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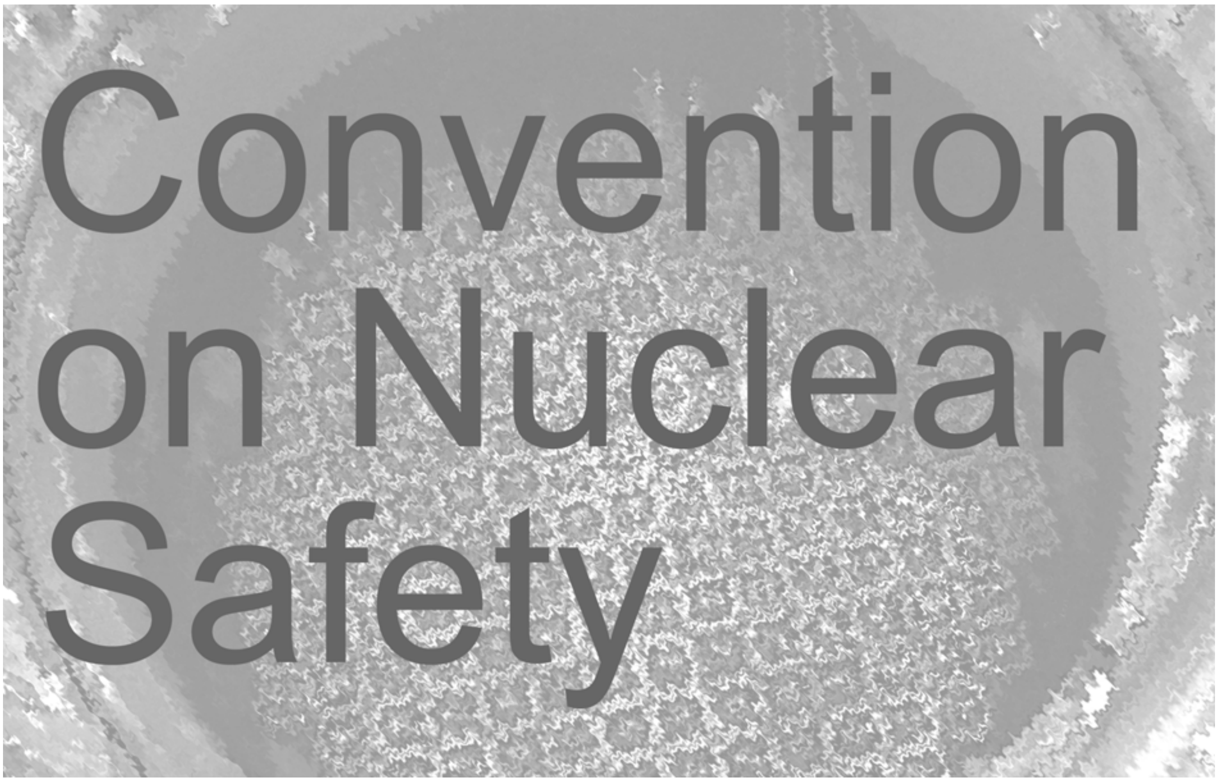
Dipartimento federale dell'ambiente, dei trasporti, dell'energia e delle comunicazioni
Federal Department of Environment, Transport, Energy and Communication

Implementation of the obligations of the



The third Swiss report in accordance with Article 5

July 2004

Contents

Foreword

Switzerland gave its signature to the Convention on Nuclear Safety on the 31st of October 1995 and ratified it on the 12th of September 1996. The first and second Swiss reports, in accordance with Article 5 of the Convention were produced and deposited with the IAEA in 1998 and 2001, respectively. In 1999 a Swiss delegation attended the first, and in 2002, the second Review Meeting of the Contracting Parties at the IAEA headquarters in Vienna.

The present third Swiss report provides updated information on the fulfilment of the obligations under the Convention. In addition, the report attempts to give adequate consideration to the topics which aroused special interest at the second Review Meeting. Once again, the third Swiss report strives to give again a complete picture of the nuclear safety status in Switzerland as of July 2004. It was written by the Swiss Federal Nuclear Safety Inspectorate (HSK), with contributions from other public and private institutions.

The introduction to the report provides general information about Switzerland, a brief political history of nuclear power and an overview of the nuclear facilities in Switzerland.

In the following sections, numbered after the Articles 6 to 19 of the Convention on Nuclear Safety, key aspects will be commented on in such a way as 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 as Appendix 1.

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

Summary and conclusions

In Switzerland, the regulatory processes applied to the licensing and safety surveillance of nuclear installations as well as the installations themselves and their operation are in concord with the 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 Nuclear Power Plant (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 organizational and human aspects as well as the goal to generate a minimum of radioactive waste, its conditioning and temporary storage are permanent features of the supervisory authority's activities. 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 also key features of the Convention on Nuclear Safety.

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 take place at regular intervals. The international alerting system is also in a mature stage and its efficiency is verified in regular exercises.

All these above mentioned aspects are described and embedded in the Swiss legislation, which also forms the basis for the granting of operating licences for the Swiss NPPs.

It can be concluded that the Convention's articles, as described in this report, are satisfied when applied to the Swiss situation of nuclear safety regulation. 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) have built up documented Quality Management (QM) systems, which are compatible with or certified to ISO 9001. The NPPs' QM systems also fulfil the requirements of IAEA Safety Series 50-C/SG-Q "Quality Assurance". Thus, also the requirements of Article 13 are now standard practice in Switzerland.

Improvements are in progress for further independence of the Inspectorate. Presently 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, but this independence is not guaranteed legally. This situation will change with a new Nuclear Energy Act which is scheduled to come into force in 2005, requiring independence of technical directives and formally independence of the supervisory authorities from the licensing authorities. A project to legally settle the Inspectorate's fully independent status in accordance with this new Act has started recently. In the mean time, the implementation of the New Public Management Elements (FLAG) in January 2004 has enabled the Inspectorate to make a clear step towards more administrative independence.

In the following, a short summary of the detailed answers to the various articles in the Convention is provided.

Article 6: Existing nuclear installations

The general safety status of the Swiss NPPs is good. The first generation NPPs of Switzerland (Beznau units I+II and Mühleberg) have 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. Recently Periodic Safety Reviews (PSR) were performed for the Mühleberg NPP in 2000/2001 and for Beznau NPPs in 2002. Both PSRs have been reviewed in depth by the Inspectorate. The final review reports of the Inspectorate have been published in 2002 and 2004 and are publicly available.

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 the NPPs Leibstadt and Gösgen in 1996 and 1999 respectively, and have been reviewed by the Inspectorate.

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

The Swiss Party therefore complies with the obligations of Article 6.

Article 7: Legislative and regulatory framework

Legislation and regulatory framework for nuclear installations is well established in Switzerland. It provides the formal basis by which the safety of nuclear installations is governed. The main legal provisions for authorisations and regulation, supervision and inspection are established in the Atomic Energy Act, the Federal Order to the Atomic Energy Act and the Radiological Protection Act.

A new federal law on the use of nuclear energy (Nuclear Energy Act) was recently approved by Swiss parliament and is scheduled to come into force in 2005. The descriptions of the legislative and regulatory framework in the underlying third Swiss report are based on this new Nuclear Energy Act.

The Swiss Party therefore complies with the obligations of Article 7.

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 (Section for Nuclear 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 and its organization has been adapted to the changed requirements.

The functions of the regulatory body are separated from organizations concerned with the promotion or utilisation of nuclear energy. The requested effective separation 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, scheduled to come into force in 2005, requires the supervisory authorities to be independent of technical directives and formally independent of the licensing authorities. A project to legally settle the Inspectorate's fully independent status in accordance with this new Act has started recently. 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.

An International Regulatory Review Team (IRRT) from IAEA audited the Inspectorate in January 2003 as a follow-up of the IRRT mission in December 1998. The purpose of the mission was to review the effectiveness of the regulatory body of Switzerland, to verify the implementation of recommendations and suggestions from the December 1998 mission, and to generally exchange information and experience in the area of nuclear, radiation, radioactive waste and transport safety regulation. Except for 4 recommendations related to the independence of the Inspectorate from the licensing authorities, all recommendations from the IRRT mission in December 1998 have been implemented. The IRRT team acknowledges a significant progress in the Inspectorate's efforts to achieve independence from the licensing authorities and strengthen its regulatory effectiveness.

The Swiss Party therefore complies with the obligations of Article 8.

Article 9: Responsibility of the licence holder

The responsibility of the licence holder for the safe operation of a NPP is required implicitly by the Swiss Atomic 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. In the new Nuclear Energy Act the responsibility of the licence holder for the safe operation of a NPP is explicitly stated.

The Swiss Party therefore complies with the obligations of Article 9.

Article 10: Priority to safety

The priority to safety has always been the first consideration for all organizations actively engaged with nuclear installations in Switzerland.

Up to 2002, all Swiss NPPs have been subjected 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.

The Swiss Party therefore complies with the obligations of Article 10.

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 financial aspects of decommissioning and waste disposal are ensured by means of dedicated funds.

The human resources of the Swiss NPPs are sufficient, although the number of staff is below the international average. The competence and the capacity of the human resources have to be closely observed, particularly in view of the electricity market deregulation.

NPP personnel is well educated and trained; regular retraining is available to keep up with advances in science and technology as well as with plant modifications.

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 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.

The Swiss Party therefore complies with the obligations of Article 11.

Article 12: Human factors

The Inspectorate's organization includes staff members dealing with human aspects, NPP organization, and safety culture. Considerable attention is paid to human factor aspects of operator support systems, including procedures, guidelines and checklists. Any 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.

Special attention is devoted to safety management and safety culture. The new regulation on NPP Organization and Safety Management (Inspectorate's Guideline R-17) is in force since 2002. Inspections in this area have started. Also, a regulatory guideline on Safety Culture is being prepared. All Swiss NPPs have established programmes to systematically develop their safety culture. Members of the Inspectorate, as well as the plant management, are both making an effort to further promote a broad safety philosophy and culture.

The Swiss Party therefore complies with the obligations of Article 12.

Article 13: Quality assurance

All Swiss NPPs have implemented QM systems compatible with or certified to ISO 9001:2000 and fulfilling the requirements of IAEA Safety Series 50-C/SG-Q "Quality Assurance". These QM systems cover plant operation as well as transportation of radioactive material.

At the Inspectorate, a QM system has been implemented and certified to ISO 9001:2000 in December 2001. Two routine certification checks were performed in November 2002 and 2003. The renewal of the ISO 9001:2000 certificate for another three years is scheduled for November 2004.

The Swiss Party therefore complies with the obligations of Article 13.

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 that 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). 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.

An Ageing Surveillance Programme (ASP) is in place for all NPPs. The objective of this program 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 for assuring that the physical state of a NPP is in compliance with the licence are

- modifications to safety related components must obtain a permit,
- a plant review has to be carried out after each refuelling outage, and
- an efficient inspection activity has to be deployed by the Inspectorate for the verification of compliance with licence requirements.

In 2004 the Inspectorate has 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.

The Swiss Party therefore complies with the obligations of Article 14.

Article 15: Radiation protection

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 limit, as far as possible, the generation of radioactive waste associated with the use of nuclear power. The low annual individual and collective doses prove the effectiveness of the methods based on the most recent recommendations of the International Commission on Radiation Protection (e.g. guidelines, job planning and supervision).

The Swiss Party therefore complies with the obligations of Article 15.

Article 16: Emergency preparedness

On- and off-site emergency organizations 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.

The required reporting procedure is laid down in an Inspectorate’s Guideline. The emergency preparedness and plans are regularly tested in the form of exercises. The channels for alerting the public, the National Emergency Operation Centre and any concerned neighbouring country are in place. Bilateral agreements exist between Switzerland and its neighbouring countries to deal with alerting in emergency situations.

For improving the on-site emergency preparedness, the Inspectorate has required the Swiss licensees to implement severe accident management guidance (SAMG). In case of an accident causing severe core damage, SAMG will support the different emergency organization teams in taking accident mitigation measures based on predefined strategies. The implementation of SAMG in all Swiss NPPs is expected to be completed by the end of 2004. In addition to the guidance for full power operation, the Swiss NPPs are currently preparing low power/shutdown SAMG.

