In the year 2005 the NPP was shut down during five month due to a superheating of the electrical generator.

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 analyzing quarterly samples. The absolute values of the liquid discharges from KKL are shown in tables C-2, C-3 and C-4.

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. 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	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
Co-58	2.3E-03	8.3E-03	2.3E-03	4.5E-03	3.0E-03	1.4E-02
Co-60	5.8E-02	1.0E-01	7.9E-02	5.8E-02	5.2E-02	1.2E-01
Zn-65					6.0E-04	1.0E-03
Zr/Nb-95						
Cs-134	8.2E-03	1.2E-02	1.0E-02	1.6E-03		
Cs-137	2.4E-02	1.5E-02	1.4E-02	5.4E-03	1.4E-03	4.2E-03
Other isotopes	1.6E-02	5.3E-02	7.7E-03	5.4E-03	2.0E-02	1.2E-02
Total Beta/Gamma without tritium	1.1E-01	1.9E-01	1.1E-01	7.5E-02	7.7E-02	1.5E-01

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

	2003	**2004**	**2005**	**2006**	**2007**	**2008**
Tritium	2.2E+00	1.9E+00	1.2E00	7.0E-01	8.4E-01	1.4E+00

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

	2003	**2004**	**2005**	**2006**	**2007**	**2008**
Total Alpha	4.6E-04	4.6E-04	2.8E-04	< 2.6E-04	< 2.7E-04	2.0E-03

C.2.4 Emissions into air relevant for the marine compartment

Measurements of actual releases of I-129 into the air are not requested by the Inspectorate. The table C-5 shows the C-14 and tritium emissions into the atmosphere by KKL.

Table C-5: C-14 and tritium emission into air in TBq from KKL

	2003	**2004**	**2005**	**2006**	**2007**	**2008**
C-14 (CO_2)	6.0E-01	4.5E-01	3.4E-01	4.1E-01	5.4E-01	5.9E-01
Tritium	1.6E+00	1.4E+00	6.0E-01	5.3E-01	5.2E-01	1.3E+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 license.

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 - 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 river Aare and it releases its liquid discharges into the river Aare 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 390 MW_{el}.

Table D-1: Annual net electrical output 2003-2008 [$GW_{el}h$]

	2003	2004	2005	2006	2007	2008
Mühleberg NPP	2744.2	2906.0	2855.3	2882.9	2897.0	2973.2

Other relevant information

The licensee of Mühleberg had performed a periodical safety review in 2005. The Inspectorate has assessed this review in depth. As a result the Inspectorate convinced the licensee of reducing the activity without tritium in the liquid discharges to a target setting of 1 GBq per year until 2010. To reach this aim, the licensee of Mühleberg has studied possibilities to reduce the quantity of waste water as well as separating different qualities of waste water for specific treatment. This work has resulted in a decrease of the activity released by 40 % compared to data from the previous evaluation in 2004.

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 analyzing quarterly samples. The absolute values of the liquid discharges from KKM are shown in tables D-2, D-3 and D-4.
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	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
Co-58	2.8E-01	5.5E-01	2.2E+00	2.1E-01	8.6E-01	1.8E-01
Co-60	2.4E+00	2.2E+00	1.2E+01	2.5E+00	3.1E+00	8.7E-01
Zn-65	2.3E-01	2.1E-01	9.0E-01	1.2E-01	7.0E-02	2.9E-02
Sr-90	1.1E-02	2.0E-02	5.2E-03	9.1E-03	8.0E-03	4.7E-04
Zr/Nb-95	5.9E-03	7.3E-03			1.9E-03	
Sb-125	7.4E-03		2.7E-02			
Cs-134	5.6E-03	2.3E-03	9.9E-03			
Cs-137	6.9E-01	3.8E-01	2.4E+00	7.7E-02	6.2E-02	1.5E-01
Other isotopes	6.6E-01	2.0E+00	8.7E+00	1.7E+00	3.4E+00	9.0E-01
Total Beta/Gamma without tritium	4.3E+00	5.4E+00	2.6E+01	4.6E+00	7.5E+00	2.1E+00

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

	2003	**2004**	**2005**	**2006**	**2007**	**2008**
Tritium	1.7E-01	1.5E-01	2.2E-01	1.9E-01	3.7E-01	1.2E-01

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

	2003	**2004**	**2005**	**2006**	**2007**	**2008**
Total Alpha	2.8E-04	1.9E-04	2.0E-4	2.2E-04	1.1E-04	6.5E-05

D.2.4 Emissions into air relevant for the marine compartment

Measurements of actual releases of I-129 into the air are not requested by the Inspectorate. Since 2005 the C-14 and tritium emissions into atmosphere are measured. Before 2005 the emissions of C-14 were estimated on the basis of measurements done over a period of several months in the 1980s.

The table D-5 shows the C-14 and tritium emissions into the atmosphere by KKM.

