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Implementation of the obligations of the

Convention on Nuclear Safety

The fourth Swiss report in accordance with Article 5

July 2007

Convention on Nuclear Safety

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Contents

Foreword

The Convention on Nuclear Safety (CNS) was signed by Switzerland on 31 October 1995, ratified on 12 September 1996 and put into force on 11 December 1996. According to article 5 of the Convention, three country reports were prepared and submitted to the IAEA with regard to the Review Meetings of the Contracting Parties organised in 1999, 2002 and 2005. A Swiss delegation participated in these meetings at the IAEA headquarters in Vienna.

The present fourth report established by the Swiss Federal Nuclear Safety Inspectorate (HSK) provides updated information on the compliance with the CNS obligations. In addition, the report attempts to give sufficient consideration to the topics which aroused special interest at the third Review Meeting.

The comprehensive overview of the nuclear safety status in Switzerland (as of July 2007) is introduced by general political information about the country, a brief history of nuclear power and an overview of the Swiss nuclear facilities.

In the following sections, which are numbered after the Articles 6 to 19 of the CNS, key aspects are commented to give a clear indication on how the various obligations imposed by the Convention are fulfilled in Switzerland. A list of abbreviations used in the text appears in Appendix 1.

An overview of the contents of the report and the conclusions about the degree of compliance with the obligations set out in the Convention is given in the "Summary and Conclusions" section.

Summary and conclusions

The requirements of the CNS articles, as described in this report, are met by Switzerland. Indeed, the requirements of the articles of the Convention – with the exception of Article 13 – were already standard practice in Switzerland before the Convention came into force. In the last years, all Swiss NPPs as well as the Swiss Federal Nuclear Safety Inspectorate (HSK) built up documented quality management (QM) systems, which are certified to ISO 9001, ISO 14001 (Environment Management) and OHSAS 18001 (Occupational Health and Safety Management). The NPPs' QM systems were originally designed to fulfil the requirements of IAEA Safety Series 50-C/SG-Q "Quality Assurance in Nuclear Power Plants and other Nuclear Installations". They also fulfil the new IAEA requirements on Management Systems GS-R-3 “The Management System for Facilities and Activities”. Therefore, Switzerland complies with the requirements of CNS Article 13.

The independence of the Inspectorate from licensing authorities or other governmental bodies dealing with the use of nuclear energy is fulfilled on a technical level. In 2005, a new Nuclear Energy Act came into force requiring formal independence of the supervisory authorities from the licensing authorities. A separate act to legally settle the Inspectorate's fully independent status in accordance with the new Nuclear Energy Act was adopted by Parliament this year and will become effective in January 2009.

The Inspectorate actively participates in international co-operation programmes – IAEA, OECD-NEA and WENRA – and is represented in numerous nuclear safety working groups in order to ensure the exchange of scientific, technical and regulatory know-how. The regulatory processes applied to the licensing and safety surveillance of nuclear installations as well as the installations themselves and their operation are up to date with the current state of science and technology.

Deterministic and probabilistic safety evaluations for fuel and core design, for safety and safety-related systems are important for the supervisory authority, either to confirm the high standard of NPP safety or to identify any plant vulnerability. In addition, these evaluations guide and prioritise inspections and provide the basis for a graded approach to safety review and assessment.

The surveillance of the NPPs' operating, control and safety systems, their component performance and integrity, their organisational and human aspects as well as the management, conditioning and interim storage of radioactive waste are permanent features of the supervisory authority's activities. Within the frame of a new integrated oversight process there is an annual systematic assessment of nuclear safety for each NPP based on the analysis of events, inspection results and operator licensing reviews. This assessment will be expanded in the future in order to include additional information related to nuclear safety. The assurance of low radiation doses to both NPP workers and the general public is an additional goal that is directly associated with the safe operation of NPPs. These are key features of the CNS.

In case of an accident in a nuclear installation, the Swiss national alerting system is geared for rapid response. Contingency plans are in place and are continually updated. Emergency drills are conducted at regular intervals. The international alerting system is also in a mature stage and its efficiency is verified in regular exercises.

In the following, a short summary of the detailed answers to the articles 6 to 19 of the Convention is provided. It is concluded that the Swiss Party complies with the obligations of these articles.

Article 6: Existing nuclear installations

The general safety of the Swiss NPPs is good. The first generation NPPs of Switzerland (Beznau units I and II, Mühleberg) which started operation in the late 1960s and early 1970s has been progressively backfitted to address the major on-going developments in NPP safety technology. Regular safety reviews have been performed for these first generation NPPs. Based on the results of these reviews, they have been granted licences to continue operation. Periodic Safety Reviews (PSRs) were performed for the Mühleberg NPP in 2000/2001 and 2005 and for the Beznau NPPs in 2002. Both PSRs were reviewed in depth by the Inspectorate. The final review reports of the Inspectorate were published in 2002 and 2007 (Mühleberg) and 2004 (Beznau). The final review reports are publicly available on the Inspectorate's website.

The second generation of NPPs (Gösgen and Leibstadt) had, already from the design stage, inherent improvements in various aspects of safety and operation. PSRs were performed also for Leibstadt and Gösgen NPPs in 1996 and 1999 respectively, and were reviewed by the Inspectorate. By the end of 2006 a new PSR for Leibstadt NPP has been submitted to HSK for review. HSK's review report will be published by the end of 2008. The new PSR for Gösgen NPP has to be submitted to HSK by the end of 2008.

In conclusion, all Swiss NPPs underwent a safety review process as required by the Convention and have incorporated improvements indicated in the respective safety review reports. The Swiss policy of continuous improvements in NPPs, based on the current state of science and technology, ensures a high level of safety.

Article 7: Legislative and regulatory framework

The legislation and regulatory framework for nuclear installations is well established in Switzerland. It provides the formal basis for the supervision and the continuous improvement of nuclear installations. The main legal provisions for authorisations and regulation, supervision and inspection are regulated in the Nuclear Energy Act, the Nuclear Energy Ordinance, the Radiological Protection Act and the Radiological Protection Ordinance. The Nuclear Energy Act and its ordinance came into force in 2005 replacing the Atomic Energy Act of 1959 and its addendum of 1978 as well as the Atomic Energy Ordinance of 1984.

Safety requirements and regulations are detailed in more than 40 regulatory guidelines of the Inspectorate, covering all aspects of NPP construction, operation and decommissioning, of nuclear waste transportation and disposal as well as radiation protection and emergency preparedness.

According to the new Nuclear Energy Act, the first step of the licensing procedure for the building of a new NPP – the general licence – is subject to a facultative referendum. There are two additional licences necessary: the construction licence and the operating licence. Appeals against these licences are possible.

The Nuclear Energy Act also provides for inspections and safety assessments performed by the Inspectorate, and for the enforcement of applicable regulations and of the terms of the licence.

Article 8: Regulatory Body

The Swiss regulatory body, composed of the Swiss Federal Nuclear Safety Inspectorate (HSK) as the supervisory authority for nuclear safety and the Swiss Federal Office of Energy as the supervisory authority for nuclear security and safeguards, possesses the authority, competence and financial resources to fulfil its assigned responsibilities.

According to the increased responsibilities and tasks of the Inspectorate, its number of personnel has been gradually increased in the last 20 years to 100, with 70 specialists in reactor safety, radiation protection, waste management etc., and its organisation has been adapted to the changed requirements.

The regulatory body is independent from organisations concerned with the promotion or utilisation of nuclear energy. The required independence of the supervisory authorities from licensing authorities or other governmental bodies concerned with the use of nuclear energy is fulfilled on a technical level. The new Nuclear Energy Act of 2005 requires the supervisory authorities to be independent of technical directives and formally independent of the licensing authorities. A separate Federal Nuclear Safety Inspectorate Act to finalise the Inspectorate's fully independent status in accordance with the Nuclear Energy Act was passed by Parliament on 22 June 2007 and will become effective on 1 January 2009. In the mean time, the implementation of new public management elements (FLAG) in January 2004 has enabled the Inspectorate to make a clear step towards more administrative independence.

The Inspectorate uses a process oriented management system which was certified according to ISO 9001 standard in December 2001. Certification according to ISO 14001 (environmental management) and OHSAS 18001 (safety & health management) is planned for November 2007. The management system is applied to all relevant activities and is subject to continuous improvement based on management reviews, evaluation of performance indicators and routine checks by the certification agency.

The Inspectorate currently faces a staff generation change. Knowledge management including a career development programme is considered to be a valuable tool in order to cope with this change and is being implemented in the Inspectorate's management system. In addition, the Inspectorate has increased its involvement and participation in nuclear safety cooperation programmes at many levels including participation in IAEA services, such as IRRS and OSART missions, staff exchanges with foreign regulators and inspection workshops with other countries. Switzerland has signed agreements on the bilateral collaboration for the exchange of information on nuclear safety and radiation protection issues with their counterparts in four neighbouring states, namely Germany, France, Italy and Austria.

Article 9: Responsibility of the licence holder

The responsibility of the licence holder for the safe operation of a NPP is explicitly required by the Nuclear Energy Act. Each NPP has accepted this condition for operation; a corresponding statement is given in the preamble of each of the NPP's operating manual. The supervisory authority conducts inspections and technical discussions with the utilities in order to assure that the operators assume full responsibility for the safety of their installations.

Article 10: Priority to safety

Priority to safety has always been given the highest consideration by all organisations actively involved in building and operating nuclear installations in Switzerland.

Up to 2002, all Swiss NPPs have been subject to an Operational Safety Review Team (OSART) mission, including a follow-up. These missions have confirmed many commendable areas of performance, particularly a strong commitment to nuclear safety and excellent plant operation, but recommended also additional safety improvements. In the past three years all Swiss NPPs were subject to WANO Peer Reviews. The plants informed the Inspectorate about the main findings and actions taken for improvements.

All NPPs have implemented programmes to improve safety culture. In 2005 the Inspectorate started periodic technical discussions with each NPP on their safety culture programmes. In 2006 two NPPs implemented an independent safety controlling, i.e. a responsible person reporting directly to the CEO.

Article 11: Financial and human resources

The Swiss NPP operators have sufficient financial resources to maintain a high safety level throughout the lifespan of the NPPs. Should a NPP no longer fulfil the regulatory safety requirements, its licence will be revoked to prevent further operating. The financing of decommissioning and of waste disposal is ensured by means of dedicated funds.

In accordance with the Swiss Nuclear Energy Act, corresponding ordinances and regulatory guidelines, there is a sufficient number of qualified staff with appropriate expertise for the management and control of nuclear installations.

NPP personnel are regularly educated and trained. Retraining is ensured to keep up with advances in science and technology as well as with plant modifications. Plant-specific full scope replica simulators are operating at all Swiss NPPs.

The fluctuation of NPP personnel is low. All Swiss NPPs have established programmes for replacement of retiring staff well in advance, allowing sufficient time for transfer of know-how to newly recruited personnel. This ensures that the necessary knowledge and experience to operate the NPPs is maintained. In 2003, the Inspectorate and the Swiss NPPs participated in an IAEA review on knowledge transfer to the next generation of NPP staff. In this context the approaches in different NPPs were investigated thoroughly, confirming the above.

Article 12: Human factors

The Inspectorate's organisation includes staff members dealing with human aspects, NPP organisation, and safety culture. Considerable attention is paid to human factor aspects of operator support systems, including procedures, guidelines and checklists. Weaknesses are identified and necessary arrangements for improvements are made. Improvements to the control rooms and the implementation of computerised plant information systems have been progressively carried out over the last few years. After each NPP event in which human factors have played a role, the involved human-system interactions and organisational aspects are investigated. Weaknesses in these areas discovered by such investigations lead to assessments of similar situations in all other NPPs.

Special attention is devoted to safety management and safety culture. The Inspectorate performed a set of oversight activities in this field. Due to the enactment of the new Nuclear Energy Ordinance in 2005 there have been formal changes to the inspection practice. The Inspectorate is currently revising its guideline on “Organisation of Nuclear Power Installations” which includes IAEA requirements on Management Systems as well as Reference Levels issued by the Western European Nuclear Regulators’ Association. The guideline describes the requirements of the Inspectorate regarding organisational structure and work processes as well as requirements that need to be taken into account by the operating organisation to safely manage organisational changes. The guideline also formulates that the operating organisation needs to be clear about giving safety first priority in all plant activities and details the requirements of a NPP organisation to analyse, monitor, reflect and foster its own safety culture.

All Swiss NPPs have established programmes to systematically develop their safety culture. Members of the Inspectorate, as well as the NPP management, are both making an effort to promote further a broad safety philosophy and culture.

Article 13: Quality assurance

The Quality Management Systems for the Swiss NPPs were designed to fulfil the requirements of IAEA Safety Standards Series No 50-C/SG-Q "Quality Assurance for Safety in Nuclear Power Plants and other Nuclear Installations". During the last reporting period the Swiss NPPs created integrated management systems by addition of the ISO 14001 and OHSAS 18001 standards to the quality norm ISO 9001. All NPPs are certified according to all three standards. These QM systems also comply with the new IAEA requirements GS-R-3 "Management Systems for Facilities and Activities".

Article 14: Assessment and verification of safety

The review and assessment procedure includes the evaluation of the safety analysis report (SAR), safety relevant systems, design basis accident analyses, probabilistic safety analysis, reports on ageing surveillance programmes, as well as other safety related documents which are made available upon request by the Inspectorate. The results of the reviews and assessments are documented. In the case of a licensing procedure, the documentation will take the form of a Safety Evaluation Report (SER). Within the frame of integrated oversight (see below) there is an annual systematic assessment of nuclear safety for each NPP based on the analysis of events, inspection results and operator licensing reviews. The assessment of the NPP's periodic safety review (PSR) is documented as a Periodic Safety Review evaluation report. PSRs are to be conducted at an interval of 10 years. As a rule, all plant documentation has to be regularly updated, including SARs and PSAs. Important conditions and prerequisites for operation are recorded as licence conditions. Since February 2005 a Probabilistic Safety Analysis (PSA) is required by the Nuclear Energy Ordinance.

An Ageing Surveillance Programme (ASP) is in place for all NPPs. The objective of this programme is to collect relevant information of structures, systems and components for monitoring ageing and understanding ageing mechanisms in order to maintain safety margins and safety functions of structures, systems and components throughout the plant lifetime.

Further requirements to assure that the physical state of a NPP is in compliance with the licence are:

- modifications to safety related components require a permit;
- a plant review has to be carried out after each refuelling outage;
- an efficient inspection activity of the Inspectorate is necessary for the verification of compliance with licence requirements.

In 2004 the Inspectorate started the development of an integrated oversight process. The aim of this oversight approach is to focus on the effect of regulatory decisions on the safety of the nuclear installation, and to foster the effectiveness, the balanced decision making and the traceability of the Inspectorate's work. To get a realistic picture of the safety of each installation, the Inspectorate implemented a systematic safety assessment system. Safety information is structured by the following key dimensions:

- distinction between safety provisions as they are defined in plant documents and their real state and behaviour;
- distinction between technical aspects and human-organisational aspects;
- levels of defence in depth;
- barriers;
- safety functions.

For each NPP, the data is summarised in a table. The inspection findings, the operator licensing reviews and the results from the event analysis are evaluated within the integrated oversight process on an annual basis.

Article 15: Radiation protection

Based on the recommendations of the International Commission on Radiological Protection (ICRP), both the Radiological Protection Act, and the Radiological Protection Ordinance, have been revised and came into force in 1994. The Inspectorate has subsequently issued revised versions of most of its relevant guidelines. The supervisory and control methods currently applied by the Inspectorate are in compliance with the Convention's requirement to keep radioactive doses to the public and the environment as low as reasonably achievable and also to keep the generation of radioactive waste associated with the use of nuclear power at the lowest possible level.

Calculated doses on the base of annual emissions for a virtual most exposed group of the population, including the exposure due to deposition from former years, have always been well below 0.2 mSv per year. Since 1994, values due to annual releases are below 0.01 mSv per year for all Swiss NPPs. Since 1994, no individual dose exceeding 20 mSv per year has been accumulated by any plant personnel or contractors during their work in the Swiss NPPs. Since 1987, all annual collective doses have remained well below 4 man-Sv per unit and all have been kept below 2 man-Sv since 1995. The low annual individual and collective doses prove the effectiveness of the measures based on the most recent recommendations of the ICRP (e.g. guidelines, job planning and supervision).

The Inspectorate reviews the radiation planning process of the NPPs as a part of its supervisory duties. Additionally the Inspectorate reviews all periodical reports of the power plants related to radiation protection measures.

Article 16: Emergency preparedness

On- and off-site emergency organisations and plans are in place for each nuclear installation. The emergency planning zones around the NPPs are defined. Emergency protective measures such as sheltering and the availability of iodine tablets are also established.

An automatic dose rate monitoring and emergency response data system (ANPA/MADUK) has been installed in and around all NPPs in Switzerland. The data (see www.hsk.ch) is transmitted online to the Inspectorate, the National Emergency Operations Centre (NAZ) and the German Ministry of the Environment of Baden-Württemberg. The MADUK/ANPA system also provides the Inspectorate with online access to the measured values of approximately 25 important plant parameters. The Inspectorate has furthermore set up an automated system for radiological prognosis.

The emergency preparedness and plans are regularly tested by exercises. The channels for alerting the public, NAZ and any concerned neighbouring country are in place. Bilateral agreements exist between Switzerland and its neighbouring countries to deal with alerting in emergency situations.

In order to improve on-site emergency preparedness, the Inspectorate has required the Swiss licencees to implement severe accident management guidance (SAMG). In case of an accident causing severe core damage, SAMG will guide the different emergency organisation teams at NPPs in taking accident mitigation measures based on predefined strategies.

Article 17: Siting

Steps and procedures for evaluating all relevant NPP site-related safety factors are established and implemented within the frame of the licensing procedure. According to the Nuclear Energy Act and the corresponding ordinance the suitability of the site is part of the general licence which will be subjected to a public vote (facultative referendum). The principle of nuclear safety relevant for siting is the protection against external hazards. All relevant factors related to the sites must be included in a Safety Analysis Report. Furthermore, an environmental impact report, a concept for decommissioning and other safety related documents have to be submitted together with the general licence application.

With the application for the construction licence an actualised SAR, a deterministic safety analysis (which can be part of the updated SAR) and a probabilistic safety analysis must be evaluated as described in Article 14. The Inspectorate reviews the submitted documents and publishes the results in a safety evaluation report (SER).

The population of the surrounding areas of a proposed NPP (including areas of neighbouring countries) is invited to participate in the comprehensive public consultation as a part of the licensing procedure. Agreements concerning the exchange of information have been signed with Austria, France, Germany and Italy.

For the re-evaluation of the relevant site-related factors, basically the same procedures as those applied for the initial review and assessment are followed. Because the reporting procedures of the power plant include the relevant site factors, any modifications of the latter and the assessment of their possible consequences are known. As part of a Periodic Safety Review, site-related factors are re-evaluated as well.

The applicability and effectiveness of the Inspectorate's re-evaluation process were demonstrated by the example of the new probabilistic assessment of the seismic hazard at the Swiss nuclear power plant sites (PEGASOS project). This project was carried out by the Swiss licencees in response to a requirement that originated from the Inspectorate’s PSA review process. As a first action based on the findings from the PEGASOS project, the Inspectorate has specified more stringent seismic hazard parameters (as compared to earlier results) to be used in the PSA studies for the Swiss NPPs. Currently, the Inspectorate is also preparing the basis for new seismic design specifications for substantial plant modifications and for licensing of new NPPs. Furthermore, the Inspectorate has requested the licencees to systematically investigate the possibilities and benefits of additional risk-reducing seismic upgrades.

Article 18: Design and construction

Design and construction of the Swiss NPPs are such that the principle of defence in depth is obeyed and a high level of safety is maintained. In particular, all Swiss NPPs have a special independent and bunkered system for emergency core cooling and decay heat removal. The various levels of defence are in place to ensure that safety limits and individual dose limits for the public are met throughout normal operation of the NPP and for all design basis accidents. In addition, the release of radioactive materials to the environment in the case of severe, beyond design basis accidents is mitigated by corresponding measures. Design, materials and components are subject to rigorous control and scrutiny and regular testing in order to verify their fitness for service. Backfitting is carried out when necessary. All Swiss NPPs possess a filtered containment venting system which has the potential to mitigate radiological consequences to the environment in most severe accident scenarios.

The analysis of the safety consequences in case of a deliberate aircraft impact showed that the safety-relevant buildings of the second generation NPPs at Gösgen and Leibstadt provide thorough protection against of a modern, fully fuelled, long-range commercial airplane. For the first generation NPPs at Beznau and Mühleberg, the analyses showed that, due to previous backfitting of special bunkered decay heat removal systems and the implementation of further provisions in the area of fire protection, an adequate level of protection against aircraft impact can still be attained (see www.hsk.ch/english/start.php "Publications").

The increased use of computer supported plant monitoring improves the man-system interface and facilitates the operation of the NPPs in all operation modes. In Beznau NPP (both units) the reactor protection and control systems have been replaced by modern instrumentation and control systems with fully computer based methods.

Article 19: Operation

The requirements for safe operation of the Swiss NPPs are laid down in the operating licence of each NPP. The operation licence includes the authorisation for commissioning. The commissioning programme, which has to be approved by the Inspectorate, comprises the pre-operational and start-up test programme as well as procedures for testing all equipment important to safety. The most important operational procedures are the Technical specifications which include the limiting conditions of operation and which are approved by the Inspectorate. The operational procedures of the NPP also refer to maintenance, testing and surveillance of the equipment.

Engineering and technical support in all safety relevant fields is available to all NPPs staff. The reliable operation of the Swiss NPPs is reflected in the low annual number of reportable events.

The Nuclear Energy Act, the Nuclear Energy Ordinance and regulatory guidelines include requirements on the notification of events and incidents. In accordance with the ordinance, each NPP uses dedicated emergency operation procedures (EOPs) in cases of operational anomalies and emergency conditions. The final goal of EOPs is to bring the plant into a safe operational state. The legislation also requires an extension of the EOPs by severe accident management guidelines. The goal of SAMG is to prevent or at least minimise impact on the environment.

In addition to its general inspection activities, the Inspectorate gains further insight into all aspects of the NPP operation from comprehensive reporting by the operator. The Inspectorate and the operators collect operational experience from domestic and foreign NPPs. In some cases the analyses of particular operating experiences have resulted in important safety related backfitting or in modifications of Swiss NPPs.

The Nuclear Energy Act implements the principle that the producers of radioactive waste are responsible for the safe and permanent management of the waste. The generation of radioactive waste at NPPs is kept as low as possible. This is achieved by virtue of fuel quality and plant cleanliness. The resulting waste is collected and separated. As a general rule, radioactive waste is conditioned as soon as practicable, mostly on site at the NPPs and the Paul Scherrer Institute (PSI), partly externally at the Central Interim Storage Facility (ZZL). All procedures for the conditioning of radioactive waste need to be approved by the Inspectorate. Spent fuel discharged from reactors is stored on site for a few years at each NPP.

The Nuclear Energy Act prohibits the reprocessing of spent nuclear fuel for a period of ten years starting 1 July 2006. At present spent fuel is also stored in transport and storage casks at ZZL, which started active operation in June 2001. The return of waste from foreign reprocessing facilities to ZZL started in 2002 and proceeds on schedule.

Introduction

Country and State

With a total surface of 41,285 km² – more than half of which is mountainous area – and a population of 7.5 million Switzerland is a small and densely populated country. The Rhine, Rhone and Inn rivers originate in the Swiss Alps which are often called the water tower of Europe.

Switzerland has four official languages: German, French, Italian and Rhaeto-Romanic , the latter being spoken by a minority of less than 1%. Today, about 20% of the residents are foreign nationals. Structurally, Switzerland has evolved as a federal state with twenty-three member states, known as cantons. Constitutionally delimited competencies and central tasks are given to the federal authorities. An important number of popular rights are guaranteed on each level. All other legislative power remains with the cantons, which have thus retained a high degree of autonomy. The municipalities and communities also enjoy considerable rights of self-government.

The Federal Council, composed of seven ministers of equal rank, acts as federal government. The Swiss Parliament consists of two chambers. The National Council represents the population as a whole. Its 200 members are elected for a term of four years. The Council of States has 46 members which represent the Swiss cantons. Each canton elects two members.

The voting population has the constitutional right to introduce and to sanction changes to the Federal Constitution and has a right of referendum on federal laws. Changes or a new article to the Federal Constitution can be requested by means of a popular initiative signed by at least 100,000 voters. All constitutional changes must be submitted to a popular vote (obligatory referendum). If a minimum of 50,000 voters challenge a parliamentary proposal for a new federal law or the change of an existing law, the issue is subject to a popular vote (facultative referendum). The cantonal constitutions contain similar rules on popular initiatives and referendums as on the federal level.

The Swiss GDP was approx. EUR 38'000 per capita in 2005. The most important economic sectors are banking, tourism, the manufacture of machinery, the chemical and pharmaceutical industry, the nutrition industry, watches and medical technology. The major export partners are Germany, USA, Italy, France, UK and Spain.

Total energy consumption was nearly 900'000 TJ in 2005. Electricity consumption represents approx. 23% of the energy consumption in Switzerland. The electricity consumption per capita exceeds the EU average by 20%, whereas total energy consumption per capita falls slightly below the EU average. Electricity is primarily produced with hydroelectric (57%) and nuclear power (38%). Therefore, the CO_2 emissions per capita are at the lowest level in Western Europe – 5.8 t per year, compared to 8.2 t in the EU and 20.6 t in the USA.

Background of nuclear power in Switzerland

Until the late 1960s, Switzerland generated electricity exclusively from hydro power without resorting to fossil fuels, the latter not being available as a natural resource in the country. Already in the mid 1950s, an interest in the relatively new nuclear energy technology was manifested to cover an increasing power demand. In accordance with the general policy concerning the production of electricity, the promotion and use of nuclear energy was left to the initiative of the private sector. It was recognised, however, that the implementation of any nuclear programme requires a legislative framework to ensure safety and radiation protection, and that such a legislation should be established exclusively at the federal level. Therefore, a corresponding article was introduced into the Swiss Constitution and approved by vote of the Swiss population in 1957. Based on this article, the Atomic Energy Act was put into force in 1959.

In 2005, a new Nuclear Energy Act and its corresponding ordinance became effective, replacing the Atomic Energy Act of 1959. With this new Nuclear Energy Act, the unconditional authority of the Federal Council to grant general licences for new NPPs was abolished and any decision on granting new general licences for new NPPs will be subject to an optional public vote. The Federal Government now also has full legal responsibility for geological waste repositories.

Since nuclear power production is within the realm of private industry, there is no "national nuclear programme" as such. During the 1960s, a series of projects for establishing NPPs were initiated. Four of them reached the stage of realisation, leading to five currently operating units commissioned between 1969 and 1984. These five units account for approximately 40% of the national electricity production.

In February 2007, the Federal Government issued a new national energy strategy, including – besides the promotion of energy efficiency, renewable energy and international co-operation – the building of new large-scale power plants and NPPs in particular.