The Swiss Party therefore complies with the obligations of Article 16.

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. As part of a PSR, site-related factors are re-evaluated, in particular by reviewing the SAR and the PSA.

The Swiss Party therefore complies with the obligations of Article 17.

Article 18: Design and construction

The 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 in place. The various levels of defence are in place to ensure that safety limits and individual dose limits for the public are respected throughout the 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 prevented or limited. 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 the radiological consequences to the environment in most severe accident scenarios.

Following the terrorist attacks carried out on the Word Trade Centre on 11th of September 2001, the Swiss NPPs were requested by the Inspectorate to carry out analyses of the safety consequences in 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 thorough 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, thanks to previous backfitting of special decay heat removal systems and implementing further provisions in the area of fire protection, an adequate level of protection against an aircraft impact can still be attained.

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 the Beznau NPP (both units) the reactor protection and control systems have recently been replaced by modern instrumentation and control systems with fully computer based methods.

The Swiss Party therefore complies with the obligations of Article 18.

Article 19: Operation

The requirements for safe operation of the Swiss NPPs are laid down in the operating licence of each NPP. The operation procedures and rules have to be followed for all operational conditions. The most important operational procedures are the Technical Specifications which include the limiting conditions of operation. The operational procedures of the NPP extend also to maintenance, testing and surveillance of the equipment. Comprehensive technical support is available. The reliable operation of the Swiss NPPs is reflected in the low annual number of reportable events.

In addition to its general inspection activities, the Inspectorate gains further insight into all aspects of the NPPs operation from comprehensive reporting by the operator.

The Inspectorate and the operators collect operational experiences from domestic and foreign NPPs. In some cases the analyses of particular operating experiences have resulted in important safety related backfitting or modifications in Swiss NPPs.

The generation of radioactive waste at NPPs is kept at a low level. The resulting waste is collected, segregated, conditioned as soon as practicable and stored on site under appropriate conditions.

In order to optimise fuel cycle cost, the Swiss NPP operators have increased fuel discharge exposures to levels that exceed the past experience basis for normal operation as well as transients/accidents. Therefore, the Inspectorate has implemented a 'high burnup' strategy, which calls for both regular and systematic inspections of lead fuel assemblies (poolside and hot-cell measurements) and participation in international safety research activities on transient/accident fuel behaviour, as a prerequisite for obtaining regulatory approval of increasing discharge exposure for reload fuel.

For further plant availability and cost optimisation, many NPP operators have adopted a reload outage scheme with alternating short and long outage intervals. To support these schemes, some changes in the Technical Specifications pertaining to test / surveillance or maintenance intervals were applied for and subsequently approved by the Inspectorate after verifying that the safety margins of the plant and plant systems were maintained.

The Swiss Party therefore complies with the obligations of Article 19.

Introduction

Country and State

With a total surface area of 41,285 km² and a population of roughly 7.5 mio inhabitants, Switzerland is a small State in Europe. Structurally, Switzerland has evolved as a federal State with twenty-six 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 a federal level, too. All other legislative power remains with the cantons, which have thus retained a high degree of autonomy. The municipalities and communes also enjoy considerable rights of self-government.

The Federal Council, composed of seven ministers of equal rank, acts a 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 who represent the Swiss Cantons. Each Canton elects two members and each half-Canton (AI/AR, BL/BS and NW/OW) elects one, regardless of size.

The voting population has the constitutional right to sanction changes to the Federal Constitution and has a right of referendum on the level of 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 proposal for a new federal law, the proposal is put to the vote (facultative referendum). The cantonal constitutions contain similar rules on popular initiatives and referendums as on the federal level.

Background of nuclear power in Switzerland

Historically, electricity generated in Switzerland came exclusively from hydro power without any recourse to fossil fuels, the latter not being available as a natural resource in the country. In the mid 1950's, an interest in the relatively new nuclear energy technology was manifested to cover an increasing electricity 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 recognized; however, that the implementation of any nuclear programme and project requires a legislative frame 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.

The Atomic Energy Act of 1959 attributes to the Federal Council the exclusive competence to grant licences for the construction of, operation of and modification to nuclear installations. Licences are based on a detailed review and assessment of nuclear safety. The supervision of nuclear power plants (NPPs) implies the legal competence to take, at any time, appropriate measures to enforce compliance with the licensing conditions.

Since nuclear power is within the realm of private industry, there is no "national nuclear programme" as such. During the 1960's, a series of projects for establishing NPPs were initiated, more or less, in parallel. Four of them reached the stage of realisation, leading to five currently operating units commissioned between 1969 and 1984. These five units contribute roughly 40% of the total national electricity production, the rest being essentially covered by hydro power complemented by a still small amount from other energy sources.

Due to the increasing opposition to nuclear power during the 1970's, it has not been possible, however, to realize several other nuclear projects for which sites had already been approved. The situation at the end of the 1980's culminated in 1990 in a double decision taken by the Swiss population:

- To accept the further operation of the existing NPPs;
- To impose a ten years stop (moratorium) on granting licences for new NPPs (as well as other nuclear installations and reprocessing plants, with the exception of facilities for radioactive waste management).

In 2003 two public votes on the prolongation of the above moratorium and on the gradual phase-out of existing NPPs were held; both propositions were rejected by the Swiss population. Simultaneously, a new Nuclear Energy Act, which provides the legal framework for the further operation of existing, and the construction of new NPPs, was accepted by the Parliament; in this case, the option of holding a public vote was not exercised. Thus, the new Nuclear Energy Act will come into force in 2005, replacing the current Atomic Energy Act of 1959. With this new Nuclear Energy Act, the unconditional competence of the Federal Council to grant general licences for new NPPs is repealed; any decision on granting new general licences for new NPPs will be subject to an optional public vote (see Article 7). Furthermore, for geological waste repositories, the Federal Government now has full legal responsibility.

Nuclear power plants

There are today four different utilities producing electricity from nuclear energy in five units. The Swiss NPPs have four different reactor designs, four different containment designs and were delivered by three different reactor suppliers. Although there is no Swiss reactor supplier, there are local suppliers for civil engineering and buildings, and for mechanical and electrotechnical equipment.

The four NPPs in operation in Switzerland and the utilities which are responsible for them are the following:

- 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 compiled in Table 1.

Table 1: Main technical characteristics of the Swiss NPPs (July 2004).

	First generation NPPs			Second generation NPPs	
	Beznau I	Beznau II	Mühleberg	Gösgen	Leibstadt
Licensed 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 Co
GE	General Electric Co (now Global Nuclear Fuel)
KWU	Kraftwerk-Union (now Framatome ANP)
BBC	Brown Boveri & Cie Ltd (now Alstom)
UO_2	Uranium oxide
MOX	Mixed oxides
ECCS	Emergency core cooling system

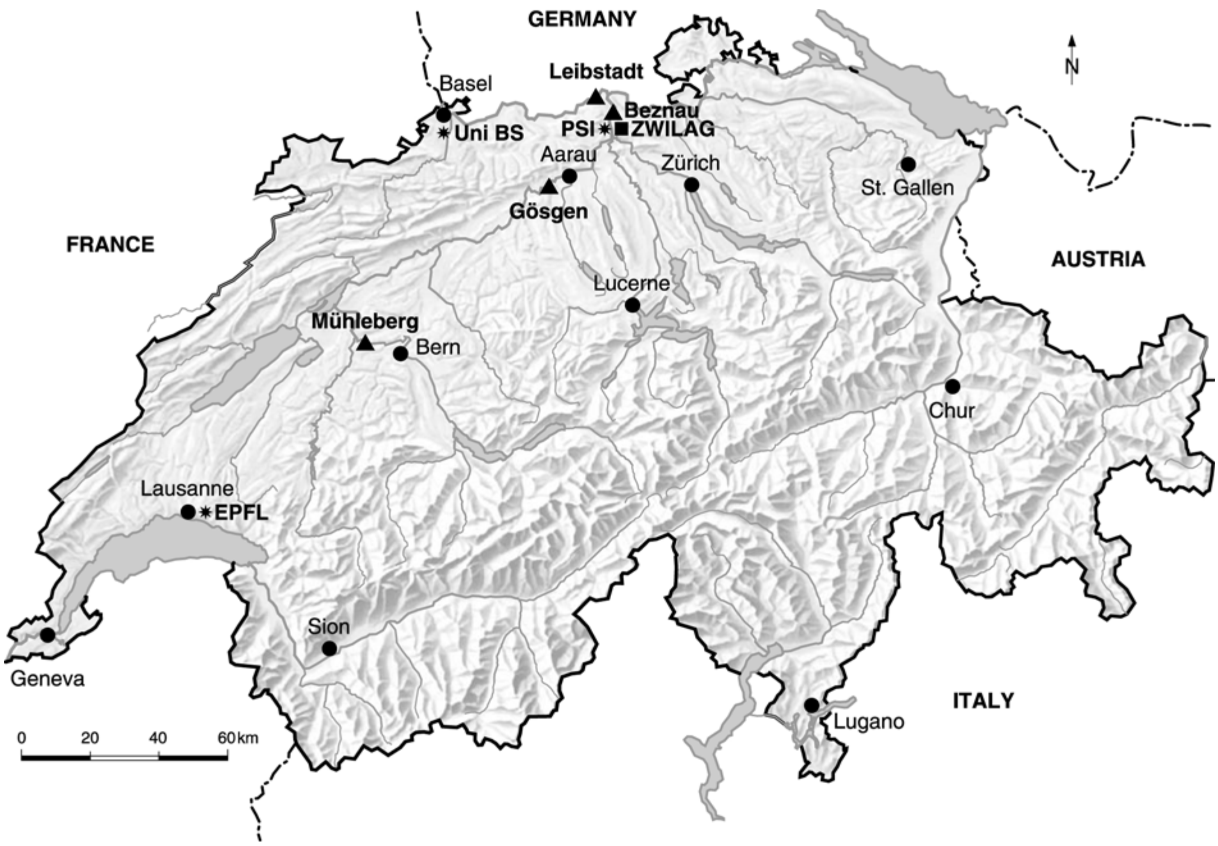


Figure 1: Geographical position of the Swiss nuclear facilities. The sites of the NPPs are marked by triangles. Experimental and research installations are marked by stars. Facilities for nuclear waste management are marked by squares. Dots mark the major cities.

Switzerland is a small and densely populated country. The number of suitable sites for NPPs is therefore limited. Two sites are situated near the German border, at a distance of 0.5 km (Leibstadt) and of 5 km (Beznau). The two other sites are about 40 km away from the French and 20 km from the German border respectively. The geographical position of all Swiss nuclear facilities is indicated on the map in Figure 1.

Facilities for nuclear education, research and development

The major part of nuclear research in Switzerland is performed at the Paul Scherrer Institute (PSI). Work is carried out at PSI in the following areas in collaboration with other national and international research institutes and with industry: 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.

At the University of Basel (Uni BS) and at the Swiss Federal Institute of Technology Lausanne (EPFL) there are small research reactors ($P < 1\ kW_{th}$) which are used mainly for teaching purposes.

The former Lucens experimental NPP (underground; D_2O moderated, CO_2 cooled; 30 MW_{th}; 8 MW_e) has been decommissioned and dismantled after it experienced a loss of coolant accident in 1969. With the exception of a small nuclear waste storage area, this site is declassified and released for non-nuclear activities since March 1995. In 2003, the nuclear waste from this storage area was transported to the Central Storage Facility (ZZL); the site will be released from nuclear legislation by the Swiss Government in 2004.

Nuclear waste

Each NPP has installations for the conditioning and temporary storage of radioactive waste resulting from its operation. At the Beznau NPP site, there is an additional facility for the dry storage of spent fuel elements which is not yet operational. At Gösgen NPP site, a building for the wet storage of spent fuel elements has been licensed.

The PSI operates the National Collection Centre for all non-nuclear radioactive waste, i.e. waste coming from medicine, industry and research. It has installations for the treatment of this radioactive waste and operates the Federal Storage Facility (BZL).

