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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 first Swiss report in accordance with Article 5

Contents

Foreword

The nuclear reactor accident at Chernobyl has shown that a binding codification of the basic principles of nuclear safety was necessary on an international level. Due to a resolution of its Governing Council, in February 1992, the IAEA gave the task to an expert group to prepare an international Convention on Nuclear Safety. The draft prepared by this expert group was accepted, within the frame of a diplomatic conference, from representatives from 84 countries; in September 1994 the Convention was opened for signing. In accordance with Article 31, the Convention entered into force, on 24 October 1996.

Switzerland gave its signature to the Convention on 31 October 1995 and ratified it on 12 September 1996. In its address concerning the Convention on Nuclear Safety, the Swiss Federal Council has stated that the Convention represents the first binding safety standard according to international law. It further praised the Convention as a significant advance in view of the codification of general basic principles for safety.

This report is issued according to Article 5 of the Convention on Nuclear Safety. It has been produced by the Swiss Federal Nuclear Safety Inspectorate (HSK/DSN). Before submission to the Federal Department of Environment, Transport, Energy and Communication, the report has been commented by the Federal Office of Energy (BFE/OFEN), the Swiss Federal Nuclear Safety Commission (KSA/CSA), and the Swiss NPPs of Beznau, Leibstadt and Mühleberg. The Gösgen NPP has chosen not to comment on the report.

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 duties 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 Swiss compliance with the obligations, as set out in the Convention, is given in the "Summary and conclusions" section.

Summary and conclusions

Currently the regulation processes applied to the licensing and safety surveillance of the NPPs, the NPP types and systems and their operation are all at the state of science and technology in Switzerland.

Deterministic and probabilistic safety assessments are important tools for the supervisory authority, either to confirm the high standard of the NPPs safety or to identify any plant vulnerability. In addition, these assessments guide and prioritise inspections.

The surveillance of the NPPs electromechanical systems, their component integrity and the human aspects as well as the goal to produce 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 NPP workers and also to 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.

The Swiss national alerting system, in cases of an accident in a nuclear installation, is geared to 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 in the articles of the Convention, with exception of Article 13, were already standard practice in Switzerland before the NSC came into force.

Improvements are aimed for in two areas:

- The independence of the Inspectorate (HSK/DSN), from other governmental bodies concerned with the use of nuclear energy is presently fulfilled on a technical level, but this independence is not guaranteed legally. Another subordination of the Inspectorate is in consideration within the frame of the current reform of the government and the administration.
- The present Inspectorate's quality assurance practices are only implied through the many documents presently in use. However, a documented QM system is currently being implemented.

In the following, main conclusions will be drawn from the previously detailed answers to the various articles in the Convention.

Article 6: Existing nuclear installations

The general safety status of the Swiss NPPs is good. The first generation NPPs of Switzerland (Beznau I+II and Mühleberg) have been progressively backfitted to address the major on-going developments in NPP safety technology. Initial and periodic safety reviews have been performed for these first generation NPPs and, based on the favourable results, they have been granted licences to continue operation.

The second generation of NPPs (Gösgen and Leibstadt) had, already from the design stage, inherent improvements in various aspects of safety and operation. A periodic safety review (PSR) has been completed for the NPP Leibstadt with favourable results. The PSR for the Gösgen plant was started in 1996 and it is now nearing completion.

Accordingly, all Swiss NPPs will have undergone the safety review process as required by the Convention and will have incorporated the necessary improvements as indicated by the safety reviews. The Swiss legally binding policy of continual improvements in NPPs, as indicated by 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

The legislation and nuclear installation regulatory framework is well established in Switzerland. It ensures the formal nature in which the safety of installations may be 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.

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/DSN) as the supervisory authority and the Swiss Federal Nuclear Safety Commission (KSA/CSA) as an advisory committee, possess the authority, competence and financial resources to fulfil their assigned responsibilities.

According to the increased responsibilities and tasks of the Inspectorate, its number of personnel has been successively increased by 55 in the last 20 years and its organisation has been adapted to new needs. This will also be the case in the future.

The functions of the regulatory body are separated from organisations concerned with the promotion or utilisation of nuclear energy. The requested effective separation of the supervisory authority from other governmental bodies concerned with the use of nuclear energy is fulfilled on a technical level.

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 the NPP is required implicitly by the Swiss Atomic Energy Act . This statement is in first place for each of the NPP’s procedure rules. Each NPP has therefore, accepted this condition for operation.

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

Article 10: Priority of safety

The priority of safety has always been the first consideration for all those organisations engaged actively with nuclear installations in Switzerland. The Inspectorate has explicitly set this down in its own Terms of Reference, appended to this document. As far as the NPPs are concerned, up to the year 2000 all of them will have undergone Operational Safety Review Team (OSART) missions and the corresponding follow-up missions. The missions carried out

so far have confirmed many commendable areas of performance, especially 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 financial resources of the Swiss NPPs for the assurance of supporting the safety of the NPPs throughout their lives are assured. Should a NPP not anymore fulfil the safety requirements, it will have its licence revoked and will be prevented to operate. The financial aspects of decommissioning are ensured by means of a fund. 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 observed tightly.

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

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

Article 12: Human factors

The Inspectorate has its own section which is concerned with human aspects, NPP organisation and safety culture. Attention is paid to ergonomic aspects and weaknesses are identified and improvements made. Modifications to the control rooms and the implementation of computerised plant information systems have been progressively carried out.

Steps to further improve the safety culture are continuously made. The members of the Inspectorate as well as the plant management are both pursuing a way to further promote a broad safety philosophy and culture.

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

Article 13: Quality assurance

Today, the Beznau, Leibstadt and Mühleberg NPPs have built up documented QM systems. In the Gösgen NPP the system is under way. It is expected that the system will be implemented by the year 2000. Furthermore, QM-systems were established and approved for the transport of radioactive materiel.

At the Inspectorate a process re-engineering project is presently being undertaken as a first step for the subsequent implementation of a QM-system.

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, safety relevant systems, design basis accident analyses, probabilistic safety analysis, ageing surveillance programmes, as well as any documents which are made available upon request by the Inspectorate. The results of the reviews and assessments are documented in a safety evaluation report. Important conditions and prerequisites for the granting of any licence are recorded as licence conditions. Among others, a condition is that the safety analysis report has to be reviewed periodically and, if needed, be updated by the licensee.

Further factors which contribute to the requirement that the physical state of a NPP continues to be in accordance with the licence requirements include: that any modifications to components important to safety must have a permit; that a plant review has to be carried out after each refuelling outage and that an efficient inspection activity is established by the Inspectorate.

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 effectiveness of these methods (e.g. guidelines, job planning and supervision) based on the most recent recommendations of the International Commission on Radiation Protection can be seen in the low annual individual and collective doses.

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

Article 16: Emergency preparedness

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

The basic reporting procedure required is laid down in an Inspectorate's Guideline. The preparedness and plans are regularly tested in the form of exercises. The ways for alerting the public and the National Emergency Operation Centre and neighbouring countries are in place. Bilateral agreements exist between the Swiss and German as well as the Swiss and French governments.

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

Article 17: Siting

Steps and procedures for evaluating all relevant NPP site-related factors are established and implemented within the frame of the licensing procedure. With the periodical review of the safety analysis report, site specific factors are also addressed.

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. The various levels of defence in depth are in place to ensure that for normal operation and for all design basis accidents the plant remains within the safety limits and individual dose limits for the public are not exceeded. In addition, the release of radioactive materials to the environment in the case of severe, beyond design basis accidents, is prevented or limited. The design, materials and components are subjected to rigorous control and scrutiny and regular testing to verify their fitness for service. Backfitting is carried out when necessary. All Swiss NPPs now possess a filtered containment venting system which has the

potential to mitigate the radiological consequences to the environment in most cases of severe accidents. The legal requirement that the Swiss NPPs have to be at the state of science and technology ensures that the technologies incorporated in the constructions are proven by experience or qualified by testing or analysis. The increasing use of computerised control systems is improving the man-machine interface and making easier the operation of the NPPs in all modes of operation.

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

Article 19: Operation

The requirements for the correct and safe operation of the Swiss NPPs are fixed in the operation licence for every NPP. The operation procedures and rules have to be followed for all operational conditions; the most important being the Technical Specifications with 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 seen in the low annual number of reportable events.

In addition to its general inspection activities, the Inspectorate gains further insight to all aspects of the NPPs operation using a comprehensive system of report-gathering from the operator.

The Inspectorate and the operators collect operational experiences concerning domestic and foreign NPPs. These experiences have resulted in some important safety-relevant backfitting and modifications.