Nuclear power plants

The five Swiss NPPs – Beznau I and II, Mühleberg, Gösgen and Leibstadt – are located at four different sites, have four different reactor and containment designs and were delivered by three different reactor suppliers (Westinghouse, GE and KWU). There are local suppliers for civil engineering and buildings, and for mechanical and electrotechnical equipment.

The NPPs are operated by the following companies:

Beznau I&II	Nordostschweizerische Kraftwerke AG
Mühleberg	BKW FMB Energie AG
Gösgen	Kernkraftwerk Gösgen-Däniken AG
Leibstadt	Kernkraftwerk Leibstadt AG

The main technical characteristics of the Swiss NPPs are summarised in Table 1.

Table 1: Main technical characteristics of the Swiss NPPs (July 2007).

	First generation NPPs			Second generation NPPs	
	Beznau I	Beznau II	Mühleberg	Gösgen	Leibstadt
Licenced thermal power P_{th} [MW_{th}]	1130	1130	1097	3002	3600
Nominal net electrical power P_{el} [MW_{el}]	365	365	355	970	1165
Reactor type	PWR	PWR	BWR	PWR	BWR
Containment type	Large dry, free standing steel inside concrete building	Large dry, free standing steel inside concrete building	Pressure suppression, Mk I inside concrete building	Large dry, free standing steel inside concrete building	Pressure suppression, Mk III inside concrete building
Normal heat sink	River Aare	River Aare	River Aare	Wet cooling tower (River Aare)	Wet cooling tower (River Rhine)
Number of reactor coolant pumps	2	2	2	3	2
Number of turbine sets	2	2	2	1	1
Number of fuel assemblies	121	121	240	177	648
Fuel	UO_2 (+MOX)	UO_2 (+MOX)	UO_2	UO_2 (+MOX)	UO_2
Number of control assemblies	25	25	57	48	149
Reactor supplier	W	W	GE	KWU	GE
Turbine supplier	BBC	BBC	BBC	KWU	BBC
Site Licence	1964	1967	1965	1972	1969
Construction licence	1964	1967	1967	1973	1975
First operation licence	1969	1971	1971	1978	1984
Commercial operation	1969	1971	1972	1979	1984
Backfitted bunkered automatic ECCS and residual heat removal system since	1993	1992	1989	Included in the original design	Included in the original design
Filtered containment venting system since	1993	1992	1992	1993	1993

Abbreviations

Mk I, Mk III	GE Containment Types Mark I and Mark III
PWR	Pressurised Water Reactor
BWR	Boiling Water Reactor
W	Westinghouse Electric Company
GE	General Electric Company
KWU	Kraftwerk Union (now Areva NP)
BBC	Brown Boveri & Cie, AG (now Alstom)
UO_2	Uranium oxide
MOX	Mixed oxide
ECCS	Emergency core cooling system

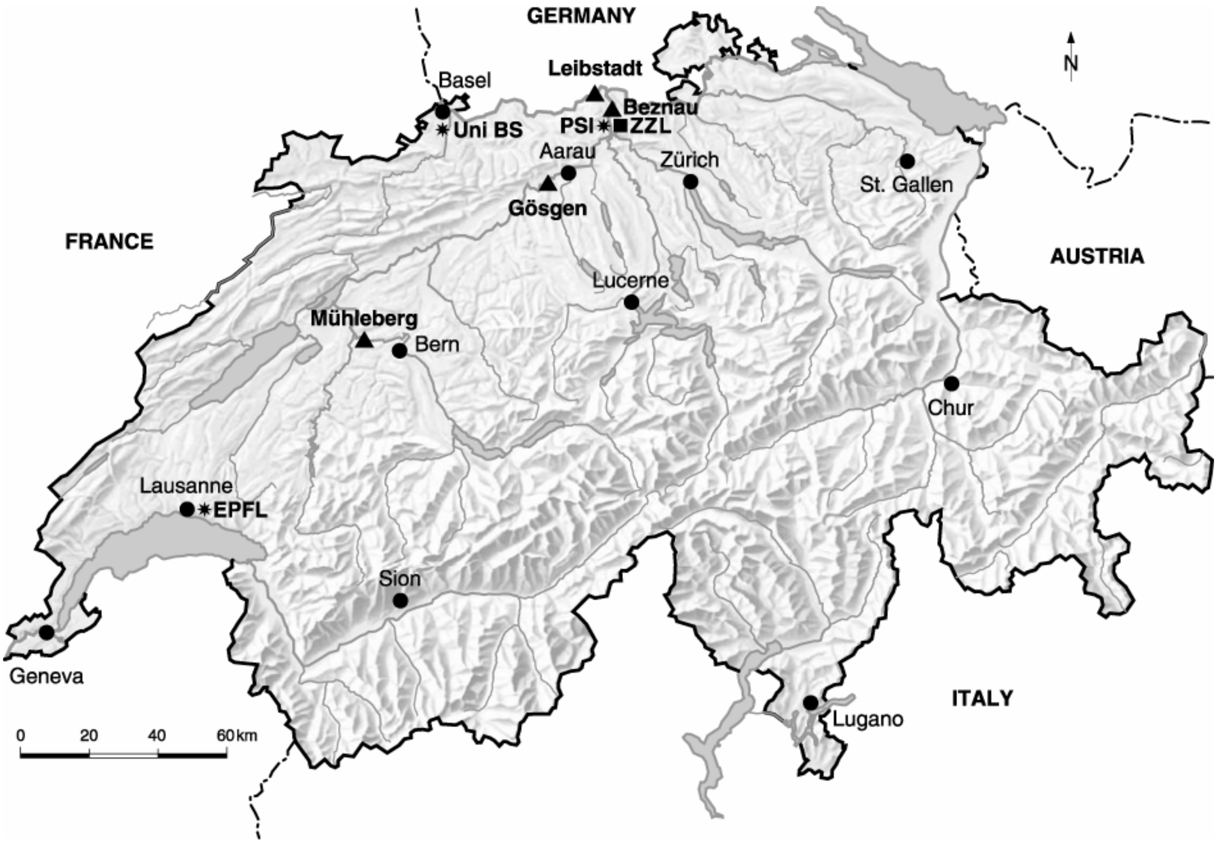

Figure 1: Geographical position of the Swiss nuclear facilities. The sites of the NPPs are marked by triangles. Experimental and research installations are marked by stars. Facilities for nuclear waste management are marked by squares. Dots mark the major cities.

Due to Switzerland's mountainous landscape, the number of suitable NPP sites is limited. Two sites are located near the German border, at a distance of 0.5 km (Leibstadt) and of 5 km (Beznau I&II). The two other sites are located about 40 km from the French and 20 km from the German border, respectively. The geographical position of all Swiss nuclear facilities is shown on the map in figure 1.

Facilities for nuclear education, research and development

The major portion of nuclear research in Switzerland is performed at the Paul Scherrer Institute (PSI). Work is carried out at PSI in collaboration with other national and international research institutes and with the industry in the following areas: elementary particle physics, biological sciences including radiation protection, solid state research and material science, nuclear energy research, non-nuclear energy research and environmental research related to the production of energy, medical research and medical treatment (oncology).

At the PSI location there are several nuclear installations and accelerators of which the research reactor PROTEUS and the Hot Laboratory are the most important from the point of view of nuclear safety. The research reactors DIORIT and SAPHIR are in the state of decommissioning. There are two small research reactors ($P < 2\ kW_{th}$) being used mainly for teaching purposes at the University of Basel (Uni BS) and at the Swiss Federal Institute of Technology Lausanne (EPFL).

The former experimental NPP in Lucens (underground, D_2O moderated, CO_2 cooled, 30 MW_{th}, 8 MW_{el}) was shut down and decommissioned after a loss of coolant accident in 1969. With the exception of a small nuclear waste storage area, this site was declassified and released for non-nuclear activities in March 1995. In 2003, the nuclear waste from this storage area was transported to the Central Interim Storage Facility (ZZL). The Swiss Government released the Lucens site from nuclear legislation in 2004.

Nuclear waste

Each NPP has installations for the conditioning and interim storage of radioactive waste resulting from its operation. At the Beznau site, an additional facility for dry storage of spent fuel elements is presently equipped and expected to start operation in autumn 2007. At the Gösgen site, a building for wet storage of spent fuel elements has been licenced in 2004 and is under construction.

PSI operates the national collection centre for all non-nuclear radioactive waste, meaning waste from medicine, industry and research. This waste can be treated at PSI installations and is interim stored at the Federal Interim Storage Facility (BZL).

The Central Interim Storage Facility for nuclear waste (ZZL) has been constructed by the utility-owned company ZWILAG right beside the PSI campus. In addition to storage capacity for spent fuel, vitrified high-level waste, intermediate and low-level radioactive waste, the facility comprises installations for the conditioning of specific waste categories and the incineration or melting of low-level waste. ZZL started active operation in June 2001. Its interim storage capacity relieves the time pressure from implementing final disposal facilities.

The technical feasibility of the disposal of high level and long-lived intermediate level waste in Switzerland has been demonstrated. As a result of a broad selection process, the NPP operators chose a region of Opalinus clay in the Zürich Weinland for detailed geological investigations. The results of these investigations formed the basis of a feasibility demonstration for a deep geological repository, which has been submitted for review to the federal authorities in 2002. The Federal Government approved this feasibility demonstration in 2006.

According to the legislation on nuclear energy, the site selection process for radioactive waste repositories will be defined in a sectoral plan within the framework of the existing spatial planning legislation. Site selection will be based primarily on technical criteria, with the main emphasis on safety, but must also address land use planning, environmental impact and socio-economic aspects. The conceptual part of the „Deep Geological Repository Sectoral Plan“ defining the process in detail was prepared by the responsible federal authorities under the leadership of the Federal Office of Energy. The cantons and the relevant authorities in Switzerland’s neighbouring countries were invited to participate in the process. A broad public consultation procedure was completed in April 2007. After the approval of the conceptual part by the Federal Government, the site selection procedure will begin.

The feasibility demonstration for a low and intermediate level waste repository has been approved by the Federal Government in 1988. The application for the federal general licence for such a repository at the Wellenberg site in Canton Nidwalden was submitted in 1994. The cantonal legislation requests a mining concession for the construction permission of a low and intermediate level waste repository. In 1995, the citizens of the canton did not approve this concession. A new application for a mining concession relating only to an exploratory drift was submitted in January 2001 and once again rejected by cantonal public vote in September 2002. The NPP operators subsequently decided to abandon the Wellenberg project.

Article 6: Existing nuclear installations

Each Contracting Party shall take the appropriate steps to ensure that the safety of nuclear installations existing at the time the Convention enters into force for that Contracting Party is reviewed as soon as possible. When necessary in the context of this Convention, the Contracting Party shall ensure that all reasonably practicable improvements are made as a matter of urgency to upgrade the safety of the nuclear installation. If such upgrading cannot be achieved, plans should be implemented to shut down the nuclear installation as soon as practically possible. The timing of the shut-down may take into account the whole energy context and possible alternatives as well as the social, environmental and economic impact.

The general safety status of the Swiss NPPs was satisfactory at the time the Convention entered into force. Extensive reviews have been and are being carried out for all NPPs at least every 10 years (periodic safety review – PSR); for all NPPs safety has been satisfactorily proven based on deterministic and probabilistic assessments, operational performance and safety culture aspects.

The Swiss NPPs of the **first generation** (Beznau and Mühleberg) went into operation from 1969 through 1972. The review and assessment of the application for the site, construction and operating licences was done by the Swiss Federal Nuclear Safety Commission (KSA). It mainly relied on US regulations and guides of that time, since the two reactor suppliers involved were US-American.

However, in those days some principles of nuclear safety were not yet commonly acknowledged and were not taken into account, such as:

- separation criteria for electrotechnical and mechanical equipment to protect the NPP from common cause failures by fire or internal flood, for example;
- rigorous application of the single failure criterion, including to supporting systems, for the case of loss of offsite power;
- protection of residual heat removal (RHR) systems against external events (such as aircraft crashes, earthquakes, floods, lightning and sabotage);
- supplementary shutdown capability in a remote area in the case of the loss of the main control room.

As early as 1980, two major backfitting projects were required by the safety authorities in order to improve the RHR systems in the first generation plants. These projects, extending over several years, were known under the name "NANO" for the PWR twin-unit at Beznau and "SUSAN" for the BWR at Mühleberg. Furthermore, in the late 1980's, a seismic requalification was carried out. The backfitting was performed mainly by adding one or two completely separated shutdown and RHR systems, including their support systems, addressing the previously mentioned four issues. For further backfitting activities see Article 14 and 18.

Extensive reviews were performed after these major backfitting projects for both plants. The reviews were completed in 1992 for Mühleberg NPP and in 1994 for Beznau NPPs. Due to these backfittings, the two NPPs were granted new operation licences. The latest extensive reviews of these NPPs were performed as PSRs. The assessment of these PSRs was completed in 2002 and 2007 for Mühleberg NPP and for Beznau NPP in 2004.

The **second generation** NPPs went into operation in 1979 (Gösgen) and in 1984 (Leibstadt). Their degree of redundancy was higher and their protection against external events was significantly improved compared to the first generation plants. Some further improvements were introduced during licensing and construction (in particular, inclusion of a special emergency heat removal system "SEHR", in Leibstadt NPP).

Both second generation plants were subject to a PSR. For the Leibstadt plant, this review was performed 1996 together with the review of the 14.7 % power uprate request of the utility. Based on this review, only minor requirements resulted. These requirements mainly related to obtaining a better response to anticipated transients without scrams. The PSR for the Gösgen plant was finished in 1999. The latest PSR for Leibstadt has been submitted to HSK by the end of 2006. HSK’s review report shall be finished by the end of 2008. The new PSR for Gösgen has to be submitted to HSK by end of 2008.

In 1993, all plants were backfitted with a filtered containment venting system to mitigate the consequences of severe accidents (e.g. failure of RHR systems). In addition to the NANO feedwater system an emergency feed water system was installed in both units of Beznau in the year 1999 and 2000. This was done to improve the reliability and the capacity of the auxiliary feed water system. Additionally, in both units of Beznau improvements of the reactor protection system and control systems concerning separation, redundancy, self-supervision, testability and reliability of power supply have been achieved by replacing the original systems with a state-of-the-art computer based system in 2000 and 2001.

An overview of the main technical characteristics of the Swiss NPPs is compiled in Table 1.

The most important measures resulting from the last PSR were:

KKB: Installation of a Full-Scope-Replica-Simulator, update of the probabilistic earthquake analysis to the state of the art and the adaptation of the inspection programme for the reactor pressure vessel head and bottom penetrations to results from the worldwide operating experience.

KKM: The PSR was adapted to the state of the art, the ageing management programme was expanded and the technical specifications as well as the instrumentation dedicated to accident management have been improved.

KKG: Lightning countermeasures have been evaluated and improvements have been implemented, the primary venting system has been upgraded to the state of the art (controllable and venting of a vapour/water mixture) and several improvements to buildings against earthquakes have been made. There have been improvements to the instrumentation dedicated to accident management, user friendliness, technical specifications and emergency plans and other more. An ageing management programme has been established and improvement in the emergency organisation has been made.

Developments and Conclusion

There are no important changes and developments concerning article 6.

The Swiss Party complies with the obligations of Article 6.

Article 7: Legislative and regulatory framework

Clause 1
Each Contracting Party shall establish and maintain a legislative and regulatory framework to govern the safety of nuclear installations.

The legislative and regulatory framework in Switzerland for governing the peaceful use of nuclear energy, the safety of nuclear installations and radiological protection is established on a four-level system:

- 1st level: Federal Constitution;
- 2nd level: Federal Laws;
- 3rd level: Ordinances (issued by federal/licensing/regulatory authorities);
- 4th level: Regulatory guidelines.

Federal Constitution (1st level)

Articles 90 and 118 stipulate that legislation for the use of nuclear energy and on radiological protection is enacted exclusively at the federal (national) level. According to this, the Federal Parliament and the Federal Council (government) have the exclusive authority to establish legislation in the field of radiation protection and the use of nuclear energy.

Federal Laws (2nd level)

The main legal provisions for authorisations and regulation, supervision and inspection are established by the following acts:

- Nuclear Energy Act (in force since 2005);
- Radiological Protection Act (in force since 1991).

Nuclear Energy Act

Under this act, nuclear installations are facilities for the utilisation of nuclear energy, for the manufacturing, use, processing or storage of nuclear materials, as well as for the disposal of radioactive waste.

The most important provisions of the Nuclear Energy Act are:

- basic principles of nuclear safety, including the precautionary principle, the protection of the population and the environment and measures to prevent sabotage and the proliferation of nuclear material;
- a licensing procedure describing authorisations (licences) for siting, construction (including design), operation (including commissioning) and decommissioning. Each licence may contain licence conditions that are mandatory for the applicant. The procedure also includes the course of action for modifications to the licence. The licensing procedure furthermore grants extensive rights of appeal to third parties. Cantonal licences and plans are no longer required. Cantonal legislation is to be respected insofar as it does not disproportionately restrict the project. (see Article 7 Clause 2 (ii));

- general responsibilities of the licence holder, including his responsibility for the safety of the installation, the requirement of periodic safety reviews for NPPs and the obligation of the licence holder to backfit the installation to the extent necessary according to worldwide operating experience and the current state of backfitting technology;
- regulations on decommissioning and on the disposal of radioactive waste, including the licencee's obligation to decommission and dispose waste at his own cost;
- special dispositions concerning geological repositories;
- the installation of supervisory authorities, their formal independence from licensing authorities and their duties, including the authority to order the application of all measures necessary and appropriate to the preservation of nuclear safety and security;
- penal provisions.

Radiological Protection Act

The Radiological Protection Act covers every aspect of the protection of the personnel in NPPs, the public and the environment against hazards caused by ionising radiation resulting from all activities, facilities, events and circumstances involving such radiation.

The Radiological Protection Act covers among others the following subjects:

- fundamental principles (justification and limitation of exposure, dose limits);
- protection of persons who are occupationally exposed to radiation and of the general population;
- the evaluation of worldwide operating experience and of the state of science and technology;
- permanent monitoring of the environment and during periods of elevated radiation;
- radioactive waste management.

Legislation in other areas with a link to nuclear energy

A number of acts (and ordinances) are related to security matters or indirectly related to nuclear safety and cover areas such as land use planning, protection of the environment and landscape, forestry, water protection, fire protection and occupational safety as well as technical safety and radiological protection aspects of the transport of radioactive substances, including fuel assemblies. The latter regulations are based on the international transport regulations, which are in turn based on the IAEA regulations for the safe transport of radioactive materials.

Ordinances (3rd level)

A number of federal ordinances (lower levels of legislation) exist that are relevant to nuclear energy legislation. The most important ordinances are:

- Nuclear Energy Ordinance (KEV, 2005)
- Radiological Protection Ordinance (StSV, 1994);
- Ordinance on the emergency organisation in case of increased radioactivity (VEOR,

1991) and the Federal Ordinance on the National Emergency Operations Centre (1990)

- Ordinance on safety-classified vessels and piping in nuclear facilities (VBRK, 2006);
- Ordinance on qualifications of personnel in nuclear facilities (VAPK, 2006);
- Ordinance on dosimetry (1999).

In the following, the major ordinances are briefly commented on:

Nuclear Energy Ordinance (KEV)

This ordinance contains the rules for the implementation of the provisions of the Nuclear Energy Act. It contains basic design criteria for NPPs and specifies the licensing requirements as well as the documents to be submitted to the licensing and regulatory authorities in support of the licensing/permit processes. The ordinance's appendix designates all plant documents that constitute an integral part of the operating licence, specifies the reporting requirements both for normal operations and for reportable events.

Radiological Protection Ordinance

This ordinance is based on the Radiological Protection Act and takes fully into account the latest recommendations of the International Commission on Radiological Protection (ICRP) (Publication No. 60). Together with the Radiological Protection Act, this ordinance regulates the radiological protection of all persons (individuals of the population and individuals working in radiation fields and with radioactive substances, including medical applications). Furthermore, the act and the ordinance on radiological protection also include all aspects of environmental protection associated with radioactive materials and ionising radiation.

Ordinance on the emergency organisation in case of increased radioactivity and the Federal ordinance on the National Emergency Operations Centre

This ordinance designates the authorities and lays down rules concerning their organisation as well as their areas of intervention in emergency situations. One of the cornerstones of the Swiss emergency organisation is incorporated in the National Emergency Operations Centre (NAZ). The Federal Ordinance on the NAZ stipulates the tasks of the Centre, its competencies, its organisational set-up and the instruments to fulfil its tasks.

Ordinance on safety-classified vessels and piping in nuclear facilities (VBRK)

This ordinance describes the qualifications on safety and on periodic testing of vessels and piping.

Ordinance on requirements for the personnel of nuclear installations (VAPK)

This ordinance describes the safety-related requirements on qualification, training and eligibility of personnel in nuclear facilities.

Planned new ordinances

By spring 2007 consultations for two new ordinances have started. The first one deals with the assumptions of threats and criteria for evaluation of protection against malfunctions with origins inside and outside of NPPs. The second ordinance deals with methodology and boundary conditions for examination of criteria for the temporary placing out of operation of NPPs.

Regulatory guidelines (4th level)

Regulatory guidelines are prepared and established by the supervisory authorities (Inspectorate and SK of BFE . The nature and use of regulatory guidelines is explained in connection with Clause 2 (i) of this Article.

Clause 2 (i)
The legislative and regulatory framework shall provide for the establishment of applicable national safety requirements and regulations.

National requirements

Safety requirements and regulations are contained in the ordinances and are detailed in regulatory guidelines. Requirements and conditions stated in ordinances are mandatory, whereas the content of regulatory guidelines is semi-mandatory. The regulatory guidelines state how the supervisory authorities (see article 8) carry out the supervision. It may be detailed or limited to safety objectives. In the latter case the applicants/licencees must seek and propose technical solutions reflecting the internationally recognised state of science and technology. The review and assessment of these proposals (being essential parts of the application) is done by the supervisory authorities.

Regulatory guidelines may contain design or procedural guidance, prescribing (administrative) procedures that have to be followed; these are again not mandatory. Applicants may choose other solutions, but when they do so, they have to demonstrate that the same level of safety is attained.

The Inspectorate has established a number of regulatory guidelines that contain mandatory as well as non-mandatory requirements and conditions. Since these guidelines were based on the former Atomic Act of 1959, a revision has become necessary and is now under way. The process of revision of all guidelines will go on for another two or three years. A list of the regulatory guidelines currently in force is given as Appendix 2. The current status of the guidelines is available under HSK's web-side www.hsk.ch.

International harmonisation

Switzerland, together with the other WENRA members, has signed up to the incorporation of the Safety Reference Levels (SRLs) into its domestic legislative framework by 2010. SRLs define the safety levels for nuclear facilities in Europe, most of which have already been implemented by nuclear facilities in Switzerland. Since 2004, the Inspectorate participates in the WENRA groups "Reactor Harmonisation" and "Waste and Decommissioning". The Swiss self assessment in the area of "Reactor Harmonisation" identified 99 issues (i.e., "Reference Levels") which have to be integrated into the Swiss legislative framework. In addition, there are 19 issues on the implementation side (all of them are documentation requirements). According to the Swiss "Reactor Harmonisation" action plan, the implementation process will be completed 2010 latest. The action plan for "Waste and Decommissioning" will be prepared by the end of 2008.

The Inspectorate takes part in several IAEA commissions. At the beginning of the planning of a new guide the Inspectorate makes an evaluation of the existing Safety Fundamentals and Safety Requirements in the field of the new guide. In 2007 the Inspectorate has started to check the implementation of the IAEA Safety Fundamentals and Safety Requirements into Swiss law. Connections to WENRA Reference levels will be made. Gaps between Swiss law and international harmonisation standards are going to be identified. If gaps with no justification will be found, Switzerland is going to fill these gaps.

Clause 2 (ii)
The legislative and regulatory framework shall provide for a system of licensing with regard to nuclear installations and the prohibition of the operation of a nuclear installation without a licence.

The Swiss licensing procedure arises directly from the requirements of the legislative and regulatory framework described above as part of Clause 1 of this Article. This licensing system involves the establishment of a supervisory body (see Article 8), the requirement for licences and the constitution of a licensing process. There are a lot of criminal provisions. The most important is in article 90 paragraph 1 of the Nuclear Energy Act. It says that the construction or operation of a nuclear facility without a licence is a criminal offence.

Types of licences

Two main licence types are applied:

- **General Licence:** It is applicable to any new nuclear installation since 1978 and includes the site licence. The four NPPs (five units) currently in operation have no general licence since they were granted site and construction licences prior to that date. The general licence determines the site and the main features of the project. A valid general licence is a prerequisite to the subsequent granting of construction and operating licences.
- **Licences for construction, commissioning, operation, modification or decommissioning:** These licences are by nature primarily technical since the main requirements relate to nuclear safety.

Granting of both licence types is subject to the licensing procedure described below.

Licensing procedure

The general licence is granted by the Federal Council and must first be approved by the Federal Parliament, and, in the case of a popular referendum, by the people of Switzerland; moreover, the general licence is granted only if the safe management of the radioactive waste, including disposal from the installation, is guaranteed, including radioactive waste arising from decommissioning and possible dismantling of the installation after final shutdown.

The other above mentioned licences are granted by the Department of the Environment, Transport, Energy and Communications (UVEK). It bases its decision on:

- the application for a project, supported by a safety analysis report (SAR) and for the construction and operating licences a probabilistic safety analysis (PSA), all to be submitted by the applicant;

- the safety evaluation by the Inspectorate, which reviews and reassesses the application of the project from the point of view of nuclear safety and radiation protection, takes into account the experiences and the state of science and technology. The result of the regulatory review and reassessment is documented in a safety evaluation report (SER), which includes conclusions and, if necessary, proposals for licence conditions to be formulated in conjunction with the licence (see Article 14);
- a statement by the advisory committee (KSA) on basic aspects of the application and on the SER, including, as far as appropriate, a proposal for licence conditions, and
- a comprehensive public consultation.

The licence will be denied or made subject to appropriate conditions, in cases where this is necessary for safeguarding Switzerland's national security, for meeting its international commitments or for protecting persons, property and other fundamental rights. The licence will also be denied if the applicant cannot provide evidence of sufficient insurance coverage (civil liability) or if he cannot demonstrate that the operating staff has the necessary skills.

Licence conditions are legally binding as soon as they are included in a granted licence; they constitute, therefore, a powerful tool for imposing requirements. The licensing procedure attributes extensive rights of appeal to the licencee or to third parties concerned with the project of a nuclear installation.

In order to control the licence conditions, a permit procedure is applied. The permits that may be granted by the supervisory authorities within the frame of a valid licence are defined in the Nuclear Energy Ordinance or in a licence. They include selected parts of the construction work; manufacture of important components; assembling and wiring on site; sets of commissioning tests as well as any safety-relevant changes to the installation during operation. This "permit procedure" may also be considered as one of the means of enforcement under the control of the Inspectorate (see Clause 2 (iv) of this Article).