In Würenlingen, the Central Storage Facility for nuclear waste (ZZL) has been constructed by the utility-owned company ZWILAG. In addition to storage capacity for spent fuel, vitrified high-level waste and other intermediate and low-level radioactive waste, the facility also comprises installations for the conditioning of specific waste streams and the incineration or melting of low-level waste. The storage facility started active operation in June 2001. The facility is an intermediate solution to relieve the time pressure for the realisation of final disposal facilities.

The application for the federal general licence for a repository for low and intermediate waste at the Wellenberg site in Canton Nidwalden was submitted in 1994. The cantonal legislation requests a mining concession for the construction permission of such a repository. The granting of this mining concession was rejected by the citizens of the canton in 1995. A new application for a mining concession relating only to an exploratory drift was submitted in January 2001 and rejected once again by cantonal public vote in September 2002. The NPP operators subsequently decided to abandon the Wellenberg project.

Concerning the disposal of high level and long-lived intermediate level waste, the work is still concentrated on the demonstration of the feasibility of such a repository in Switzerland. As a result of a broad selection process, the NPP operators chose a region of Opalinus clay in the Zürich Weinland for further geological investigations. The results of these investigations form the basis of a feasibility demonstration, which was submitted for review to the federal authorities in December 2002. The Federal Government will take a decision on the feasibility demonstration in the beginning of 2006.

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/CSA). US Regulations and Guides were mainly relied on at that time, since the two reactor suppliers concerned 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 e.g. fire or internal flood;
- Rigorous application of the single failure criterion, also to supporting systems, for the case of loss of offsite power;
- Protection of residual heat removal (RHR) systems against external events (aircraft crashes, earthquakes, floods, lightning and sabotage);
- Supplementary shutdown capability in a remote area for the case of 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, taking care of the previously mentioned four points. 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. As a consequence of these backfittings, the two NPPs were granted new operation licences. The latest extensive reviews of these NPPs were performed as PSRs. The assessment of which was completed in 2002 for the Mühleberg NPP and for the 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 the Leibstadt NPP).

Both second generation plants were subject of a PSR. For the Leibstadt plant, this review was performed 1996 together with the review of the 15% power uprate request of the utility. Based on this review, only minor requirements resulted, and these were mainly concerned with obtaining a better response to anticipated transients without scrams. The PSR for the Gösgen plant was finished in the year 1999.

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 the Beznau NPP in the year 1999 and 2000. This was done to improve the reliability and the capacity of the auxiliary feed water system. Also in both units of Beznau NPP, improvements of the reactor protection system and control systems concerning separation, redundancy, self-supervision, testability and reliability of power supply have been achieved when replacing the original systems by 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.

Conclusion

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 on 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 competence 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:

- Federal Law on the use of Nuclear Energy (Nuclear Energy Act, scheduled to come into force in 2005)[1];
- Radiological Protection Act (in force since1991).

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 weapons;
- 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 licensee. The

[1] The introduction of the new legislative framework entails the enactment of a number of additional ordinances as well as the adjustment of existing ones. Most of this work is scheduled to be completed by the year 2007.

procedure also includes the course of action for modifications to the licence. The licensing procedure furthermore attributes extensive rights of appeal to third parties. Cantonal licences and plans are no longer required. Cantonal law 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 for periodic safety reviews for nuclear power plants and the obligation of the licence holder to retrofit the installation to the extent necessary according to experience and the current state of retrofitting technology;
- Regulations on decommissioning and on the disposal of radioactive waste, including the licence holder's obligation to decommission and dispose waste at his own cost, special dispositions concerning geological repositories;
- The definition 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 inter alia the following subjects:

- Fundamental principles (justification and limitation of exposure, dose limits);
- Protection of persons occupationally exposed to radiation and of the general population;
- The taking into account of experience (feed-back) and of the state of science and technology;
- Permanent monitoring of the environment and, during periods of elevated radiation, protection of the public (emergency preparedness: emergency organization outside NPPs);
- Radioactive waste management.

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:

- Federal Ordinance on Radiological Protection (Radiological Protection Ordinance) (1994);
- Federal Ordinance on Dosimetry (1999);
- Federal Ordinance concerning the Swiss Federal Nuclear Safety Commission (KSA) (1983);
- Federal Ordinance concerning the Fees in the Area of Nuclear Energy (1985);

- Federal Ordinance on the Protection of the Population in the Vicinity of Nuclear Installations in the Case of an Emergency (Emergency Preparedness Ordinance) (1983);
- Federal Ordinance on the National Emergency Operations Centre (1990);
- Federal Ordinance on the Emergency Organization in Case of Increased Radioactivity (1991);
- Federal Ordinance on the Distribution of Iodine Tablets to the Population (1992);
- Federal Ordinance on Alerting the Authorities and the Public (2003).

In addition the Federal Ordinance to the Nuclear Energy Act (Nuclear Energy Ordinance) is in preparation.

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

Federal Ordinance on Radiological Protection

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.

Federal Ordinance on the Emergency Organization in Case of Increased Radioactivity and the Federal Ordinance on the National Emergency Operations Centre

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

Federal Ordinance concerning the Swiss Federal Nuclear Safety Commission (KSA)

This ordinance designates the KSA as the advisory committee on nuclear safety. The ordinance delineates the aspects for which the Federal Department for Environment, Transport, Energy and Communication (ETEC) and the Federal Council can receive advice from its advisory committee on nuclear safety.

Nuclear Energy Ordinance (draft)

This ordinance contains the rules for the implementation of the provisions of the Nuclear Energy Act. It contains basic design criteria for nuclear power plants 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. It designates the Inspectorate as the supervisory authority for nuclear safety and the Section KE of the Federal Office of Energy (BFE) as the supervisory authority for nuclear security and safeguards. The ordinance's appendix designates all plant documents that constitute an integral part of the operating license, specifies the reporting requirements both for normal operations and for reportable events.

Lower level legislation in other areas with a link to nuclear energy

A number of ordinances are 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.

Regulatory Guidelines (4th level)

Regulatory guidelines are prepared and established by the supervisory authorities (Inspectorate and KE). 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.

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 guides is not. The regulatory guidelines state how the supervisory authorities (Inspectorate and KE) propose to carry out the supervision, and may be detailed or limited to safety objectives. In the latter case the applicants/licensees 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.

Over the years, the supervisory authorities have established a number of regulatory guidelines that contain mandatory as well as non-mandatory requirements and conditions, based on old legislation (Atomic Act of 1959). These guidelines will be rewritten in the near future, in accordance with the new Nuclear Energy Act reflecting that the above mentioned ordinances will from 2005 onwards contain all mandatory requirements. A list of the regulatory guidelines currently in force is given as Appendix 2.

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. It also implies that it is forbidden to operate a nuclear facility without a valid licence.

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, but 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 ETEC. It makes its decision on the basis of

- the application for a project, supported by a safety analysis report (SAR) and for the construction and operating licenses 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
- 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 important 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 licensee 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 (draft). 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 offices of supplier organizations. 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 licensee's activities and, in that respect, to ensure that the licensee fulfils its prime responsibility for safety. The Inspectorate, with the help of its mandated experts, reviews the licensee's programmes and independently assesses licensee 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, ETEC) 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. It can suspend or withdraw a licence when these prerequisites are no longer fulfilled. The Inspectorate has the authority to suspend or withdraw permits.

Conclusion

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.

Organization and competence of the regulatory body

The organizational chart (Figure 2) gives an overview of the organization of the regulatory body in Switzerland. Besides the licensing authorities, the Federal Council and the Federal Department ETEC (see Article 7). The Swiss regulatory body consists of the following organizational units:

- The Swiss Federal Nuclear Safety Inspectorate (HSK) as the supervisory authority for nuclear safety;
- The Section for Nuclear Energy (KE) 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 Committee to the Federal Government on nuclear safety.

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

Supervisory authorities

The Inspectorate is established by the Nuclear Energy Ordinance (draft) as the competent authority for supervising nuclear installations at all stages of their lifecycle. It is part of the Federal Department of Environment, Transport, Energy and Communication (ETEC) and is attached to the BFE. The Section for Nuclear Energy (KE) 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 of 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.

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.

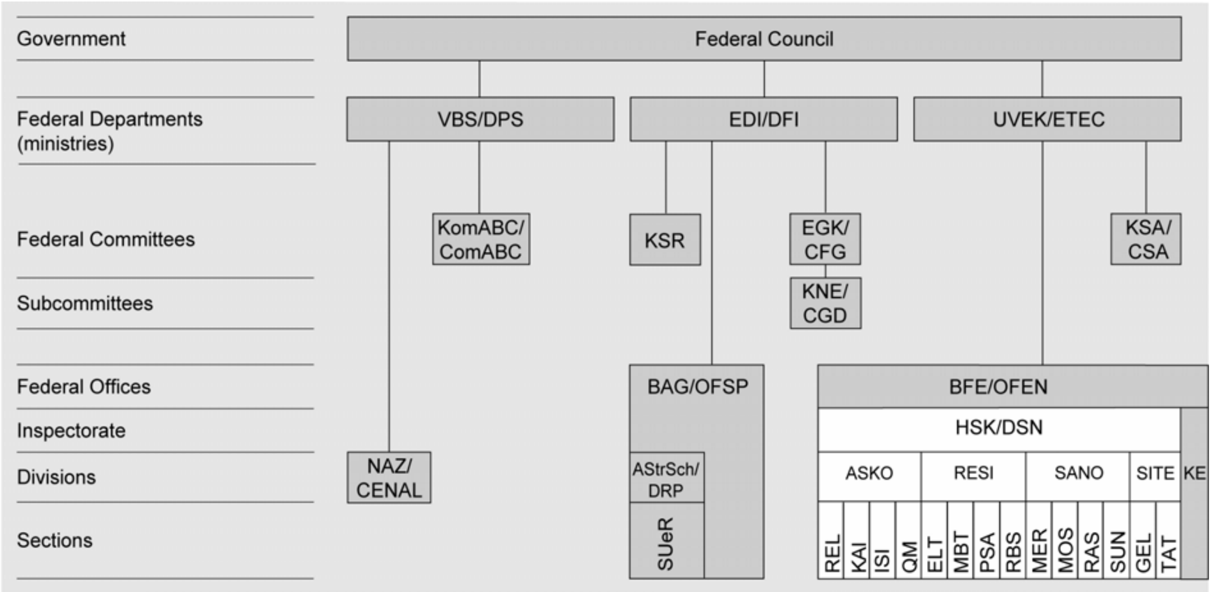
Moreover, the KSA observes operation of the nuclear installations, considering fundamental aspects of nuclear safety and proposes necessary measures. The KSA has the following competences:

- 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.

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 Operation Centre (NEOC), as part of the General Secretariat of 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.



Abbreviations as of July 2004
(If the French abbreviation exists, it is given after the slash)

ASKO	Division for Support, Coordination & Communication
AStrSch/DRP	Radiation Protection Division, Bern
BAG/OFSP	Federal Office of Public Health, Bern
BFE/OFEN	Federal Office of Energy, Bern
EDI/DFI	Federal Department of Home Affairs, Bern
EGK/CFG	Federal Geological Committee
ELT	Section for Electrical & Control Engineering
GEL	Section for Geological Disposal
HSK/DSN	Swiss Federal Nuclear Safety Inspectorate, Würenlingen
ISI	Section for Information, Safety Research & International Programs
KAI	Section for Inspection Management
KE	Section for Nuclear Energy of the BFE, Bern
KNE/CGD	Committee for Nuclear Waste Disposal
KomABC/ComABC	Federal Commission for Radiological, Biological & Chemical Protection
KSA/CSA	Swiss Federal Nuclear Safety Commission
KSR	Swiss Federal Commission for Radiation & Monitoring of Radioactivity
MBT	Section for Mechanical & Civil Engineering
MER	Section for Radiation Measurement, Technology & Radioecology
MOS	Section for Human & Organizational Factors
NAZ/CENAL	National Emergency Operations Centre (NEOC), Zurich
PSA	Section for Probabilistic Safety Analysis & Accident Management
QM	Quality Management
RAS	Section for Occupational Radiological Protection
RBS	Section for Reactor, Fuel & Systems Engineering
REL	Section for Human Resources & Logistics
RESI	Division for Reactor Safety
SANO	Division for Radiation Protection & Emergency Preparedness
SITE	Division for Transport & Waste Management Safety
SUeR	Section for Radiation Monitoring
SUN	Section for Accident Consequences & Emergency Preparedness
TAT	Section for Transport & Waste Technology
UVEK/ETEC	Federal Department for Environment, Transport, Energy & Communication
VBS/DPS	Federal Department for Defence, Civil Protection & Sports

Figure 2: Organization of the regulatory body in Switzerland: Organizational chart of the federal authorities involved in supervision of, and environmental protection associated with nuclear installations.