The generation of radioactive waste at NPPs is kept at a low level. The waste arising is collected, segregated and conditioned as soon as practicable. Temporary storage of waste takes place on site under appropriate and adequate conditions.

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 7,094,000 Switzerland is commonly designated a small State. Structurally, Switzerland has evolved as a federal State with twenty-six member States, known as cantons. Some limited powers and central tasks are kept within the domain of the federal authorities and a number of popular rights are also guaranteed federally. All other legislative matters are given to the cantons, which have retained a high degree of autonomy. The municipalities and communes, also enjoy considerable rights of self-government.

The senior executive body is the Federal Council, which consists of seven ministers of equal rank. 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 distribution of seats being calculated according to the strength of the political parties. The Council of States, with 46 members, represents the cantons. Each canton, regardless of size, elects two members according to its own electoral system.

The voting population always has the opportunity of the last word. Changes 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 the vote (compulsory referendum). If a minimum of 50,000 voters challenge federal laws, these proposals are put to the vote (optional referendum).

Background of nuclear power in Switzerland

Historically, electricity generated in Switzerland came exclusively from hydro power without any contribution from fossil fuels; the latter are not available as natural resources in the country, anyway. From the middle of the 1950's there was an increasing interest for nuclear energy as a new technology that appeared appropriate to cover the increasing demand for electricity without having to use fossil fuels for generating it. According to the general policy concerning the production of electricity, the promotion and use of nuclear energy was left to the initiative of the private sector. Nevertheless, it was recognised that the implementation of any programme and project needed a legislative frame to ensure safety and radiation protection, and that such a legislation should be established exclusively at the federal level. Therefore the 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 power in 1959.

The Federal Council (government) is legally given the exclusive competence to grant licences concerning the construction, operation and modifications to nuclear installations. These licences are based on a detailed review and assessment of the nuclear safety. The supervision of nuclear power plants (NPPs) implies the legal competence to take the appropriate measures, at any time, to enforce compliance with the licensing conditions.

Since nuclear power has been installed on a private basis, there is no "national programme" as such. During the 1960's, a series of projects for establishing NPPs were then started, more or less, in parallel; four of them reached the stage of realisation, leading to five units, commissioned between 1969 and 1984, and they are now in operation. These five units

contribute to roughly 40 % of the total electricity production in Switzerland, the rest being essentially covered by hydro power with a negligibly 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 realise several other nuclear projects for which sites had already been approved. The situation evolved at the end of the 1980's toward a double decision taken by the Swiss population, in 1990, by means of a vote:

- to accept 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).

Two new popular initiatives concerning the prolongation of the moratorium and the gradual close down of the existing NPPs have been launched by opposition groups to nuclear power recently.

Nevertheless, the utilities, being responsible for the energy supply, have to cover the increased consumption needs through other channels: the main one is the financial participation of Swiss electricity utilities in the construction of several NPPs in France with a proportional access right on their electricity production.

Swiss nuclear facilities

Nuclear power plants

There are nowadays 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 as follows:

- Beznau I+II (Nordostschweizerische Kraftwerke AG)
- Mühleberg (Bernische Kraftwerke 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 (January 1998)

	First generation NPPs			Second generation NPPs	
	Beznau - I	Beznau - II	Mühleberg	Gösgen	Leibstadt
Licenced thermal power P_{th} [MW_{th}]	1130	1130	1097	3002	3138
Nominal electrical power P_{el} [MW_{el}]	365	357	355	970	1030
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 sup-pression, Mk I inside concrete building	Large dry, free standing steel inside concrete building	Pressure sup-pression, Mk III inside concrete building
Normal heat sink	river (Aare)	river (Aare)	river (Aare)	wet cooling tower (Aare)	wet cooling tower (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 shutdown and residual heat removal system since	1993	1992	1989	included	included
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
KWU	Kraftwerk-Union (now Siemens)
BBC	Brown Boveri & Cie Ltd (now ASEA-Brown Boveri-ABB)
UO_2	Uranium oxide
MOX	Mixed oxides

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 densely populated country. The number of suitable sites for NPPs is therefore limited. Two sites are situated near the German border, at 0.5 km (Leibstadt) and at 5 km (Beznau). The two other sites are at about 40 km 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 most nuclear research in Switzerland is done at the Paul Scherrer Institute (PSI). Work is carried out at PSI in the following areas in national and international collaboration with other research institutes and 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.

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 accelerator installation with the spallation-neutron source, medical uses such as positron emission tomography, the decommissioned and partially dismantled research reactor "DIORIT" and the "SAPHIR" research reactor (not any more in operation, since 1994) are also mentioned here.

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 exception of a small nuclear waste storage area the site is declassified and released for non-nuclear activities since March 1995.

Nuclear waste

Each NPP has installations for the conditioning and temporary storage of radioactive waste arising from its operation. The PSI also has such an installation for treating radioactive waste arising from medicine, industry and research. The Federal interim storage for radioactive waste is also at the location of PSI. Furthermore, on the premises of the Beznau NPP there is a temporary storage called "ZWIBEZ" for waste arising out of fuel reprocessing and for spent fuel elements.

In Würenlingen a central interim storage facility for nuclear waste is presently under construction by the "ZWILAG" company. The final low and medium level waste disposal site at Wellenberg is still in the planning stage.

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 satisfactorily at the time the Convention entered into force. Major backfittings have been carried out in the last 15 years to improve the safety. All Swiss NPPs are reviewed at least annually on the occasion of refuelling. Profound reviews have been or are being carried out for all NPPs and their safety has been satisfactorily proven in both deterministic and probabilistic ways.

The NPPs of the **first generation** in Switzerland (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). The main reliance was then set on US Regulations and Guides since the two reactor suppliers concerned were US-American, as well as on the inherent safety of the light water reactor type.

However, in those days, some principles of nuclear safety were not yet commonly acknowledged and were not taken into account; examples are, in particular:

- 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, considering the case of loss of the offsite power;
- protection of residual heat removal (RHR) systems against external events (aircraft crashes, earthquakes, floods, lightning and sabotage);
- a supplementary shutdown capability in a remote area in case of a loss of the main control room.

As early as 1980, two major backfitting projects were required by the safety authorities to improve the RHR systems in the first generation plants. These projects were known under the name "NANO" for the PWR twin-unit at Beznau and "SUSAN" for the BWR at Mühleberg and they extended over several years. 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 18.

Periodic safety reviews (PSR) were performed after these major backfitting projects for both plants. The reviews were completed in 1992 for Mühleberg and in 1994 for Beznau. As a consequence of these backfittings, the two NPPs were granted new operation licences.

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. 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 finished in 1996, resulting in only minor requirements concerning better response to anticipated transients without scrams. The PSR for the Gösgen plant was started in 1996 and it is now nearing completion.

In 1993, all plants were improved by installing a filtered containment venting system to mitigate the consequences of severe accidents (e.g. failure of RHR systems).

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

- 1st level: Federal Constitution
- 2nd level: Federal Laws
- 3rd level: Federal Ordinances
- 4th level: Guidelines (Directives, Guides)

Federal Constitution (1st level):
Article 24quinquies (approved in 1957) stipulates that the 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 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 with the following acts:

- Federal Act on the Peaceful use of Atomic Energy (Atomic Energy Act, approved in 1959).
- Federal Order concerning the Atomic Energy Act (approved in 1978).
- Radiological Protection Act (approved in 1991).

In addition to the federal legal provisions the cantons retain competencies for granting various authorisations (in particular, the law on construction and land use planning, protection of the environment and landscape, protection of workers, forestry, fire and disaster prevention, water protection, use of river water for cooling purposes). The cantons retain, furthermore, the sovereignty on their underground territory. This has been, up to now, irrelevant for NPPs, but becomes important for radioactive waste management.

Atomic Energy Act
Atomic installations under this act are NPPs, research reactors and installations for mining, processing, storing or conditioning nuclear fuels and radioactive waste.

The main features of the Atomic Energy Act are as follows:

- a licensing system describing authorisations (licences) for siting, construction (including design), operation (including commissioning), modifications to nuclear installations, decommissioning and the licence conditions (see Article 7 Clause 2 (ii));

- the definition of a regulatory body and the attribution of competence for ordering the application of all measures to protect persons and property and other important rights and to safeguard Switzerland's national security and ensure compliance with its international commitments (see Article 8);
- penal provisions.

A complete revision of the Atomic Energy Act is currently in progress.