Clause 2 (iii)
The legislative and regulatory framework shall provide for a system of regulatory inspection and assessment of nuclear installations to ascertain compliance with applicable regulations and the terms of licences.

The legal basis for inspections by the Inspectorate is given in the Nuclear Energy Act, which prescribes supervision, hence inspection, by Federal authorities.

The Nuclear Energy Act grants the Inspectorate an unrestricted right of access. This right of access extends to all relevant documentation, including documentation located in the offices of supplier organisations. This right of access is given to all the Inspectorate's representatives (and/or external experts under contract with the Inspectorate).

The objective of regulatory inspections is to receive evidence of the quality of the licencee's activities and, in that respect, to ensure that the licencee fulfils its prime responsibility for safety. The Inspectorate, with the help of its mandated experts, reviews the licencee's programmes and independently assesses licencee performance by (i) observing specific activities and by (ii) carrying out its own inspections and taking its own measurements.

Clause 2 (iv)
The legislative and regulatory framework shall provide for the enforcement of applicable regulations and of the terms of the licence, including suspension, modification or revocation.

The licensing and regulatory authorities have full power of enforcement on the basis of the Nuclear Energy Act. They can order all measures necessary to protect persons and property and other important rights, to safeguard Switzerland's national security and to ensure compliance with its international commitments, as well as to check the application of measures.

Concerning licences, the licensing authorities (Federal Council, Department of the Environment, Transport, Energy and Communications) will deny a licence (general licence, licence for construction, commissioning, operation, modification or decommissioning of NPPs) when the prerequisites enunciated in the law are not fulfilled. They can suspend or withdraw a licence when these prerequisites are no longer fulfilled. The Inspectorate has the authority to suspend or withdraw permits.

The supervisory authorities shall regulate all necessary and reasonable measures aimed at preserving nuclear safety and security. In the event of an immediate threat, they may impose emergency measures that deviate from the issued licence or ruling. If necessary they may seize nuclear goods or radioactive waste and eliminate sources of threat at the cost of the proprietor. They may call on the intervention of cantonal and communal police forces, as well as the investigation bodies of the customs administration. In the event that offences against the provisions of this act may have been committed, the supervisory authorities may call on the intervention of the relevant federal police authority. The Federal Council may order the precautionary shutdown of nuclear power plants in extraordinary situations.

Developments and Conclusion

On 1 February 2005 the new Nuclear Energy Act and the Nuclear Energy Ordinance came into force. They displace the old Atomic Act dating back into 1959. Basing on the new legislation other new ordinances are either planned or have already come into force. The new legal basis contains now a lot of the requirements of the guidelines of the Inspectorate. Therefore all guidelines of the Inspectorate are going to be revised formally and substantially.

There have been made improvements in harmonising with international requirements of WENRA and IAEA.

The Swiss Party complies with the obligations of Article 7.

Article 8: Regulatory body

Clause 1

Each Contracting Party shall establish or designate a regulatory body entrusted with the implementation of the legislative and regulatory framework referred to in Article 7, and provided with adequate authority, competence and financial and human resources to fulfil its assigned responsibilities.

Organisation and competence of the regulatory body

Besides the licensing authorities, the Federal Council and the Department of the Environment, Transport, Energy and Communications (see Article 7), the Swiss regulatory body consists of the following organisational units:

- the Swiss Federal Nuclear Safety Inspectorate (HSK) as the supervisory authority for nuclear safety and radiological protection;
- the Safeguards and Protection against Sabotage of Nuclear Facilities Section (SK) of the Swiss Federal Office of Energy (BFE) as the supervisory authority for nuclear security and safeguards.

In addition, the Swiss Federal Nuclear Safety Commission (KSA) is designated as an advisory body to the Federal Council and the Department (UVEK). Its main duties shall be to examine fundamental issues concerning nuclear safety, to monitor the operation of nuclear facilities and provide advisory opinions on applications submitted for licences relating to nuclear facilities.

Like KSA, there are several other federal authorities that have duties associated with the operation of NPPs, but they have no authority over these plants.

<u>Supervisory authorities</u>

The Inspectorate is established by the Nuclear Energy Ordinance as the authority for supervising nuclear installations at all stages of their lifecycle. It is part of BFE. Section SK of the same office covers the aspects of physical protection and safeguard.

These supervisory authorities have the following competences and duties:

- establish safety criteria and requirements taking into account experience (feedback) and the state of science and technology;
- prepare safety evaluation reports (SER) to support the decision of the licensing authority;
- supervise the fulfilment of regulations including inspections, reporting and request documentation on aspects of nuclear safety and radiological protection;
- grant, suspend or withdraw permits;
- order the application of all measures necessary and appropriate to the preservation of nuclear safety and security, including the precautionary and active protection of the personnel in the NPPs, the public and the environment against hazards caused by radiation;

- ensure on- and off-site emergency planning and appropriate information in the event of an emergency according to Article 16.

The Inspectorate coordinates the activities of the supervisory authorities.

Advisory committee

The Swiss Federal Nuclear Safety Commission (KSA) is involved in the licensing process as it has to review and comment on the licence applications and the corresponding safety evaluation reports prepared by the supervisory authorities and to forward its conclusions and recommendations to the Federal Council.

Moreover, KSA observes operation of the nuclear installations, considering fundamental aspects of nuclear safety and proposes necessary measures. KSA has the following competences:

- comment on new or changed laws and the development of the regulations with respect to nuclear safety, and to recommend additional or modified regulations;
- recommend measures to increase the safety of nuclear installations or to improve the licensing procedure and the surveillance of operation;
- propose of research work in the field of nuclear safety.

Discrepancies in the safety requirements of KSA and the supervisory authorities will by escalated to the licensing authority for resolution and become transparent within the frame of the revision process.

Others

The authorities listed below have duties associated with the operation of NPPs, but they are not involved in the licensing process and they have no authority over these plants:

- the National Emergency Operations Centre (NAZ), as part of the Federal office of Civil Protection in the Federal Department of Defence, Civil Protection and Sports (VBS), is in charge of all emergency situations, including those due to events at NPPs as far as protection of the public and the environment is concerned;
- the Division of Radiological Protection at the Federal Office of Public Health (BAG), which is in charge of radiological monitoring of the environment (outside of the nuclear installations);
- a number of advisory committees to the government or governmental departments covering aspects of radiological protection, emergency planning and waste disposal.

Financial and human resources

All expenses of the safety authorities (with exception of the regulatory framework and the information of the public) adding up to almost 30 million CHF per year, are covered by fees from licence holders. Nuclear safety research, as far as promoted and endorsed by the regulatory body, is endowed with a budget of 4.2 million CHF and is covered by public funds. Additional 1.7 million CHF are financed partly by the operators of NPPs and partly by the Paul Scherrer Institute (PSI, a research centre).

Supervisory authorities

The Inspectorate is part of the BFE. In conjunction with the implementation of a New Public Management System (FLAG) the Inspectorate has published a four year Business Plan and carries the responsibility for a government approved global budget. The FLAG regime has become effective in January 2004 and helps the Inspectorate to improve its flexibility for budget decisions and recruiting of personnel.

The Inspectorate currently has a staff of about 70 specialists. The distribution of specialists over the different branches is:

- 29 reactor safety;
- 24 radiation protection and emergency preparedness;
- 10 waste management and transport safety;
- 10 inspection management and international affairs.

The staff for administrative and infrastructural tasks consists of about 20 people.

The Section SK of the Federal Office of Energy currently consists of 6 people.

Independent consultants are engaged for the supervision of special fields in the Swiss NPPs. The complete area of the surveillance of manufacturing, repair, replacement, modification and in-service inspections of pressure-bounding components has been fully outsourced to the Swiss Association for Technical Inspections (SVTI), an independent private organisation. To cover special technical areas (e.g. civil engineering), an additional amount of money, corresponding to about 16 full-time experts, is made available every year.

Advisory committee

The KSA consists of 13 part time members, supported by a secretariat with a staff of 4 full-time positions and, if necessary, by experts in specific fields of interest. Its members are appointed by the Federal Council upon proposition by the Committee itself. All 13 members are appointed "ad Personam", that is they do not represent their organisations. The Committee members cover a broad range of expertise including most if not all disciplines related to reactor safety, radiation protection, emergency preparedness, waste management and transport safety.

Quality management

The Inspectorate uses a process oriented Management System (MS) which was certified according to ISO 9001 standard in December 2001. Attainment of the certificates according to ISO 14001 (environmental management) and OHSAS 18001 (safety & health management) is planned for November 2007.

The Inspectorate's Management System is applied to all its relevant activities and includes the Inspectorate's safety policy as well as the Inspectorate's Performance Mandate. The Performance Mandate was enacted by the Federal Council and provides for requirements, goals and the corresponding controlling procedures, including performance indicators, for a period of four years. On the other hand the Inspectorate got its own Global Budget. Within this budget it is free to decide where to invest its financial means. Especially the restrictions on personal budgets have been omitted. This gives more flexibility than a classical budget where every expense is specified.

The Management System is subject to continuous improvement from self evaluations through internal audits, management reviews, evaluation of performance indicators and routine checks by the certification agency.

- **Internal audits**: ISO 9001 requires that the institution shall arrange for audits of its activities at appropriate intervals to verify that its operations continue to comply with the requirements of the quality system. A team of ten staff members assigned and trained as quality auditors carries out internal audits according to a yearly audit plan. All processes are internally audited at least once in three years.
- **Management reviews**: These are carried out twice a year by the senior management of the Inspectorate to assess the staff quality performance (e.g. by appraisal of performance indicators) and to reflect changes that have taken place (or are expected to take place) in the organisation, facilities, staffing, procedures, activities and workload. The senior management is also responsible for ensuring that any action identified during an internal audit, surveillance or reassessment visits by IRRS and the certification body or complaints from customers and internal suggestions for improvement are implemented within the agreed time limit. This process is supported and managed by a sophisticated but simple IT tool.
- **Performance indicators**: Performance indicators have been defined for each process. The results are evaluated by the process owners and reviewed in conjunction with the management review mentioned above.
- **External audits**: Having passed a follow-up mission by an International Regulatory Review Team (IRRT) from IAEA in 2003 the external audits in the reporting period were restricted to the renewal audit for the ISO 9001 certificate in 2004. The second renewal audit for certificate is planned in November 2007.

All these efforts and measures provide the means for continuous assessment and opportunities for improvement of the Inspectorate's Management System. They also facilitated the introduction of the New Public Management Elements and generally strengthen the Inspectorate's regulatory effectiveness.

Knowledge management and training

The Inspectorate currently faces a generation change. In the years 2005 to 2007 it will have to replace one third of its management and will at the same time loose valuable know-how. Knowledge management is considered to be a valuable tool in order to cope with this change.

The specific implementation is integrated in the Inspectorates Management System. It includes a systematic compilation of the competence and knowledge need of every organisational unit which is annually required by the management. The training of the staff members is based on this compilation. There is a career development programme making use of personal potential assessments. In addition the Inspectorate tries to replace leaving employees at a very early stage in order to create a certain overlapping period with the successor of the position.

In addition the Inspectorate has increased its involvement and participation in nuclear safety assistance programmes at many levels including participation in international working groups and IAEA services, such as IRRS and OSART missions, staff exchanges with foreign regulators, and inspection workshops with other countries.

Exchange of safety related information

Switzerland has concluded agreements on the bilateral collaboration for the exchange of information on nuclear safety and radiation protection issues with their counterparts in many countries of which Germany and France are the most important ones. The agreements all include at least early notification in the case of nuclear accidents and/or extraordinary radiological situations. The collaboration with France, Germany and Austria also includes standing binational commissions.

The German-Swiss and French-Swiss commissions are most active due to the sizeable nuclear power generating programmes of the countries concerned. They go well beyond the early notification to include information exchange on all nuclear safety and radiation protection aspects of interest. Their permanent technical working groups meet at least once per year. The collaboration with France includes common inspections in nuclear installations of either country performed jointly by members of the French and Swiss safety authorities. Both German-Swiss and French-Swiss commissions have proved instrumental in harmonizing and coordinating transborder emergency management. They are expected to play an important role in the current effort to identify the site for a future Swiss deep geological repository for highly radioactive nuclear waste.

Clause 2

Each Contracting Party shall take the appropriate steps to ensure an effective separation between the functions of the regulatory body and those of any other body or organisation concerned with the promotion or utilisation of nuclear energy.

Swiss nuclear power plants

Swiss NPPs are operated by private companies. Individuals as well as cantons and municipalities hold a major part of the shares of these companies. That part of the federal administration to which the regulatory body is attached does not hold shares in the nuclear industry. The regulatory body is therefore not directly linked to anybody or any organisation concerned with the promotion or utilisation of nuclear energy.

Separation of the supervisory authority for nuclear safety from other governmental bodies concerned with the use and promotion of nuclear energy

The Nuclear Energy Act clarifies and expands the position, duties and responsibilities of the Inspectorate as the supervisory authority for nuclear safety in the areas of establishing safety criteria and preserving nuclear safety.

The Federal Office of Energy (BFE) is in charge of the execution of the energy legislation. It deals with questions of energy economics and energy politics and considers aspects of supplying security. In addition, the BFE also supports nuclear energy research.

The Inspectorate is part of the BFE, but acts at the technical level independently from the rest of the Office and from the Federal Department of Environment, Transport, Energy and Communication (UVEK). The legal review and assessment of applications through the Inspectorate is conducted solely on the basis of nuclear safety criteria and is exclusive of any other considerations. The Inspectorate informs the public by means of reports about its conclusions and considerations.

The Nuclear Energy Act requires the supervisory authorities to be independent of technical directives and formally independent of the licensing authorities. As a first step towards formal independence the Federal Council established the FLAG-System at the Inspectorate in the year 2004. FLAG stands for "Management with Performance Mandate and Global Budget". The Performance Mandate provides for requirements, goals and the corresponding controlling procedures, including performance indicators, for a period of four years. On the other hand the Inspectorate got its own Global Budget. Within this budget it is free to decide where to invest its financial means and is therefore separated from the BFE from a financial point of view.

To legally settle the Inspectorate's fully independent status and to achieve formal independence of the Inspectorate from the licensing authorities a new law is in elaboration. The legislative work has started in 2003.

With the Federal Nuclear Safety Inspectorate Act (ENSIG) the Swiss supervisory autorities (Inspectorate and Section SK) will be separated from the BFE and converted into an institution under public law. Therewith the supervisory authorities obtain formal, institutional and financial independency. The new act has been passed by the Parliament on 22 June 2007 and will become effective on 1 January 2009.

Developments and Conclusion

There is progress in the independency of the Nuclear Safety Inspectorate (HSK). A new act is in elaboration. The Inspectorate will be separated from the BFE and converted into an institution under public law.

The Management System of the Inspectorate is well established and highly supports both management and daily business. Minor modifications are made continuously in order to further develop and improve the Management System. However the basic structure of the systems remained the same and still covers all requirements of the related ISO and IAEA standards.

The Swiss Party complies with the obligations of Article 8.

Article 9: Responsibility of the licence holder

Each Contracting Party shall ensure that prime responsibility for the safety of a nuclear installation rests with the holder of the relevant licence and shall take the appropriate steps to ensure that each such licence holder meets its responsibility.

The Nuclear Energy Act stipulates that the licence holder is responsible for the safety of the installation. The most important duties of licence holders are the following ones:

- always accord to nuclear safety the priority necessary when operating the nuclear installation and especially comply with the prescribed limits and conditions;
- establish a suitable organisation and employ suitable and qualified specialist personnel in sufficient numbers. The Federal Council defines the minimum requirements and regulates the training of the specialised personnel;
- take measures to keep the installation in good condition;
- carry out inspections and also safety and security assessments throughout the entire life of the installation;
- in the case of a NPP, periodically conduct a safety review;
- report to the regulatory authorities periodically on the condition and operation of the installation and immediately on reportable events;
- backfit the installation to the extent necessary according to experience and current state of backfitting technology and beyond, provided this contributes to a further reduction of risk and is appropriate;
- keep track of advances in science and technology and of operational experience at comparable installations;
- maintain complete records on the technical facilities and on operation, and revise the safety analysis report and security analysis report when necessary;
- exercise quality-assuring measures for all activities practised in the course of operation;
- keep up to date the plan for decommissioning, or the project for the observation phase, and the plan for sealing the installation.

The supervisory authority has to ensure that the licence holder fulfils its legal duties and that the licence holder also implements all conditions and obligations stated in the licence.

In order to keep the responsibility with the operator, HSK refrains from a too prescriptive approach in regulation. Requirements on certain issues are stated in the Nuclear Energy Act and the corresponding ordinances. Regulatory guidelines specify details to the ordinances. In the daily regulatory work, e.g. after the detection of deviations during inspections, HSK requires the correction of the deviation, however the way how to correct it, is left to the NPP, as long as it complies with the overall requirement.

In the daily regulatory work (inspections, review of documents, safety reviews, regulatory meetings) HSK verifies that the decisions taken by the licencee are safety-oriented, i.e. that the licencee keeps the responsibility for safe operation.

The delegation of the responsibility of the licencee to the plant management is a legal process that maintains the plant manager accountable for safety. Delegation is described in an internal organisational document that defines the responsibility for safety of the plant manager. This document also defines the way how resources are defined and devoted. The development of resources for safety is an issue in the annual meetings between HSK and NPP management.

The responsibility of interfacing organisations and contractors is defined in contracts between the licencee and the organisations. The procedure to establish these contracts is part of the plant's management systems and is inspected by HSK according the regulatory guideline on the organisation of NPPs.

Leibstadt and Beznau NPP introduced in 2006 safety controlling. The safety controller is a person with no operational duties. He or she is assigned to independently review all kind of safety issues like decisions, operation, daily work, allocation of resources etc. in respect to safety. He or she informs the plant manager on safety issues and reports to the CEO of the plant.

Developments and Conclusion

The present report gives practical examples how this article is fulfilled in Switzerland.

The Swiss Party complies with the obligations of Article 9.

Article 10: Priority to safety

Each Contracting Party shall take the appropriate steps to ensure that all organisations engaged in activities directly related to nuclear installations shall establish policies that give due priority to nuclear safety.

Ab initio, Switzerland has given top priority to the safety of NPPs, and will continue to do so. Relevant legislation requires explicitly, that all reasonable measures be taken to protect persons, property and other important rights (including those relating to environment, nature, landscape and land use planning). Further, Switzerland's national security must be safeguarded and compliance with Switzerland's international commitments must be ensured at all times. In its supervisory functions, the regulatory body is committed by law to give first priority to nuclear safety.

Furthermore, for the utilities, safe and incident-free functioning of their NPPs has first priority, as a precondition to ensure their economical and long-term operation. The priority given here to safety is expressed in the operating policy of each of the NPPs, prepared by the plant management, communicated to the entire staff of the NPPs and submitted to the Inspectorate, as well as in other documents.

From a technical point of view (i.e. design and construction), Swiss NPPs are in line with the state of science and technology due to their original design and due to backfitting. However, operation and maintenance may be influenced by economic and social changes. It is the responsibility of the operators to ensure that economic and social changes do not result in a reduction of safety; the Inspectorate, in turn, has to assure that the licencee takes by all means this obligation seriously. In all plants, the personnel has a high awareness of the safety significance of their activities, continuously enhanced by training in safety issues. Safety Culture is an important element in all Swiss NPPs to foster a high level of safety (see Article 12). All plants have implemented programmes for improving safety culture. This is done by training sessions, workshops, special information after safety significant events etc. The programmes are conducted by the NPPs in special cases with the aid of external experts. In 2005 the Inspectorate started periodic technical discussions with each plant on their safety culture programmes. The Inspectorate refrains from a generic evaluation of safety culture. The Inspectorate concentrates on specific issues of safety management instead.

In 1992, Switzerland has started to invite Operational Safety Review Teams (OSART). Up to 2002, all Swiss NPPs had been subjected to an OSART mission, including a follow-up. The missions have confirmed many commendable areas of performance, particularly a strong commitment to nuclear safety and excellent plant operation, but recommended also additional safety improvements. One of the findings was a tendency towards complacency. The NPPs concerned have initiated programmes to make the staff aware of this problem and to foster a better developed questioning attitude. The OSART missions are a valuable tool for the NPPs, helping them to question their safety performance during plant operation. In the past three years all Swiss NPPs were subject to WANO Peer Reviews. The plants informed the Inspectorate about the main findings and actions taken for improvements.

On several occasions, opinions on the necessity of certain regulatory requirements differed between the safety authority and the NPPs. In the ensuing discussions, cost aspects and the technical justification of regulatory requirements are weighed against each other. In order to make the decision process transparent, the Inspectorate uses the following graded approach to decide on the justification of safety measures:

- safety measures required by the legislation (this includes licence conditions);
- recommendable safety measures based on the state of science and technology;
- safety measures appearing desirable from the viewpoint of experience and the state of backfitting technology and simultaneously reasonable on the basis of the cost/benefit ratio.

Different external influences, such as economical constraints, changes in the availability of suppliers, etc. may force the nuclear installations to adapt their organisations to new needs. To ensure that organisational changes do not have a negative impact on safety, the Inspectorate requires in its guideline on the organisation of NPPs the following main steps in the "management of change":

- examination of the safety impact of organisational changes prior to their implementation;
- implementation of changes with the help of a project management where personnel-related aspects will be considered;
- in-house evaluation of change processes to ensure that the expected safety-related effects will be valid once the change becomes effective.

Developments and Conclusion

The main issues during the past three years have been the periodic discussions on safety culture with each NPP and the completion of WANO peer reviews by all Swiss NPPs.

The Swiss Party complies with the obligations of Article 10.

Article 11: Financial and human resources

Clause 1

Each Contracting Party shall take the appropriate steps to ensure that adequate financial resources are available to support the safety of each nuclear installation throughout its life.

The new nuclear legislation requires that nuclear installations have to be kept in good condition and that the licence holder has to provide the necessary means to the person responsible for the safe operation of a nuclear installation.

The licence holders are well established companies with good financial records. They have so far covered all the costs of construction, operation and maintenance (including replacement of obsolete or worn components) of their NPPs as well as the fees of the regulatory body (see Article 8). They also have implemented voluntarily many modifications or backfitting measures shown necessary by the state of science and technology in addition to those required by the safety authorities (see Articles 6 and 18).

If, for any reason, (e.g. inadequate financial resources), backfitting measures considered necessary and required by the safety authorities could or would not be implemented, the licensing authority would suspend or revoke the operating licence. An operating organisation facing such a licence suspension or withdrawal has obviously an interest in implementing the requirements, should it intend to continue normal operation.

The decommissioning fund is established according to the Nuclear Energy Act. It covers the costs arising from decommissioning, including later dismantling, and it is financed by regular contributions from the licence holder. In the case that the means of the fund are not sufficient to cover the costs of decommissioning of a NPP, the owners of the other NPPs are also liable for the amount in debt.

Clause 2

Each Contracting Party shall take the appropriate steps to ensure that sufficient numbers of qualified staff with appropriate education, training and retraining are available for all safety-related activities in or for each nuclear installation, throughout its life.

Requirements regarding qualified staff

The Nuclear Energy Act requires the availability in sufficient number of qualified staff with appropriate expertise for the management and the control of nuclear installations for all life cycles. Specific minimum qualification requirements and training of specialised staff are regulated in related ordinances (Nuclear Energy Ordinance, Ordinance on requirements for the personnel of nuclear installations, Ordinance on checks of trustworthiness and Ordinance on security guards). HSK does not require a regular fit-for-duty programme. Some cases of consumption of psychotropic substances and the actions taken by the plant were reported to HSK. HSK considered the measures implemented by the licencee as appropriate. The new Ordinance on the requirements on the personnel of NPPs requires annual medical tests on the regular consumption of psychotropic substances.

Staffing

The Nuclear Energy Ordinance and a related Inspectorate's guideline (organisation of NPPs) specify the required organisational arrangements to operate nuclear installations. The Nuclear Energy Ordinance requires that the organisation of the facility must be structured in such a manner that it ensures internal responsibility for at least the following activities and areas:

a. operation of the facility in all operating modes;

b. maintenance, material and testing methods, technical support;

c. design and monitoring of the reactor core;

d. radiation protection and radioactive waste;

e. water chemistry and use of auxiliary chemicals;

f. emergency planning and preparedness;

g. supervision and assessment of nuclear safety;

h. security;

i. quality assurance for services provided by contractors;

j. training and further education of personnel;

k. promotion of safety awareness.

There is no specific requirement on staffing of NPPs. The rather low staffing in the early times of the nuclear industry in Switzerland has increased to today's suitable number. The number of staff is 305 for Mühleberg NPP and 497 for the twin unit Beznau NPP by the end of 2006 for the 350 MW class. The second generation plants of the 1000 MW class is staffed with 394 for Gösgen NPP and 413 for Leibstadt NPP by the end of 2006.

The fluctuation of NPP personnel is low. All Swiss plants have well established programmes for replacement of retiring staff well in advance, allowing sufficient time for transfer of know-how to new employees. This ensures that the necessary knowledge and experience to operate the NPPs is maintained.

Supplementing its own personnel, the licencees of NPPs use the workforce from contractors, particularly for maintenance work during the annual refuelling outages and plant modifications. This includes specialists of the manufacturer or supplier of important components or systems and other external experts for specific tasks, e.g. inspection of specific components or computerised calculation of specific safety issues.

Education and training

The professional scientific and engineering education and training possibilities in Switzerland have reached a high quality level. This ensures a satisfactory basis for the recruitment of qualified personnel. However, recent changes in the educational system (application of the European "Bologna Process") tend to modify the educational basis. During the past year the industry complains about the reduction in the number of young engineers. HSK follows this tendency carefully in respecting the Ordinance on requirements for the personnel of nuclear installations and the related Inspectorate's guideline B10 (in development) specify the qualification and competencies of the staff for the operation of nuclear installations. The requirements on education and training of radiation protection personnel are specified in a special ordinance and in the Inspectorate's guideline R-37.

For NPPs the Ordinance on requirements for the personnel of nuclear installations specifies requirements for education, knowledge in nuclear engineering and experience for the plant manager, division heads and subdivision heads, the licenced shift personnel, the training manager for the licenced personnel, the head of the organisational unit for radiation protection and the head of the security section. Similar requirements apply for the members of research reactors and storage facilities.

The selection of personnel to be licenced by regulatory body for key functions in NPPs as control room operators, shift supervisors and radiation protection experts requires the successful completion of a vocational training in a technical profession of three to four years and a minimum of two years experience in their profession (the latter is not compulsory for radiation protection experts). For safety engineers, an engineering or university degree is required. Specific training in nuclear fundamentals, basics in electrical and mechanical engineering, water chemistry, safety concepts and radioprotection is provided by the Reactor School of the Paul Scherrer Institute. The selection procedure for all licenced control room personnel includes aptitude tests. According to the Ordinance on requirements of the personnel of nuclear installations, the plant manager needs an engineering or university degree, basic knowledge in nuclear engineering and specific knowledge necessary for this function, management experience and experience within the NPP he or she is going to manage.

Staff members for which a professional licence is not mandatory are selected from applicants with appropriate education and experience. Adequate training with regard to the tasks assigned to these members comprises specific courses and "on the job" training.