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 MSFr 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 2 MSFr and is covered by public funds. Additional 3.5 MSFr are financed by the operators of NPPs and the Paul Scherrer Institute (PSI).

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. It is supported by an administrative infrastructure with a staff of about 20 people.

The Section KE of the Federal Office of Energy currently consists of about 7 people. The current organizational structure of the Federal Authorities involved in supervision of, and environmental protection associated with nuclear installations, is shown in Figure 2.

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 organization. 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.

The Inspectorate has increased its involvement and participation in nuclear safety assistance programmes at many levels including participation in IAEA services, such as IRRT and OSART missions, staff exchanges with foreign regulators, and inspection workshops with other countries.

Knowledge Management provisions have been incorporated into the Inspectorate's Quality Management System. These serve to continuously review competency requirements for staff members and ensure staff development and succession planning.

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. The members are experts in fields relevant to nuclear safety; they perform their function independently as individuals and do not represent their respective organizations or enterprises.

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 organization 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 organization 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 supply 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 (ETEC). 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 Nuclear Energy Act requires the supervisory authorities to be independent of technical directives and formally independent of the licensing authorities. The work to legally settle the Inspectorate's fully independent status, to achieve formal independence of the Inspectorate from the Licensing authorities, has started recently. In the mean time, the implementation of New Public Management Elements (FLAG) has enabled the Inspectorate to make a clear step towards more administrative independence.

Upon request of the Swiss Government authorities, an International Regulatory Review Team (IRRT) from IAEA audited the Inspectorate in January 2003 to conduct a follow-up of the IRRT mission in December 1998. The team acknowledged two particular developments which will have a positive impact both on the independence and the regulatory effectiveness of the Inspectorate:

- Implementation of the New Public Management Elements (FLAG);
- Introduction of a new Nuclear Energy Act.

Except for 4 recommendations all recommendations and suggestions of the IRRT mission in December 1998 have been implemented. The IRRT team confirmed a significant progress in the Inspectorate's efforts to achieve independence from the licensing authorities and strengthen its regulatory effectiveness.

Separation of the advisory committee from other governmental bodies concerned with the use of nuclear energy

The KSA is affiliated to the ETEC and reports directly to the Federal Council. It is therefore independent from other governmental bodies concerned with the use of nuclear energy.

Conclusion

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 as follows:

- 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 organization and employ suitable and qualified specialist personnel in sufficient numbers. The Federal Council defines the minimum requirements and orders the training of the specialist 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 nuclear power plant, 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 the 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.

Conclusion

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 organizations engaged in activities directly related to nuclear installations shall establish policies that give due priority to nuclear safety.

Switzerland has from the beginning given top priority to the safety of NPPs, and will continue to do so. This is explicitly stated in the relevant legislation requiring that all reasonable measures be taken to protect persons, property and other important rights (including those relating to the environment, nature and the 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), the 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 licensee takes this obligation seriously under all circumstances. 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). For maintenance personnel and contractors, special training programmes are conducted in the different NPPs in order to increase safety awareness.

In 1992, Switzerland 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.

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.

To ensure that organizational changes do not have a negative impact on safety, the Inspectorate requires the following "management of change":

- Examination of the safety impact of organizational 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.

The Inspectorate is aware of the fact that the impending liberalisation of the electricity market is putting an economic pressure on the utilities. This might affect nuclear safety over time. Discussions between the Inspectorate and the operators about this issue and related problems are ongoing. In general, the operators of NPPs emphasise that the priority given to safety is not influenced by economic pressure.

Conclusion

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.

Apart from the decommissioning fund (see below), the current legislation on nuclear energy does not explicitly require special financial guarantees from the licence holders to cover the costs of necessary measures for maintaining the safety of their NPPs.

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 organization 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.

Personnel requiring an approval or a licence

The Nuclear Energy Act implicitly require the availability in sufficient number of qualified staff with appropriate expertise for the management and the control of NPPs. Should, for any reason, these requirements not be fulfilled, the licensing authority would suspend or revoke the operating licence.

Staffing

In the early times of the nuclear industry in Switzerland, the staffing at NPPs was low compared to today. A considerable number of tasks were carried out by external sub-contractors. For example, a NPP of the 350 MW_{el} class of the first generation started with a minimum of about 100 persons per plant. Later, the utilities recognised the advantage of in-house competence for maintenance and engineering. This, as well as increased requirements from the Inspectorate, has had the consequence that the number of staff increased to 305 for the Mühleberg NPP and to 497 for the twin unit NPP Beznau by the end of 2003. The second generation plants of the 1000 MW_{el} class started already with a higher number of personnel (325 to 350) and increased to slightly higher numbers (394 for the Gösgen NPP and 413 for the Leibstadt NPP by the end of 2003).

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

Education and training

The professional scientific and engineering training and education available in Switzerland has reached a high quality level and is open to all qualified persons. This leads to a satisfactory basis for the recruitment of qualified personnel.

The following Inspectorate's Guidelines relate to the education and training of NPP personnel:

- R-17: Organization of nuclear power plants;
- R-27: Selection, training and examination of NPP staff requiring a licence;
- R-37: Recognition of courses for radiation protection controllers and chief controllers; examination regulations.

Following the enactment of the Nuclear Energy Act, an Ordinance on Training and Qualification of the Personnel of Nuclear Installations will be issued. The most important issues from the guidelines mentioned above will be contained in these new ordinances. Other issues and details will be contained in updated versions of (or new) regulatory guidelines.

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 individuals comprises courses and "on the job" training.

The selection of personnel to be authorised for key functions in NPPs as field operators, control room operators, shift supervisors, stand-by safety engineers or radiation protection experts requires the successful completion of a technical training 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. The selection procedure for all licensed control room personnel includes aptitude tests. According to the draft of the "Ordinance on Training and Qualification of the Personnel of Nuclear Installations", the Plant Manager needs an engineering or university degree, the specific knowledge necessary for this function, management experience and experience within the respective NPP. Also a formal approval by the Inspectorate is required prior to the plant manager's appointment.

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

- **Field operators**: Employees who intend to become licensed control room personnel 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 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 (of 59 weeks) 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 adverse 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 the 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.

The simulator training, which is also used for requalification, is specific for each NPP. Plant-specific full scope simulators are operating at the Leibstadt, Mühleberg and Gösgen NPPs.

At the Beznau NPP, a compact simulator with a plant-specific full scope model has been operating for individual training since 1987. Team training takes place at a full scope simulator in Pittsburgh (USA). A project is ongoing to implement a full-scope simulator by 2007.

Conclusion

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 Organizational Factors (MOS) in which today five human factors specialists (three psychologists, one physicist, one engineer) deal with human and organizational factors as well as with the Human-System-Interaction (HSI) in the context of NPPs' safety. The Section's work is based on the idea that nuclear safety depends on man, technology, organization and their mutual interactions – the so called MTO-approach.

Human-System-Interaction

HSI issues, especially in the control room, have been considered in Switzerland at a very early stage. 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 the 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 simulator. The Inspectorate granted the approval for 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.

The Gösgen NPP is currently modifying its paper-based emergency operating procedures. The originally event-based procedures are complemented by symptom-based elements and the structure as well as the graphical representation of the whole set is improved. The Inspectorate is closely reviewing the different modifying phases, i.e. conceptualisation, development and evaluation (verification and validation) of the new emergency operating procedures. Thereby, the Inspectorate concentrates its attention particularly on human factors criteria communicated to the plant before the development of the new procedures.

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

Organization and safety culture

The importance of organizational aspects for safety in NPPs is reflected in the Inspectorate's Guideline R-17 "Organization of Nuclear Power Plants". This guideline describes the expectations of the Inspectorate regarding safety management in the Swiss nuclear power plants. Changes in the economic and political environment, especially the deregulation of the electricity market, stress the importance of the regulatory authority formulating requirements regarding management of change. For this reason, the Inspectorate's Guideline R-17 also addresses requirements that need to be taken into account by the operating organization to safely manage organizational changes.

To inspect if NPP organizations follow the Inspectorate's Guideline R-17 an inspection handbook has been developed, where the criteria specified in the guideline are compiled and further assistance to assess them is added. The assessment criteria are divided into "formal" and "customary" criteria to fulfil the Inspectorate's Guideline R-17 expectations. "Formal compliance" means that organizational rules, formulated in plant's documents, meet the expectations. "Customary compliance" means that the formal rules are perceived, interpreted and managed accordingly by the members of the organization. At the end of an inspection the Inspectorate provides a feedback to the plant management, where the inspection findings are contrasted in favour or against fulfilment of Inspectorate's Guideline R-17. In addition to the information whether the organizational expectations are met, the feedback seeks to initiate a self-reflection process where pros and cons of solutions are discussed, if a plant organization does not meet the guideline expectations. This inspection procedure takes into account the difficulties of defining clear organizational structures and of directly regulating them. As a result of this feedback, the Inspectorate might accept chosen plant solutions if they have been carefully reflected and match the specific (safety related) demands in the organization, even if they do not comply with the Inspectorate's Guideline R-17.

Beside the guideline and the handbook, the so called MOSAIK inspection procedure is used at the Inspectorate as an instrument for monitoring of organizational aspects of the licensees' work processes such as documentation, communication and co-ordination, safety rules, availability of appropriate work equipment, housekeeping, etc. It consists of a catalogue of questions which the Inspectorate's inspectors, without specific expertise in the field of human factors, may answer as appropriate during their technical inspections. The catalogue is not intended to be used as a checklist, but rather as a set of possible questions that could be incorporated into the inspection plan during the preparation phase of an inspection. One goal of the instrument is to provide a large amount of data about organizational aspects in Swiss nuclear installations in order to detect and follow trends over a prolonged period. Besides that, it is intended to foster a broader view on work processes by directing the attention of the inspectors as well as of the operating organizations to organizational aspects. The MOSAIK instrument has recently been revised based on the experience made by inspectors during an initial three year period of usage.

Large attention is also given to the concept of safety culture. Numbers of steps to systematically improve safety culture have been taken by the Swiss NPPs. This includes Safety Culture workshops with NPP staff, Safety Culture self-assessment programmes, etc. In particular, the Inspectorate is involved in international (IAEA) efforts to develop guidance for regulatory authorities concerning the oversight of safety culture in the operating organizations. The Inspectorate also plans to develop its own guidelines on safety culture with the purpose of specifying its understanding of the concept and of defining and making transparent the approach to be applied in the oversight of safety culture in Swiss NPPs.

Conclusion

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.

Nuclear power plants

Operational Safety

Following the Inspectorate's requirement, the NPPs have developed Quality Management (QM) systems based on international standards and guidelines such as the "IAEA Safety Standards and Guides on Quality Assurance for Safety in Nuclear Power Plants and other Installations". The QM systems of the Swiss NPPs cover also the requirements of the ISO 9001:2000 standards.

The Inspectorate approves and supervises the completeness and the proper function of the whole QM system of the NPPs on the basis of IAEA quality assurance (QA) code and guides[2]. This is done by checking basic QM documents and the periodic reports of NPPs on that subject. Regulatory inspections are performed periodically on specific topics (e.g. quality 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 created a working group to co-ordinate and harmonise efforts to comply with this requirement. The plant-specific application of the harmonised self-assessment function is inspected periodically. Special attention will be paid to the control of contractors by the NPPs.

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 certain 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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[2] Quality Assurance for Safety in Nuclear Power Plants and other Nuclear Installations, IAEA Safety Series No. 50-C/SG-Q

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

Beznau NPP: The documented QM system is 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 9001:2000 and ISO 14001 (environmental management). In order to demonstrate the compliance with the current nuclear IAEA QA standards for NPPs, the inspectorate requires an updated review.