Federal Order concerning the Atomic Energy Act

This order has been enacted as a complementary law to the Atomic Energy Act. The main features are:

- the introduction of a general licence and the procedure to obtain this licence;
- the justification of the need of a nuclear installation and of the energy produced to be demonstrated;
- radioactive waste management aspects, including final disposal, and establishment of a fund for decommissioning;
- enhanced public participation for every new nuclear installation.

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 due to ionising radiation arising from all activities, facilities, events and circumstances involving such radiation.

The Radiological Protection Act covers inter alia:

- 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;
- permanently monitoring the environment and, during periods of elevated radiation, protecting the public (emergency preparedness: emergency organisation outside NPPs);
- radioactive waste management.

Federal Ordinances (3rd level)

The following ordinances (lower levels of legislation) are relevant to nuclear energy legislation:

- Federal Ordinance on definitions and authorisations (licences) in the field of nuclear energy (Atomic Energy Ordinance) (1984);
- Federal Ordinance on Radiological Protection (Radiological Protection Ordinance) (1994);
- Federal Ordinance concerning the Supervision of Nuclear Installations (1983);
- Federal Ordinance concerning the Swiss Federal Nuclear Safety Commission (KSA/CSA) (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 Organisation in Case of Increased Radioactivity (1991);
- Federal Ordinance on the Distribution of Iodine Tablets to the Population (1992).

The most important of these ordinances are briefly commented on below. The last four ordinances, all dealing with emergency preparedness, will be addressed in Article 16.

Federal Ordinance on Radiological Protection

This ordinance is based on the Radiological Protection Act and takes full account of the latest International Commission on Radiological Protection (ICRP) recommendations (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 concerning the Supervision of Nuclear Installations

This ordinance formally transfers governmental competencies in the licensing and supervision process specifically to the Swiss Federal Nuclear Safety Inspectorate (HSK/DSN) as supervisory authority. The ordinance formally establishes the Inspectorate as the competent authority for supervising nuclear installations at all stages of their life.

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

This ordinance specifies the Swiss Federal Nuclear Safety Commission (KSA/CSA) as the advisory committee on nuclear safety. The ordinance delineates the aspects for which the competent Ministry and the Federal Council expect advice from its advisory committee on nuclear safety.

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

There exists other ordinances which are indirectly related to nuclear safety and cover areas like 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, in turn based on the IAEA regulations for the safe transport of radioactive materials.

Guidelines (4th level)

Guidelines are prepared and established by the safety authorities. Formally, guidelines are not part of the legislation. Their nature and use 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;

The Swiss policy for regulation and supervision of nuclear installations, as expressed in the legislation, is to keep regulations short (without entering into technical aspects), essentially indicating that nuclear safety and radiological protection have to be ensured.

The legislation and regulations are thus limited to the prescription of safety objectives. This puts the applicants/licensees under the obligation to propose and seek technical solutions reflecting the internationally recognised state of science and technology, as well as corresponding safety criteria. The necessary governmental review and assessment of these proposals (being essential parts of the application) is done by the safety authorities.

Although the applicants/licensees have the obligation to propose acceptable technical solutions, experience has shown that it is useful to make known to them how the safety authorities will review and assess the application for a licence. This is done by means of guidelines prepared and established by the safety authorities.

These guidelines indicate ways of implementing some of the safety requirements. They address particular aspects which the Inspectorate requires to be taken into account, as they are suggested by experience gained in Switzerland and abroad and the state of science and technology. In particular, the guidelines state in detail, how the Inspectorate proposes to carry out its legal obligations.

Most of the guidelines are so-called "design guidelines"; they are not mandatory; applicants may choose other solutions, but then they have to demonstrate that the same level of safety is attained. A few guidelines, called "procedure guidelines", prescribe (administrative) procedures that have to be followed; they are then mandatory.

In the course of the years, the safety authorities have established a number of guidelines among which more than 30 are presently in force. A list of the presently valid guidelines 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 system arises directly from the appropriate 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 regulatory body (see Article 8), the definition of 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 have to be distinguished:

- **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. Under the Atomic Energy Act, the conditions to be met and the procedure, are identical in all five cases.

Granting of both licence types are subjected to the licensing procedure described below.

Licensing procedure

Licences are granted by the Federal Council. It makes its decision on the basis of:

- the application for a project, supported by a safety analysis report (SAR), both to be submitted by the applicant;
- a procedure of review and assessment of the application for verifying that the project satisfies the safety objectives and takes account of experience and of the state of science and technology. This procedure leads to a safety evaluation report (SER), which is established by the Inspectorate and gives the results from the points of view of nuclear safety and radiation protection, including conclusions and, if necessary, proposals for licence conditions to be formulated in the licensing decision (see Article 14);
- a statement of the advisory committee on basic aspects of the application and on the SER including, as far as appropriate, a proposal for licence conditions;
- a comprehensive public consultation.

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

In addition to the licensing procedure described above, various requirements must first be met before the Federal Council can grant a general licence. Where necessary, the Federal Council may make the licence subject to appropriate conditions or requirements, in particular to ensure that the following legal requirements are met:

- the general licence must be approved by the Federal Parliament;
- the power to be generated from the installation has to be needed in the country. When determining such a need, account should be taken of possible financial savings, substitution of fossil fuels and the development of other forms of energy;
- moreover, the general licence is granted only if safe long-term disposal (final storage) of the radioactive waste from the installation is guaranteed, including that arising from decommissioning and possible dismantling of the installation, after final shutdown.

An illustration of the licensing procedure appears in the two flow charts in Figure 2 and Figure 3.

Licence conditions are legally binding as soon as they are included in a granted licence; they constitute, therefore, a powerful tool for imposing requirements.

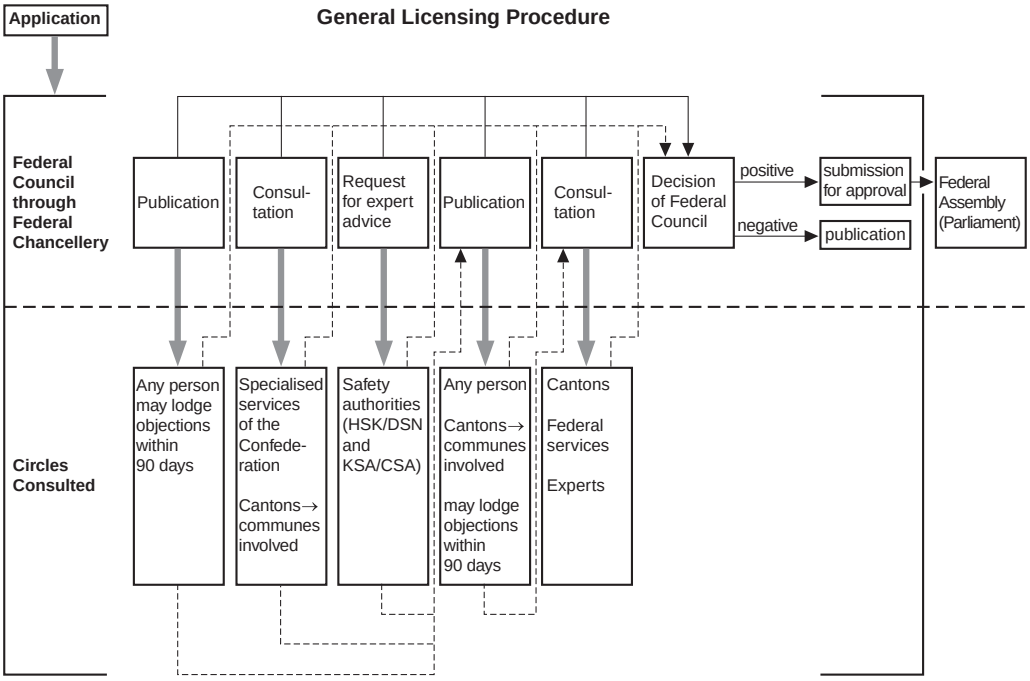


Figure 2: Licensing procedure from application for, to granting of, the general licence. The procedure follows the solid lines. The dotted lines indicate the flow of documentation.