In the following, the education and training for licenced personnel is summarised.

- **Field operators**: Employees who intend to become licenced control room personnel have to start as field operators. There is no mandatory licensing at this level. However, an officially recognised examination is common. Courses and "on the job" training lead to good knowledge of the NPP and also to basic knowledge in radiation protection, physics and nuclear engineering.
- **Control room operator:** This function requires a formal licence. To become a control room operator, a candidate must have one to two years of field operator experience. A thorough theoretical education at the reactor school of the Paul Scherrer Institute (PSI) or at an equivalent institution is required. Following this basic education, a set of courses at the NPP, "on the job" training and simulator training complete the plant-specific education. The professional licence is granted after an examination by experts from the NPP concerned and from the Inspectorate.
- **Shift supervisors:** Applicants for this level have to be experienced control room operators (one to three years of experience). They receive additional education and training in leadership, specific plant behaviour, procedures and full scope simulator training with their team. The examination procedures mentioned above are also applied for the licensing of shift supervisors.
- **Stand-by safety engineers:** Shift supervisors with an engineering or university degree can apply to be stand-by safety engineers. Leadership under unfavourable conditions, as well as extended and detailed knowledge of emergency procedures, are particularly important aspects of the additional training needed for this job. The

professional licence is granted after an examination by experts from the NPP concerned and from the Inspectorate.

- **Radiation protection experts:** Radiation protection specialists and radiation protection technicians are trained at the radiation protection school of PSI or at equivalent institutions. Final examination of candidates for these two functions takes place under the supervision of the Inspectorate. The licence of high level radiation protection experts is granted upon successful completion of high level courses.

For each of the above functions, there is adequate retraining. It comprises simulator training (except for radiation protection experts), plant-specific courses and theoretical courses, usually at the reactor and radiation protection schools of the PSI. Training for licenced control room personnel is provided by members of the training section of the operational department. They are professionals and hold a diploma in adult education.

The simulator training, which is also used for requalification, is specific for each NPP. Beznau NPP replaced its compact simulator by a full scope replica simulator. So, all Swiss NPPs have full scope replica simulators on site.

The determination of training needs and the feedback of operational experience into the training process is prescribed in the management systems of the NPPs. HSK inspects these processes as well as training programmes and the training records at the plant. NPPs give account of the accomplished training courses in their monthly reports. The ratio of time devoted to training to the total working time is one of HSK's safety indicators.

The personnel of the NPPs is well educated and trained and regular retraining is provided in order to keep up with advances in science and technology as well as with modifications to the plant.

All activities are supervised and inspected by the regulatory body which is also an expert in the first licence examination.

The financial resources devoted to training are defined in the annual budget of the NPPs. An overview of this budget is part of the annual management meeting between NPPs and HSK.

In order to maintain specific knowledge on nuclear technology within Switzerland, Swiss NPPs sponsor a special professorship at the Federal Institute of Technology ETH.

Developments and Conclusion

Since the last reporting period the new ordinances on nuclear energy, on requirements for the personnel of nuclear installations, on checks of trustworthiness and on security issues were released. The Inspectorate's guideline B10 that details the requirements on training and qualification is in preparation and will be issued by 2008. Plant-specific full scope replica simulators are operating at all Swiss NPPs.

The Swiss Party complies with the obligations of Article 11.

Article 12: Human factors

Each Contracting Party shall take the appropriate steps to ensure that the capabilities and limitations of human performance are taken into account throughout the life of a nuclear installation.

In the early 1990's, the Inspectorate set up the Section for Human and Organisational Factors (MOS) in which today five human factors specialists (two psychologists, one physicist, two engineers) deal with human and organisational factors as well as with the Human-System-Interaction (HSI) in the context of NPPs' safety. The Section's work is based on the conception that nuclear safety depends on man, technology, organisation and their mutual interactions - therefore it reflects the so called MTO-approach.

Human-System-Interaction (HSI)

HSI issues, especially in the control room, have been taken into account early in Switzerland. Although the four Swiss NPPs are of different design, the basic ergonomical principles used in the original design of the control rooms were very similar. All plants use schematics of the systems on the control desks and panels in order to guide the operators in their manipulations. The real instruments and controls are part of these schematics and allow immediate surveillance of the results of operator actions. The modernisation of the control rooms at Beznau NPP brought additional ways of HSI based on a sophisticated computerised plant information system. Based on this, a computerised alarm system and a computerised emergency operating procedures system were installed in both units. The systems went through a detailed verification and validation process, including a dynamic human factor validation on a full scope replica simulator. The Inspectorate granted the approval of the systems in 2000.

All Swiss NPPs have safety parameter display systems (SPDS) which help the operators to get a quick overview of the plant status.

Gösgen NPP modified its paper-based emergency operating procedures in 2002 - 2004. The originally event-based procedures were complemented by symptom-based elements. The structure as well as the graphical representation of the whole set was improved. The Inspectorate closely reviewed the different modifying phases, i.e. conceptualisation, development and evaluation (verification and validation) of the new emergency operating procedures. The Inspectorate concentrated its attention also on human factors criteria (e.g. situation awareness and cognitive workload of crew members) communicated to the plant before the development of the new procedures. Procedures were thoroughly verified and validated concerning technical and human factors requirements as well. Both activities were performed with representatives of actual and licenced plant operators on the Gösgen full scope simulator. Thereafter all the licenced operators got a special training on the new emergency operator procedures. The Inspectorate approved the procedures in 2005.

Beznau NPP is currently altering the presentation of its technical specifications. Before the plant started the development of the new presentation, the Inspectorate required a detailed analysis and diagnosis of the actual technical specifications as well as the demand of a revision and analysis of requirements of the new technical specifications. During the development of the new technical specifications the Inspectorate is demanding of the plant a special review process in order to ensure that ergonomic changes will not result in technical changes by mistake.

Leibstadt and Beznau NPP are about to replace remote control rooms for the control of processes with low safety significance by computerised controls. This increases the reliability of operations and the flexibility for modifications. NPPs include future users of the Systems in the project teams. So, their ideas, recommendations and expertise contribute to well accepted and sound solutions. HSK watches these projects closely; they may serve as prototypes for further possible modifications towards computerised control rooms.

After each event in a NPP in which human factors have played a role, the involved HSI, human performance and organisational aspects are investigated. Any weaknesses in these areas discovered by such investigations lead to assessments of similar situations in all other NPPs.

The Nuclear Energy Ordinance requires that NPPs establish a group that analyses human factor contributions to a safety significant event. All NPPs are about to install such groups and to provide them with adequate education and training.

All NPPs decided to use the SOL-System for in-depth event analysis. The co-ordinators for event analysis are trained in the application of this tool and acquired additional Human Factors expertise in specialised institutions.

The University of Applied Sciences of Northwestern Switzerland is about to initiate a post graduate course in safety psychology. In this context the University created a special Forum which meets several times a year for discussions of human and organisational issues. Swiss NPPs, HSK, the aviation industry, public transportation companies and chemical industries are represented in this forum for exchange of experience.

Organisation and safety culture

In Article 30 Clause 5 of the Nuclear Energy Ordinance the Inspectorate is assigned to specify the detailed requirements on organisational structure in guidelines. The current guideline on organisation does not meet all these requirements. Hence, the Inspectorate is currently revising its guideline on organisation of nuclear power installations. The legal bases of the revised guideline are corresponding articles on organisational requirements of the Nuclear Energy Act, the Nuclear Energy Ordinance, and the Convention on Nuclear Safety, the IAEA requirements on Management Systems as well as Reference Levels issued by the Western European Nuclear Regulators' Association (WENRA).

This guideline describes the requirements of the Inspectorate regarding organisational structure and work processes as well as requirements that need to be taken into account by the operating organisation to safely manage organisational changes. The guideline also formulates that the operating organisation clearly has to give first priority to safety in all plant activities. Attention is also given to the concept of safety culture. The guideline details the requirements of a NPP organisation to analyse, monitor, reflect and foster its own safety culture.

The Inspectorate performed a set of oversight activities in the area of safety management and safety culture. Among these are in particular inspections and technical discussion. The purpose of inspections is to control whether the organisational structure and work processes of the inspected nuclear power installation meet the legal requirements on organisation. Technical discussions, however, represent a less formal information exchange between Inspectorate and operating organisation on safety culture aspects and safety culture related activities.

Developments and Conclusion

Due to the enactment of the new Nuclear Energy Ordinance there have been formal changes to the inspection practice.

The Swiss Party complies with the obligations of Article 12.

Article 13: Quality assurance

Each Contracting Party shall take the appropriate steps to ensure that quality assurance programmes are established and implemented with a view to providing confidence that specified requirements for all activities important to nuclear safety are satisfied throughout the life of a nuclear installation.

Operational Safety

Following the Inspectorate's requirement, NPPs have developed Quality Management (QM) systems based on international standards and guidelines such as the IAEA Safety Series 50-C/SG-Q “Quality Assurance for Safety in NPPs and other Nuclear Installations". All Swiss NPPs implemented an Integrated Management System and are certified according the norms ISO 9001 (Quality Management) and ISO 14001 (Environmental Management) and OHSAS 18001 (Occupational Health and Safety). All Management Systems of the Swiss NPPs also comply with the new IAEA requirements GS-R-3 “Management Systems for Facilities and Activities”.

The Inspectorate approves and supervises the completeness and the proper function of the whole QM system of the NPPs on the basis of the IAEA requirements on Management Systems[1]. This is done by checking basic QM documents and periodic reports of NPPs on that subject. Regulatory inspections are performed periodically on specific topics (e.g. QM documentation and records, etc.) or on the results of the NPP-independent assessment methods (results of internal and external audits, non-compliance etc.) and the derived actions taken for improvement. In cases of larger QM system changes, which have to be notified to the Inspectorate, specific inspections are performed.

Further, the Inspectorate requires the implementation of a documented self-assessment function in the QM system. The NPPs have implemented appropriate self-assessment processes in their management systems and perform the self-assessment periodically.

Main activities in NPPs and their outcome have to be reported to and assessed by the Inspectorate. This includes the definition of applicable standards. All plant activities outside normal operation such as backfitting, replacement and modifications of systems and components, etc. need a permit. For specific areas, aspects of quality assurance activities are defined in corresponding Inspectorate's guidelines, or quality plans are required.

Transport of radioactive material

The Inspectorate requires that all Swiss NPPs have, as part of their quality management system, special QM rules covering the transport of radioactive materials. These rules based on the IAEA transport quality assurance requirements, are now well developed and were approved by the Inspectorate after positive audit results. Regular follow-up audits take place at intervals of about 2 - 3 years.

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[1] Quality Assurance for Safety in Nuclear Power Plants and other Nuclear Installations, IAEA Safety Series No. 50-C/SG-Q, since 2006 IAEA Requirements GS-R-3 (Management Systems).

Summary of developments and specific aspects of QM systems in Swiss NPPs

Beznau NPP: The documented QM system has been in operation since 1985; it is based on IAEA standards and also embodies the ISO standards. A process oriented management system was introduced in 2002 - 2003 and certified according to ISO 9001 and ISO 14001 (environmental management). The system was transferred into an integrated system and since 2004 the plant holds certificates in ISO 9001, ISO 14001 and OHSAS 18001.

Gösgen NPP: The plant has introduced an integrated QM system and received the approval of the Inspectorate early 2004. This QM system is based on the IAEA QA Code and ISO QM standards. After the implementation of environmental and operational health and safety standards and such creating an integrated system, the plant received the certificates according to ISO 9001, ISO 14001 and OHSAS 18001 in 2004.

Leibstadt NPP: The previous QM system was based on IAEA and ISO standards and was approved by the Inspectorate in 1995. Now a modern integrated management system called "Total Quality Management" is in place. This includes working tools like electronic QM documentation. This implementation was closely followed by the Inspectorate. Since 2005 Leibstadt NPP holds certificates in ISO 9001, ISO 14001 and OHSAS 18001.

Mühleberg NPP: The process oriented QM system, based on the IAEA QA standards (also embodying ISO standards), was approved by the Inspectorate in 1999. During the last years improvements have been implemented as a result of operating experiences. The Inspectorate supervises the application and improvement of the system in periodical inspections. Today Mühleberg NPP has an integrated management system after obtaining the certification according to ISO 9001, ISO 14001 and OHSAS 18001 in 2004.

Other nuclear Installations

For operational safety, the Central Interim Storage Facility (ZZL) has established a Quality Assurance programme which is based on the IAEA QA standard. The system was certified according to ISO 9001 in 2003 and the certificate is regularly renewed. For the transport of radioactive materials, IAEA quality transport standards are required by the Inspectorate. Other nuclear installations have a specialised, simplified or partial QA programme, depending on their radioactive inventory and according to the risk impact. All systems are acknowledged by the Inspectorate.

Developments and Conclusion

During the last reporting period Swiss NPPs created integrated management systems by addition of the ISO 14001 and OHSAS 18001 standards to the quality standard ISO 9001. All NPPs hold a certificate on all three standards.

The Swiss Party complies with the obligations of Article 13.

Article 14: Assessment and verification of safety

Clause (i)

Each Contracting Party shall take the appropriate steps to ensure that comprehensive and systematic safety assessments are carried out before the construction and commissioning of a nuclear installation and throughout its life. Such assessments shall be well documented, subsequently updated in the light of operating experience and significant new safety information, and reviewed under the authority of the regulatory body.

Overview of Safety Analyses

The licensing process includes a detailed review and assessment by the Inspectorate of the appropriate safety analyses that must be submitted with the application. These analyses are recorded in the deterministic Safety Analysis Report (SAR) and in the Probabilistic Safety Analysis (PSA). The objective of the regulatory assessment is to verify compliance with the applicable regulations and regulatory guidelines (see Article 7).

Typically, conditions or restrictions are imposed when granting a licence. One example of such condition is that the SAR and the PSA shall correspond to the current licensing basis. Thus, appropriate revisions are to be submitted periodically for the Inspectorate's review and approval. Instant revisions are mandatory in the case of major plant changes or in conjunction with a plant licence renewal.

A Periodic Safety Review (PSR) has to be performed at least every ten years. This PSR may be combined with a safety review associated with plant licence renewal applications. The scope and process of the PSR are defined in Inspectorate's guideline R-48. Important elements of the PSR are the deterministic assessment, the probabilistic assessment and the operational experiences over the past 10 years.

The process of periodically updating the PSA (Living PSA) has been widely developed and is implemented in all Swiss NPPs. As part of the PSR, the PSA has to be fully revised, taking into account also improvements of the PSA methodology. Updated reliability data and minor plant modifications have to be examined every five years. Significant changes have to be taken into account every year.

(Integrated Oversight see on page 55)

Review and Assessment of Safety Analyses

The Inspectorate documents all results and insights of the assessment of the safety analysis. For licensing applications, such as an application for a new installation, a safety evaluation report (SER) is issued, which also lists the applied regulations/guidelines and criteria and commonly includes a safety assertion by the Nuclear Safety Commission (KSA). The final licensing decision is based on the conclusions derived from this safety assessment (see also Article 7).

For the review and assessment process, new and existing installations are treated differently. For new installations, the following items are included:

- site characteristics (see also Article 17);
- design, quality and condition of structures, systems and components relevant to safety and operational radiological protection (see also Article 18);
- plant operation (see also Article 19);
- fuel and core design, fuel performance during normal operation and transients (mainly for NPPs);
- design basis accidents (DBA);
- beyond design basis accidents;
- organisation and personnel (see also Article 12);
- emergency preparedness (see also Articles 16 and 17);
- waste management and decommissioning.

Additional items pertain to existing installations, for which a renewal of the licence is necessary from time to time (Mühleberg) or within the framework of a PSR:

- operational experience (see also Article 19);
- backfitting, modification(s) and ageing of plant systems/components.

Assessments of backfitting actions or modifications relative to safety (related) systems/components within the current licence (i.e. no new licence necessary) are covered by the Inspectorate permit procedure. This procedure entails that, of all items listed above, those affected by the modifications must be addressed. The results of such assessments are documented in specific reports or directly in the letter of permit. As in the case of a licence, conditions or restrictions may be imposed in conjunction with the permit.

Some selected Swiss regulatory processes for the review and assessment of both new and existing installations are described in the following sections.

<u>Review and assessment of safety systems, safety related systems and their components</u>

This process is described in a number of Inspectorate's guidelines (R-06, R-18, R-23, R-31, R-35). The licencee must submit an appropriate application which encompasses all safety-relevant aspects and describes the measures taken to ensure safety. The Inspectorate review covers (but is not limited to) the following issues:

- quality assurance of manufacturing, assembling and commissioning;
- personnel qualification (e.g. for welders);
- specifications of systems and components, system and instrumentation and control equipment drawings, construction drawings;
- impact on safety concepts and on results of safety analyses, safety analysis as appropriate;
- operating experience from licencee and from other plant operators;
- implementation and test plan.

The depth of the review depends on the safety significance of the systems/components concerned.

Review of design basis accident analyses

This review aims at verifying the expected behaviour of the plant under postulated abnormal conditions. Based on a set of accident scenarios, the licencee has to demonstrate that the relevant plant and core specific parameters stay within their safety limits. In addition, the licencee must show that the individual dose limits for the public, as defined in the Radiological Protection Ordinance and included in the Inspectorate's guideline R-100, are not violated.

The Inspectorate review covers at least the following aspects:

- qualification, validation and state-of-the-art of the computer programmes used;
- compatibility of assumptions with systems and components design;
- conservatism of simplifications and assumptions;
- adequacy of postulated single failures;
- compliance with pertinent operational and safety limits.

Review of beyond design basis accident analyses

Beyond design basis accidents are analysed by means of the Probabilistic Safety Analysis (PSA). The Swiss PSAs are plant specific-level 1 and level 2 studies, including internal and external events. Up to now low power and shutdown modes were considered in the level 1 analyses only. As of February 2005 the PSA is anchored into the Swiss regulation by means of the Nuclear Energy Ordinance. The ordinance implies the need to analyse low power and shutdown modes also in the level 2 PSA. The Inspectorate's PSA review aims at developing a thorough understanding of plant features, vulnerability to potential severe accidents, and plant-specific operating characteristics. Also, the general applicability of the PSA models as a tool of the regulatory framework is assessed. The review focuses on:

- general appreciation of the PSA models, assumptions, analytical methods, data and numerical results;
- understanding the range of uncertainties in core damage frequencies, fuel damage frequencies, containment performance, and releases of radioactive effluents.

Full Power PSA: A two-step evaluation process has been developed for reviewing the full power PSA studies:

- The preliminary qualitative review is aimed at performing a quick evaluation of PSA findings and major conclusions, PSA approach and analytical methods, and plant design features for preventing and mitigating potential severe accidents. This preliminary review also generally verifies the PSA documentation for completeness, and identifies areas for more comprehensive assessment and analysis in the next review stage.
- The detailed review aims at a comprehensive evaluation of the PSA models, assumptions, data and analysis techniques, and verifies the adequacy of the PSA models for representing the current plant design and operational characteristics.

  As part of this review phase, a detailed re-analysis is performed, often using alternative methods. For the level 1 part of the analysis, a fault tree linking technique is used; the level 2 portion of the PSA is evaluated based on state-of-the-art computer codes, assessing severe accident behaviour, containment loads, containment performance, containment failure modes and accident source terms. In addition, site audits, including plant walkdowns of several days are conducted, focusing on the review of the external events analysis.

Low Power and Shutdown PSA: The low power and shutdown PSA studies are reviewed by means of a detailed qualitative approach that is to a large extent based on the insights gained from the review of full power studies.

Guidance documents providing specific review and documentation instructions have been prepared for the PSA review of both the full power and the low power and shutdown PSAs. Also, two guidelines are currently under development in order to (a) further harmonise the quality and the scope of the Swiss PSAs, and (b) define both the general role of the PSA within the Inspectorate's decision making process and the requirements for specific PSA applications, such as probabilistic assessment of safety level and operational experience, selecting components for the ageing surveillance programme, or the assessment of changes to the technical specifications (tech specs).

Review of Ageing Surveillance Programme (ASP)

In 1991, the Inspectorate required the implementation of an Ageing Surveillance Programme (ASP), for both first and second generation NPPs. The objective of this programme is to collect relevant information of structures, systems and components (SSCs) for monitoring ageing and understanding ageing mechanisms in order to maintain safety margins and safety functions of SSCs throughout the plant lifetime. In 1992, a utility working group was formed to set up a programme for a joint approach on ageing management. The main target of this group is to fulfil the Inspectorate's requirements and, in addition, to provide a technical basis for optimising maintenance and improving the reliability of components.

The ASP is part of the overall maintenance strategy for the Swiss NPPs. It addresses the fields of civil engineering, electrical and mechanical components and focuses on safety-related SSCs. More specifically, the ASP aims at providing information on the relevant ageing and degradation mechanisms for component materials, environmental effects, operation history, etc. For every safety-relevant component, it is possible to make an assessment of the existing maintenance programme while indicating possible deficiencies therein. Periodic testing, maintenance tasks and in-service inspections, as well as routine controls are performed according to planned schedules or when required. The annual refuelling outage also provides the chance to perform special inspections and examinations (e.g. visual, eddy-current, dye penetrate, remote video camera inspections, ultrasonic testing, and measurement of sub-critical crack growth). It is required that the testing procedures used are qualified.

The Inspectorate has developed its ASP guideline R-51 according to the IAEA Safety Reports Series No. 15 "Implementation and Review of a NPP Ageing Management Programme". In this guideline, the Inspectorate presents the way it assesses the appropriateness of the NPP's ASPs.

Safe operation of NPPs must take into account the effects of ageing on safety margins and the actual state of SSCs. Identification and awareness of all known and possible ageing degradation mechanisms on safety-relevant SSCs is widely recognised as essential for implementing effective NPP ageing surveillance and life management. Plant-specific ASPs provide a systematic and knowledge-based approach to monitoring ageing in NPPs. It is, however, also necessary to follow NPP experiences worldwide, and to check for any potential generic problems or to implement best practices as the state of knowledge evolves. This is a continual process, and, in principle, ASPs are only as good as the amount of updated information they contain. Swiss NPP ASPs are living programmes, based on the state of technology principles.

The Swiss ASPs consider classified mechanical as well as electrical components, concrete structures and buildings. Non-classified components are registered in the dossiers only when they are risk-relevant.

Licencees are required to update their ASP files upon new safety relevant findings (e.g. originating from Safety Analysis Reviews or the SARs) or every ten years at the latest.

Evaluation of Periodic Safety Review

Periodic Safety Review (PSR) is an additional control mechanism for the Inspectorate, aiming to identify and assess the actual safety condition of the plant. To this end, the actual plant status and the past operating experience is compared against the current level of science and technology and the operating experience of other plants. The licencee is responsible for carrying out the PSR, whereas the Inspectorate evaluates the PSR as submitted by the licencee, adding its own experience from previous inspections, assessments and reviews. The scope and process of the PSR are defined in Inspectorate's guideline R-48.

For a PSR and the evaluation thereof, the present "defence in depth" plant safety concept of having several layers of protection (preventive measures to warrant reliable plant operation, to prevent operational occurrences, to curb limited faults and accidents, and finally to limit the effects of severe accidents) plays a central role. The licencee is thus required

- to explain the plant-specific implementation of the "safety policy";
- to assess plant operational performance and management;
- to perform a deterministic safety status evaluation;
- to perform a probabilistic safety analysis,

and on these basis, to demonstrate that typical safety objectives (controlling reactivity, core cooling, containment of radioactive materials, and limiting radioactive releases) effectively apply to normal and abnormal plant operation. The licencee has to demonstrate how the evolving state of science and technology was considered for plant design and operation, and how the experience gained in similar plants worldwide was addressed. In addition, when assessing the operational experiences over the past 10 years, special attention must be given to organisational and human factor aspects and its impact on safety. The Inspectorate appraisal comprises an assessment of the licencee's safety culture, integrating all safety-related information supplied with the PSR.

Not only the present safety status must be reviewed, but also an assessment of the future safety status must be included in the PSR. For this assessment, the trend analyses from e.g. component performance and non-availability of safety equipment, as well as results from currently implemented ageing surveillance programmes, may be used.

Clause (ii)
Each Contracting Party shall take the appropriate steps to ensure that verification by analysis, surveillance, testing and inspection is carried out to ensure that the physical state and the operation of a nuclear installation continue to be in accordance with its design, applicable national safety requirements, and operational limits and conditions.

As already mentioned in the response to Clause (i), appropriate safety analyses have to be submitted to the Inspectorate in support of approval request for each modification or backfitting to safety (related) systems or components. For granting such a permit, the following is needed: proof of qualification for manufacturing, assembling and commissioning, evidence of meeting safety limits, definition of special start-up tests as necessary, and a procedure for periodic inspections and audits. All these are needed to ensure that each modification or backfitting action is in accordance with the previously approved safety requirements, and that the applicable safety margins and operational limits are maintained.

For the verification of the safe condition and operation of the nuclear installations, the following activities play a central role.

Refuelling and outage activities

During each refuelling outage, the plant is subjected to a review, covering many aspects as illustrated by the following examples:

- In-service inspections, preventive maintenance and repairs/modifications relative to safety-related mechanical equipment, undertaken by the licencee to maintain or enhance the safety of the plant, are monitored by the Inspectorate and supervised and verified by its mandated expert, the Swiss Association for Technical Inspections (SVTI). SVTI covers this whole range of activities by a combination of selective supervision and random checks, whereas the Inspectorate focuses on special topics.
- Review of mandatory periodic functional testing of systems and components, including switchover tests of the electric power supply, are carried out by the licencee. These tests are performed according to written procedures, and all test results are documented. The Inspectorate attends selected tests, and also reviews the results of the whole test programme.
- The cycle-specific fuel and core-related issues are reviewed in conjunction with the "Refuelling Licensing Submittal" which the licencee submits at the beginning of the plant refuelling outage. Approval of fuel and core loading by the Inspectorate is a pre-requisite for cycle start-up. Fuel handling and inspection are also reviewed by the Inspectorate, and selected fuel inspection campaigns are attended.

The Inspectorate issues a letter of permit to restart plant operation after the maintenance/refuelling outage. In this letter the Inspectorate passes judgement on the outage maintenance and refuelling activities, the radiological status of the plant and cycle-specific safety analyses. This permit may also include conditions for plant operation or requirements and recommendations for maintaining or improving plant safety. The Inspectorate documents its own activities during the outage in a separate outage report.

Backfitting and replacement

Backfitting and replacement of safety related equipment is a recurring phenomenon in Swiss NPPs while existing equipment no longer satisfies today's standards or becomes difficult to maintain (e.g. spare parts no longer available), or also based on Inspectorate's requirements e.g. following PSRs. Installation and Commissioning of such new, modern and high performance, equipment, largely occur during the plant outage. The Inspectorate reviews the process for such activities, and subsequently follows this process very closely. In most cases Inspectorate's approvals are required for installation and commissioning. Some examples of implementing such new equipment are (a) the replacement of the reactor protection system and control systems by a computer-based system for both units of Beznau NPP, (b) the replacement of the source and intermediate range nuclear instrumentation by a digital wide range monitor system at Beznau and Mühleberg NPP, (c) the implementation of computer-based operator support systems (process computer, process visualisation, online operating procedures) at Gösgen, Mühleberg and Beznau NPPs, (d) the implementation of necessary systems/equipment for primary feed and bleed operation in accident conditions at Gösgen NPP, and (e) the reinforcement of brick walls for improved seismic resistance at Gösgen NPP.