Leibstadt NPP: The previous QM system was based on IAEA and ISO standards and was approved by the Inspectorate in 1995. Recently a modern QM system called "Total Quality Management" was adopted. This includes working tools like electronic QM documentation. This change was closely followed by the Inspectorate. A certification according to ISO-9001:2000 was successfully completed in June 2004.

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. A certification according to ISO-9001:2000 and ISO 14001 is foreseen towards the end of 2004.

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. The plant received the certificate according to ISO 9001:2000, ISO 14001:1996 and OHSAS 18001:1999 in May 2004.

Other nuclear Installations

For operational safety, the nuclear central interim storage facility (ZWILAG) has established a Quality Assurance programme which is based on the IAEA QA standard. The system was certified according to ISO 9001:2000 in 2003. For the transport of radioactive materials, the IAEA quality transport standards are required by the Inspectorate. Other nuclear installations have a specialized, simplified or partial QA programme, depending on their radioactive inventory and according to the risk impact. All systems are acknowledged by the Inspectorate.

Nuclear Safety Inspectorate (HSK)

A quality management system has been established and implemented; the ISO 9001:2000 certificate was obtained in December 2001. Two routine certification checks were performed in November 2002 and 2003. The renewal of the ISO 9001:2000 certificate for another three years is planned for November 2004.

The activities and responsibilities of the Inspectorate are laid down in a process oriented Management System. The Inspectorate's Management System is applied to all its relevant activities and supports also its well structured inspection and enforcement policies. It 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 9001:2000 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 as quality auditors carries out internal audits according to a yearly audit plan.

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 organization, 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 IRRT and the certification body, or complaints from customers and internal suggestions for improvement are implemented within the agreed time limit.

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.

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 (FLAG) and generally strengthen the Inspectorate's regulatory effectiveness.

In summary, the process oriented Management System of the Inspectorate

- makes processes and responsibilities transparent,
- allows optimisation of processes and improves efficiency,
- improves communication and exchange of information,
- preserves know-how, facilitates introduction of new employees,
- is the basis for continuous improvement of the organization,
- provides focus on "stakeholder", and
- integrates legal and other conditions.

Conclusion

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 license. One 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 license 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 license 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 most of the 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 considered every five years. Significant changes have to be taken into account every year.

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;
- Organization 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 license is necessary from time to time (Beznau unit II and 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 license (i.e. no new license 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 approval. As in the case of a license, 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.

Review and assessment of safety systems, safety related systems and their components

This process is described in a number of Inspectorate's Guidelines (R-06, R-18, R-23, R-31, R-35). The licensee 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 result of safety analyses, safety analysis as appropriate;
- Operating experience from licensee 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 analysis

This review aims at verifying the expected behaviour of the plant under postulated abnormal conditions. Based on a set of accident scenarios, the licensee has to demonstrate that the relevant plant and core specific parameters stay within their safety limits. In addition, the licensee must show that the individual dose limits for the public, as defined in the Radiological Protection Ordinance and 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 programs 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

The 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. Low power and shutdown modes are considered in the level 1 analyses only. 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 the 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. In combination with additional PSA guidance documents currently under development, these documents will lead to a harmonization of the PSA studies and related applications, such as probabilistic event analyses, selecting components for the ageing surveillance programme, or the assessment of Plant Technical Specifications (Tech Specs) changes.

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 program 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 a requirement that the testing procedures used are qualified.

The Inspectorate has prepared its own guideline concerning ASPs, scheduled to be issued in 2004. In this guideline, the Inspectorate presents the way it assesses the appropriateness of the NPP's ASPs. The NPPs can, however, use other approaches and methods, if they can be shown to fulfil, or even exceed, the basic principles and aims laid down in the Inspectorate's Guideline.

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 Inspectorate has reviewed and approved the current plant-specific dossiers concerning the ASPs for Safety Class 1 SSCs and has found them to be practically complete. For the Safety Class 2 SSCs, some minor aspects remain to be approved e.g. relative to containment penetrations. The same situation exists for Safety Class 3 SSCs (e.g. emergency diesel). Non-classified components are registered in the dossiers only when they are relevant to increasing the risk of a failure or accident. The dossiers are revised and adjusted according to developments and requirements.

ASPs include mechanical as well as electrical components, concrete structures and buildings.

Appraisal of Periodic Safety Review

The 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 licensee is responsible for carrying out the PSR, whereas the Inspectorate evaluates the PSR as submitted by the licensee, 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 licensee is thus required to

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

and on these bases, 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 licensee 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 organizational and human factor aspects and its impact on safety. The Inspectorate appraisal comprises an assessment of the licensee'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 back-fitting to safety (related) systems or components. For granting such a permit, the following are 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 licensee 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). The 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 licensee. 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 licensee 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. The installation and the commissioning of such new, mostly 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 conventional reactor protection system and control systems by a computer-based system for both units of the Beznau NPP, (b) the replacement of the source and intermediate range nuclear instrumentation by a digital wide range monitor system at the Beznau and Mühleberg NPP, (c) the implementation of computer-based operator support systems (process computer, process visualisation, on-line operating procedures) at the Gösgen, Mühleberg and Beznau NPPs, (d) the implementation of necessary systems/equipment for primary feed and bleed operation in accident conditions at the Gösgen NPP, and (e) the reinforcement of brick walls for improved seismic resistance at the Gösgen NPP.

Inspection, reporting and information meetings

Inspection

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;
- Organizational 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. By establishing the current (first) version of the BIP, the Inspectorate complied with one of the recommendations from the IRRT review of 1998 (see also Article 8). 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 as well as the amount of the Inspectorate's internal resources available for inspections. These periodic inspections are a valuable part of the PSR assessment. In the BIP, both result-oriented (aiming at reviewing the process outcome) and process-oriented inspections (aiming at reviewing the process itself) are included in a balanced manner. 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 licensee.

For each nuclear installation, the Inspectorate designates a co-ordinator in charge of assuring constant communication, exchange of information and documents between the licensee 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

The Inspectorate's Guideline R-15 prescribes in detail which data on plant operation have to be reported by the licensees. 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. The licensee 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.

Such licensee 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 licensee.

Information meetings

Information meetings between the Inspectorate's and the licensee's management are held twice per year. At these meetings, the licensee 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 licensee 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 licensee, in order to obtain the latest information on the plant status and its performance.

Meetings between the Inspectorate's senior management and the licensee 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

In 2004 the Inspectorate has started the introduction and development of an integrated oversight approach. The basic idea behind this 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. The main elements of the oversight approach are:

- **Effectiveness:** Decisions and requirements must be consistently enforced. Their effect must be reviewed and, if necessary, followed-up by additional measures.
- **Balance:** All safety aspects of an installation must be taken into account. Apart from deterministic and probabilistic factors, operational aspects, maintenance and organization will be considered. The oversight process must concentrate on key safety aspects. The safety requirements and the level of supervision will be reviewed periodically and adjusted if need be.
- **Traceability:** The Inspectorate must apply a consistent oversight plan and a comprehensive set of regulations. It must follow a standardised decision making process that is based on clearly defined criteria, in order for decisions and requirements to be transparent and comprehensible.

By this oversight approach the regulatory activities are more focused on the impact of their work and less on the output of the work. It helps to focus regulator's activities on the key and safety relevant aspects. At the same time it forces the regulator to have a questioning attitude towards its own work in respect to safety.

A structured and safety-oriented decision making process is under development as part of the integrated oversight approach to increase its robustness, transparency and traceability.

Conclusion

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 they came 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 on October 2001 with minor (mainly administrative) improvements. A next revision based on the new Nuclear Energy Act, is foreseen for 2005.

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).

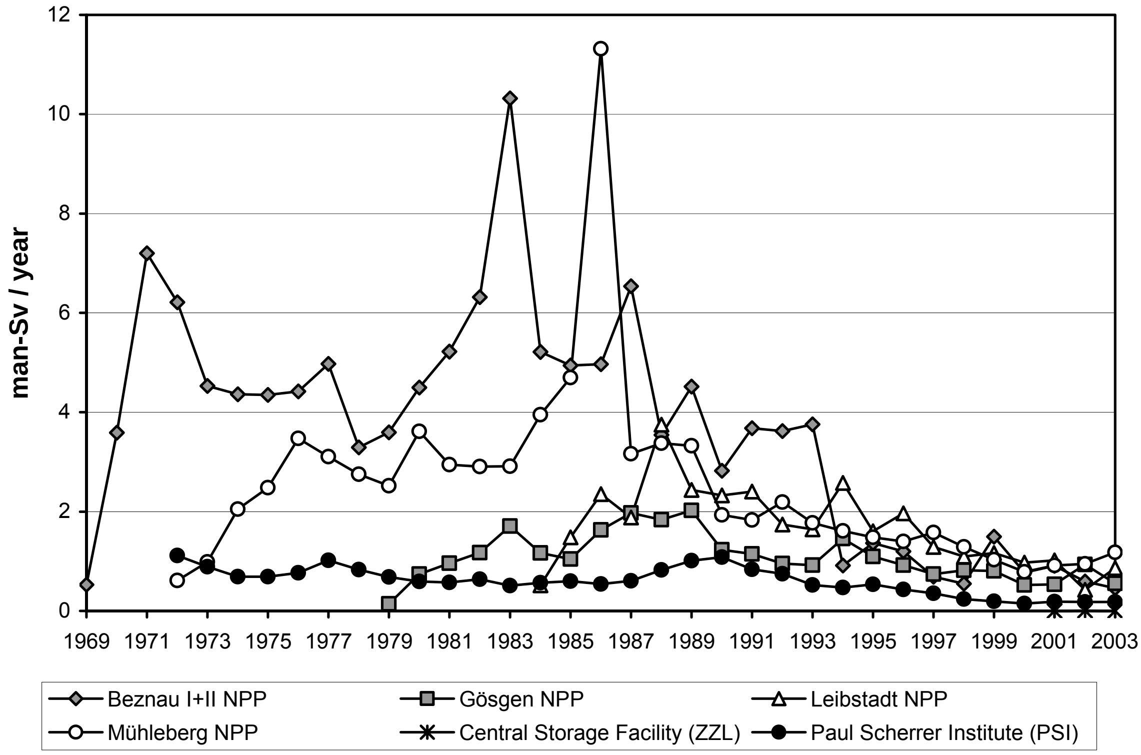

Figure 3: Annual collective doses for the personnel in Swiss NPPs, the interim storage facility ZZL and the research institute PSI. The two peaks are related to extraordinary work carried out in 1983 (Beznau NPP: Replacement of anti-vibration bars in the steam generators of one unit) and 1986 (Mühleberg NPP: Replacement of the re-circulation pipes due to stress corrosion cracking). In 1993, the steam generators of the NPP Beznau I were exchanged with a collective dose of 1.2 man-Sv. In 1999, the same work was performed at the 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 shall not cause a corresponding dose of more than 0.1 mSv per year. The Guideline R-41 defines the rules for the calculation of doses due to emissions. 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, values due to annual releases are 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 have always been below the source-related dose constraint.