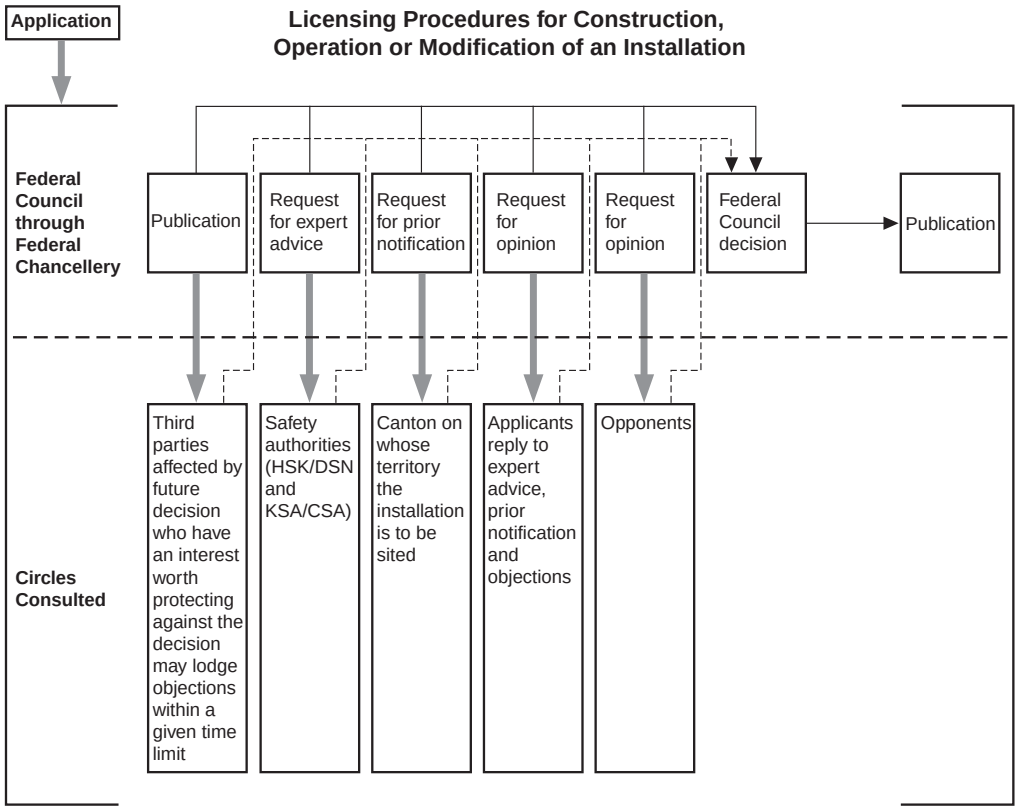


Figure 3: Licensing procedure from application for, to granting of, the licence for, respectively, construction, operation, modification or decommissioning. The procedure follows the solid lines. The dotted lines indicate the flow of documentation.

In its capacity as supervisory authority, and in order to facilitate the control of the licensing process, the Inspectorate has introduced the permit procedure which can be used within the frame of a valid licence (see flow chart in Figure 4). The Inspectorate defines sets of licensee's activities (e.g. selected parts of construction work; manufacture of important components; assembling and wiring on site; sets of commissioning tests; start up after refuelling or after modification or repair; etc.) for which a permit is necessary. 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).

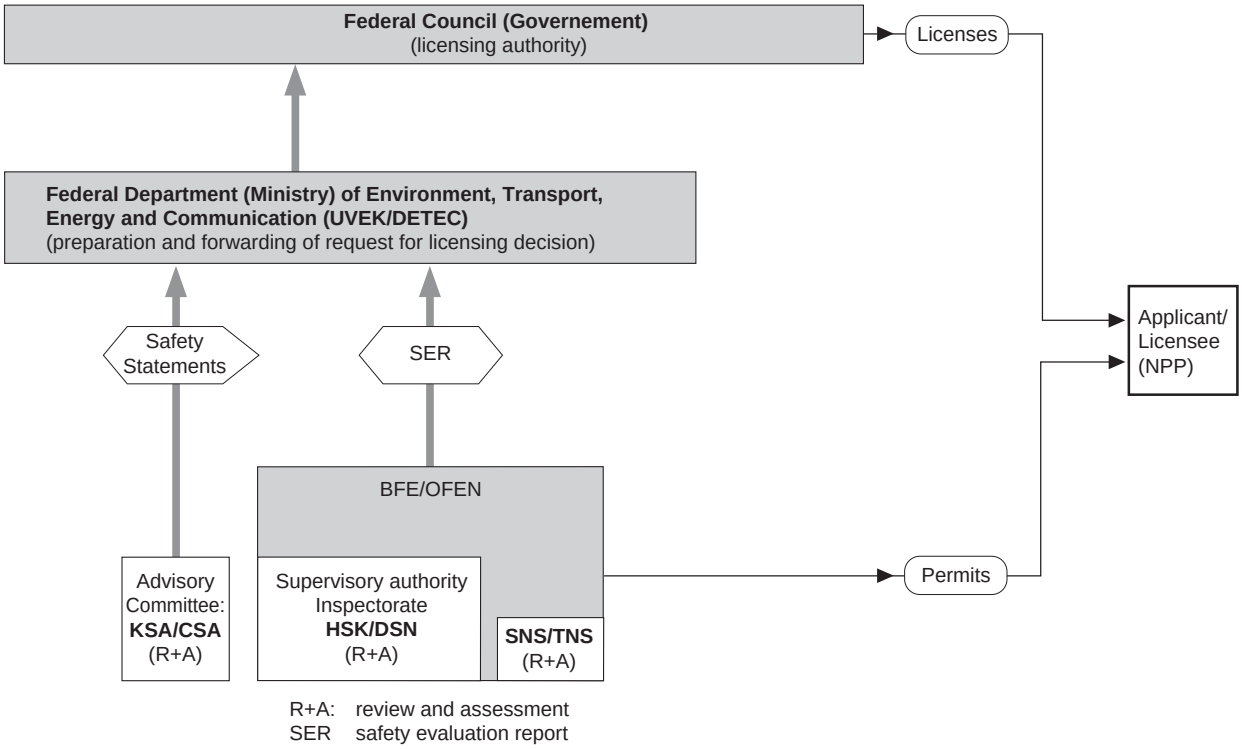


Figure 4: Licensing process: Preparation of safety evaluation reports and granting of licences and permits.

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 Swiss regulatory body is given in the Atomic Energy Act, which prescribes supervision, hence implicitly inspection, by Federal authorities. The Federal Ordinance concerning the Supervision of Nuclear Installations designates the Inspectorate as the competent authority for supervising nuclear installations, including, therefore, inspection of NPPs.

The means and authority needed by the Inspectorate for carrying out inspections are derived from the Atomic Energy Act which states the right of access. This right of access extends to every part (locations, structures, components) of the NPP and to all relevant documentation, including that also at the works and at the offices of the suppliers of equipment. This right of

access is given to all the Inspectorate's representatives (and/or external experts under contract with the Inspectorate).

The objectives of regulatory inspections are to give evidence to the Inspectorate 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, including its mandated experts, reviews the licensee's programmes, ensures for itself the licensee's adequate performance, by observing specific activities, and carries out measurements and controls of its own.

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 Federal Council and Agencies designed by it have full power of enforcement on the basis of the Atomic 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 Federal Council has to deny the granting of 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 that is already in force when these prerequisites are not anymore fulfilled.

Concerning the permits, it is the Inspectorate which can suspend or withdraw them.

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.

Organisation and competence of the regulatory body

The organisational chart (Figure 5) gives an overview of the organisation of the Swiss Regulatory Body. Beside the licensing authority, which is the Federal Council itself (see Article 7), it consists of the following elements:

- a supervisory authority,
- an advisory committee.

The supervisory authority and the advisory committee are hereafter called the nuclear safety authorities.

Other Federal authorities have duties associated with the operation of NPPs, but they have no competencies within these plants and they are not involved in the licensing process.