Inspection, reporting and information meetings

<u>Inspection</u>

The purpose of regulatory inspections (announced and unannounced) is to provide the basis for an independent judgement on safety-related issues such as:

- quality measures taken during construction, plant modifications and operation;
- availability of documentation (e.g. operating instructions, technical specifications, emergency instructions, emergency plans);
- adherence to operating instructions and technical specifications;
- judicious plant operation and recording of safety performance;
- adequacy of PSA models to represent the current plant configuration and operational characteristics;
- housekeeping practices to prevent or mitigate fire and seismic hazard consequences;
- availability and training of operating personnel;
- radiation protection;
- human factor aspects and human-system-interaction;
- organisational aspects and safety culture.

The yearly inspection plan is based on an outline, the Basic Inspection Programme (BIP), which contains a systematic basis for selecting and scheduling *periodic* inspections. The inspection intervals suggested in the BIP are based on the safety significance of the objects (components/systems/processes) to be inspected, national and international experience with these objects, public interest issues. These periodic inspections are a valuable part of the PSR assessment. The BIP will be revised as part of the implementation of the Inspectorate's integrated oversight process.

In addition to the *periodic* inspections described above, *topical* inspections focusing on special issues are defined by the Inspectorate's management on a case-to-case basis. Obviously, *reactive* types of inspections are also carried out, meaning that the Inspectorate acts in response to e.g. events that happen during plant operation, during the outage or plant modifications proposed by the licencee.

For each nuclear installation, the Inspectorate designates a co-ordinator in charge of assuring constant communication, exchange of information and documents between the licencee and the Inspectorate, and adequate dissemination of such information and documents within the Inspectorate. The co-ordinator is also responsible for record-keeping as well as for updating a list of "pending matters".

All Inspectorate's inspectors are staff members, based at the Inspectorate's headquarters. There are neither site resident inspectors nor regional offices. Basically, each Inspectorate's staff member is a specialist in his/her particular field, and fulfils duties in three main areas of activities:

- review and assessment;
- preparation of regulations and guidelines;
- inspection and enforcement.

The amount of time spent on the various activities depends on the actual workload and associated priorities. The activities in the first two areas take place at the Inspectorate's headquarters; while in the latter area of activity, the staff member represents the Inspectorate as an inspector at the NPP site.

On average, 80 inspections per plant and per year are carried out.

Reporting

Art. 37 Clause 1 and Appendix 3 Nuclear Energy Ordinance (KEV) define the reports to be submitted to the regulatory body for the purpose of assessing the status and operation of the facility. The KEV delegates the regulation of the requirements on the content of the reports to regulatory guides. Data related to general plant performance, including radiological characteristics and plant modifications for which no permits are required, must be reported on a periodic (monthly or yearly) basis. However, events such as equipment failures, scrams and failed mandatory tests have to be reported within a fixed (short) period of time given by Appendix 6 of the KEV. The licencee is also obliged to review international event information available through different channels like WANO, IAEA, and supplier's information letters. The insights gained from these reviews have to be reported at least every three months. A set of safety indicators has been defined, to be updated and reported by the plants annually.

Such licencee reporting may result in regulatory requirements and/or recommendations for improvement. Moreover, the Inspectorate also reviews information on international events as well as insights from safety research. This review may also result in regulatory action and, as appropriate, in requirements and/or improvement recommendations to the licencee.

Information meetings

Information meetings between the Inspectorate's and the licencee's management are held twice per year. At these meetings, the licencee reports on plant operation. Special issues and ongoing/planned projects are further topics of discussion. The Inspectorate takes position on the various topics, and clarifies current or forthcoming requirements (as a rule, safety-related requirements are presented to the licencee before they are enforced).

Furthermore, each designated plant co-ordinator from the Inspectorate (see above) conducts a meeting about once per month with the respective licencee, in order to obtain the latest information on the plant status and its performance.

Meetings between the Inspectorate's senior management and the licencee top level management are held once per year. In these meetings, special safety issues, such as the consequences of electricity market deregulation and increased competition, are discussed. In addition to all these periodic information meetings, special meetings may be arranged at any time on topical/pending matters and ongoing projects, as appropriate. In addition, management meetings between the Inspectorate's senior management and the joint management of all nuclear utilities are held once per year to discuss common topics of interest.

Integrated Oversight: Annual Systematic Safety Assessment

In 2004, the Inspectorate started the introduction and development of an integrated oversight approach. The basic idea is to integrate all aspects of nuclear safety into a comprehensive oversight strategy. The goal is twofold: On the one hand, the Inspectorate has to make sure that it has sufficient information about design, state and effectiveness of all safety provisions in order to assess the safety of each nuclear installation realistically. On the other hand, the Inspectorate has to make sure that it takes adequate and effective action whenever it detects weaknesses in safety provisions. Every assessment and every decision about the actions to be taken has to be justified in a traceable manner.

To get a realistic picture of the safety of each installation, the Inspectorate implemented a systematic safety assessment system. Safety information is structured by the following key dimensions:

- distinction between safety provisions as they are defined in plant documents and their real state and behaviour;
- distinction between technical aspects and human-organisational aspects;
- levels of defence in depth;
- barriers;
- safety functions.

For each NPP, the data is summarised in a table (see figure 2).

Currently, the inspection findings, the operator licensing results and the results from event analysis are evaluated within the integrated oversight process on an annual basis. In the future, information from periodic licencee reports, safety indicators and insights from the plant modification authorisation process will also be integrated into the systematic safety assessment system.

The systematic safety assessment system is not a one way process that defines how the data is aggregated into a picture of plant safety. The structure of the safety assessment system also defines what kind of information has to be gathered.

Goals \ Subject		Requirements		Operational experience	
		Design requirements	Operational requirements	State and behaviour of the plant	State and behaviour of man and organisation
Safety functions	Controlling reactivity				
	Cooling the fuel				
	Confining radioactive materials				
	Limiting exposure to radiation				
Levels of defence in depth	Level 1 Prevention of abnormal operation and failures				
	Level 2 Control of abnormal operation				
	Level 3 Control of accidents within the design basis				
	Level 4 Control of severe plant conditions				
	Level 5 Mitigation of the radiological consequences of significant external releases				
Barrier integrity	Fuel integrity				
	Integrity of the primary cooling system boundary				
	Containment integrity				
Overall safety	Multiple level aspects				

Figure 2: Table used for the safety assessment.

Each finding of an inspection is assigned to one or several cells of the table. The same holds for the results of the analysis of events. Each direct or indirect cause identified and each safety relevant effect is assigned.

Findings are rated on a scale that is based upon the International Nuclear Event Scale (INES). The goal of the scale is to assess all levels of safety performance from good practice to severe accidents on one single scale. The categories are defined as follows:

- **Category G: Good practice**
  All requirements are fulfilled and the practice of other NPPs is clearly exceeded.
- **Category N: Normality**
  All requirements are fulfilled.
- **Category V: Need for Improvement**
  Deviations from requirements in documents that do not need formal authorisation by the Inspectorate fall into this category.
- **Category A: Deviation**
  Deviations from normal operation within operational limits and conditions.
- **Categories 1 to 7**
  Rating according to the INES-Manual.

Categories V and A correspond to INES 0. Findings from inspections falling into categories A or higher will be treated as events. Any finding V and higher requires action.

Inspection data, operator licensing data and event analysis data is collected in a database. A software tool allows displaying safety assessment data. For any period and installation specified all ratings can be displayed in the table. Each rating is linked to the source document. The resulting distribution of ratings is evaluated at the end of the year for each NPP. The result of this evaluation influences the focus of inspections in the following year. The insights from the annual safety assessment of each plant are published in the annual report of the Inspectorate.

In the future, every aspect assessed a weight will be assigned to. Where applicable, this weight will depend on the probabilistic importance and the safety class of the system or component involved.

Developments and Conclusion

The main changes include an update of the description on the use of the PSA and a more detailed description of the integrated oversight approach. Within the frame of integrated oversight there is an annual systematic assessment of nuclear safety for each NPP based on the analysis of events, inspection results and operator licensing results. This assessment will be expanded in the future in order to include additional information related to nuclear safety.

The Swiss Party complies with the obligations of Article 14.

Article 15: Radiation protection

Each Contracting Party shall take the appropriate steps to ensure that in all operational states the radiation exposure to the workers and the public caused by a nuclear installation shall be kept as low as reasonably achievable and that no individual shall be exposed to radiation doses which exceed prescribed national dose limits.

Based on the recommendations of the International Commission on Radiological Protection (ICRP) (mainly Publication No. 60), both the Radiological Protection Act, as well as the Radiological Protection Ordinance, have been revised and have come into force in 1994. The Inspectorate has subsequently issued revised and adapted versions of most of its relevant guidelines:

- R-07: Guideline for radiation protection zones in nuclear installations and in the Paul Scherrer Institute;
- R-11: Radiation protection objectives during normal operation of nuclear installations;
- R-12: Determining and reporting of doses of occupationally radiation exposed personnel in nuclear installations and the Paul Scherrer Institute;
- R-13: Release of inactive materials and zones from controlled areas;
- R-41: Calculation of the radiation exposure in the vicinity of nuclear installations due to emissions of radioactive materials;
- R-47: Testing of radiation measuring instruments.

The Radiological Protection Ordinance has been revised in January 2000 and new dose factors complying with the IAEA safety series No. 115 have been included. The last review of the Radiological Protection Ordinance was performed in October 2001 with minor (mainly administrative) improvements. A next revision based on the new Nuclear Energy Act, is in preparation for 2008. After the enactment of this revision a new ordinance will be launched concerning the handling of unsealed radioactive material in nuclear facilities, in which detailed requirements on building and equipment are determined. This ordinance will partially replace the Inspectorate's guideline R-07.

Dose limits

The Radiological Protection Ordinance limits the general maximum individual total dose for NPP personnel (plant personnel and contractors) as a rule to 20 mSv per year. Exceptionally, a limit of 50 mSv per year, but not exceeding 100 mSv in five years, can be authorised by the Inspectorate.

Since 1994, no individual dose exceeding 20 mSv per year has been accumulated by any plant personnel or contractors during their work in the Swiss NPPs. Since 1987, all annual collective doses remained well below 4 man-Sv per unit and all have been kept below 2 man-Sv per year since 1995. These facts are illustrated in figure 3, showing annual collective doses going back to 1969 (note: the NPP Beznau consists of two units both located on the same site).

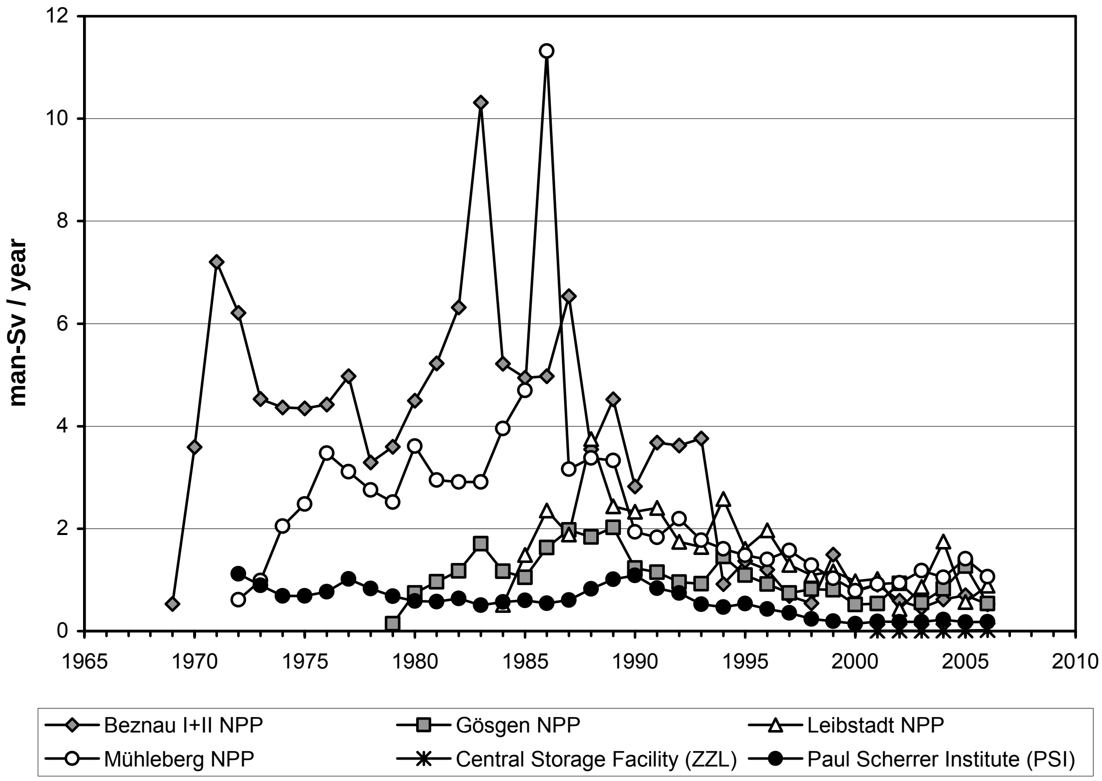


Figure 3: Annual collective doses for the personnel in Swiss NPPs, the Central Interim Storage Facility (ZZL) and the research institute PSI. The two peaks are related to extraordinary work carried out in 1983 (Beznau NPP: Replacement of anti-vibration bars in the steam generators of one unit) and 1986 (Mühleberg NPP: Replacement of the re-circulation pipes due to stress corrosion cracking). In 1993, the steam generators of NPP Beznau I were exchanged with a collective dose of 1.2 man-Sv. In 1999, the same work was performed at NPP Beznau II with a collective dose of 0.64 man-Sv. This dose reduction can be largely attributed to "lessons learned" from earlier similar operations and to optimisation of radiation protection.

The dose due to non-natural sources, for a person of the general population, is limited to 1 mSv per year by the Radiological Protection Ordinance. The Inspectorate's guideline R-11 defines a source-related dose constraint of 0.3 mSv per year representing the maximum allowed dose for persons living nearby nuclear installations resulting from emissions and direct radiation for each NPP site (independent of the number of reactors). Direct radiation may not cause a corresponding dose of more than 0.1 mSv per year.

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.

The Inspectorate’s guideline R-41 defines the rules for the calculation of doses due to emissions and discharges. The maximum allowed emissions are defined in the licences, based on the characteristics of the NPP and on the results of the dose calculations, taking in consideration the ALARA principle. Calculated doses on the base of annual emissions for a virtual most exposed group of the population, including the exposure due to deposition from former years, have always been well below of 0.2 mSv per year. Since 1994, calculated values due to annual releases have been below 0.01 mSv per year for all Swiss NPPs. These facts are illustrated in figure 4. For all Swiss NPPs, doses due to direct radiation were always below 0.1 mSv per year. Thus, it is shown that the sum of the annual dose caused by direct radiation and emission has always been below the source-related dose constraint.

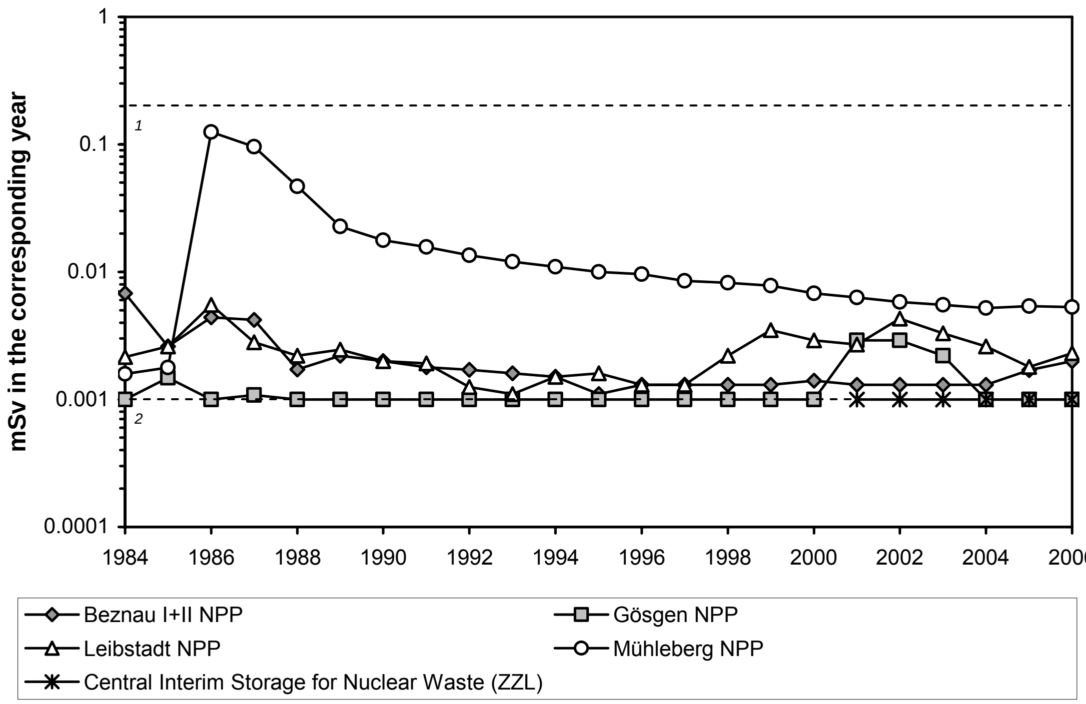


Figure 4: Doses calculated on the base of annual emissions from the Swiss NPPs and the Central Interim Storage Facility (ZZL) without contribution of direct radiation. The annual doses are calculated for a virtual most exposed group of the population[3], including the exposure due to deposition from former years. The peak in the figure of Mühleberg NPP is related to an emission of radioactive particles in 1986 (a malfunction of the waste treatment system of dry resin).

[1] *0.2 mSv per year value (source-related dose constraint minus direct radiation constraint).*

[2] *Values below 0.001 mSv per year are not shown as such on the figure.*

[3] *Virtual person, permanently located at the main plume area, consuming all food produced locally and all drinking water from the river downstream of the NPP in question.*

Steps taken to ensure that radiation exposure is kept as low as reasonably achievable

Over the years, NPP-specific methods have been progressively used, to keep radiation exposure arising from the operation and maintenance work of NPPs as low as reasonably achievable. Since the year 1994, when the new dose limit of 20 mSv came into force, no plant or contractor personnel reached this limit. The mean individual doses for plant personnel and contractors (see figure 5) show a decreasing trend over the last couple of years in all Swiss NPPs indicating the significant efforts made particularly since 1988. However, the mean dose for NPP personnel is mostly higher than the doses for contractors. This indicates that sensitive work, in high dose rate areas, is preferably carried out by the plant internal personnel.

The most significant dose reduction measures undertaken at the Swiss NPPs during the last years are compiled in Table 2.

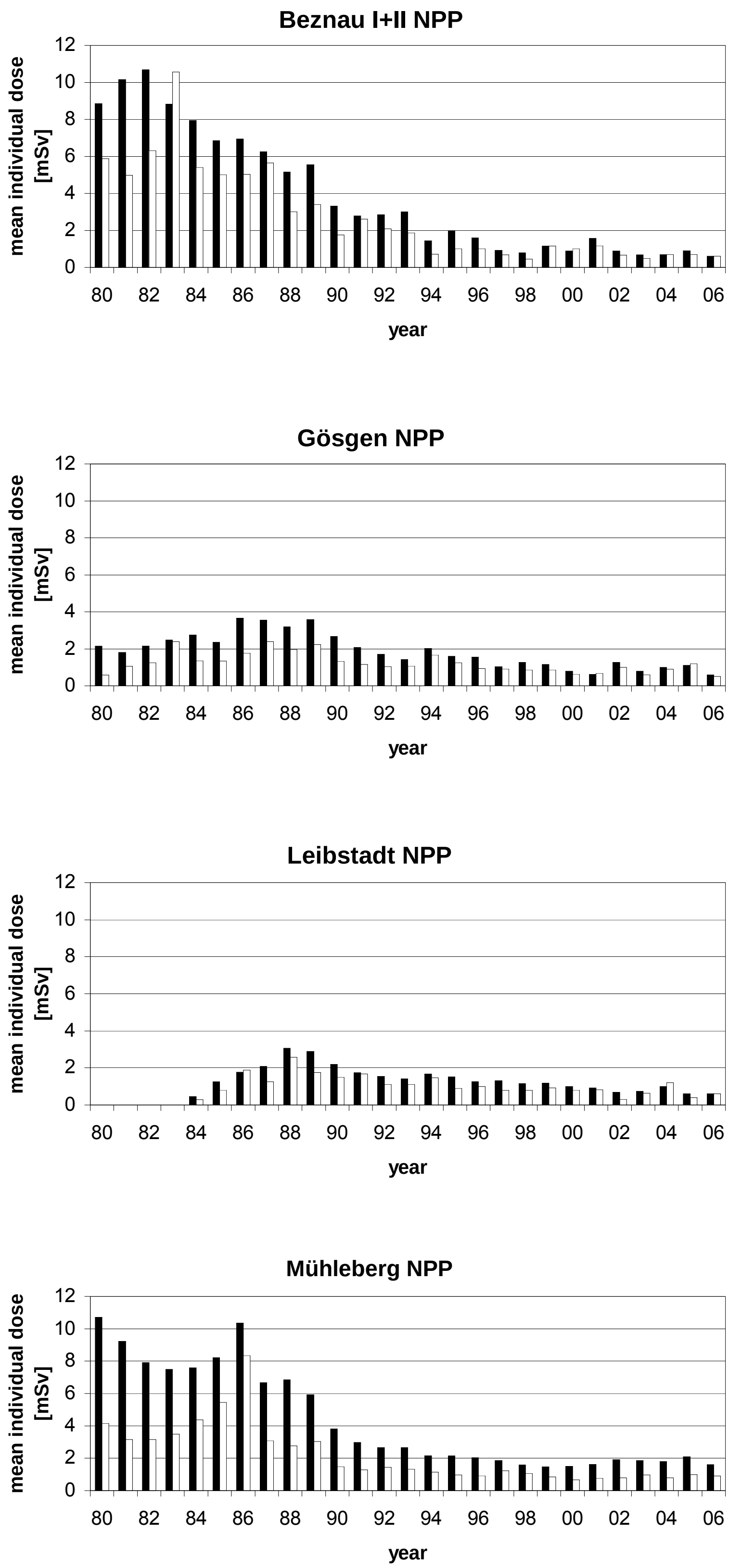


*Figure 5: Mean individual dose of plant personnel (dark bars) and contractors (*white *bars) in Swiss NPP.*

Table 2: Main dose reduction measures in Swiss LWRs.

Plant	Typical outage collective dose [man-mSv]	Main dose reduction measures
Beznau NPP	250	Temporary lead shielding (70 tons). Low dose rate areas for personnel (< 0.005 mSv/h). Individual acoustic dose and dose rate warning. Strong emphasis on training and motivation. Daily job-specific follow up of doses vs. planning including interventions if necessary to keep the NPP-internal dose constraint of 10 mSv p.a. for workers. Remote tools for primary system inspection. Improved water chemistry, reducing fixation of colloids on primary system surfaces. Exchange of the steam generators in both plants. With these new steam generators the inspection and maintenance activities are reduced, leading to less doses.
Mühleberg NPP	900	Temporary lead shielding (85 tons). Permanent racks for supporting removable lead sheets. Replacement of components with "Stellite" parts by components made from a cobalt-free alloy. Daily follow up of job specific actual doses vs. planning doses. Zn-64-depleted zinc feed in primary water. Online noble chemistry (OLNC) primary water operation mode affected a reduction of the dose rates of the recirculation pipes.
Gösgen NPP	600	Temporary lead shielding (20 tons). Highly compartmentalised containment with compartments made out of concrete. Daily follow up of total and selected job specific actual doses vs. planning doses. Zn-64-depleted zinc feed in primary water.
Leibstadt NPP	900	Temporary lead shielding (32 tons). Temporary shielding with water bags. Job tickets (bar code) with online follow up. Very detailed job planning for jobs implying collective doses > 50 man-mSv. Job planning for jobs implying collective doses > 10 man-mSv. Decontamination of re-circulation loops. Zn-64-depleted zinc feed in primary water. Extensive mock-up training. Lowering power before starting the shutdown to reduce iodine in the steam line and turbines.

In order to keep the doses low in a reasonable way under consideration of optimisation, the ICRP recommends in its publication 75 the use of operational dose constraints based on estimated levels achievable by the application of good practice. In this sense, the Inspectorate's guideline R-11 requires the NPP to determine dose planning objectives (e.g. max. individual doses or collective job doses) for the respective activities base on:

- empirical values for comparable activities in its own or a comparable installation;
- current radiological situation;
- international experiences;
- optimisation processes.

According to the Radiological Protection Ordinance, radiation protection is deemed to be optimised if the following conditions are met:

- Different possible solutions have been individually assessed and compared.
- The sequence of decisions that led to the particular solution is traceable.
- Due consideration has been given to the possible occurrence of incidents and the safe storage of radioactive sources which are no longer in use.

In detail the Inspectorate requires:

- Special quality management rules for the radiation protection department as a part of NPP's QM system, (see Article 13) including procedures, which define the determination of dose planning objectives, the optimisation process, the documentation as well as the relevant regulations regarding competencies.
- A radiation protection planning (including determination of dose planning objectives) in accordance with the internal procedure, if the anticipated collective dose of a planned activity in a nuclear installation leads to higher individual or collective doses than the internally determined planning thresholds (typically 5, 10 or 20 man-mSv).
- A report on radiation protection planning in the case of a planned shutdown, and if the planning of an activity results in an anticipated collective dose higher than 50 man-mSv.

The Inspectorate has to examine the dose planning objectives in detail, if the expected annual collective dose exceeds 1.5 man-Sv per NPP. In this case, the Inspectorate will require optimisation measures, if appropriate.

The NPP has to compare the monitored doses with the dose planning objectives. If relevant deviations become obvious the activity has to be stopped, the planning has to be revised and improvements have to be implemented.

In all Swiss NPPs the waste water is collected and treated in batches. However, for the treatment of waste water in every power plant a different abatement technique is used. In Beznau NPP the radioactivity in the waste water is reduced by centrifugation and chemical precipitation. In Gösgen NPP the evaporation and in Leibstadt the centrifugation and evaporation technique are used, while in Mühleberg the centrifugation and ion exchange technique is applied.

Three of the Swiss NPPs – Gösgen, Leibstadt and Mühleberg - have conventional offgas treatment systems which consist of catalytic recombiners, offgas-condensers, hold-up-lines, activated carbon filter columns, HEPA-filters and offgas pumps. Beznau NPP has a different system which works with four pressurised hold-up-tanks.