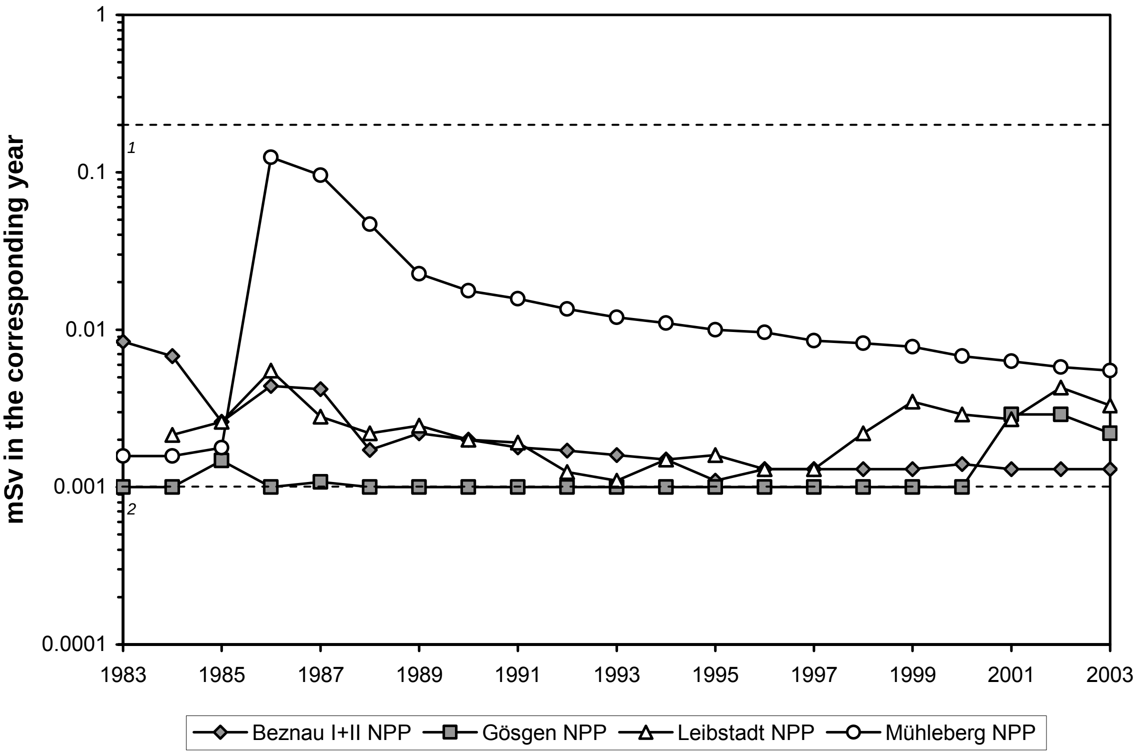

Figure 4: *Doses calculated on the base of annual emissions from the Swiss NPPs without contribution of direct radiation. The annual doses are calculated for a virtual most exposed group of the population[3], including the exposure due to deposition from former years. The peak is related to an emission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

[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] *Fictitious person, permanently located at the critical place, consuming all food produced locally and all drinking water from the river downstream of the nuclear power plant in question.*

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

NPP-specific methods have been progressively used, over the years, 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 generally 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.

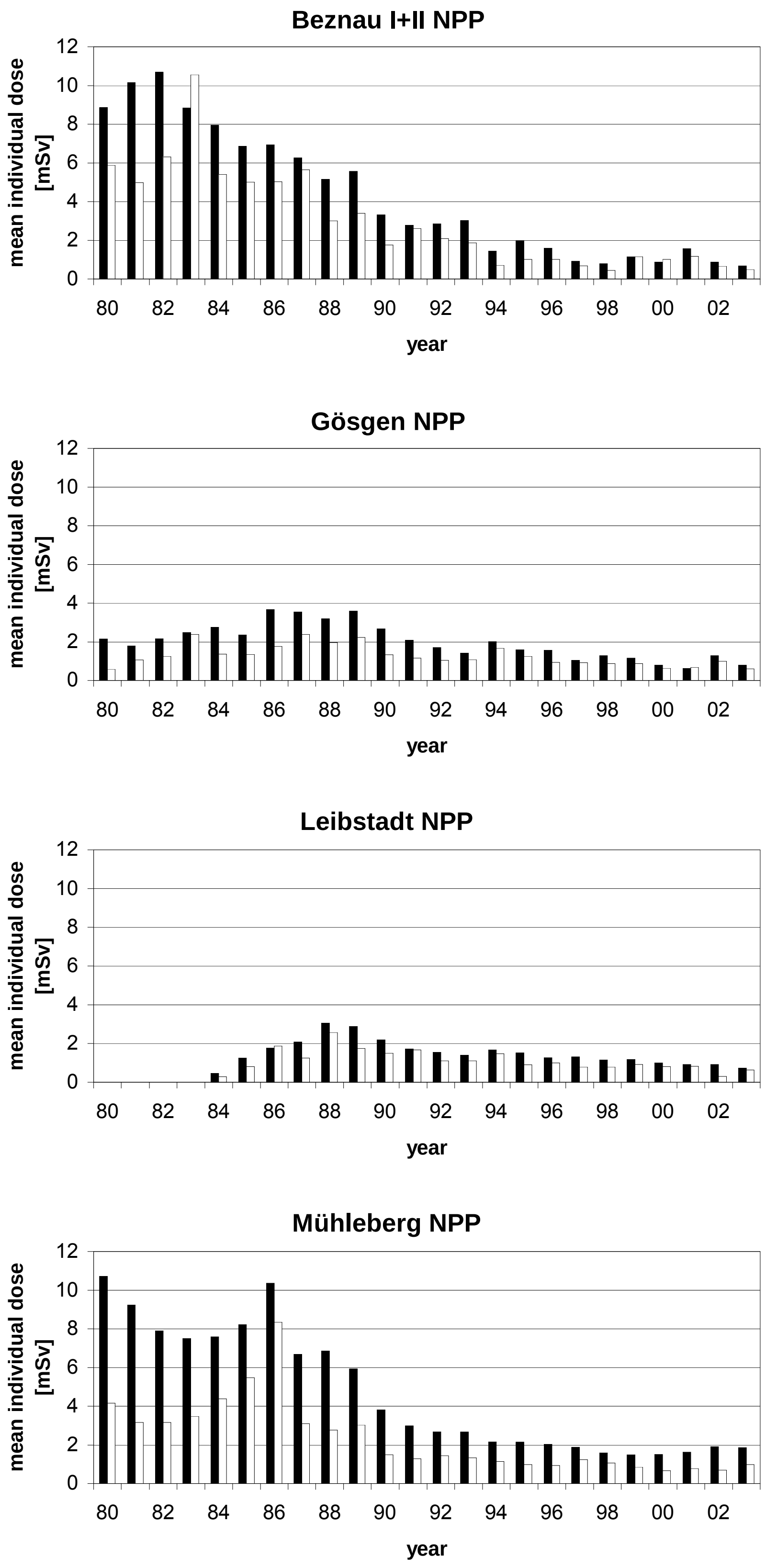

*Figure 5: Mean individual dose of plant personnel (dark bars) and contractors (*white *bars) in Swiss NPP.*

Table 2: Main dose reduction measures in Swiss LWRs.

Plant	Typical shutdown collective dose [man-mSv]	Main dose reduction measures
Beznau NPP	500	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. 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.
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.
Leibstadt NPP	900	Temporary lead shielding (32 tons). Temporary shielding with water bags. Job tickets (bar code) with on-line follow up. Very detailed job planning for jobs implying doses > 50 mSv. Job planning for jobs implying doses > 10 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 the 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 from 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;
- The current radiological situation;
- International experiences;
- Optimisation processes.

According to the Radiological Protection Ordinance, radiation protection is deemed to be optimised as soon as 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 (regulation), 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 about the 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 or in the case of a planned shutdown.

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.

Environmental radiological surveillance

The Radiological Protection Act establishes the legal basis for the radiological surveillance of the environment to be also in accordance with the corresponding legislation for foodstuff. More detailed requirements are laid down in the Radiological Protection Ordinance. On this basis, the Inspectorate, in collaboration with the Federal Office of Public Health, has established the programme for the environmental surveillance of each NPP in plant-specific procedures on the emission and the surveillance of the radioactivity.

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 comparative measurements.

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 guideline value (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 guideline value. The models and parameters used for the calculation are defined in the Inspectorate's Guideline R-41.
- 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 Inspectorate. The programme includes online measurements of the dose rate around the plants (MADUK, see Article 16), as well as regular sampling and measurements of air, 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 published in the annual report of the Federal Office of Public Health.

Regulatory control activities

As mentioned above, the Inspectorate reviews the radiation planning process of the NPPs as part of its supervisory duties. Typically, this review will be performed in conjunction with the radiation protection planning for oncoming shutdowns.

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

Further on the Inspectorate reviews periodical reports about radiation protection.

Conclusion

The Swiss Party complies with the obligations of Article 15.

Article 16: Emergency preparedness

Clause 1

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 Concept, Ordinances and Inspectorate's Guidelines:

- Federal Concept on the Emergency Planning and Preparedness for the Vicinity of Nuclear Power Plants (1998);
- Federal Ordinance on the Protection of the Population in the Vicinity of Nuclear Installations in the Case of an Emergency (Emergency Preparedness Ordinance) (1983, updated 1991);
- Federal Ordinance on the Emergency Organization in Case of Increased Radioactivity (1991, updated 1999);
- Federal Ordinance on the National Emergency Operations Centre (1990, up-dated 1999);
- R-42: Responsibilities for decisions to implement particular measures to mitigate the consequences of a severe accident at a nuclear installation (1993, updated 2000);
- R-45: Planning and execution of emergency exercises in Swiss nuclear power plants (1997, updated 2004);
- Federal Ordinance concerning iodine prophylactics in the case of a nuclear accident (1992, updated 2003);
- Federal Ordinance on Alerting the Authorities and the Public (2003).

On-site emergency organization

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

- Operating procedures for abnormal situations;
- Emergency procedures;
- Reporting procedure to the Inspectorate and for radiological events also to the National Emergency Operations Centre (NEOC);
- Reporting procedure to the district police for fast evolving accidents.

The emergency preparedness documentation of the NPPs is inspected every year.

Furthermore, in late 2000, the Inspectorate required the Swiss licensees to implement Severe Accident Management Guidance (SAMG). In case of an accident with a severely damaged core, SAMG will support the different emergency organization teams in taking accident mitigation measures based on predefined strategies. Already in the year 2001, the Beznau NPP implemented a full Westinghouse Owners Group (WOG) SAMG programme including a validation emergency exercise. So far, all other plants have at least developed the technical bases for SAMG, which are mainly derived from the results of the plant specific level-2 PSAs. The Leibstadt NPP decided to follow the Boiling Water Reactor Owners Group (BWROG) SAMG approach, and the NPP Mühleberg SAMG concept is quite similar. The SAMG implementation for both plants is expected to be completed by the end of 2004. The Gösgen NPP is developing a SAMG-extension of the "Emergency Handbook".

In addition to the guidance for full power operation, the Swiss utilities are currently preparing low power/shutdown SAMG.

For communication in the case of an emergency, dedicated telephone and fax lines are installed between the NPPs, the Inspectorate and the NEOC. The communication system is tested once a month. An automatic dose rate monitoring and emergency response data system (MADUK/ANPA) has been installed at all NPPs in Switzerland. The system continuously monitors the dose rate at about 12 locations in the vicinity of each NPP. The data are transmitted on-line to the Inspectorate and the NEOC. In accident situations, the system also provides the Inspectorate with on-line 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 visualize these measurements, to diagnose the plant state, and to simulate possible future accident developments.

Off-site emergency organization

The off-site emergency organization is based on the resources that have been built up within the frame of Switzerland's general defence 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 Organization Radioactivity (FEOR) co-ordinates the usage of civil and military support at the federal, cantonal and communal levels.

The legal basis for the FEOR is given in the Federal Ordinance on the Emergency Organization 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 FEOR has a permanent team, the NEOC, which is responsible for alerting, instructing and informing the public and for the initiation of early countermeasures in all cases of radiological accidents.

The responsibilities of the major organizations 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 NEOC regarding potential off-site radiological consequences for the public.

- The NEOC is responsible for the transmission of warning and alerting orders to the cantonal authorities, and also for initial countermeasures for the protection of the public.
- The 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 canton has the responsibility to distribute to the public information on radioactivity 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 measures actually required can be implemented without any detailed pre-planning.

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. Besides 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 Federal Ordinance on the Emergency Organization in Case of Increased Radioactivity. The concept describes which protective measures are to be adopted for an expected radiation dose (see Table 3).

Table 3: Emergency reference levels according to the Federal Ordinance on the Emergency Organization in Case of Increased Radioactivity. 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 protective measures have to be taken under most circumstances.