Supervisory authority

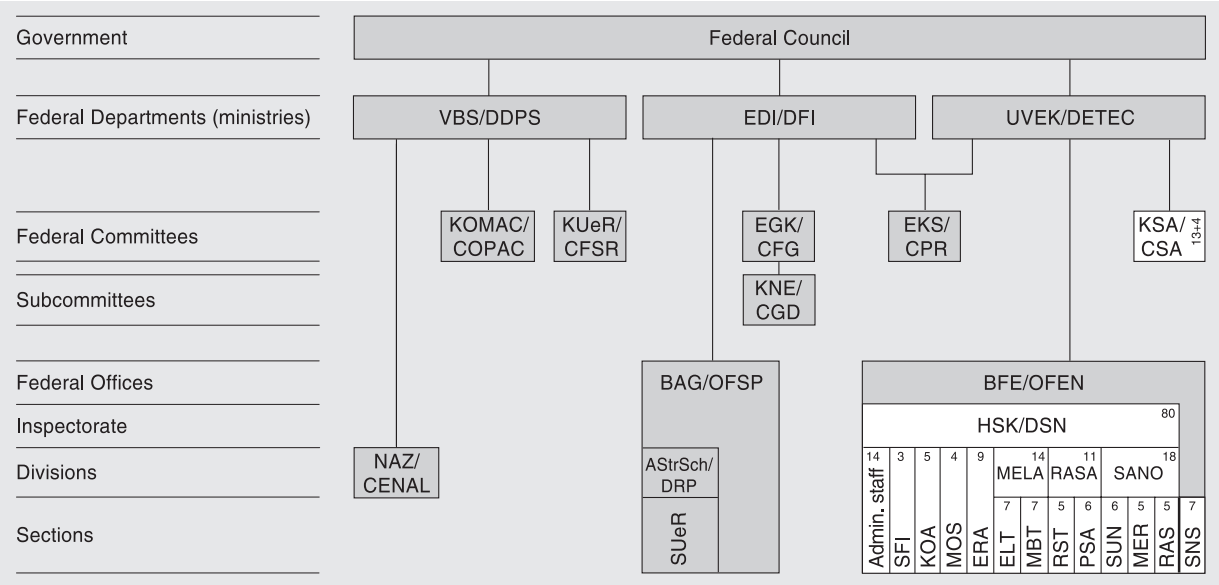
The Swiss Federal Nuclear Safety Inspectorate (HSK/DSN) is established by the Federal Ordinance concerning the Supervision of Nuclear Installations, as the competent authority for supervising nuclear installations at all stages of their life. It is part of the Federal Office of Energy (BFE/OFEN). The Section for Nuclear Technology and Security (SNS/TNS) of the same Office covers the aspects of physical protection and safeguard.

The supervisory authority has the competence to:

- establish safety criteria and requirements taking into account experience (feedback) and the state of science and technology;
- work out safety evaluation reports to support the decision of the licensing authority;
- supervise the fulfilment of regulations including inspections, reporting and request documentation on aspects of nuclear safety and radiological protection;
- grant, suspend or withdraw permits;
- order the application of all measures to protect persons and property and other important rights and to safeguard Switzerland’s national security and ensure compliance with its international commitments, within the frame of a valid licence.

Advisory committee

The Swiss Federal Nuclear Safety Commission (KSA/CSA) 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 Inspectorate and to forward its conclusions and recommendation to the Federal Council.



Abbreviations as of January 1998
(If the French abbreviation exists, it is given after the slash)

AStrSch/DRP	Radiation Protection Division, Bern
BAG/OFSP	Federal Office of Public Health, Bern
BFE/OFEN	Federal Office of Energy, Bern (formerly BEW)
EDI/DFI	Federal Department of Internal Affairs, Bern
EGK/CFG	Federal Geological Committee
EKS/CPR	Federal Committee for Radiation Protection
ELT	Section: Electrical and Control Engineering
ERA	Section: Radioactive Waste Management
HSK/DSN	Swiss Federal Nuclear Safety Inspectorate, Würenlingen
KNE/CGD	Committee for Nuclear Waste Disposal
KOA	Section: Co-ordination of Nuclear Power Plant Supervision
KOMAC/COPAC	Federal Committee for Radiological and Chemical Protection
KSA/CSA	Swiss Federal Nuclear Safety Committee
KUeR/CFSR	Swiss Federal Committee for Radioactivity Surveillance
MBT	Section: Mechanical and Civil Engineering
MELA	Division: Mechanical and Electrical Equipment
MER	Section: Radiation Measurement Technology and Radioecology
MOS	Section: Personnel, Organisation and Safety Culture
NAZ/CENAL	National Emergency Operations Centre, Zurich
SNS/TNS	Section: Nuclear Technology and Safeguards, Bern
PSA	Section: Probabilistic Safety Analysis and Accident Management
RAS	Section: Occupational Radiological Protection
RASA	Division: Reactor Design and Safety Analysis
RST	Section: Reactor and Safety Technology
SANO	Division: Radiation Protection and Emergency Preparedness
SFI	Safety Research and International Programmes
SUeR	Section: Radiation Monitoring
SUN	Section: Accident Consequences and Emergency Preparedness
UVEK/DETEC	Federal Department for Environment, Transport, Energy and Communication (formerly Federal Department for Transport, Communication and Energy EVED/DFTCE)
VBS/DDPS	Federal Department for Defence, Civil Protection and Sport (formerly Federal Military Department EMD/DMF)

Figure 5 Organisational chart of the Federal Authorities involved in supervision of, and environmental protection associated with, nuclear installations: organisation of the Regulatory Body in Switzerland.

Moreover the commission observes the operation of the nuclear installations, considering fundamental aspects of nuclear safety and proposes necessary measures. The Commission has the competence to

- comment on new or changed laws and the development of the regulation 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 the operation;
- propose research work in the field of nuclear safety.

Others

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

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

Financial and human resources

All expenses of the safety authorities (with exception of the work on the regulatory framework and the information of the public) adding up to 26.5 Mio SFr per year, are covered by fees from licence holders.

The nuclear safety research, as far as promoted and endorsed by the regulatory body, is endowed with a budget of 2.1 Mio SFr and is covered by public funds. Additional 3.5 Mio SFr are financed by the operators of NPPs and the Paul Scherrer Institute (PSI).

Supervisory authority

The Inspectorate, as part of the BFE/OFEN, is financially supported by this Office. Within this frame, the Inspectorate has its own budget covering the expenses for infrastructure, training, travel, communication and consultant fees.

According to the increased responsibilities and tasks of the Inspectorate its number of personnel has been successively increased by 55 in the last 20 years and its organisation has been adapted to new needs. This will also be the case in the future.

The personnel of the Inspectorate consists now of 66 specialists. It is supported by an administrative infrastructure support staff of 14 people. The SNS/TNS consists of 7 people. The numbers of specialists working in each field are given in Figure 5.

Use of consultants is made in special fields of the supervision of the Swiss NPPs. The complete area of the surveillance of in-service inspections of pressure bounding components, corresponding to the workload of 12 professionals, has been outsourced to the Swiss Association for Technical Inspections (SVTI/ASIT), an independent private organisation,

financed by the operators of pressure bounding components. To cover special technical areas, an additional amount of money, corresponding to 16 full time experts, financed by budget or directly by the licence holders, is spent every year.

Even by taking into account the increase of the personnel together with the use of consultants, the human resources available to the supervisory authority are still lower then the recommendation given in the IAEA "Code on the Safety of Nuclear Power Plants: Governmental Organisation".

Advisory committee

The Commission 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 for nuclear safety; they perform their function in person and do not represent organisations 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 organisation concerned with the promotion or utilisation of nuclear energy.

Swiss NPPs are operated by private companies. The public body holds, through Cantons and municipalities, a major part of the shares of these companies. That part of the Federal governmental organisation to which the regulatory body is attached does not have shares in the nuclear industry. The regulatory body is therefore effectively separated from any organisation concerned with the promotion or utilisation of nuclear energy.

Separation of the supervisory authority from other governmental bodies concerned with the use of nuclear energy

The BFE/OFEN is in charge of the execution of the energy legislation. It concerns itself with questions of energy economics and energy politics and considers aspects of supply security. In addition, the BFE/OFEN also supports nuclear energy research.

The Inspectorate is part of the BFE/OFEN, but acts at the technical level independently from the rest of the Office and from the Federal Department of Environment, Transport, Energy Communication (UVEC/DETEC). The legally required 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. An assessment of the Management Commission of the National Council in 1980 showed that there has never been a conflict of interest between the safety requirements formulated by the Inspectorate and the other duties of the BFE/OFEN and that the administrative subordination of the Inspectorate does not affect its technical independence. Although the Inspectorate acts technically independent from the rest of the Office for its functions relating to nuclear safety, this independence is not guaranteed legally.

Several parliamentary interventions postulated an administratively more independent position for the Inspectorate. As a consequence, a governmental project organisation is considering possible subordination of the Inspectorate within the frame of the formation of a National Safety Agency, covering all aspects of conventional and nuclear safety.

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

The Commission is affiliated to the UVEK/DETEC 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 Atomic Energy Act implements the principle that the safe use of nuclear energy rests with the private licence holder, but that this use has to be placed under the supervision of Federal authorities for all nuclear safety aspects. The prime responsibility for the safe operation of NPPs rests with the licence holder, even though this is not explicitly stated in the Atomic Energy Act. This statement is also included in each of the NPP's own plant regulations.

The supervisory authority has to ensure that the licence holder fulfils its legal and regulatory 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 organisations engaged in activities directly related to nuclear installations shall establish policies that give due priority to nuclear safety.