The NPPs have formulated site specific targets for liquid und gaseous discharges with the intention of keeping the doses for the general public low in a reasonable way under consideration of optimisation. Supplementary every ten years the licencee of each Swiss NPP has to perform a periodic safety review. In the frame of this review the licencee has to assess the liquid and gaseous discharges of his plant and to benchmark against the corresponding discharges of similar European reactors. As a result of this process, in the year of 2004, Beznau NPP decided to improve the abatement system for liquid discharges by nanofiltration, a further developed cross-flow filtration technology. During a test phase in the year of 2006 the licencee of Beznau NPP showed that the liquid discharges can be reduced by nanofiltration to less than the median value of the European pressurised water reactors. In 2007 the licencee started the regular operation of the nanofiltration system.

Operating radiation protection organisation

To ensure independence of the radiation protection organisation from the operation department of the facility, the licencee has to carry out three requirements, which are based on regulations in the radiation protection act.

- The licencee has to provide a direct communication link between the authorised radiation protection expert and the management representative of the licencee.
- The licencee has to delegate competences to the radiation protection experts to intervene in the operation of the NPP if radiation protection rules are injured.
- The licencee has to provide adequate personal resources in the radiation protection organisation. His staff has to be composed of professionals with approved education and training. Radiation protection relevant tasks are reserved to these professionals.

Detailed descriptions of these rules are part of the NPP's documentation necessary for granting of a licence for operation. Modifications of the radiation protection rules of the NPP have to be authorised by the Inspectorate.

Regulatory control activities

As mentioned above, the Inspectorate reviews the radiation protection planning process of the NPPs as a part of its supervisory duties. Typically, these reviews are performed in conjunction with the radiation protection planning for oncoming outages.

Inspections concerning radiation protection matters are focused on the outage phases. Normally, these inspections are planned on the basis of the radiation protection planning of the plant several weeks in advance and are centred on activities with an anticipated collective dose greater than 50 man-mSv. Other routine inspections are performed in every NPP during operation in addition to specific inspections focused on special topics, like radiation instrumentation, contamination control etc.

Additionally the Inspectorate reviews all periodical reports of the NPPs related to radiation protection measures. The Inspectorate operates a computerised data bank on radiological and chemical plant data provided monthly by the licencees.

Environmental radiological surveillance

The Radiological Protection Act establishes the legal basis for the radiological surveillance of the environment. More detailed requirements are laid down in the Radiological Protection Ordinance and in the legislation for foodstuff. On this basis, the Inspectorate has issued discharge and environment monitoring regulations. These regulations contain requirements on the control of discharges and a complete programme 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 in co-operation with the Inspectorate, the National Emergency Operations Centre and the cantons. The programme is reviewed annually and modified as necessary.

The Inspectorate defines requirements for the measuring devices as well as how the measurements have to be carried out. It monitors the correct maintenance of the devices and audits the measurement book-keeping during annual inspections. In addition, it performs its own quarterly benchmark tests with each plant.

The environmental surveillance programme has three main aspects:

- Measurement of the emissions from the plant and comparison of the actual emissions with the limits set in the licence for the operation of the NPP. The limits are chosen in such a way that the dose for persons living in the vicinity of the plant remains well below the source-related dose constraint (see section "dose limits" above).
- Calculation of the dose from the measured emissions for the most exposed persons living in the vicinity of the NPP. The calculated values are compared directly with the source-related dose constraint. The models and parameters used for the calculation are defined in the Inspectorate's guideline R-41 (future name: B11).
- Programme for the radiological surveillance of immissions. The environment is monitored nation-wide by the Federal Office of Public Health. The vicinity of the NPPs is additionally monitored by the NPP and the Inspectorate independently. The programme includes online measurements of the dose rate near the plants (MADUK, see Article 16), as well as regular sampling and measurements of air, aerosol fallout, water, soil, plants and foodstuff.

The results are published in annual reports of the Inspectorate. A summary of the results of the entire environmental radiological surveillance is also published in the annual report of the Federal Office of Public Health.

Developments and Conclusion

The figures with the annual collective doses for the personnel in Swiss NPPs, the mean individual dose of plant personnel and contractors and the annual doses for a virtual most exposed group of the population were actualised with the data up to the year 2006.

Further more the text of the 2004 report was completed with the abatement techniques for liquid and gaseous discharges and it is described how the licencees of the NPPs periodically show that the discharges are kept as low as reasonably achievable.

A passage about the independence of the operating radiation protection organisation from the operating department of the facility was inserted.

The Swiss Party complies with the obligations of Article 15.

Article 16: Emergency preparedness

Clause (i)

Each Contracting Party shall take the appropriate steps to ensure that there are on-site and off-site emergency plans that are routinely tested for nuclear installations and cover the activities to be carried out in the event of an emergency.

For any new nuclear installation, such plans shall be prepared and tested before it commences operation above a low power level agreed by the regulatory body.

Prior to the start-up of a new NPP, on-site and off-site emergency plans, which must be approved by the Inspectorate, are required. The general requirements for emergency preparedness are based on the following acts, ordinances, Inspectorate's guidelines and concepts:

Acts:

- Nuclear Energy Act;
- Radiological Protection Act.

Ordinances:

- Nuclear Energy Ordinance;
- Radiological Protection Ordinance;
- Ordinance on the protection of the population in the vicinity of nuclear installations in the case of an emergency (Emergency Preparedness Ordinance);
- Ordinance on the emergency organisation in case of increased radioactivity (VEOR);
- Ordinance concerning iodine prophylactics in the case of a nuclear accident;
- Ordinance on alerting the authorities and the public (AV);
- Ordinance on foreign substances and contaminants of foodstuffs (FIV).

Guidelines:

- R-45 (future name: B11): Planning and execution of emergency exercises in Swiss NPPs.

Concepts

- Concept for the emergency protection in the vicinity of nuclear power plants, Federal Commission for NBC Protection 2006.

On-site emergency organisation

Each NPP has a plant-specific emergency preparedness documentation which includes the following information:

- operating procedures for abnormal situations;
- emergency operating procedures;
- severe accident management guidance (SAMG);
- reporting procedure to the Inspectorate and for radiological events also to the National Emergency Operations Centre (NAZ);
- reporting procedure to the cantonal police for fast evolving accidents.

The emergency preparedness documentation of the NPPs is inspected regularly.

The implementation of SAMG programmes at the Swiss NPPs was started in 2001 and is almost finished now. Appropriate and validated guidance for the mitigation of severe accidents during full power operation is available at all plants. The validation was done by means of corresponding emergency exercises carried out under observation of the Inspectorate. Beznau and Leibstadt NPP (Westinghouse PWR/GE BWR) decided to follow the Owners Group (WOG/BWROG) SAMG approaches, whereas Mühleberg NPP (GE BWR) and Gösgen NPP (Siemens KWU PWR) developed rather new concepts. In addition to the full power SAMG, all plants except of one have developed special guidance for low power/shutdown conditions.

For communication in the case of an emergency, dedicated telephone and fax lines are installed between the NPPs, the Inspectorate and NAZ. The communication system is tested once a month.

Off-site emergency organisation

The off-site emergency organisation is based on the resources that have been built up within the frame of Switzerland's general population protection concept. These resources consist of a well developed shelter infrastructure and well trained troops for fire and disaster intervention. In the case of a radiological emergency the so called Federal Emergency Organisation Radioactivity (EOR) co-ordinates the usage of civil and military support at the federal and regional levels.

The legal basis for the EOR is given in the Ordinance on the emergency organisation in case of increased radioactivity. The link to the Federal Council (government) is established by the Steering Committee on Radioactivity (LAR) consisting of the directors of all relevant federal offices. The EOR has a permanent team, the NAZ, which is responsible for alerting and informing the public and for the initiation of early countermeasures in all cases of radiological accidents.

The responsibilities of the major organisations involved in emergency preparedness are as follows:

- The NPP-staff is responsible for the detection and assessment of an accident, for the implementation of on-site countermeasures to control it, and for the immediate and continuous transmission of information to the relevant off-site authorities.
- The Inspectorate is responsible for judging the adequacy of the on-site countermeasures implemented by the NPP staff. The Inspectorate also advises the NAZ re-

garding potential off-site radiological consequences for the public.

An automatic dose rate monitoring and emergency response data system (MADUK/ANPA) has been installed around all NPPs in Switzerland. The system continuously monitors the dose rate at about 12 locations in the vicinity of each NPP. These data are transmitted online to the Inspectorate, to NAZ and to the German Umweltministerium of Baden-Württemberg. They are also available on the internet (www.hsk.ch).

The MADUK/ANPA system also provides the Inspectorate with online access to the measured values of approximately 25 important plant parameters. The Inspectorate developed a special software package (accident diagnostics, analysis and management system ADAM) in order to visualise these measurements, to diagnose the plant state, and to simulate possible future accident developments.

The Inspectorate has furthermore set up an automated system for radiological prognosis. The calculations are performed hourly using the ADPIC-Dispersion code (Monte-Carlo) with actual and forecasted meteorological data. The results of these calculations are also made available to the NAZ and the responsible authorities of Germany. In accident situations, calculations of the radiological impact based on the available source term are produced within half an hour approximately.

- NAZ is responsible for the transmission of warning and alerting orders to the cantonal authorities, and also for initial countermeasures for the protection of the population. To this end, NAZ is responsible for the coordination of the measuring teams, data treatment and evaluation, and for the assessment of the radiological situation. NAZ is also responsible for the information of and the communication with the international partners.
- LAR is responsible for proposing appropriate measures to the government for issuing corresponding instructions to cantonal authorities and to the population.
- The cantonal and communal authorities are responsible for the execution of protective countermeasures issued for the public.
- The Swiss agency for therapeutic products (Swissmedic) has been responsible for pre-distribution of iodine tablets to the population. In the future the medical service of the Swiss army will take over this responsibility.
- The canton where the NPP is located has the responsibility to inform its citizens on the possible consequences of an accident in the facility and on how to react in case of an emergency.

The information to media in an accident situation is given by the above authorities according to their competence.

Emergency planning zones

In accordance with the Emergency Protection Ordinance, three emergency planning zones have been defined for each NPP in Switzerland:

- Zone 1 comprises the area around a NPP in which acute danger to the population could arise during an accident and, consequently, in which immediate protective measures are required. Depending on the NPP's power and exhaust height of the stack of the NPP, Zone 1 extends to a radius of about 3 - 5 km.

- Zone 2 adjoins Zone 1. It encloses an area with an outer radius of about 20 km and is divided into 6 overlapping sectors. Alerting of the public can be performed in the specific sectors concerned.
- The rest of Switzerland, (outside Zones 1 and 2) is referred to as Zone 3. Measures to protect the public in Zone 3 during the passage of the radioactive plume are not expected to be necessary. It is assumed that any measure actually required can be implemented without any detailed pre-planning.

The outer border zone 1 and 2 follow the political border the corresponding municipalities.

Emergency protective measures

The primary objective of emergency protective measures for the vicinity of NPPs is to prevent acute radiation sickness resulting from the accidental release of radioactive materials. Beside this primary objective, the emergency protective measures aim to minimise the number of long-term and genetic radiation damages.

The designated protective measures for the population are based on the concept of emergency reference levels of dose quoted in the Ordinance on the emergency organisation in case of increased radioactivity. The concept describes which protective measures are to be considered (see Table 3). For every potential protective measure a lower and upper dose intervention level is given. If the expected dose is above the lower intervention level, optimised protective measures are taken considering negative side-effects. If the expected dose is above the upper intervention level, the corresponding protective measure has to be taken.

Table 3: Intervention levels

Protective measures	Dose acquired in the first year after the accident	Lower dose intervention level	Upper dose intervention level
Staying inside houses	Effective dose from external radiation and inhalation	1 mSv	10 mSv
Staying inside cellars or shelters	Effective dose from external radiation and inhalation	10 mSv	100 mSv
Evacuation	Effective dose from external radiation and inhalation	100 mSv	500 mSv
Intake of iodine tablets	Thyroidal dose from inhalation of radioactive iodine	30 mSv	300 mSv
Restriction of certain foodstuffs	Effective dose from ingestion	1 mSv	20 mSv

Furthermore, limit and tolerance values for foodstuffs are given by the FIV. The limit values correspond to the maximum permitted levels of radioactive contamination of foodstuffs laid down in the EURATOM regulations.

Protective measures to be applied during the cloud phase must be prepared in such a way that they can be implemented in a preventive manner already in the initial phase of the accident. The primary actions to be taken in the cloud phase include sheltering, taking of iodine tablets and possibly evacuation before any release has occurred. The following points are noted:

- The solid construction of Swiss houses and the high availability of private and public fallout shelters, sheltering in houses, cellars or fallout-shelters offer mostly sufficient protection against radioactive cloud shine in the cloud phase of an accident. This is therefore considered the most important protective measure. In order to prevent infiltration of radioactive materials, windows and outside doors should be closed and air-conditioning systems should be shut off.
- Iodine tablets are distributed to all houses, schools and enterprises in Zone 1 and 2. In Zone 3, the tablets are stored by the cantons and should be available to the population within 12 hours.
- Evacuation of parts of the population (especially in Zone 1) during the initial phase of an accident is taken into consideration, if a release of radioactive materials is not to be expected during the evacuation time.

Protective measures during the ground phase are applied according to the actual radiological situation in the environment as indicated by the results of measurements. Important protective measures are: Staying inside houses, evacuation after cloud passage, restriction of access to certain areas, restriction of certain foodstuffs, countermeasures in agriculture, decontamination and medical support.

Alert procedures

At the onset of an accident, the NPP personnel immediately inform the Inspectorate and the NAZ. If the accident poses a threat to the public and the environment, a three-stage warning and alert procedure is set in motion. For efficiency reasons, protective measures for the public should be implemented before radioactivity is actually released from the plant. Therefore, the criteria for warning and alert are primarily based on the situation in the NPP.

- A **warning** is issued at latest when a high dose-rate is monitored inside the containment. The warning (by telephone) puts the federal, cantonal and municipality organisations (within Switzerland) on stand-by for a possible alert. NAZ informs foreign organisations such as the IAEA and authorities in neighbouring countries. It also activates the hotline operated by a professional medical call centre.
- A first **alert** is issued by sirens when an accident evolves in such a way that it could possibly lead to a dangerously high release of radioactive materials to the environment. The alert ensures that the population at risk is made aware of the emergency situation, so that it can prepare to take countermeasures. Instructions are given over the radio.
- Further **alerts** are issued if necessary to give advices to the population for intake of iodine tablets, keep inside the house, go to shelter, etc.

The siren signal and its meaning are described in the Swiss telephone directories.

A special regulation has been set up for the initiation of countermeasures for accidents involving auxiliary systems like off-gas systems, because in such accidents, a release can occur rapidly. In such a situation, the assessment of the dose to the public must be made by the NPP-operator. The decision to alert the public depends on the available time and amount of releases. If the annual limit for the release of noble gases (10^{15} Bq) will be released in less than 1 hour, which gives a dose in the immediate surroundings of the plant of about 1 mSv, then the public within the emergency planning zone 1 will be alerted by sirens and advised to stay inside houses for the next few hours. This action is announced by the plant operator and the alert is initiated by the cantonal police (responsible for the countermeasures for the emergency planning zone 1), without waiting for an order from the national organisation.

Emergency exercises

Emergency training is periodically checked within the frame of emergency exercises, to be performed once per year in every NPP (HSK-B11). Co-operation between the different teams involved and co-operation with external organisations are aspects that are specially exercised and practised in a combined exercise every two years. In addition, each of the plant's emergency teams, e.g. the fire brigade, has to perform its own specific exercises.

Clause 2
Each Contracting Party shall take the appropriate steps to ensure that, insofar as they are likely to be affected by a radiological emergency, its own population and the competent authorities of the States in the vicinity of the nuclear installation are provided with appropriate information for emergency planning and response.

Population in the vicinity of the Swiss NPPs has received a leaflet from the cantonal authorities describing possible dangers associated with a nuclear accident and explaining the prepared countermeasures to cope with the consequences. A brochure covering these topics is also available on www.hsk.ch. The warning and alerting of the population in case of accidents is described in Clause (i) of this Article.

Switzerland is party to the Conventions on Early Notification and on Assistance. Bilateral agreements regarding notification and information exchange in case of a nuclear accident with all neighbouring countries (Germany, France, Italy, Austria and Liechtenstein) are in place. Although Switzerland is not member of the European Union, it is part of the European Community Urgent Radiological Information Exchange Network ECURIE. NAZ has the responsibility for notification and for providing the necessary information. Switzerland also participates to the INES reporting network and is committed to report all events rated as level 2 or higher. For incidents in NPPs, the Inspectorate is responsible for the reporting, whereas for other radiological incidents it is the Federal Office of Public Health.

Due to the proximity of the NPPs Leibstadt and Beznau to the national border, special plans have been drawn up with Germany. The objective of these plans is to ensure the same level of protection on both sides of the border for the population and the environment and to harmonise the procedures. Dedicated leased lines are in place to guarantee communication between authorities. Plans and procedures are regularly up-dated in bilateral working groups within the framework of the "German-Swiss Commission for the safety of Nuclear Installations".

In case of an accident in a NPP, the long term consequences may go beyond the planning zones. Therefore, the collaboration with France and Austria has been intensified. With France an expert group on nuclear emergency matters has been established within the "Commission Franco-Suisse" and with Austria a yearly information exchange takes place.

The emergency plans are not only tested at the national level. For exercises in NPP of Leibstadt or Beznau, German authorities at the local and federal level are also involved. The last exercise took place in 2005. In recent years, national authorities of Germany, France and Austria have been invited to take part in some full scale exercise organised in Switzerland every two years. Switzerland participates in the exercises of the French NPPs of Fessenheim and Bugey which are located about 50 respectively 30 km off the Swiss border.

Preparedness and response on the international level is regularly verified by participation in international exercises conducted by the IAEA or ECURIE. INEX exercises of OECD/NEA are other opportunities to verify special aspects of emergency management. Switzerland was involved in almost all of these exercises.

Emergency plans and procedures have to be improved continuously and adapted to new challenges and changing situations. Experts from several Swiss authorities take an active part in these activities. Currently, Switzerland is supporting the International action plans for strengthening the international preparedness and response system for nuclear and radiological emergencies approved by the IAEA Board of Governors. The Working Group on International Communications is chaired by a representative of NAZ.

Finally, to improve the emergency response system on the national and international level, members of the Inspectorate and the NAZ are actively supporting the activities of the Working Party on Nuclear Emergency Matters of the OECD/NEA.

Clause 3
Contracting Parties which do not have a nuclear installation on their territory, insofar as they are likely to be affected in the event of a radiological emergency at a nuclear installation in the vicinity, shall take the appropriate steps for the preparation and testing of emergency plans for their territory that cover the activities to be carried out in the event of such an emergency.

Does not apply to Switzerland.

Developments and Conclusion

Since the last review of the CNS, the Nuclear Energy Act and the corresponding ordinance came into force. These regulations do not introduce new prescriptions concerning emergency preparedness for existing plants. They rather fix established practises at a higher legal level.

The new Federal Ordinance on iodine tablets states that these tablets have to be distributed to all houses, schools and enterprises in Zone 1 and 2. Before, the distribution was mandatory for Zone 1 only.

The Federal Commission for NBC-Protection has updated its concept on the emergency planning and preparedness for the vicinity of NPPs to take into account the new legal situation.

The Swiss Party complies with the obligations of Article 16.

Article 17: Siting

Clause (i)

Each Contracting Party shall take the appropriate steps to ensure that appropriate procedures are established and implemented for evaluating all relevant site-related factors likely to affect the safety of a nuclear installation for its projected lifetime.

According to the Nuclear Energy Act and the corresponding ordinance the suitability of the site is required by the general licence. The established and implemented procedures for the general licence as well as the various requirements associated with its issuing are discussed in Article 7.

The Nuclear Energy Act contains a list of conditions for the issuance of a general licence. The first two conditions are that the protection of human beings and the environment can be ensured and the issuance of a licence does not conflict with any other provisions of federal legislation, in particular legislation governing environmental protection, preservation of local natural and cultural heritage and area development plan.

The principles for nuclear safety are stipulated in the Nuclear Energy Ordinance. According to this ordinance the following reports have to be submitted with the application for a general licence: a safety report (SAR), an environmental impact report, a report on compliance with area planning requirements, a concept for decommissioning, and a report for the disposal of resulting radioactive waste. The principle of nuclear safety relevant for siting is the protection against external hazards, including earthquakes, flooding, accident-induced civil or military aircraft crashes, wind, lightning, interruption or failure of external cooling water supply, failure of external power supply as well as effects of gas, fire and explosion due to neighbouring industrial plants or installations. Therefore, all relevant factors related to the sites (natural characteristics and human activities) have to be included in the SAR, in particular:

- geology, seismology, hydrology (including flooding) and meteorology;
- population distribution, neighbouring industrial plants and installations;
- anticipated exposure to radiation in the vicinity of the facility;
- routes and frequency of transport by air, waterways, on the ground, as well as aviation flight corridors.

During the licensing procedure the Inspectorate evaluates all relevant site-related factors likely to affect the safety of a nuclear installation and defines additional requirements on the design of the plant in a safety evaluation report (SER), if necessary.

Before the construction of a NPP a programme for radiological surveillance in the vicinity of the NPP is established by the Federal Office of Public Health and the Inspectorate. The programme includes sampling and measurement of air, water, soil and foodstuff. The first data set is collected before the commissioning of the NPP and is used as a baseline to investigate the influence of the NPP after its commissioning.

Specific siting criteria do not exist, but the relevant factors for safety have to be evaluated each time when a new feature (e.g. a gas pipeline or industrial building) is planned to be built in the vicinity of a NPP.

Clause (ii)

Each Contracting Party shall take the appropriate steps to ensure that appropriate procedures are established and implemented for evaluating the likely safety impact of a proposed nuclear installation on individuals, society and the environment.

Switzerland is a small and densely populated country. The number and size of suitable sites for NPPs are limited. The concept of safety by distance encounters natural limitations in Switzerland. The existing NPPs are, nevertheless, sited in areas where the population density is relatively low compared to the mean value for the industrialised regions of Switzerland.

With the application for the construction permit an actualised SAR, a deterministic safety analysis (which can be a part of the actualised SAR) and a probabilistic safety analysis (PSA) have to be submitted. In theses documents the likely safety impact of the NPP on individuals, society and the environment is evaluated as described in Article 14. The Inspectorate reviews the submitted documents and publishes the results in a safety evaluation report (SER).

The Nuclear Energy Ordinance contains requirements concerning measures to prevent accidents that may be initiated either within (internal) or outside (external) the facility. For the deterministic safety analysis the Radiation Protection Ordinance gives dose constraints for the public during normal operation and for design basis accidents; on this basis, the actual dose limits are defined in the Inspectorate's guideline R-11 for normal operation and R-100 for transients and accidents. The dose constraints are ranked as a function of the incident frequency. The methodology and boundary conditions for dose assessment in normal operation and accident analysis are established in the Inspectorate's guideline R-41 (see Article 15). For the PSA the Nuclear Energy Ordinance demands in the case of the construction of a new NPP that the mean core damage frequency is not greater than 10^{-5} per annum.

Clause (iii)

Each Contracting Party shall take the appropriate steps to ensure that appropriate procedures are established and implemented for re-evaluating as necessary all relevant factors referred to in subparagraphs (i) and (ii) so as to ensure the continued safety acceptability of the nuclear installation.

For re-evaluating the relevant factors, basically the same procedures as those applied for the initial review and assessment (see Clauses (i) and (ii) above) are followed. Because the reporting procedures of the power plant include the relevant site factors, any modifications of the latter are known (e.g. establishment of a new industrial plant in the vicinity of the NPP). The notification of such modifications by the licencee normally includes an assessment of their possible consequences. As part of a PSR, site-related factors are re-evaluated, in particular by reviewing the SAR (which includes the deterministic safety analysis) and the PSA.

The re-evaluation processes essentially contribute to ensuring the continued safety acceptability of the NPP by confirming the validity of earlier assessments or by indicating the impact of changes in site-specific factors on safety. The applicability and effectiveness of the Inspectorate's re-evaluation process are illustrated by means of the new probabilistic assessment of the seismic hazard at the Swiss NPP sites (PEGASOS project). This project was carried out by the Swiss licencees in response to a requirement that originated from the Inspectorate's PSA review process.

Project PEGASOS

Initial Situation

The Swiss Nuclear Power Plants (NPPs) are designed and built to resist strong earthquakes. They are among the buildings having highest seismic safety in Switzerland. Nevertheless, earthquakes continue to represent a non-negligible hazard to the Swiss NPPs. Therefore, the Inspectorate attaches great importance to the most comprehensive and accurate assessment of seismic hazard.

Advances in Analysis Methods

As one step in assessing the seismic threat to the Swiss NPPs, historic earthquake data was gathered. In the mid-1970's, for the purpose of evaluating the original designs, this data was analysed statistically and presented in the form of seismic hazard maps. With the introduction and development of the Probabilistic Safety Assessments (PSA) in the 1980's, refinements in requirements, based on advancements in seismic hazard analysis methodology, were further specified. From that point on, seismic hazard studies had to address uncertainties associated with the inherent scatter of data and the limitations of analysis models.

Requirement by Inspectorate

Swiss PSA studies, which were conducted by the licencees, have been instrumental in confirming that seismic events are a substantial contributor to the overall risk at the plants. Noting further advances of international projects in the field of probabilistic seismic hazard analysis, the Inspectorate concluded that the results from the original seismic hazard studies no longer represented the current state-of-the-art. In 1999, the Inspectorate requested the licencees to determine the seismic hazard according to updated methods, and to include a comprehensive evaluation of all contributions to the uncertainties in the resulting hazard.

The PEGASOS Project

In order to satisfy the Inspectorate's requirement, the licencees initiated the project PEGASOS – a German acronym for "Probabilistic Assessment of Seismic Hazard for Swiss Nuclear Power Plant Sites." Based on a modern and peer-reviewed methodology developed in the USA, seismic hazard was evaluated considering the broad knowledge of the relevant international expert community. Leading national and international earth science experts from independent organisations were brought on board for this unique study in Europe. The preparatory work was started in 1999. The actual project work was launched in 2001, and was completed in the summer of 2004.

Project Review by the Inspectorate

The Inspectorate established its own team of recognised experts who conducted a participatory review of the PEGASOS project. In its final report from the participatory review, the Inspectorate concluded that the methodological requirements had been accomplished and that the project sets a new international standard for seismic hazard assessment of NPPs. The Inspectorate found that the results of the PEGASOS project currently represent the best possible basis for the specification of seismic hazard parameters for Swiss PSA applications and for seismic design of Swiss nuclear facilities. However, the Inspectorate also declared that the documented uncertainty range is rather broad and that this range could likely be reduced by further investigations.