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
	Thyroidal dose from inhalation of radioactive iodine	30 mSv	300 mSv
Restriction of certain foodstuffs	Effective dose from ingestion	1 mSv	20 mSv

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 sufficient protection against radioactive cloudshine in the cloud phase of an accident and 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 shut off.
- Iodine tablets are distributed to all houses in Zone 1. Since the last up-date of the Federal Ordinance concerning iodine prophylactics in the case of a nuclear accident the distribution in all houses is also required in Zone 2.
- 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 NEOC. If the accident poses a threat to the public and the environment, a three-stage warning and alert procedure is set in motion: warning, first general alert (for preparation of countermeasures) and additional general alert (for implementing countermeasures). 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 community organizations (within Switzerland) on stand-by for a possible alert. The NEOC also informs foreign organizations such as the IAEA and authorities in neighbouring countries.
- A first **general alert** is issued 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 general alert (given by activating sirens) 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.
- An additional **general alert** is given if a dangerously high release of radioactive materials is imminent or has already occurred. This alert (given by activating sirens) advises the population to take immediate shelter in a cellar or fallout-shelter.

The siren signal and their 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 instantaneously. 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 timing 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 (about 5 km) 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 regional public authority (responsible for the countermeasures for the emergency planning zone 1), without waiting for an order from the national organization.

Emergency exercises

Emergency training is periodically checked within the frame of emergency exercises, to be performed once per year in every NPP. Co-operation between the different teams involved and co-operation with external organizations 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.

The 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. The warning and alerting of the population in case of accidents is described in Clause (i) of this Article.

Notification abroad, in the case of an emergency in Switzerland, is performed by the NEOC, in accordance with bilateral agreements with the neighbouring countries Germany, France, Italy and Austria[3], as well as in accordance with the Convention on Early Notification of the IAEA. The NEOC is furthermore connected to the European Community Urgent Radiological Information Exchange (ECURIE) reporting system. In the case of an accident with a rating of 2, or higher, on the international nuclear event scale (INES), notification to the IAEA and the European Community is mandatory.

In addition to the general emergency preparedness for nuclear accidents in the countries concerned, special plans have been drawn up for those Swiss NPPs situated near the Swiss border. The objective of all these efforts is to provide adequate emergency protection on both sides of the border. Bilateral agreements on these matters exist between the Swiss Government and the governments of Germany, France and Austria. The international emergency exercise INEX-2-CH combined specific Swiss and German objectives. In addition to Swiss response organizations, more than 30 countries and international organizations participated in the exercise. The objectives focused on the ability of international organizations and countries to deal with the various aspects of communication, decision-making and public information.

The INEX-exercises provided a very useful and successful test of the systems and procedures established to inform the international community about a NPP accident. Other benefits include experience with bilateral agreements and a realistic display of public and media concerns and needs for information.

German authorities fully participate on a regular basis in combined emergency exercises for the two Swiss NPPs which are in the vicinity of the German border (Leibstadt and Beznau NPPs). The last exercise with participation of the German Authority took place in 2003. Switzerland regularly participates in IAEA (CONVEX) and ECURIE exercises. It took also part in the NEA exercises (INEX).

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[3] Liechtenstein is direct alerted by the NEOC in the same manner as a Swiss canton (not as a neighbouring state).

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.

Conclusion

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 Federal Order to the Atomic Energy Act, the suitability of the site is part of 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.

With the application for the licence, all relevant factors related to the sites (natural characteristics and human activities) have to be included in the safety analysis report (SAR) and in the probabilistic safety analysis (PSA), in particular:

- Geology, seismology, hydrology (including flooding) and meteorology;
- Population distribution (in SAR only), neighbouring industrial plants and installations;
- Routes and frequency of transport by air, waterways, on the ground, as well as aviation flight corridors.

The Inspectorate evaluates all relevant site-related factors likely to affect the safety of a nuclear installation by external events (e.g., earthquake, flood, lightning, fire, wind, aircraft crashes, or explosion due to neighbouring industrial plants or installations) and defines additional requirements on the design of the plant, if necessary.

Specific siting criteria do not exist, but the relevant factors for the 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 is limited. The concept of safety by distance encounters natural limitations in the Swiss case. 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.

The likely safety impact of nuclear installations on individuals, society and the environment, is evaluated in the SAR, as described in Article 14.

Additionally, the Radiation Protection Ordinance prescribes that the licence holder has to adopt suitable measures to prevent the occurrence of events leading to accidents and to mitigate their consequences. The mentioned ordinance gives dose guideline values for the public during normal operation and for design basis accidents; on this basis, the actual dose limits are then defined in the Inspectorate's Guideline R-11 for normal operation and R-100 for transients and accidents. The dose limits 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).

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. As the reporting procedures 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 licensee 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 and the PSA.

The re-evaluation processes contribute essentially 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 the safety. The applicability and effectiveness of the Inspectorate's re-evaluation process are illustrated by means of two examples originating from the PSA review process and resulting in appropriate measures being adopted:

- Seismic backfits were performed in all Swiss NPPs as a consequence of the Inspectorate's on-site inspections and insights gained by PSA. Backfitted components and structures include electrical cabinets, motor control centres, cable trays, diesel oil tanks, pipe runs and masonry walls. The Beznau NPP initiated a new project to systematically identify and strengthen risk-related seismic vulnerabilities.
- Based on a requirement from the Inspectorate, a large scale project for the re-examination of the seismic hazard at the existing sites of Swiss Nuclear Power Plants is underway with the involvement of independent scientific and engineering organizations. In this project an improved assessment of the site specific hazard is made by performing a plant-specific PSA. An extensive elicitation process is part of the project with involvement of experts from Europe and from US. The Inspectorate is closely following the study by performing peer reviews during the project. A technical review based on preliminary results of the project has been initiated by the Swiss utilities. It is expected that final results of the project will be available by the end of 2005.

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 adjoining 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 Nuclear Safety Commission for 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 programs, operational experience of nuclear installations and the legislative framework for nuclear safety and radiation protection.

Conclusion

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.

The design and construction of the Swiss NPPs are based on the US-American (Beznau I+II, Mühleberg, Leibstadt) and the German (Gösgen) standards as 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 plant 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) already is, or soon will be 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 nuclear power plants with light water reactors". Other important Inspectorate's Guidelines for the licensing process are listed in Appendix 2.

After the granting of a license, the design and construction of the existing NPPs are reassessed 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).

However, three important deficiencies were identified:

- The insufficient protection from external events of natural origin, especially earthquakes and flooding;
- Insufficient protection from man-made external events, e.g. aircraft crash;
- The 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 Inspectorate's experts).

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 plant providing emergency power for the NPPs of the first generation. The impact of external flooding was analysed on a deterministic basis, assuming the 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 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 the 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 Swiss specific 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 the Gösgen NPP, a special emergency heat removal system, again using ground water as an ultimate heat sink, was already included in the original design; also, this NPP is currently implementing the necessary systems/equipment to enable primary feed and bleed in accident conditions.

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 burst disc.

Due to the terror attacks carried out on the Word Trade Centre on 11th of September 2001, the Swiss NPPs were requested by the Inspectorate to carry out analyses of the safety 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, thanks to previous backfitting of special decay heat removal systems and implementing further provisions in the area of fire protection, an adequate level of protection against an 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 the 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 are currently being evaluated.

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 correspond therefore 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 for 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 license for the two new systems, the Inspectorate required that the plant perform a verification and validation program 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 recognized 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.

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 units of the four Swiss NPP sites 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/licensee 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, 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 licensee proceeds to a design review to verify that the "as built state" reflects correctly 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, a permit is granted by the Inspectorate for each new operational cycle after shutdown for maintenance and refuelling. This permit 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 shutdown period and the approval of the reload licensing documentation (see Article 14).

In October 1998, the Leibstadt NPP received the operation license for a power uprate of 14,7 % of rated power upon the application of the licensee. 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 program. 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

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 a NPP has to be in accordance with an appropriate set of limiting conditions of 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 so-called Plant Technical Specifications (Tech Specs). The Tech Specs contain also the plant-specific surveillance requirements. Concerning the structure of the Tech Specs, the licensees 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. The Tech Specs have to be revised according to plant modifications, operational experience and new knowledge. This is regularly performed by the licensee, and the modified wording needs again a permit by the Inspectorate. In this way, the Tech Specs have achieved through the many operational periods a mature state of content and usefulness.

Compliance with the operating procedures is controlled by the licensee's staff according to its own rules. Further procedures are provided by the licensees to ensure safe operation of the plant. 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.

In 2001 a Swiss NPP reported that two plant operators did not completely follow a checklist on valve alignment. However they signed off the checklist pretending that they had completed their task correctly. The falsification was detected by the deputy shift-supervisor, and the two operators were subsequently suspended from their jobs with immediate effect. The safety significance of the event was low, since the systems were not altered since the last check and a malfunction of the system would have caused an alarm in the main control room. The operator and the Inspectorate investigated the incident thoroughly, also analysing organizational circumstances that might have contributed to the event. The operator identified problems with shift work as one main contributor to the event and he initiated workshops for all shift personnel in an institute for the treatment of insomnia. The Inspectorate performed inspections on the use of checklists in all Swiss NPPs. As a result, in all NPPs the processes on creating and using checklists as well as the surveillance on the completion of checklists were reviewed.

Regulatory surveillance of plant operation relies on the information obtained from the operating organizations 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 (since the INES classification became operational in Switzerland) 7 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 organizations 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 organization and the doses to the personnel and the public are the most important. Particular emphasis is put on event reporting and investigation. Lessons learned and feedbacks 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 licensees invest in efforts to optimise plant operation. In two NPPs such optimisation programs 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 already been reviewed and approved by the Inspectorate for one licensees, and are still under review for the other. 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.

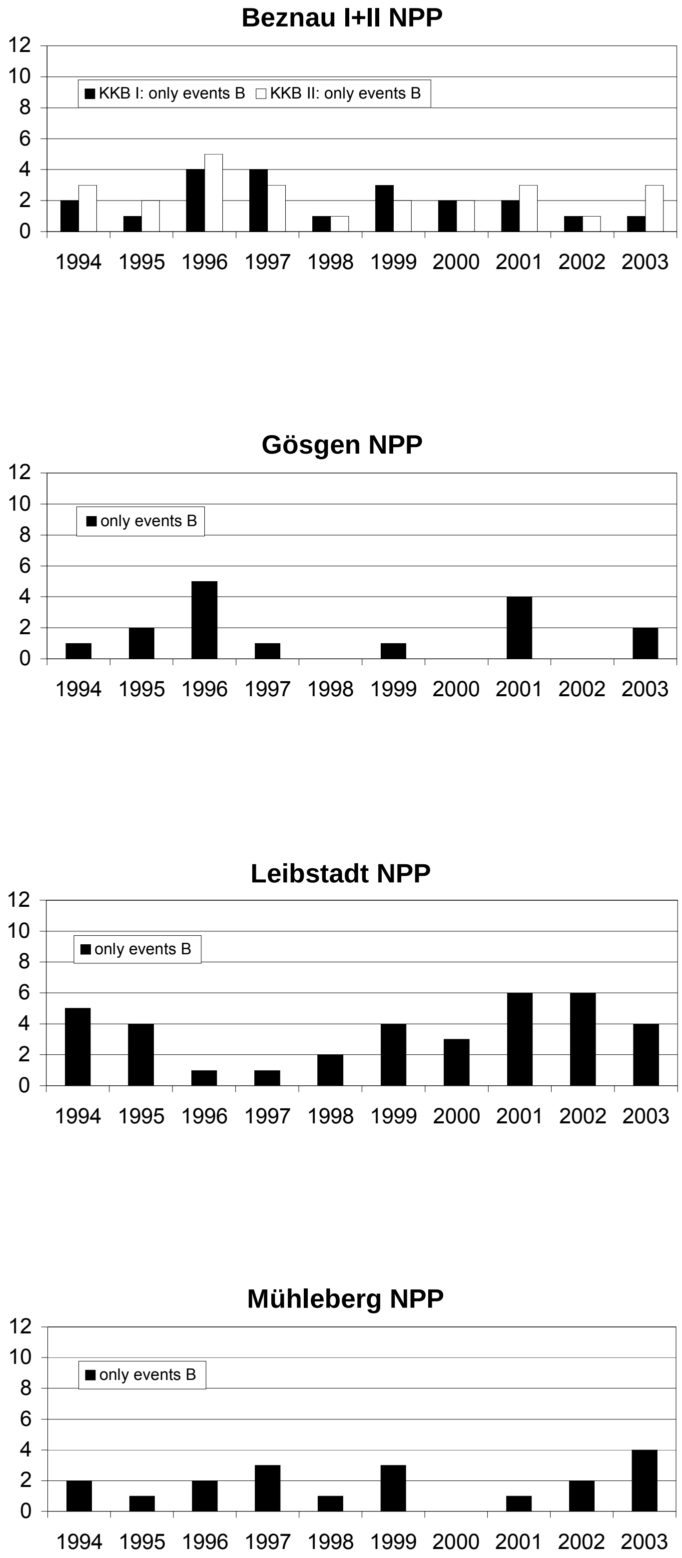

Figure 6: Annual number of reportable events in Swiss NPPs.