Table D-5: C-14 and tritium emission into air in TBq from KKM

	2005	2006	2007	2008
C-14 (CO_2)	3.5E-01	3.7E-01	3.7E-01	3.4E-01
Tritium	1.9E-01	3.2E-01	2.1E-02	7.7E-03

D.2.5 Quality assurance of retention/data management

The data management system of KKM is certified in accordance with ISO 9001:2008 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 license.

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 - Waste Treatment and Interim Storage (ZWILAG)

E.1 Site Characteristics

The ZWILAG waste treatment and interim storage facility is owned by the four Swiss nuclear power plant licensees.

Low and medium-level radioactive waste from Swiss nuclear power plants as well as from medicine, industry and research is processed by a conditioning and an incineration and melting plant in ZWILAG. The site also provides interim storage for all types of radioactive waste and spent fuel assemblies from Swiss nuclear power plants.

The ZWILAG is located next to the Paul Scherer Institute near the village Würenlingen in the canton Aargau. It releases its liquid discharges into the river Aare which belongs to the catchment area of the Rhine.

The waste treatment and interim storage facility ZWILAG in Würenlingen was put in operation step by step. First the interim storage facility started operation in 2001. In 2004 after several inactive tests the incineration and melting plant started a series with low-level radioactive waste. In the years from 2001 to 2004 the emissions into the air and discharges into the river Aare were very low and are therefore not reported. Switzerland started reporting on ZWILAG to OSPAR in 2005.

Other relevant information

In January 2009 as a result of an inspection the Inspectorate has required the licensee to study the possibilities to reduce the liquid discharges. As a result of this study in 2010 the licensee will reduce the Cs-137 content in the liquid discharges by sorption with an inorganic ion exchange powder.

E.2 Discharges

E.2.1 Abatement systems

Installed systems:

The waste water is collected and treated in batches. The radioactivity in the waste water can be reduced by evaporation and centrifugation. To the evaporation system belongs also an ion exchanger to process the distillate. 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.

<u>Systems in operation:</u>

Until now the licensee of ZWILAG didn't use the evaporation and the centrifugation system on a large scale.

E.2.2 Efficiency of systems

With the evaporation system the concentration of radioactivity in the discharged water can be reduced by a factor of 10'000. The tritium discharges are not reduced by the abatement system.

E.2.3 Annual liquid discharges

Beside gamma spectrometry ZWILAG determines the activity of tritium, Sr-90 and alpha-emitters by analyzing quarterly samples. The absolute values of the liquid discharges from ZWILAG are shown in tables E-1, E-2 and E-3.
In figure 2 in the main report, the discharges of radioactive substances without tritium are plotted as a function of time. At the ZWILAG a clear upward trend can be observed. The discharges of radioactive substances without tritium increased up to a value of 2.6 GBq in 2008. The Inspectorate will focus its attention on ZWILAG's liquid discharges in 2010.

Table E-1: Liquid discharges without tritium in GBq from ZWILAG

Isotope	2005	2006	2007	2008
Co-58				
Co-60	1.2E-02	2.4E-06	2.6E-03	6.7E-03
Zn-65	1.7E-04			
Sr-90	9.9E-04			
Zr/Nb-95				
Sb-125	4.0E-02	1.2E-02	2.6E-04	2.4E-03
Cs-134		1.1E-02	5.2E-02	6.0E-02
Cs-137	1.2E-01	2.6E-01	1.7E+00	2.5E+00
Other isotopes	2.3E-03	7.7E-04	2.6E-02	1.2E-02
Total Beta/Gamma without tritium	1.7E-01	2.8E-01	1.7E+00	2.6E+00

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

	2005	2006	2007	2008
Tritium	1.2E-01	8.5E-4	1.3E-01	3.4E-01

Table E-3: Liquid alpha discharges in GBq from ZWILAG

	2005	2006	2007	2008
Pu-239/Pu-240	9.7E-6	2.2E-6	2.4E-6	2.8E-6
Pu-238/Am-241	4.5E-6	1.7E-6	3.1E-6	4.5E-6
Cm-242	3.6E-7	3.3E-8	8.0E-8	7.8E-8
Cm-243/Cm-244	5.1E-6	2.0E-6	3.2E-7	4.4E-7
Total Alpha	2.0E-5	5.9E-6	5.9E-6	7.8E-6

E.2.4 Emissions into air relevant for the marine compartment

Measurements of actual releases of I-129 into air are not requested by the Inspectorate. Table E-4 shows the tritium emissions from ZWILAG.

Table E-4: C-14 and tritium emission into air in TBq from ZWILAG

	2005	2006	2007	2008
C-14 (CO_2)	5.2E-05	8.3E-05	1.5E-2	3.7E-04
Tritium	3.8E-04	2.3E-04	3.1E-1	1.7E-1

E.2.5 Quality assurance of retention/data management

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

E.2.6 Site specific target discharge data

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

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.