PEGASOS Follow-up Developments

After project completion, the licencees began to evaluate the PEGASOS results, particularly with respect to the possibility of implementing them for analysis purposes. An identified challenge concerned how to address and accommodate the broad uncertainty range, which is mainly a consequence of the lack of strong motion data for Switzerland. The licencees organised two workshops in Switzerland, with the objective of discussing open issues and next steps to be taken. Additionally, the study results were presented during an OECD-sponsored conference in Korea. The first detailed account of PEGASOS made to the public occurred in June 2007 via a media conference. On this occasion the Inspectorate issued a status report regarding the PEGASOS project and the subsequent developments.

Based on the PEGASOS review findings, the licencees developed a programme for a refinement effort. They discussed the key refinement issues in the USA in May 2007, in meetings with the American industry as well as with HSK and the relevant American authorities. According to the international experience with new studies on seismic hazard (USA, IAEA), it is expected that the discussions among experts, and the implementation of the PEGASOS refinement project, may take substantial additional time.

Measures Taken by the Inspectorate

As a first action based on the findings from the PEGASOS project, the Inspectorate has specified more-stringent seismic hazard parameters (as compared to earlier results), to be used in the PSA studies for the Swiss NPPs. Currently, the Inspectorate is also preparing bases, approaches and decisions regarding new seismic design specifications for substantial plant modifications and for licensing of new NPPs.

Furthermore, in the context of the continuous backfitting process undertaken by the Swiss NPPs, the Inspectorate places particular emphasis on seismic safety. In addition to the major seismic backfittings that were realised in the past (e.g. installation of bunkered emergency systems), further seismic backfittings or improvements were performed in all Swiss NPPs as a consequence of the Inspectorate's on-site inspections and insights gained through PSA studies. Components and structures that have been backfitted over the past years include electrical cabinets, motor control centres, cable trays, diesel oil tanks, pipe runs, control room bracing, and masonry walls. As a result of the PEGASOS project, the Inspectorate has requested the licencees to systematically investigate the possibilities and benefits of additional risk-reducing seismic upgrade measures.

Clause (iv)

Each Contracting Party shall take the appropriate steps to ensure that appropriate procedures are established and implemented for consulting Contracting Parties in the vicinity of a proposed nuclear installation, insofar as they are likely to be affected by that installation and, upon request providing the necessary information to such Contracting Parties, in order to enable them to evaluate and make their own assessment of the likely safety impact on their own territory of the nuclear installation.

The population of the surrounding areas of a proposed NPP (including areas of neighbouring countries) is included in the comprehensive public consultation within the frame of the licensing procedure.

Agreements concerning the exchange of information have been signed with Austria, France, Germany and Italy.

The German-Swiss Commission for the Safety of Nuclear Installations (DSK), including its working groups, and the French-Swiss Nuclear Safety Commission (CFS) meet annually for consultation, exchange of information and experience. They also define adequate mandates for working groups; for example exchange of operational experiences, emergency protection planning and exercises, radiation protection, surveillance of ageing and waste disposal.

Also, representatives of Austria and Switzerland meet annually for exchange of information about nuclear programmes, operational experience of nuclear installations and the legislative framework for nuclear safety and radiation protection.

Developments and Conclusion

Changes and developments: Clause (i) was supplemented with a chapter describing how the Inspectorate assesses the radiological impact in the vicinity of a NPP after its commissioning. In Clause (iii) the reporting regarding the project for the re-examination of seismic hazard at the existing sites of Swiss Nuclear Power Plants (PEGASOS) project was updated.

The Swiss Party complies with the obligations of Article 17.

Article 18: Design and construction

Clause (i)

Each Contracting Party shall take the appropriate steps to ensure that the design and construction of a nuclear installation provides for several reliable levels and methods of protection (defence in depth) against the release of radioactive materials, with a view to preventing the occurrence of accidents and to mitigating their radiological consequences should they occur.

Design and construction of the Swiss NPPs are based on the US-American (Beznau I+II, Mühleberg, Leibstadt) and German standards (Gösgen) as was applicable at the time of their construction. These were, and still are, internationally recognised standards that incorporate the principle of defence in depth. The various levels of defence are in place to ensure that for all design basis accidents the NPP remains within the safety limits and that individual dose limits for the general public are not exceeded (see also article 14). In addition, the release of radioactive materials to the environment in the case of severe, beyond design basis accidents is prevented or at least limited. For the mitigation of beyond design basis accidents, severe accident management guidance (which is considered to be an element of defence in depth) is available at all Swiss NPPs (see Article 16).

The design and construction of the Swiss NPPs are thoroughly assessed within the **licensing procedure**. The results of this assessment are part of the safety evaluation report (SER) and they play an important role in the licensing decision (see Articles 7 and 14). The basic requirements of the safety authorities for design and construction are the IAEA design criteria and the Inspectorate's guideline R-101: "Design criteria for safety systems of NPPs with light water reactors". Other important Inspectorate's guidelines for the licensing process are listed in appendix 2.

After the granting of a licence, the design and construction of the existing NPPs are re-assessed periodically, an in-depth review of the design as compared with the actual state of science and technology is performed at least every 10 years (PSR, see article 14). Deficiencies in the NPP, as compared to the current state of science and technology, are identified. If these have a major safety impact, they have to be addressed and remedied by means of appropriate backfitting.

The **first generation** of the Swiss NPPs (Beznau I+II and Mühleberg) were constructed using designs from the late 1960's, before the establishment of the "general design criteria" (GDC), in 1972, by the US Atomic Energy Commission (now the US-NRC). The comparison between the Swiss first generation NPP designs and the GDC revealed that the most important design criteria had already been recognised and incorporated. These NPPs also included several unique features in their designs, which were not standard at the time of their construction:

- double containment (free-standing leak-tight steel plus concrete outer shell);
- load rejection and/or turbine trip without scram;
- continuous emergency power supply from a nearby hydro-electric plant;
- ground water as emergency feedwater system (Beznau);
- containment size doubled in relation to reactor power (Mühleberg);

- hilltop reservoir to flood the core (Mühleberg);
- outer torus (Mühleberg)

However, three important deficiencies were identified:

- insufficient protection from external events of natural origin, especially earthquakes and flooding;
- insufficient protection from man-made external events, e.g. aircraft crash;
- lack of separation of safety-relevant systems.

For the first generation NPPs, the seismic risk was determined on a deterministic basis by experts of the utilities in the middle of the 1960's. Since 1974, the design of a NPP is based on the Safe Shutdown Earthquake (SSE) and the Operating Basis Earthquake (OBE) principles. The former is defined as an earthquake with a peak horizontal acceleration at the rock surface of 0.15 g corresponding to a median frequency of about 10^{-4}/year (based on the seismic risk map developed in 1977 by the Inspectorate's experts). The seismic hazard was reassessed within the project PEGASOS which was completed in 2004, applying state of the art probabilistic methods. The results of this study are still under discussion (see Article 17).

As Switzerland is a mountainous country with hundreds of dams, the most probable cause for flooding a NPP site is a dam break. This can result in the loss of the hydro-electric emergency power for the NPPs of the first generation. The impact of external flooding was analysed on a deterministic basis, assuming a sudden disappearance of the dam. To mitigate the consequences of the flood, special equipment was installed in the NPPs. As an example, in the case of the Beznau NPP, special diesel generators and auxiliary feedwater pumps are located in flood-proof areas; in the case of the Mühleberg NPP, a flood-proof diesel generator was installed and a hilltop reservoir can be manually aligned to the plant to flood the core. Originally, only the reactor building was designed as flood-proof. The backfitted shutdown and RHR-systems for the Mühleberg and Beznau plants (SUSAN and NANO projects, see Article 6) are both installed in flood-proof buildings.

In conclusion, in all first generation NPPs, a comprehensive analysis and backfitting programme has been carried out and improvements have been realised. The backfitting projects included adding one or two completely separated shutdown and residual heat removal systems, both, including their support systems, are protected against external events (see Article 6).

The **second generation** plants were based on US-American and German design criteria. Contrary to the first generation plants, the design of the second generation plants includes protection against an aircraft crash.

The sites of the second generation plants, the Leibstadt NPP and the Gösgen NPP, were chosen such that they cannot be flooded even by an upstream dam break. Some special measures have been taken against the loss of cooling water. Both plants have special well water sources to cope with the loss of normal water intake from the rivers. At the Leibstadt NPP, three (small) cooling towers were installed as an emergency heat sink in case of a loss of cooling water. The US-American design of the Leibstadt NPP had to be adapted to specific Swiss requirements, according to the Inspectorate's guideline R-101, with regard to external events and third party intervention. To fulfil these additional requirements, a special emergency heat removal system, which uses ground water as an ultimate heat sink, was added to the plant design during the construction period. In addition, a steel construction was installed at the interface between the nuclear island and the turbine island to protect the nuclear island from the effects of multiple pipe breaks in the seismically lower qualified turbine island. In the case of Gösgen, a special emergency heat removal system, again using ground water as an ultimate heat sink, was already included in the original design. In 2005, the necessary systems and equipment to enable primary feed and bleed in accident conditions were installed.

To mitigate the radiological consequences for the environment in the case of a severe accident, a filtered containment venting system was backfitted in all Swiss NPPs in the early 1990's on request of the regulatory body. The main design criteria are:

- capacity in decay heat ≈ 0.5% for PWRs and ≈ 1% for BWRs;
- active venting by a valve;
- passive venting by a rupture disc.

Due to the terrorism attacks on the Word Trade Centre on 11 September 2001, the Swiss NPPs were requested by the Inspectorate to carry out safety analyses for the case of a deliberate aircraft impact. The analysis showed that the safety-relevant buildings of the second generation of NPPs at Gösgen and Leibstadt provided complete protection for the case of a modern, fully fuelled, long-range commercial airplane. The first generation NPPs at Beznau and Mühleberg were originally not designed against such scenarios. Nevertheless, the analyses showed that, due to the previous backfitting of special decay heat removal systems and the implementation of further provisions in the area of fire protection, an adequate level of protection against aircraft impact can still be provided.

Clause (ii)
Each Contracting Party shall take the appropriate steps to ensure that the technologies incorporated in the design and construction of a nuclear installation are proven by experience or qualified by testing or analysis.

The design, materials and components are subject to rigorous control and scrutiny and regular testing to verify their fitness for service. The legal requirement that the Swiss NPPs have to comply with the prevailing state of science and technology ensures that the technologies incorporated in the constructions are proven by experience or qualified by testing or analysis.

All four NPPs used the US-American ASME-Code for the design of the primary circuit, the containment, and the safety systems. Also in the case of the Gösgen NPP, which is of German design, compliance with the ASME-Code was demanded by the Inspectorate.

For civil engineering aspects, the Swiss SIA-Code was used. For faulted loads, such as loss of coolant accidents, earthquakes, and aircraft crash, special load combinations with special safety factors had to be developed and incorporated into the design.

The various systems, structures and components (SSCs) are classified into internationally recognised nuclear Safety Classes. These classifications reflect the relevance to safety importance. Safety-classified components have to fulfil high requirements in design, materials, fabrication processes, maintenance and inspection. Nevertheless, some material and design deficiencies have appeared in the course of time. Important examples of such deficiencies, together with steps taken by the Swiss NPPs to control, eliminate or mitigate deficiencies are described below:

- In the late 1960's, the nickel-based material Alloy 600 was used extensively in primary circuits of NPPs since its manufacturing, corrosion and mechanical properties appeared favourable for the operational conditions and service requirements at that time. However, despite earlier experience, this material suffered from stress corrosion cracking in the LWR coolant environment. In Switzerland, the steam generator tubing of the NPP Beznau (Units I and II) experienced stress corrosion cracking after only a few years in service. After years of sleeving and plugging, the problem was resolved by replacing the steam generators (Beznau I: in 1993 and Beznau II: in 1999). The new steam generators contain tubing material which is much more resistant to stress corrosion cracking.
- The re-circulation piping in the Mühleberg BWR NPP was made from stainless steel, corresponding to the normal practices and standards for this type of component. However, after 14 years in service, and in common with some other BWRs of similar design and construction, some areas of the welds experienced stress corrosion cracking. The issue has been addressed by replacing the re-circulation piping with improved material.
- In 1990, after 18 years of operation, the Mühleberg NPP was the first BWR worldwide to report the appearance of horizontal cracks in the stainless steel core shroud. These were discovered during the annual in-service inspection. Until then, stainless steel (Type 304) was deemed adequate for this application. However, the special water chemical environment and fabrication methods used lead to the long-term initiation and growth of cracks. The design of the core shroud does not allow for a simple replacement. As a precautionary measure, tie rods have been put in place. Even in case of a full circumferential separation of the core shroud, these tie rods will hold the core shroud together and in place. This ensures that the core itself will be undamaged. Some 30 BWRs are now reported to be affected by core shroud cracking. In 2000, hydrogen injection and Noble Metal Chemical Addition (NMCA) have been introduced at the NPP Mühleberg to protect the reactor internals against stress corrosion cracking. The results of these measures have not yet revealed a significant impact on crack growth. Still, the benefit of applying NMCA has to be evaluated on a mid to long term basis.

Strategies for managing ageing-related problems, as an integrated part of a comprehensive ageing surveillance programme (ASP) are described in Article 14.

Clause (iii)

Each Contracting Party shall take the appropriate steps to ensure that the design of a nuclear installation allows for reliable, stable and easily manageable operation, with specific consideration of human factors and the man-machine interface.

As mentioned in clause (i) of this Article, the Swiss NPPs were constructed using US-American or German designs and therefore correspond to the requirements of these countries concerning reliable, stable and easily manageable operation, as well as human factors and the human-system-interface (HSI).

However, in the case of NPP control rooms, which are most important from a HSI point of view, improvements compared to the original design have been implemented in three Swiss NPPs. Corresponding to the European view of an ergonomic control room, synoptic representations for piping systems and push button technology to activate valves and motors were used (see also Article 12).

Newly developed technologies such as computerised visualisation techniques to present processes in the NPPs, including abnormal conditions, have been introduced to enhance the easiness of operational control. The degree of automation has been increased to reduce the need for manual action over a period of 30 minutes dealing with design basis accidents (DBA) and of 10 hours in the case of external events.

The Beznau plant has installed two computerised systems to improve the HSI. The first system is a computerised alarm system with a prioritisation scheme for displaying the most important message within a safety function. The second is a computerised "emergency operating procedures" (EOP) system based on the written EOPs. It guides the shift supervisor step by step through the EOPs. A paper-based backup system, which is based on classified instrumentation, is used to cope with possible computer failures. As a prerequisite for the operation licence for the two new systems, the Inspectorate required that the plant perform a verification and validation programme on a full scope simulator and to take the necessary remedies, if deviations to design criteria were detected. These activities were closely followed by the Inspectorate.

The NPP Mühleberg has introduced a computerised visualisation system, including SPDS (safety parameter display system), to support the operating staff and to improve the presentation of plant information.

The Leibstadt NPP installed an SPDS shortly after the beginning of its commercial operation. The Gösgen NPP recently completed the implementation of an SPDS.

Presently the Inspectorate is collecting the information about recognised difficulties during the human factor validation of operator support systems. This information will serve as a basis for a regulatory guideline in the area of Human System Interfaces.

Developments and Conclusion

The Swiss Party complies with the obligations of Article 18.

Article 19: Operation

Clause (i)

Each Contracting Party shall take the appropriate steps to ensure that the initial authorisation to operate a nuclear installation is based upon an appropriate safety analysis and a commissioning programme demonstrating that the installation, as constructed, is consistent with design and safety requirements.

Each of the five Swiss commercial reactors has a legally granted and valid licence for operation. The initial licence for operation includes the licence for commissioning. Essentially, the basis for granting an operational licence comprises of the following elements:

- the safety analysis report (SAR), submitted by the applicant/licencee together with the formal application;
- the safety evaluation report (SER), prepared by the Inspectorate as a conclusion of its review and assessment;
- the Statement on the safety review issued by the Nuclear Safety Commission (KSA).

Wherever appropriate, the SER and the KSA statement propose a number of conditions to be fulfilled for operation with the requested licence.

The operation licence includes the authorisation for commissioning. The commissioning programme, which has to be approved by the Inspectorate, comprises the pre-operational and start-up test programme as well as procedures for testing all equipment important to safety. Usually, the licencee proceeds to a design review to verify that the "as built state" correctly reflects the intended design according to safety requirements (safety criteria and licence conditions), and the function/operability of this equipment. The commissioning itself and all steps of the start-up tests are kept under regulatory control by means of the permits granted by the Inspectorate.

Within the frame of the operation licence, an expert report is issued by the Inspectorate for each new operational cycle after outage for maintenance and refuelling. This expert report is also the regulator's substantiated opinion that the safety of the NPP for the next operation cycle is in accordance with the requirements. It is based on the Inspectorate's assessment of the operational performance including radiation protection, the events of the last cycle on the results of the maintenance and refuelling activities during the outage period and the approval of the reload licensing documentation (see Article 14).

In October 1998, Leibstadt received the operation licence for a power uprate of 14,7 % of rated power upon the application of the licencee. The power was increased by 6 % in 1998 and then by subsequent steps of at most 3 % of the previous rated power level. For each step a permit was granted by the Inspectorate, after completion of an adequate test programme. The uprate was finished in 2002.

Clause (ii)

Each Contracting Party shall take the appropriate steps to ensure that operational limits and conditions derived from the safety analysis, tests and operational experience are defined and revised as necessary for identifying safe boundaries for operation.

See Clause (iii) below.

Clause (iii)

Each Contracting Party shall take the appropriate steps to ensure that operation, maintenance, inspection and testing of a nuclear installation are conducted in accordance with approved procedures.

These two clauses are closely linked; as a consequence they are both considered simultaneously in the following text.

The operation of an NPP has to be in accordance with an appropriate set of limiting conditions for operation (LCO) approved by the Inspectorate. The LCO constitute boundary conditions for the procedures and instructions for normal operation. The LCO are derived from the safety analysis and test results and are included in the plant technical specifications (tech specs). Tech specs also contain the plant-specific surveillance requirements. Concerning the structure of tech specs, the licencees follow the formal set-up by the reactor supplier.

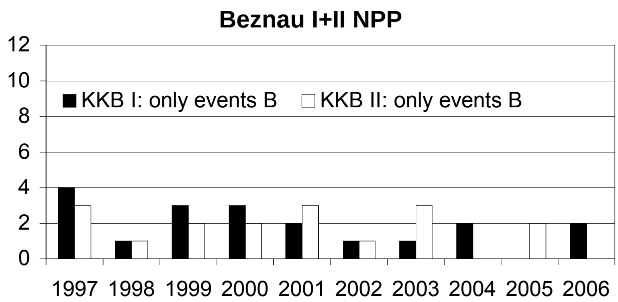
For putting into force this plant-specific document, and any change to it, a permit has to be granted by the Inspectorate. Tech specs have to be revised according to plant modifications, operational experience and new knowledge. This is regularly performed by the licencee, and the modified wording needs again a permit by the Inspectorate. In this way, tech specs have achieved a mature state through the many operational periods.

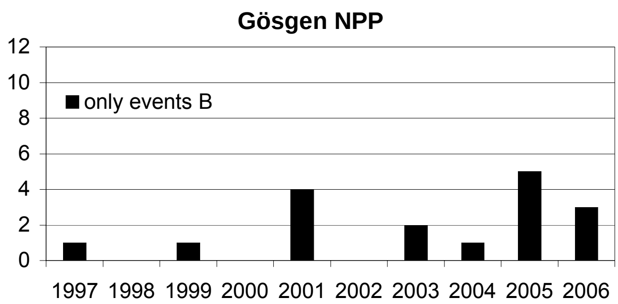
Further procedures are provided by the licencees to ensure safe operation of the NPP. They are based on regular verification of the operability of safety-related equipment. These procedures are used as elements of extensive surveillance programmes that cover maintenance, inspection and testing. They encompass in-service inspection by non-destructive examination of components, periodical examinations of electronic, electro technical and mechanical equipment, periodic functional testing of systems and components as well as an ageing surveillance programme (ASP, see Article 14). Recently, several non-destructive testing qualification pilot projects were conducted or started in Swiss NPPs.

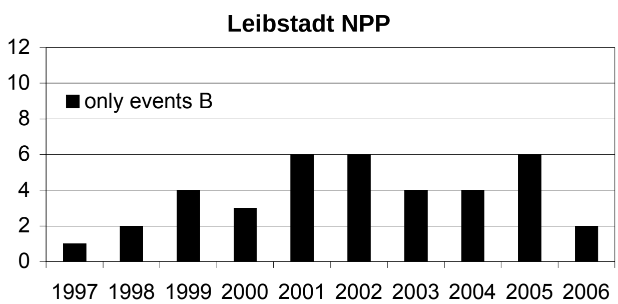
Regulatory surveillance of plant operation relies on the information obtained from the operating organisations by means of a reporting system (according to Inspectorate's guideline R-15, see Article 14) and on the information collected within the frame of the Inspectorate's inspection activities and on its own measurements. Since 1992 (when the INES classification became operational in Switzerland) 8 INES-1 events occurred in Swiss NPPs. The annual numbers of reportable events according to the Inspectorate's guideline R-15, which are shown in figure 6, are low.

In accordance with the reporting system, the operating organisations report periodically (monthly, annually, after refuelling outage) on the operational performance and on activities related to safety, among which modifications to plant equipment, procedures and organisation and the doses to the personnel and to the public are the most important. Particular emphasis is put on event reporting and investigation. Lessons learned and feedback from events are an essential contribution to operational experience. In addition, the level for event reporting in Switzerland is low. Therefore the Inspectorate is well informed even about minor events of safety interest by comprehensive event reports. The incident analysis by the utility and by the Inspectorate is an important tool for increasing nuclear safety (see also Clause vii).

As a consequence of increased price competition on the electricity market, all licencees invest in efforts to optimise plant operation. In two NPPs such optimisation programmes included initiatives for yearly alternating short and long outages, where the short outages are mainly used for refuelling. This entails test and maintenance intervals of two years for part of the safety-related equipment. The corresponding changes in plant technical specifications have been reviewed and approved by the Inspectorate for two licencees. With regard to the future electricity market deregulation, the utilities also work out plans for so-called risk-informed projects. This concerns mainly maintenance and testing. Pilot projects in the field of in-service testing have already been worked out and have been carefully assessed by the regulator.







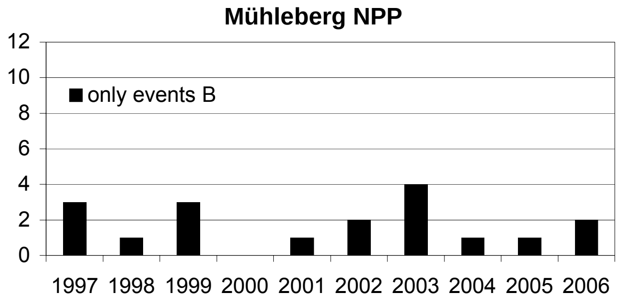


Figure 6: Annual number of reportable events in Swiss NPPs.

Clause (iv)
Each Contracting Party shall take the appropriate steps to ensure that procedures are established for responding to anticipated operational occurrences and to accidents.

In addition to the operating procedures for all modes of normal operation, each NPP uses dedicated procedures in cases of operational anomalies and emergency conditions, called emergency operation procedures (EOPs). EOPs are required by Art. 28 clause 1 letter a and Appendix 3 of the Nuclear Energy Ordinance (KEV). They specify the measures to be taken to manage incidents and accidents up to the time of core damage. Since the EOPs provide only partial support for mitigation of severe accidents, Art. 28 clause 1 letter a and appendix 3 of the Nuclear Energy Ordinance (KEV) require an extension of the EOPs by severe accident management guidelines (SAMG). KEV delegates the regulation of the content of the EOPs and SAMGs to regulatory guides. Changes in the content of EOPs and SAMGs must be reported to the regulatory body. EOPs and SAMGs are developed and implemented by the plants within the frame of the top level organisational documents of the plants, which are required by the KEV and reflect the policy of the operating organisation. Plant modifications, operating and training experiences, scientific and technological developments and lessons learnt from events in NPPs initiate modifications of EOPs and SAMGs if required.

The emergency procedures of the NPPs include steps related to the alerting of the NPP stand-by safety engineer. Also documented are the stand-by safety engineer's duties, in particular, the obligation to determine whether an emergency condition actually exists, to alert the plant's emergency staff and to inform the Inspectorate in the case of any event requiring immediate reporting. The on-site criteria to be fulfilled before declaring an emergency and for alerting and alarming are described in the NPP's emergency procedures. Further information on alerting and alarm procedures is given in Article 16.

The final goal of EOPs is to bring the plant into a safe operational state. The goal of SAMGs is to prevent or at least minimise impacts on the environment. Taking appropriate remedial actions after an event is a task of the emergency staff. Restart of normal operation after an event requires that the state of the plant is in accordance with the technical specification.

For each event that impairs or might impair nuclear safety a review and an evaluation of the case and the notification of the regulatory body is required by Article 38 clause 3 KEV. Deadlines for the notification are given by appendix 6 KEV.

Clause (v)
Each Contracting Party shall take the appropriate steps to ensure that necessary engineering and technical support in all safety related fields is available throughout the lifetime of a nuclear installation.

The NPPs have developed their own on-site technical support, which takes care of the surveillance test programme, reactor engineering and fuel management, operational experience feedback, plant modifications and safety-related computer applications. These functions are carried out by different technical departments at the NPPs. In most cases, a department at the NPP's headquarters is responsible for core and cycle design and for fuel procurement. If ever knowledge in very specialised areas of nuclear safety is required, each plant can subcontract its reactor supplier for technical support.

Furthermore, there are local suppliers and consultants at hand. Nevertheless, as it is necessary that the plant on-site personnel has enough knowledge and experience to establish correct contracts on clearly defined safety issues, the plant management seeks an equilibrium between on-site and off-site technical support.

In view of the electricity market deregulation, and under the actual increased economic pressure, the conservation of corporate knowledge becomes an important issue. The Inspectorate is aware of this fact and the issue is discussed in the regular management meetings between the Inspectorate and the NPPs. A problem to ensure technical support may arise in Switzerland in the future if the nuclear know-how and capacity continues to thin out and research activities are reduced at research institutes and universities. The Inspectorate is aware of this problem and follows the international activities and trends concerning this issue.

Clause (vi)
Each Contracting Party shall take the appropriate steps to ensure that incidents significant to safety are reported in a timely manner by the holder of the relevant licence to the regulatory body.

The Nuclear Energy Act, the Nuclear Energy Ordinance and the Inspectorate's guidelines contain requirements on the notification of events and incidents:

- Notification of events to allow early recognition of deviations and their correction;
- Notification of incident/accident conditions to alert the Inspectorate's emergency organisation and other authorities;
- Notification of events of public interest to allow the Inspectorate to make an independent assessment and to rapidly inform the public.

For practical reasons three classes of safety significance are defined. They are related to reporting time and content requirements (S emergency, A high significance, B low significance). Two additional classes are used for special purposes: class Ö events of public interest, for example smoke or noise at the plant site (immediate reporting) and class U events, which are lower than B, but still of safety interest to the Inspectorate. A catalogue of consequences is used as classification criteria in the guideline, which has to be applied to the event in the NPP. The guideline also requires the Inspectorate to be provided with a preliminary INES rating of the event, based on the INES User Manual. A written confirmation of the event by the licencees forms the basis for the Inspectorate to review in short-term the classification and event type and to take immediate actions if the event reveals unexpected barrier degradation. For events classified as S, A or Ö a specific emergency team of the Inspectorate meets as required by its internal emergency preparedness rules, to review the event and inform the media if necessary. The Inspectorate is currently developing a new guideline related to the reporting and the classifying classification of events. Thereby, it is intended to replace the existing national safety significance classes by the INES classification system, solely.