Switzerland has, from the beginning, set the safety of NPPs on top of the priorities and will continue to do so. This is explicitly expressed in the relevant legislation with the requirement to take all measures to protect persons and property and other important rights (including those relating to the environment, nature and the landscape and land use planning) and to safeguard Switzerland's national security and ensure compliance with its international commitments. By implementing the legislation, the regulatory body gives the first priority to nuclear safety.

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

From a technical point of view (design, construction), the Swiss NPPs are in line with the state of science and technology due to their original design and to backfitting. However, operation and maintenance may be influenced by economical and social changes. It is the responsibility of the authorities and the operators to ensure that economical and social changes do not lead to a reduction in safety. In all plants the personnel is very aware of the safety significance of their activities, due to their close relationship to the process and their continuous training in safety issues. For maintenance personnel and contractors, special training programmes are conducted in the different NPPs in order to increase safety awareness.

In 1992, Switzerland decided to invite Operational Safety Review Teams (OSART) to review the Swiss NPPs. Two such missions took place in 1994 and 1996 in the Leibstadt and Beznau NPPs. Both have already gone through the follow-up visit. Two other missions are planned for the years 1999 and 2000 in the Gösgen and Mühleberg NPPs. The missions carried out so far have confirmed many commendable areas of performance, especially 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. Both NPPs concerned have initiated programmes in order 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, to question their safety performance during operation.

In several cases, discussions arise between the safety authority and the NPPs about the necessity of certain regulatory requirements. In these discussions the costs for the implementation of the requirements and the low probability for an actual need for the specific installation are weighed against each other. In order to make the decision process transparent, the Inspectorate uses the following graded approach to decide on the implementation of the safety measures:

- those required by the legislation (this includes licence conditions);
- those required by the state of science and technology;

- those appearing desirable from the viewpoint of the experience and the state of science and technology and simultaneously reasonable on the basis of the cost/benefit ratio.

The Inspectorate is aware of the fact that the ongoing deregulation of the electrical energy market is putting a high economic pressure on the utilities. This may lower the priority given to nuclear safety. Discussions between the Inspectorate and the operators about this issue and the related problems have been started. The operators of NPP emphasise that the priority given to safety is not influenced by this economic pressure. The development of organisational issues and the readiness of the operators to comply with safety requirements are followed closely by the Inspectorate.

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 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 organisation facing such a licence suspension or withdrawal has obviously interest in implementing the requirements, should it intend to continue normal operation.

The decommissioning fund is established according to the Federal Order to the Atomic 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 Atomic Energy Act requires, that for the management and the control of NPPs, qualified staff with appropriate expertise has to be available in sufficient number (implicit requirement) to meet all legal regulations. 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 amount of tasks were carried out by external sub-contractors. For example a NPP of the 350 MWe 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 (HSK/DSN) has had the consequence that the number of staff increased to 290 for the Mühleberg NPP and to 460 for the twin unit NPP Beznau. The second generation plants of the 1000 MWe class started already with a higher number of personnel (325 to 350) and increased to slightly higher numbers (375 to 400) in 1997. These numbers are still below the international average, even considering that the working time in Swiss industry is in the order of 42 hours per week.

The fluctuation of NPP personnel is low. This ensures that the necessary knowledge and experience to operate the NPPs is maintained.

Education and training

The professional training and education in the field of engineering and science which is available in Switzerland has attained a high level of quality and it is available for those who are interested. Therefore, there is a good basis for the recruitment of adequately qualified personnel.

The following HSK Guidelines are mandatory concerning education and training of NPP personnel:

- R-17: Organisation and personnel 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.

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 of courses and "on the job" training.

The selection of personnel to be later authorised for key functions in NPPs as field operators, control room operators, shift supervisors, stand-by safety engineers or radiation protection experts requires that they have successfully completed a technical professional training of three to four years and a minimum of two years experience in their profession (the latter not for radiation protection experts). For future safety engineers, an additional engineering degree is required. The selection procedure for all licenced control room personnel includes aptitude tests.

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

- **Field operators**: Employees who intend to become licenced control room personnel start as field operators. There is no mandatory licensing at this level. However, an examination is common. Courses and "on the job" training lead to a 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 person 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 an equivalent institution is required. Following this basic education, a set of courses at each 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 also 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 degree can apply as stand-by safety engineers. Leadership under adverse conditions, as well as extended and detailed knowledge of emergency procedures, are especially 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 also the Inspectorate.
- **Radiation protection experts:** Radiation protection controllers and chief controllers 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 (e.g. the postgraduate radiological protection course, National Radiation Protection Board (NRPB), Harwell, UK).

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 and Mühleberg NPPs. At the Gösgen NPP, a plant specific full scope simulator, which will replace the present training at the German simulator centre in Essen, is under construction. At 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).

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 1980's the Inspectorate (HSK/DSN) has set up the Section on Personnel, Organisation and Safety Culture in which three human factor specialists and a psychologist deal with the man-machine interface (MMI), ergonomy, organisational aspects and human factors in the safety of a NPP.

Man-machine interface and ergonomy

MMI issues, especially in the control room, have been considered very early on in Switzerland since human factors play an important role concerning the safe operation of a NPP. Although the four Swiss NPPs are of different design, the basic ergonomical principles used in the design of the control rooms are 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 an immediate surveillance of the results of operator actions.

The Beznau, Leibstadt and Mühleberg NPPs have a safety parameter display system which helps the operators to get a quick overview on the status of the plant.

Nowadays, the utilities are even more aware of the importance of human factor issues. That is the reason for which three Swiss NPPs have proceeded to make major modifications to their control rooms in order to improve the illumination, ventilation, visibility and legibility of instruments, etc. They have also taken into account their own experience regarding the collaboration within the shift and this has resulted in a rearrangement of the different working places.

Beznau NPP has installed a sophisticated computerised plant information system. Based on this, it is also planned to install an advanced system called "Alarm System and Computerised Procedures in the Control Room". At the present time, the Inspectorate is assessing these systems for which it expects to grant the permit in 1999.

After each event, notified to the Inspectorate, in which human factors have played a role, the MMI and ergonomical and organisational aspects are investigated. The detection or identification of any ergonomical weaknesses through such investigations, or otherwise, leads to an assessment of similar situations in all other NPPs. Many events in the past and still some today have their root causes in an insufficient consideration of ergonomical aspects.

Organisation and safety culture

The importance of organisational and human aspects for safety in NPPs is referred to in the HSK Guideline R-17. It covers the recruitment, the qualification, the training, the requalification as well as the licensing of persons whose duties have an immediate bearing on safety. All licenced members of the operating staff have to be examined at the time of recruitment and if necessary at appropriate times thereafter to ensure that their psychological and physical

condition are compatible with the duties and responsibilities assigned to them (for training and requalification, see Article 11).

Besides these rather traditional staffing aspects, human factors also comprise organisational and individual attitudes relating to safety, which have become important issues over the last years. This approach to safety is a result of what is called "safety culture". Safety culture is a relatively new concept, which is drawing increased attention in Switzerland.

The following activities show that safety culture aspects in Switzerland have gained in importance in the nuclear industry during the last few years

Numbers of steps to systematically improve safety culture have been performed (e.g. a seminar of the Commission (KSA/CSA) on "Safety Culture in a Nuclear Installation, Reflections on its Assessment and Promotion", a workshop of the Swiss Association for Atomic Energy (SVA/ASPEA) on "Human factor in NPP organisation" and several NPP programmes, initiated following the OSART missions (see Article 10)).

The members of the Inspectorate, as well as the plant management, are increasingly aware of the significance of this broader approach to safety and are eager to apply safety culture concepts to day-to-day NPP operation. Consequently, the development and promotion of this concept continues to draw high attention.

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

The safety authorities have not issued any general regulations or guidelines on quality assurance or quality management (QM) so far. Following an Inspectorate's (HSK/DSN) requirement, the NPPs have developed, or are developing, their own 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 ISO 9000 Series and other guidelines.

The Inspectorate has required that all Swiss NPPs have a QM-system covering the transport of radioactive materials. These systems are based on the IAEA transport quality assurance requirements. They are well developed and were approved by the Inspectorate after positive results of audits. Regular follow-up audits take place at intervals of about 2-3 years.

The Inspectorate has not yet done any audit of a whole QM system at the NPPs but it looks into the plant procedures within the scope of event analysis or during the investigation of reported anomalies.

The main internal regulations and working documents related to safety at the NPPs are assessed and approved by the Inspectorate. Main activities in NPPs and their results have to be reported to, and assessed by, the Inspectorate. 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 HSK Guidelines.

Today, the Beznau, Leibstadt and Mühleberg NPPs have built up a documented QM system. In the Gösgen NPP the system is being prepared. It is expected that the system will be implemented by the year 2000.