Appendix F - Paul Scherrer Institute (PSI)

F.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 hot cells, 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 river Aare 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.

F.2 Discharges

F.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.

F.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.

F.2.3 Annual liquid discharges

Beside gamma spectrometry the PSI has to determine the activity of Tritium, Sr-90 and alpha-emitters by analyzing quarterly samples. The absolute values of the liquid discharges from PSI are shown for the last six years in the tables F-1 and F-2.

In figure 2 in the main report, the discharges of radioactive substances without tritium are plotted as a function of time. The discharges of radioactive substances without tritium show a downward trend form 2003 to 2008 of one order of magnitude.

Table F-1: Liquid discharges without tritium in TBq from PSI

Isotope	2003	2004	2005	2006	2007	2008
Be-7		3.0E-07	2.3E-08	6.2E-07	7.9E-06	1.1E-07
Na-22	5.1E-06	3.4E-06	5.3E-06	2.8E-07	8.4E-07	4.1E-07
S-35	3.9E-06	4.6E-06			1.3E-05	9.7E-06
Mn-54	2.3E-07	6.3E-07	2.8E-06	1.5E-07	2.4E-07	3.2E-07
Co-56		1.3E-07			3.9E-08	6.2E-08
Co-57	4.0E-08	7.3E-07	1.2E-08	2.9E-07	5.2E-07	7.2E-07
Co-58	4.8E-09	2.5E-06	1.4E-08	6.4E-07	7.8E-07	4.8E-07
Co-60	1.0E-05	8.5E-06	1.5E-06	3.7E-06	6.1E-07	1.3E-06
Zn-65		4.8E-09		6.1E-08	1.1E-08	
Sr-85	3.9E-09	2.4E-07	9.3E-08	9.4E-08		2.6E-07
Sr-90		3.3E-07	1.9E-06	5.7E-06	3.1E-05	6.0E-06
Y-90		3.3E-07	1.9E-06	5.7E-06	3.1E-05	6.0E-06
Ru/Rh-106					1.3E-07	
Ag-110m					6.4E-09	
Sb-122						
Sb-124					1.7E-09	
Sb-125	1.4E-07				3.1E-08	
Te-123m						
I-125	7.1E-06	1.1E-05	3.1E-06	7.1E-07	1.1E-06	3.4E-06
I-126						
I-131	5.0E-06	3.1E-06	1.5E-06		3.7E-07	
I-133	3.9E-08					
Ba-133	4.6E-08	9.2E-08				
Cs-134	4.4E-07	1.1E-06	2.5E-06	8.4E-07	6.9E-06	5.2E-07
Cs-137	2.3E-05	2.1E-05	1.5E-05	2.3E-05	2.0E-04	1.6E-05
Ce-141				7.0E-08		
Eu-152	7.2E-08	2.8E-06	2.1E-08	1.3E-07		

Isotope	2003	2004	2005	2006	2007	2008
Eu-154				3.4E-08		
Lu-172				9.3E-08	1.5E-08	
Lu-177	1.3E-08	8.6E-07	1.3E-06			
Os-185					3.6E-08	
Po-210		5.4E-06				
Total Beta/ Gamma activity without tritium	5.5E-05	6.7E-05	3.7E-05	4.2E-5	2.9E-4	4.5E-05

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

	2003	2004	2005	2006	2007	2008
Tritium	3.3E-01	6.6E-02	1.1E-02	3.8E-02	4.3E+00	3.1E-01

Table F-3: Liquid alpha discharges in GBq fromPSI

	2003	2004	2005	2006	2007	2008
U-234/U-238	1.1E-07				1.1E-08	1.7E-08
Pu-239/Pu-240	1.6E-06	5.3E-06	5.6E-07	1.2E-06	1.1E-07	1.2E-07
Pu-238/Am-241	4.5E-07	3.5E-06	2.2E-07	1.4E-06	6.6E-08	5.7E-08
Cm-243/Cm-244	7.4E-09			8.6E-08	9.7E-9	6.5E-09
Total Alpha	2.2E-06	8.8E-06	7.8E-07	2.7E-06	2.0E-07	2.0E-07

F.2.4 Emissions into air relevant for the marine compartment

Measurements of actual releases of I-129 into air are not requested by the Inspectorate. Table F-4 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 into the atmosphere.

Table F-4: Tritium emissions into air in TBq from PSI for the last six years

	2003	2004	2005	2006	2007	2008
Tritium	1.1E+00	8.9E-01	6.8E-01	1.3E+00	2.5E+00	1.8E+00

F.2.5 Quality assurance of retention/data management

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

F.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 license.

F.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.

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

The submitted data are complete.

F.3 Environmental Impact

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

F.4 Radiation Doses to the Public

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

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