To be sure that the guideline will be utilised properly by the NPP, the classification is a formal part of the process for the licence and requalification of shift supervisor and on-call engineer. During periodic emergency drills, the event classification is also an important objective for the NPP staff and the regulatory body.

The Inspectorate has established as part of its quality management system (see Article 13), an internal process of event investigation which includes the independent assessment and classification of all reported national events. A special advisory working group, consisting of experts in nuclear, mechanical, electrical and system engineering, human factors and radiation protection, gives advice to the director of the Inspectorate. The final classification is then decided by the director.

It has been the Inspectorate's practice for several years to summarise these events and their classification in the publicly available Inspectorate's annual report.

Clause (vii)
Each Contracting Party shall take the appropriate steps to ensure that programmes to collect and analyse operating experience are established, the results obtained and the conclusions drawn are acted upon and that existing mechanisms are used to share important experience with international bodies and with other operating organisations and regulatory bodies

One important process in the Swiss NPPs deals with non-conformance control and corrective actions, guided by procedures within the QM system. Any non-conformance is reported and raised as an issue in the NPP's daily morning meeting where the necessary follow up steps (e.g. work authorisations) are initiated.

The safety impact of non-conformances is evaluated. In the case of events that are either of interest or of significance to safety, the non-conformance is reported to the Inspectorate. In addition, a plant internal investigation team starts a thorough analysis of the event. In the case of more complicated contributing factors it uses dedicated root cause analysis methods. As a result of this analysis the event investigation team suggests any necessary measures to be implemented at the plant. These suggestions are once more reviewed by the plants internal safety committee prior to implementation.

Low level non-conformance events (below the reporting level), near misses and other types of failures or malfunctions are notified and evaluated during the daily meeting between plant managers and representatives of all important technical divisions. Depending on the safety relevance or the operational impact of the non conformance remedial actions are initiated immediately or the problem is transferred for further evaluation to the event investigation team or a technical division.

After the decision on adequate remedies the implementation is assigned to a division. The finalisation has to be reported to the safety review committee. All the acquired operating experience is used further in different plant improvement programmes.

The four CEOs of the Swiss NPPs have initiated and are monitoring the exchange of operating experience between the Swiss NPPs. This group of CEOs is supported by several working groups that deal with issues such as training, nuclear safety performance, surveillance of ageing, management systems, radiological and chemical plant performance, fire brigades and industrial safety.

Every NPP has a process in place for dealing with all aspects of information exchange on external operating experience. According to this process, information on external events is screened and evaluated. Depending on the significance and applicability to the own plant, the information is evaluated in detail and modifications are implemented if necessary. The Inspectorate periodically inspects this process. Furthermore, the plants are required to report to the Inspectorate the external events that were evaluated in detail on a 3 monthly basis. Important external sources are the World Association of Nuclear Operators (WANO) event information, the Plant Owners Group event information, the incident reporting system (IRS) of IAEA (information provided by the regulatory body), and VGB (Association of Power and Heat Generating Utilities) in Germany. Specialised expert working groups from Swiss NPPs meet periodically for the exchange of operational experience information from abroad and detailed information exchange on own recent plant events.

In the Periodic Safety Review, which is formally required from all NPPs at least every 10 years, the plants have to assess their own operating experience as well as all important applicable external events in a summarised version. This review is also assessed by the Inspectorate in a report open to the public.

The Inspectorate has its own process installed to assess events in nuclear installations in other countries. In the case that the Inspectorate's assessment shows potential for safety improvements at Swiss NPPs the plants are required to analyse the situation in their own installation and to take appropriate actions. For the Inspectorate the main source for information is the IRS of the IAEA/NEA. The Inspectorate is member of the system since it's foundation in 1980. The membership includes the preparation of safety instructive reports for the nuclear community and to attend and organise meetings and workshops on important safety issues. The Inspectorate delegates members of its staff to the OECD/NEA/CSNI "Working Group on Operational Experience" (WGOE) as well as to the "Working Group on Human and Organisational Factors" (WGHOF).

The Inspectorate draws additional important information from INES reports, from NRC information letters and from bilateral contacts (e.g. safety commissions) with the neighbour countries, France and Germany.

Examples of Swiss events reported to the IRS are the cracking of the core shroud of BWRs, the break of a PWR reactor coolant pump shaft, the failure and incorrect testing of a PWR reactor trip breaker and coolant temperature stratification in a BWR feed water line.

Examples of operational experience information from abroad that lead to major modifications at Swiss NPPs are:

- Based on the Generic Letter 89-10 of the US-NRC, the Inspectorate required a re-evaluation from all Swiss licencees on the functional analysis of motor-operated valves in safety related systems. As a consequence, certain gate valves were modified at each Swiss NPP.

- After the incident in Barsebäck 2 (Sweden) on 28 July 1992, where clogging of the suction line strainers in the suppression pool occurred, the Inspectorate started a programme of short-term actions and measures for resolution of the issue in all NPPs. Short-term actions included inspections and a detailed review of thermal insulation types employed, clogging analysis of the strainers and the preparation of accident management measures for BWR plants. As a result, all emergency core cooling system suction strainers in the BWRs (Mühleberg and Leibstadt) were replaced during their outage periods in 1993 by new equipment with a considerably enlarged strainer area. For the PWRs, backfitting actions were at that time found to be unnecessary. A reassessment of this issue which took place after the release of the latest French and NRC research results revealed that the design of the PWR suction strainers is still appropriate. Nevertheless, one licencee decided to mount new state of the art suction strainers of a cassette type in order to improve safety and to get more flexibility regarding the use of thermal insulation material in the containment.
- Two hydrogen explosions occurred in a European and a Japanese BWR at the end of 2001, which resulted in ruptured pipes. This is a known phenomenon, of which assessments were already made in the past; based on the said events, re-evaluation of these earlier assessments were ordered for the two Swiss BWRs. Improvements with procedures (e.g. filling of empty pipes with water) were immediately implemented. Small hardware modifications (e.g. improved insulation, installation of thermocouples) were made during annual outage. The investigations are not yet finished because other hardware modifications are still under study. However, the impact of hydrogen explosions on the environment is limited and no new "design basis accident" has to be considered.

- The Reactor Vessel Head Corrosion event at the Davis Besse NPP (USA) in 2002, where a significant amount of boric acid corrosion was detected due to leakage through cracks in the nozzles of control rods, has created a centre of high attention in the nuclear community. Swiss operators as well as the Inspectorate were already vigilant to this phenomenon due to previous experience: a small head corrosion event caused by leakage happened in the early 1970's in a Swiss NPP; and also - already 5 years before the said US event was reported - cracks in the control nozzles in US plants had been found and reported. All this previous experience was used by the Inspectorate to define requirements for improved periodic surveillance on nozzles cracks and leakage control by the plant operator. Therefore, the Davis Besse event did not lead to any additional actions.

- The incident at Forsmark 1 NPP (Sweden) which occurred on the 25 July 2006 also led to major investigations by the Inspectorate. HSK checked in detail those aspects which had been identified as being significant for the course of the event. The technical and organisational measures that are in place at the Swiss NPPs in order to deal with the consequences of similar event types were comprehensively checked. The results of the investigation were published in a specific report which is available at the Inspectorate’s website. As result of these investigations, it can be stated that there are no gaps in the technical and organisational precautions implemented in the Swiss NPPs to protect the plants from the effects of grid disturbances. Nevertheless, HSK did recommend that when training shift personnel on the simulator, additional losses of redundancies of safety systems, as well as the loss of information systems and signals in the control room, should be trained periodically.

The inspectorate publishes information on selected events that occurred in Swiss NPPs and on the use of external operating experience information in its annual report.

Clause (viii)

Each Contracting Party shall take the appropriate steps to ensure that the generation of radioactive waste resulting from the operation of a nuclear installation is kept to the minimum practicable for the process concerned, both in activity and in volume, and that any necessary treatment and storage of spent fuel and waste directly related to the operation and on the same site as that of the nuclear installation take into consideration conditioning and disposal.

The Nuclear Energy Act implements the principle that the originator of radioactive waste is responsible for the safe management of this waste. It is further mandatory that, as a prerequisite for licensing a NPP, the safe and permanent management and disposal of the waste generated by the facility are ensured. The legislation on radiological protection (i.e. the Radiological Protection Act and the Radiological Protection Ordinance) also requires that the production of radioactive waste is kept as low as possible. By law, the radioactive waste originating in Switzerland must, be disposed of domestically.

The critical review of projects for nuclear installations by the nuclear safety authorities during the licensing phase and the supervision by the Inspectorate of the construction and the operation of such installations ensure that the legal requirements are complied with.

Spent fuel discharged from the reactor is stored on site for a few years at each NPP. The Nuclear Energy Act prohibits the reprocessing of spent nuclear fuel for a period of ten years starting 1 July 2006. In the past, the operators of the NPPs have signed contracts with foreign companies for reprocessing approximately 1200 tons of spent fuel. All the spent fuel covered by these contacts had been shipped abroad by June 2006 and 961 tons had already been reprocessed at the end of 2006. At present spent fuel is also stored in transport and storage casks at the Central Interim Storage Facility (ZZL), which started active operation in June 2001. The return of waste from foreign reprocessing facilities to the ZZL started in 2002 and proceeds on schedule. At the Beznau NPP site, there is an additional facility for dry storage of spent fuel elements which is not yet operational. At the Gösgen NPP site, a building for wet storage of spent fuel is under construction. Starting up is planned for 2008. The decision on the further management steps (reprocessing or direct disposal) will be taken later.

The generation of radioactive waste at NPPs is kept at a low level. This is made possible by virtue of fuel quality and plant cleanliness. The resulting waste is collected and segregated. Waste with such low activity levels that they can be exempted from regulatory control are cleared for re-use or conventional disposal under the supervision of the Inspectorate. The clearance conditions are defined in Annex 2 of the Radiological Protection Ordinance. The procedures for clearance are detailed in the regulatory guide HSK-R-13.

As a general rule, radioactive waste is conditioned as soon as practicable, mostly on site at the NPPs and Paul Scherrer Institute (PSI), and partly externally at the ZZL. According to the Nuclear Energy Ordinance all procedures for the conditioning of radioactive waste have to be approved by the Inspectorate. Such approval requires that the waste products comply with the acceptance criteria of storage, fulfil the requirements of the disposal planning organisation (NAGRA) and can be transported in compliance with the dangerous goods regulations. Detailed requirements are documented in the new regulatory guide HSK-B05. Storage of operational waste takes place on site under appropriate and adequate conditions. The requirements regarding storage of radioactive waste are detailed in the regulatory guide HSK-R-29.

Developments and Conclusion

Changes and developments: Due to the introduction of the new Nuclear Energy Act there have generally been few formal changes to the last report.

Clause (iii): The permit for applying modified technical specifications has been granted by the Inspectorate.

Clause (vi): Introduction of the INES scale as the sole classification system for events within the frame of the Inspectorate's Integrated Oversight Project.

Clause (vii): Minor change due to the Installation of new suction strainers in a PWR plant.

Clause (viii) There are only a few formal changes like new names of guidelines, and updated figures.

The Swiss Party complies with the obligations of Article 19.

Outlook

The Swiss Party to the Convention on Nuclear Safety is committed to closely follow developments in the field of nuclear safety, and implement these if appropriate. Best practices receive due attention and are considered for adaptation if they improve the regulator's work or if they help operating the Swiss NPPs more safely. A new Nuclear Energy Act was put into force in 2005. HSK continually strives to improve the regulatory framework. The formal independence of the Swiss Federal Nuclear Safety Inspectorate from the licensing authorities is well under way. A separate act to legally settle the inspectorate's fully independent status in accordance with the new Nuclear Energy Act was adopted by the parliament this year and is scheduled to become effective soon.

The technical feasibility of the disposal of high level and long-lived intermediate level waste in Switzerland has been demonstrated. The Federal Government approved this feasibility demonstration for a deep geological repository in a region of Opalinus clay in 2006. Subsequently a detailed "Deep Geological Repository Sectoral Plan" defining the selection procedure for potential sites was drafted by the Swiss Federal Office of Energy, involving the general public and stakeholders in Switzerland and in neighbouring countries. After approval of the conceptual part of the plan by the Federal Government, the site selection procedure will begin, taking scientific, technical and socioeconomic factors into account.

In a spirit open to international technical co-operation, the Swiss regulatory body maintains close relationships with regulatory bodies world-wide and engages actively in knowledge transfer. Thus, several co-operation projects are currently ongoing to promote the use of modern safety assessment methods in order to enhance the technical capabilities of some of the partner regulatory bodies. With the implementation of the integrated oversight approach, the Inspectorate will further enhance the effectiveness, balanced decision making and traceability of its work.

A gap between power supply and demand is anticipated for the next 10 to 20 years as the first generation NPPs are expected to reach the end of their technical lifetimes and bilateral agreements on the electricity supply from France will expire. In February 2007, the Federal Government issued a new national energy strategy, including – besides the promotion of energy efficiency, renewable energy and international co-operation – the option of building new large-scale power plants and NPPs in particular. According to the New Nuclear Energy Act, the general licence for a new NPP can be subjected to a referendum.

The continued active Swiss participation in the IAEA and the OECD NEA underlines the fundamental role Switzerland attributes to these organisations. Furthermore, the close bilateral co-operation with neighbouring countries in all nuclear safety matters will remain an important issue for the Inspectorate.

In the future, considerable efforts are needed to improve communication in nuclear safety matters. Both domestically and internationally, a transparent, understandable and adequate information policy is of paramount importance to establish a sound basis for an open dialogue across borders and between stakeholders. Such transparency includes the working processes and methods employed by the regulatory body. The reporting under the Convention on Nuclear Safety plays a significant role in this respect and generates trust. In line with the CNS, Switzerland will engage in maintaining and improving its high standard of nuclear safety and will actively support the corresponding international activities. In the international nuclear community, the Swiss regulatory body strives to be a reliable partner.

Appendices

- Appendix 1: List of abbreviations used in the present report
- Appendix 2: List of the Inspectorate’s guidelines presently in force

Appendix 1: List of abbreviations used in the present report

ADAM	Accident Diagnostics, Analysis and Management System
ALARA	As Low As Reasonably Achievable
ANPA	Emergency Response Data System
ASME	American Society of Mechanical Engineers
ASP	Ageing Surveillance Programme
BAG	Federal Office of Public Health (Bundesamt für Gesundheit)
BFE	Federal Office of Energy (Bundesamt für Energie)
BIP	Basic Inspection Programme
BWR	Boiling Water Reactor
BWROG	Boiling Water Reactor Owners Group
BZL	Federal Interim Storage Facility (Bundeszwischenlager)
CFS	French-Swiss Commission for Nuclear Safety and Radioprotection
CSNI	Committee on the Safety of Nuclear Installations (NEA/OECD)
DBA	Design Basis Accident
DSK	German-Swiss Nuclear Safety Commission for Nuclear Installations
ECCS	Emergency Core Cooling System
ECURIE	European Community urgent radiological information exchange
ENSI	Swiss Federal Nuclear Safety Inspectorate (Eidgenössisches Nuklear-Sicherheitsinspektorat)
EOP	Emergency Operating Procedures
EOR	Federal Emergency Organisation Radioactivity
EPFL	Swiss Federal Institute of Technology, Lausanne (Ecole Polytechnique Fédérale de Lausanne)
ETH	Swiss Federal Institute of Technology, Zurich (Eidgenössische Technische Hochschule)
FLAG	New Public Management System (Führen mit Leistungsauftrag und Gesamtbudget)
GDC	General Design Criteria
HSI	Human System Interaction
HSK	Swiss Federal Nuclear Safety Inspectorate (Hauptabteilung für die Sicherheit der Kernanlagen)
IAEA	International Atomic Energy Agency
ICRP	International Commission on Radiological Protection
INES	International Nuclear Event Scale
INEX	International Emergency Exercise
IRRS	Integrated Regulatory Review Service
IRRT	International Regulatory Review Team
IRS	Incident Reporting System
ISO	International Standards Organisation
KEG	Nuclear Energy Act (Kernenergiegesetz)
KEV	Nuclear Energy Ordinance (Kernenergieverordnung)
KSA	Swiss Federal Nuclear Safety Commission (Eidgenössische Kommission für die Sicherheit von Kernalagen)

LAR	Steering Committee for Radioactivity
LCO	Limiting Conditions of Operation
LWR	Light Water Reactor
MADUK	Automatic Dose Rate Monitoring System
MOX	Mixed oxide
NAGRA	National Cooperative for the Disposal of Radioactive Waste (Nationale Genossenschaft für die Lagerung radioaktiver Abfälle)
NAZ	National Emergency Operations Centre (Nationale Alarmzentrale)
NEA	Nuclear Energy Agency
NMCA	Noble Metal Chemical Addition
NPP	Nuclear Power Plant
NRC	Nuclear Regulatory Commission
OBE	Operating Basis Earthquake
OECD	Organisation of Economic Co-operation and Development
OHSAS	Occupational Health and Safety Assessment Series
OSART	Operational Safety Review Teams (IAEA)
PEGASOS	Probabilistic Assessment of Seismic Hazard for Swiss NPP Sites
PSA	Probabilistic Safety Analysis
PSHA	Probabilistic Seismic Hazard Analysis
PSI	Paul Scherrer Institute, a research institute
PSR	Periodic Safety Review
PWR	Pressurised Water Reactor
QA	Quality Assurance
QM	Quality Management
RHR	Residual Heat Removal
SAMG	Severe Accident Management Guidance
SAR	Safety Analysis Report
SER	Safety Evaluation Report
SIA	Swiss Society of Engineers and Architects
SK	Supervisory authority for nuclear security and safeguards (part of BFE)
SPDS	Safety Parameter Display System
SSC	Systems, Structures and Components
SSE	Safe Shutdown Earthquake
StSG	Radiological Protection Act (Strahlenschutzgesetz)
StSV	Radiological Protection Ordinance (Strahlenschutzverordnung)
Sv	Sievert
SVTI	Swiss Association for Technical Inspections
Swissmedic	Swiss agency for therapeutic products
Tech specs	Plant technical specifications
TJ	Terajoule
UVEK	Federal Department of Environment, Transport, Energy and Communication (Eidgenössisches Departement für Umwelt, Verkehr, Energie und Kommunikation)

VBS	Federal Department of Defence, Civil Protection and Sports (Eidgenössisches Departement für Verteidigung, Bevölkerungsschutz und Sport)
VEOR	Ordinance on the emergency organisation in case of increased radioactivity (Verordnung über die Einsatzorganisation bei erhöhter Radioaktivität)
VGB	Association of Power and Heat Generating Utilities in Germany
WANO	World Association of Nuclear Operators
WGOE	Working Group on Operational Experience
WOG	Westinghouse Owners Group
ZWILAG	Owner company of ZZL
ZZL	Central Interim Storage Facility, Würenlingen (Zentrales Zwischenlager)

Appendix 2: List of the Inspectorate's guidelines presently in force

Status: July 2007

Languages: All guidelines are originally written in German; guidelines noted e or f have also been translated into English or French. For guidelines denoted with " * ", only the title has been translated into English.

Note: All guidelines are available on the HSK Internet website (www.hsk.ch).

Guideline	Title of Guideline	Date of current issue
HSK-B05* (former name: R-14)	Requirements for the conditioning of radioactive waste Anforderungen an die Konditionierung radioaktiver Abfälle	February 2007
R-04/d*	Supervisory procedures governing the construction of nuclear power plants: Design of buildings Aufsichtsverfahren beim Bau von Kernkraftwerken: Projektierung von Bauwerken	December 1990
R-05/d*	Supervisory procedures governing the construction of nuclear power plants: Mechanical equipment Aufsichtsverfahren beim Bau von Kernkraftwerken: mechanische Ausrüstungen	October 1990
R-06/d*	Safety classification, class boundaries and construction regulations concerning equipment of light water reactor nuclear power plants Sicherheitstechnische Klassierung, Klassengrenzen und Bauvorschriften für Ausrüstungen in Kernkraftwerken mit Leichtwasserreaktoren	May 1985
R-07/d*	Guideline for radiation protection zones in nuclear installations and in the Paul Scherrer Institute Richtlinie für den überwachten Bereich der Kernanlagen und des Paul Scherrer Institutes	June 1995
R-08/d*	Safety of buildings for nuclear installations: Federal procedures for construction supervision Sicherheit der Bauwerke für Kernanlagen, Prüfverfahren des Bundes für die Bauausführung	May 1976
R-11/d*	Radiation protection objectives during normal operation of nuclear installations Strahlenschutzziele im Normalbertrieb von Kernanlagen	May 2003
R-12/d*	Determining and reporting the doses of occupationally radiation exposed personnel of nuclear installations and the Paul Scherrer Institute Erfassung und Meldung der Dosen des strahlenexponierten Personals der Kernanlagen und des Paul Scherrer Institutes	October 1997
R-13/d*	Release of inactive materials and zones from controlled areas (Clearence Guideline) Inaktivfreigabe von Materialien und Bereichen aus kontrollierten Zonen (Freimessrichtlinie)	February 2002
R-15/d*	Reporting guideline for nuclear power plants Berichterstattung über den Betrieb von Kernkraftwerken	December 1999
R-16/d*	Seismic plant instrumentation Seismische Anlageninstrumentierung	February 1980

Guideline	Title of Guideline	Date of current issue
R-17/e R-17/d	Organisation of nuclear power plants R-21/d Organisation von Kernkraftwerken	June 2002 June 2002
R-18/d*	Supervision of repairs, modifications and replacement of mechanical equipment in nuclear installations Aufsichtsverfahren bei Reparaturen, Änderungen und Ersatz von mechanischen Ausrüstungen in Kernanlagen	December 2000
R-21/e R-21/d R-21/f	Protection Objectives for the Disposal of Radioactive Waste Schutzziele für die Endlagerung radioaktiver Abfälle Objectifs de protection pour le stockage final des déchets radioactifs	November 1993 November 1993 November 1993
R-23/d*	Revisions, tests, replacements, repairs and modifications of electrical equipment in nuclear installations Revisionen, Prüfungen, Ersatz, Reparaturen und Änderungen an elektrischen Ausrüstungen in Kernanlagen	January 2003
R-25/d*	Reporting guideline concerning the Paul Scherrer Institute and the nuclear installations of the Swiss Confederation and the cantons Berichterstattung des Paul Scherrer Institutes sowie der Kernanlagen des Bundes und der Kantone	June 1998
R-27/d*	Selection, training and examination of NPP staff requiring a licence Auswahl, Ausbildung und Prüfung des lizenzpflichtigen Betriebs-personals von Kernkraftwerken	May 1992
R-29/d*	Requirements for the interim storage of radioactive waste Anforderungen an die Zwischenlagerung radioaktiver Abfälle	March 2004
R-30/d*	Supervisory procedures for construction and operation of nuclear installations Aufsichtsverfahren beim Bau und Betrieb von Kernanlagen	July 1992
R-31/d*	Supervisory procedures regulating the construction and the backfitting of nuclear power plants: 1E classified electrical equipment Aufsichtsverfahren beim Bau und dem Nachrüsten von Kernkraftwerken: 1E klassierte elektrische Ausrüstungen	October 2003
R-32/d*	Guideline for meteorological measurement on sites of nuclear installations Richtlinie für die meteorologischen Messungen an Standorten von Kernanlagen	September 1993
R-35/d*	Supervisory procedures governing the construction of nuclear power plants: System engineering Aufsichtsverfahren beim Bau und Änderungen von Kernkraftwerken: Systemtechnik	May 1996
R-37/d*	Recognition of basic and advanced radiation protection training in the fields of HSK regulation Anerkennung von Strahlenschutz-Ausbildungen und -Fortbildungen im Aufsichtsbereich der HSK	July 2001
R-39/d*	Registration of radiation sources and material testing experts on a nuclear installation site Erfassung der Strahlenquellen und Werkstoffprüfer im Kernanlagen-areal	January 1990
R-40/d*	Filtered containment venting for light water reactors: design requirements Gefilterte Druckentlastung für den Sicherheitsbehälter von Leichtwasserreaktoren, Anforderungen für die Auslegung	March 1993

Guideline	Title of Guideline	Date of current issue
R-41/d*	Calculation of radiation exposure in the vicinity of nuclear installations due to emissions of radioactive material Berechnung der Strahlenexposition in der Umgebung aufgrund von Emissionen radioaktiver Stoffe aus Kernanlagen	July 1997
R-42/e R-42/d	Responsibility for decisions to implement extraordinary measures to mitigate the consequences of a severe accident at a nuclear power plant Zuständigkeiten für die Entscheide über besondere Massnahmen bei einem schweren Unfall in einer Kernanlage	July 2003 February 2000
R-45/d* (future name: B11)	Planning and execution of emergency exercises in Swiss nuclear power plants Planung und Durchführung von Notfallübungen in den schweizerischen Kernanlagen	January 2004
R-47/d*	Testing of radiation measuring instruments Prüfung von Strahlenmessgeräten	October 1999
R-48/d*	Periodic Safety Review of Nuclear Power Plants Periodische Sicherheitsüberprüfung von Kernkraftwerken	November 2001
R-49/d*	Technical safety requirements for the security of nuclear installations Sicherheitstechnische Anforderungen an die Sicherung von Kernanlagen	December 2003
R-50/d*	Technical safety requirements for fire protection in nuclear installations Sicherheitstechnische Anforderungen an den Brandschutz in Kernanlagen	March 2003
R-52/e R-52/d	Transport and Storage Cask (T/S-Casks) for interim storage Transport- und Lagerbehälter (T/L-Behälter) für die Zwischenlagerung	July 2003 November 2003
R-60/d*	Surveillance of fuel element production Überprüfung der Brennelementherstellung	March 2003
R-61*	Supervision of the use of fuel elements and control rods in light water reactors Aufsicht beim Einsatz von Brennelementen und Steuerstäben in Leichtwasserreaktoren	June 2004
R-100/d*	Nuclear power plant operating conditions Anlagezustände eines Kernkraftwerks	June 1987
R-101/e R-101/d	Design criteria for safety systems of nuclear power plants with light water reactors Auslegungskriterien für Sicherheitssysteme von Kernkraftwerken mit Leichtwasser-Reaktoren	May 1987 May 1987
R-102/e R-102/d	Design criteria for the protection of safety equipment in NPPs against the consequences of airplane crash Auslegungskriterien für den Schutz von sicherheitsrelevanten Ausrüstungen in Kernkraftwerken gegen die Folgen von Flugzeugabsturz	December 1986 December 1986
R-103/d*	Plant internal measures against the consequences of severe accidents Anlageinterne Massnahmen gegen die Folgen schwerer Unfälle	November 1989

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