This does not imply that there was formerly no quality assurance in these plants. Quality has a long tradition in Switzerland that is based on a good professional training and experience. Furthermore, in addition to the quality of work within the plant, quality assurance related paragraphs have been included early in the NPP internal documents that regulate general organisation, radiation protection and emergency preparedness. They provided quality assurance steps although there was no formal system in force at that time.

The following short description is a summary of the status of system implementation in Swiss NPPs:

- **Beznau NPP:** The documented QM system is in place since 1985; it is based on IAEA standards. Since then, it has been updated continuously taking into account newer developments.

- **Leibstadt NPP:** In the early 1980's, the Inspectorate has required a documented QM system for the plant. The now existing system is based on IAEA and ISO standards and has been approved by the Inspectorate in 1995.
- **Mühleberg NPP:** A QM system, based on the IAEA and ISO standards, has been developed. Existing procedures and other internal regulations are either incorporated or modified to be compatible with new system concept. The review of the system concept and the procedure manual by the Inspectorate is currently under way.
- **Gösgen NPP:** Following a request of the Inspectorate, the plant has recently started preparatory efforts for the implementation of a QM system. The system will also be based on IAEA standards.

In the framework of the above mentioned QM programmes, the NPPs have to ensure that the suppliers of safety relevant equipment have implemented an appropriate quality assurance system.

Supervisory authority

No QM system has been established so far. However, many basic requirements pertaining to quality assurance systems are covered by internal administrative regulations. Together with the HSK Guidelines and individual lists of duties for all personnel members, they form a tight network of requirements concerning the commitment to quality.

Nevertheless, a process re-engineering project was started and is to be finished in 1999. This re-engineering project is considered to be a prerequisite for the subsequent implementation of a QM system.

It should also be noted that the Swiss Association for Technical Inspections (SVTI/ASIT), as a major consultant of the Inspectorate, is ISO 9000 certified.

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;

Background

Within the frame of the licensing process, the Inspectorate (HSK/DSN) assesses in detail the application and the safety analysis report (SAR). Basis for, and objective of, this assessment is to verify compliance with the appropriate regulations and guidelines (see Article 7).

The results and insights of the review and assessment are documented in a safety evaluation report (SER) by the Inspectorate and a safety statement by the Commission together with the assessment guidelines and criteria which have been used.

The licensing decision is based on the conclusions of the safety authorities reached at the end of the detailed review and assessment of the SAR, of the probabilistic safety analysis (PSA), and of additional documents that may be requested from the applicant.

Important conditions and prerequisites for the granting of a licence are imposed as licence conditions. One condition is that the SAR has to be annually checked for conformity. A detailed revision has to be submitted to the Inspectorate periodically. Periodic safety reviews (PSR) have to be performed in periods of about ten years.

Items Reviewed

The review and assessment procedure depends on whether it is applied to new installations or to existing plants within the framework of a periodic safety review (PSR). The different items included in the review and which are assessed for new installations are:

- site characteristics (see also comments to Article 17);
- design, quality and condition of structures, systems and components relevant to safety and operational radiation protection (see also comments to Article 18);
- operation (see also comments to Article 19);
- fuel related issues;
- design basis accidents (DBA);
- beyond design basis accidents;
- organisation and personnel (see also comments to Article 12);
- emergency preparedness (see also comments to Articles 16 and 17);
- waste management and decommissioning.

For plants which are already in operation and for which a new licence is periodically required (Beznau II and Mühleberg), or in the framework of a PSR, the assessment covers the following aspects in addition to those considered for a new installation:

- operational experience (see also comments to Article 19);
- backfitting, modification and ageing.

The process of assessment of backfitting actions or modifications for which the current licence remains valid (i.e. no need for the licensing authority to issue a new licence) is controlled by the Inspectorate by means of the permit procedure. This applies to components or systems important to safety. This procedure covers all the aspects addressed above, as long as they may be affected by the modifications. The results and findings of the PSA or an assessment for a permit are documented. If necessary, the licensee has to fulfil the requirements arising from these assessments.

Insights of the review and assessment process

Some selected aspects of the processes used in Switzerland for the assessments of both new and existing installations are described in more detail in the following sections.

Safety Assessment for safety systems, safety related systems and their components:

The review process for modifications, replacements and repairs of safety relevant systems is described in various HSK Guidelines (R-18, R-23, R-35). The applicant must submit to the Inspectorate an appropriate application which encompasses all safety relevant aspects and describes the measures taken to ensure safety. The Inspectorate's review covers, in particular, the following aspects:

- quality assurance in manufacture, assembling and commissioning;
- personnel qualification (e.g. for welders);
- specifications of systems and components, system and instrumentation and control (I&C) equipment drawings, construction drawings;
- impact on safety concepts and on result of safety analyses, approval of the stress analysis;
- operating experience from own plant and from other plants;
- test programme.

The depth of the review is dependent on the safety significance of the systems or components concerned.

Review of design basis accident analysis

The review is aimed at confirming 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 HSK Guideline R-11, are not violated. This has to be proven for any postulated single failure under the most conservative assumptions.

The review of the Inspectorate 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 relevant operational and safety limits.

Review of probabilistic safety assessment

The Inspectorate's review approach is aimed at developing a thorough understanding of plant features, vulnerability to potential severe accidents, and plant specific operating characteristics. Therefore, these reviews are focused on:

- understanding the general validity of the PSA models, assumptions, analytical methods, data and numerical results;
- understanding the range of uncertainties in core damage frequencies, containment performance, and releases of radioactive effluents;
- assessment of applicability of PSA models as tools to assist plant operation and effective control.

A two step evaluation process has been developed for this review:

- **Preliminary review:** This review is aimed at performing a quick qualitative evaluation of PSA findings and major conclusions, PSA approach and analytic methods, documentation and plant design features for preventing as well as for mitigating potential severe accidents. This preliminary review should also identify areas for more focused assessment and analysis in the next review stage.
- **Detailed quantitative review:** This review aims at a detailed quantitative evaluation of the PSA models, assumptions, data, and analysis techniques and the adequacy of PSA logic model in representing the actual plant design and operational characteristics.
  As part of this review phase, a detailed reanalysis 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.

A PSA review guidance document has been prepared to support the assessment process. This document contains specific instructions for PSA review, applications, and review documentation.

Review of ageing

An ageing surveillance programme (ASP), for both first and second generation NPPs, was required by the Inspectorate in 1991. The aim of this was to ensure that safety goals would be maintained throughout the life of the NPPs. In 1992, a utilities working group was formed to set up a programme for a joint approach on ageing management. The main target of the 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 strategies for the Swiss NPPs. The ASP addresses the fields of civil engineering, electrical and mechanical components and it is concentrated on safety-classified components, systems and structures.

In particular, the ASP gives information on the relevant ageing and degradation mechanisms, materials, environmental effects and operation history etc.. As the main result, for every safety-

relevant component, it will be possible to make an assessment of the existing maintenance programme and it will also indicate possible deficiencies in it. In the latter case, a list of improvements related to operation and maintenance has to be presented to the Inspectorate. Until now, no new ageing mechanism has been identified which could seriously reduce component's safety margins in the foreseeable future.

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), a safety evaluation and the granting of a permit by the Inspectorate are necessary for each modification or backfitting to systems and components important to safety. The conditions to be satisfied for granting such a permit are the following: proof of qualification for manufacturing, assembling and commissioning, proof of safety and special start-up tests and a procedure for periodic inspections and audits. The fulfilment of these conditions is needed to ensure that each modification or backfitting action conforms to the initially approved safety requirements and that the necessary safety and operational limits are maintained.

The assurance that the physical state and the operation of the nuclear installation are safe is gained inter alia within the activities described below.

Refuelling and outage activities

At 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 modifications are undertaken by the licensee to maintain or enhance the safety of the plant. The in-service inspections, repairs and modifications to safety relevant mechanical equipment are monitored by the Inspectorate and supervised and verified by its mandated expert the Swiss Association for Technical Inspections (SVTI/ASIT). Whereas the SVTI/ASIT covers its whole area of competence by a combination of selective supervision and random checks, the Inspectorate's activities are always directed to selected themes.
- Review of mandatory periodic functional tests of systems and components, including switch-over tests of the electrical supply, are carried out by the licensee. All these tests are performed in compliance with written procedures and are documented. The Inspectorate attends selected tests and reviews the results of the whole test programme.
- Safety relevant electronic and electrotechnical equipment that are not any more satisfying today's standards and safety I&C equipment that has become obsolete with time, has to be replaced by modern and higher performance equipment. The installation and the commissioning of this new equipment takes place mostly during the shutdown period. Such replacements are carried out according to licensees' programmes previously approved by the Inspectorate which also closely follows them up.