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). The EOPs are a requirement by the Inspectorate. 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 accident, the Inspectorate has required an extension of the EOPs by adding severe accident management guidance (SAMG). To date, the SAMG implementation in Switzerland is nearly completed (see Article 16).

The emergency procedures of the NPP 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 emergency procedures. Further information on alerting and alarm procedures is given in Article 16.

The NPP of Gösgen is currently revising its EOPs by complementing the existing event oriented procedures by a symptom oriented part. At the same time the procedures are adapted according to state-of-the-art formats (see also Article 12).

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.

Ordinances and 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 organization and other authorities;
- Notification of events of public interest to allow the Inspectorate to make an independent assessment and to rapidly give official information to the public.

For practical reasons three classes of safety significance are defined. They are related to reporting time and content requirements (S emergency, A significant, 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 of the Inspectorate. A catalogue of consequences is used as classification criteria in the guideline, which has to be applied to the real event situation 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 licensees 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 degradations. 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.

To be sure that the guideline will be utilised properly by the NPP, the classification is a formal part of the process for the license and requalification of shift supervisor and on-call engineer. During periodic emergency drills, the event classification is also an important objective for the NNP 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 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 organizations 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 non-conformances are evaluated against their safety impact. 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-conformances 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 decision on the 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 programs.

The four managers of the Swiss NPPs have initiated and are monitoring the exchange of operating experience between the Swiss NPPs. This group of managers is supported by several working groups that deal with issues such as training, nuclear safety performance, surveillance of aging, 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 of 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 summarized 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 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 organize 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 "Special Experts Group on Human and Organizational Factors" (SEGHOF). An example of Inspectorate's commitment to these working groups is the organization of a NEA/WANO Workshop in 2002 on "Recurring events" at Böttstein Castle in Switzerland.

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 from all Swiss licensees a re-evaluation of 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 28th of 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 shutdown periods in 1993 by new equipment with a considerably enlarged strainer area. For the PWRs, retrofitting actions were at that time found to be unnecessary; the issue is still under investigation, and new research results may lead to a reassessment.
- 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, in-

stallation of thermocouples) were made during the annual shutdowns. 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 with respect 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 USA 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 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 Federal Nuclear Energy Act implements the principle that the generator of the radioactive waste is responsible for the safe management of the 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 shall, as a general rule, 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 present legislation neither prescribes nor prohibits the reprocessing of spent fuel. However, the new nuclear energy act prohibits the reprocessing of spent nuclear fuel for a period of ten years starting 1st of July 2006. In the past, the operators of the NPPs have signed contracts with foreign companies for reprocessing approximately 1200 tons of spent fuel. Most of the spent fuel covered by these contacts has already been shipped abroad. At present spent fuel is also stored in transport and storage casks at the Central 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 the dry storage of spent fuel elements which is not yet operational. At the Gösgen NPP site, a building for the wet storage of spent fuel is pending licensing approval. 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 Inspectorate's Guideline R-13.

As a general rule, radioactive waste is conditioned as soon as practicable, mostly on site, partly externally at the Paul Scherrer Institute (PSI) or ZZL. According to Inspectorate's Guideline R-14 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 organization (NAGRA) and can be transported in compliance with the dangerous goods regulations. Storage of operational waste takes place on site under appropriate and adequate conditions. The requirements regarding storage of radioactive waste are detailed in the Inspectorate's Guideline R-29.

Conclusion

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, and implement as appropriate, any new developments enhancing nuclear safety. Best practices receive due attention and are considered for operating the Swiss nuclear power plants more safely and/or for improving the regulator's work. Efforts are underway in Switzerland to improve the legal basis with the enactment of the new Nuclear Energy Act in 2005. Simultaneously, a project has started to achieve the required formal independence of the Inspectorate. In the radioactive waste disposal area a demonstration of the feasibility of a repository for high level and long-lived intermediate level waste in Switzerland was submitted for review to the federal authorities in December 2002 by the NPP operators. The Federal Government will take a decision on this demonstration in 2006.

In a spirit open to international technical co-operation, the Swiss regulatory body maintains a close relationships with partner regulatory bodies world-wide and engages actively in know-how transfer. Thus, several co-operation projects are currently ongoing to promote the use of modern safety assessment methods in order to improve the technical capabilities of some of the partner regulatory bodies. With the implementation of the integrated oversight approach in the near future, the Inspectorate's activities will improve the focus on the effect of its work and decision-making on the safety of the nuclear installations. This oversight approach will foster the effectiveness, the balanced decision making and the traceability of the Inspectorate's work. This will be even more important in future as all Swiss NPP operators have begun evaluating plant lifetime extension, encouraged by the outcome of the public votes of 18th of May 2003, which sustain further safe operation of existing NPPs in Switzerland.

The continued active Swiss participation in the IAEA and the OECD NEA underlines the important role Switzerland attributes to these organizations. Further, the close bilateral co-operation with our neighbouring countries in all nuclear safety matters will remain a feature which the Inspectorate takes very seriously.

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 also the working processes and methods employed by the regulatory body.

The reporting under the Convention on Nuclear Safety plays an important role in this context. Creating transparency generates trust.

Switzerland will thus engage in maintaining and improving its high standard of nuclear safety, assist other countries where needed in attaining a high level in nuclear safety, support international organizations and participate in nuclear safety activities. In the international nuclear community, the Swiss regulatory body pledges to be a reliable and transparent partner.

Appendices

- Appendix 1: List of abbreviations used in the present report
- Appendix 2: List of the Inspectorate's Guidelines presently in force
- Appendix 3: List of annual reports

Appendix 1: List of abbreviations used in the present report

ADAM	Accident Diagnostics, Analysis and Management System
ASME	American Society of Mechanical Engineers
ASP	Ageing Surveillance Programme
BAG	Federal Office of Public Health
BFE	Federal Office of Energy
BIP	Basic Inspection Programme
BWR	Boiling Water Reactor
BWROG	Boiling Water Reactor Owners Group
CFS	French-Swiss Nuclear Safety Commission
CONVEX	Convention Exercise
CSNI	Committee on the Safety of Nuclear Installations (NEA/OECD)
DBA	Design Basis Accident
DSK	German-Swiss Nuclear Safety Commission for Nuclear Installations
ECURIE	European Community urgent radiological information exchange
EOP	Emergency Operating Procedures
EPFL	Swiss Federal Institute of Technology Lausanne
ETEC	Federal Department of Environment, Transport, Energy and Communication
FEOR	Federal Emergency Organization Radioactivity
FLAG	New Public Management System
GDC	General Design Criteria
GSKL	Swiss Society of NPP Managers
HSI	Human-System-Interaction
HSK	Swiss Federal Nuclear Safety Inspectorate
R-xy	Reference number of guidelines prepared and established by the HSK
IAEA	International Atomic Energy Agency
ICRP	International Commission on Radiological Protection
IEC	International Electrotechnical Commission
INES	International Nuclear Event Scale (NEA and IAEA)
INEX	International Emergency Exercise
IRRT	International Regulatory Review Team
IRS	Incident Reporting System (NEA and IAEA)
ISO	International Standards Organization
KE	Section for Nuclear Energy of the BFE
KSA	Swiss Federal Nuclear Safety Commission
LAR	Steering Committee for Radioactivity
LCO	Limiting Conditions of Operation
LWR	Light Water Reactor
MADUK/ANPA	Automatic Dose Rate Monitoring and Emergency Response Data System
NAGRA	National Cooperative for the Disposal of Radioactive Waste
NAZ	National Emergency Operation Centre (NEOC)

NEA	Nuclear Energy Agency of the OECD
NEOC	National Emergency Operation Centre (NEOC)
NMCA	Noble Metal Chemical Addition
NPP	Nuclear Power Plant
NRPB	National Radiological Protection Board, Harwell (UK)
OBE	Operating Basis Earthquake
OECD	Organization of Economic Co-operation and Development
OHSAS	Occupational Health and Safety Assessment Series
OSART	Operational Safety Review Teams (IAEA)
PSA	Probabilistic Safety Analysis
PSHA	Probabilistic Seismic Hazard Analysis
PSI	Paul Scherrer 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
SEGHOF	Special Experts Group on Human and Organizational Factors
SER	Safety Evaluation Report
SIA	Swiss Society of Engineers and Architects
SPDS	Safety Parameter Display System
SSCs	Systems, Structures and Components
SSE	Safe Shutdown Earthquake
SVA	Swiss Association for Atomic Energy
SVTI	Swiss Association for Technical Inspections
Tech Specs	Plant Technical Specifications
US-NRC	United States Nuclear Regulatory Commission
Uni BS	University of Basel
UVEK	Federal Department of Environment, Transport, Energy and Communication (ETEC)
VBS	Federal Department of Defence, Civil Protection and Sports
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
ZZL	Interim Storage Facility, Würenlingen

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

Status: July 2004

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
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, interface between classes 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 the construction supervisory (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-14/d *	Requirements for the conditioning of radioactive waste (Anforderungen an die Konditionierung radioaktiver Abfälle)	March 2004
R-15/d *	Reporting guideline concerning the operation of 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/d R-17/e	Organisation von Kernkraftwerken Organization of nuclear power plants	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/d R-21/e R-21/f	Schutzziele für die Endlagerung radioaktiver Abfälle Protection Objectives for the Disposal of Radioactive Waste Objectifs de protection pour le stockage final des déchets radioactifs	November 1993 November 1993 November 1993
R-23/d *	Revisions, testing, replacement, repair and modification 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 governing 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 radiation protection and further training in the supervision areas of HSK (Anerkennung von Strahlenschutz-Ausbildungen und -Fortbildungen im Aufsichtsbereich der HSK)	July 2001
R-39/d *	Registration of radiation sources and material testers 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 the radiation exposures in the vicinity of nuclear installations due to emissions of radioactive materials (Berechnung der Strahlenexposition in der Umgebung aufgrund von Emissionen radioaktiver Stoffe aus Kernanlagen)	July 1997
R-42/d R-42/e	Zuständigkeiten für die Entscheide über besondere Massnahmen bei einem schweren Unfall in einer Kernanlage Responsibility for decisions to implement certain measures to mitigate the consequences of a severe accident at a nuclear power plant	February 2000 July 2003
R-45/d *	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 securing 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/d R-52/e	Transport- und Lagerbehälter (T/L-Behälter) für die Zwischenlagerung Transport and Storage Cask (T/S-Casks) for interim storage	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 conditions (Anlagezustände eines Kernkraftwerks)	June 1987
R-101/d R-101/e	Auslegungskriterien für Sicherheitssysteme von Kernkraftwerken mit Leichtwasser-Reaktoren Design criteria for safety systems of nuclear power plants with light water reactors	May 1987 May 1987
R-102/d R-102/e	Auslegungskriterien für den Schutz von sicherheitsrelevanten Ausrüstungen in Kernkraftwerken gegen die Folgen von Flugzeugabsturz Design criteria for the protection of safety equipment in NPP against the consequences of airplane crash	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

Appendix 3: List of annual reports

The following annual reports are available on the HSK Internet website (www.hsk.ch):

- Inspectorate's annual report for 2001
- Inspectorate's annual report for 2002
- Inspectorate's annual report for 2003

Impressum

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