- The fuel and core related issues are mainly evaluated with the review of the "Reload Licensing Report" to be submitted by the licensee at the end of the plant shutdown for maintenance and refuelling as a prerequisite for plant start-up. Fuel assembly handling and inspection are also reviewed.

In its permits for restarting the plant after the maintenance and refuelling shutdown, the Inspectorate comments on the outage activities, the refuelling activities, the radiological status of the plant and cycle-specific analyses. These permits also include conditions for the operation, requirements and recommendations for maintaining or improving plant safety. In addition, the Inspectorate documents its own activities during the revision, in a detailed outage report.

Inspection, reporting and information meetings

Inspection

The purpose of regulatory inspections (announced and unannounced) is to give to the Inspectorate a means to make its own independent opinion on, inter alia:

- quality measures taken during construction, plant modifications and operation;
- availability of all documentation (operating instructions, technical specifications, emergency instructions, emergency plans, etc.);
- adherence to operating instructions, technical specifications, etc.;
- careful operation and recording of safety performance;
- housekeeping practices to prevent or mitigate fire and seismic hazard consequences;
- availability and training of operating personnel;
- radiation protection;
- human factors and safety culture;
- organisational aspects relating to human factors and the man-machine interface.

For each nuclear installation, the Inspectorate designates a co-ordinator in charge of assuring a permanent contact and the exchange of information and documents between the licensee for that particular NPP and the Inspectorate as well as the adequate distribution of such information and documents within the Inspectorate. The co-ordinator is also responsible for record keeping as well as for permanently updating the list of "unresolved issues".

All Inspectorate staff members are also inspectors and have their office at the Inspectorate’s headquarters. There are no resident site inspectors and no regional offices. Each member of the Inspectorate, who is a specialist in a particular field, fulfils duties relevant to his/her field in the three areas. These are:

- review and assessment,
- inspection and enforcement,
- preparation of regulations and guides.

This depends on the actual work programme and priorities of the Inspectorate. He/she is therefore a reviewer and assessor at the Inspectorate headquarters and becomes an "inspector" on the site of a NPP, as a member and representative of the Inspectorate.

Reporting

HSK Guideline R-15 prescribes in detail which information on plant operation, including radiological aspects, have to be reported on a monthly and yearly basis. Events like equipment failures, scrams and failed mandatory tests have to be reported within mandatory given times. Plant modification for which no permit is necessary, is also contained in the reporting requirement.

Such reports may result in regulatory requirements and/or recommendations for improvement. Events reported internationally abroad and insights from safety research may also result in requirements and/or recommendations.

Information meetings

During power operation, meetings are regularly held (approximately two to three times per year per plant) to inform the Inspectorate on plant operation. At these meetings the Inspectorate explains its position on various themes of interest and current requirements, or announces forthcoming requirements. As a rule, safety relevant questions are presented to the operating organisation (plant management) before the requirements are set into force.

In addition to these regular information meetings, special discussions are held on selected current issues not yet resolved and ongoing projects. These discussions may be called at any time, according to need. The Inspectorate plant co-ordinator conducts, at least once per month, meetings and inspections (see previous paragraph) at the plant which is assigned to him. Meetings at management level are held approximately once or twice per year.

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

- R-07: Guideline for radiation protection zones in nuclear installations.
- R-11: Objectives of the protection of persons from ionising radiation in the vicinity of nuclear power plants.
- R-12: Dosimetry for occupationally radiation exposed personnel of nuclear installations.
- R-41: Calculation of environmental radiation exposures due to emissions from nuclear installations.

Dose limits

The Radiological Protection Ordinance limits the maximum individual total dose for NPP personnel (plant personnel and contractors) generally 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. A guideline value of 4 Person·Sv per year for the plant annual collective dose is given in HSK Guideline R-11. The collective dose for each NPP has to be kept below this guide value for normal operation, including refuelling and outage activities.

Since 1994 no individual dose of more than 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 Person·Sv per unit and all have kept below 3 Person·Sv per year since 1994. These facts are illustrated in Figure 6, showing annual collective doses going back to 1969.

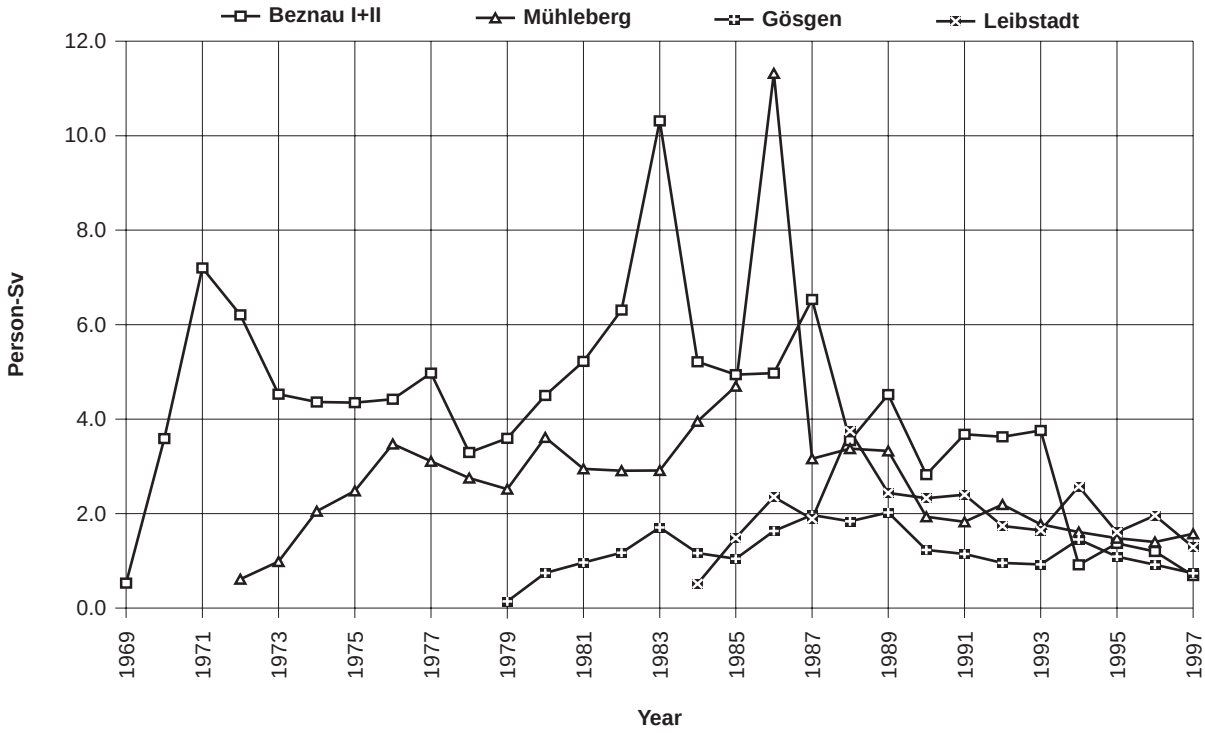


Figure 6: Annual collective doses for the Swiss NPPs. The two peaks are related to extraordinary work carried out in 1983 (Beznau NPP: Replacement of anti-vibration bars in the steam generators of one unit) and 1986 (Mühleberg NPP: Replacement of the recirculation pipes due to stress corrosion cracking).

The dose due to non-natural sources, for the general population, is limited to 1 mSv per year. The HSK Guideline R-11 defines a source-related dose guideline value of 0.3 mSv per year for each NPP. Emissions (air and water paths combined) shall not cause a corresponding dose of more than 0.2 mSv per year, leaving thus a maximum of 0.1 mSv per year due to direct radiation. The HSK Guideline R-41 defines the rules for the calculation of doses due to emissions. Based on the results, the maximum allowed emissions are defined for each plant.

Doses caused by effective emissions have always been well below the authorised maximum admissible values of 0.2 mSv per year. Since 1994, values due to annual releases are below about 0.001 mSv per year for all Swiss NPPs.

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. The fact that the goal of keeping all individual doses below 20 mSv per year has been reached in all Swiss NPPs, even before 1994, has already been mentioned in the previous Section. Figure 6 shows clearly the results of these significant efforts, made especially since 1988. The mean individual doses for plant personnel and contractors (see Figure 7) show a decreasing trend over the last years in all Swiss NPPs. The mean dose for NPP personnel is generally higher; this indicates that sensitive work, in high dose rate areas, is preferably executed using the plant internal personnel.

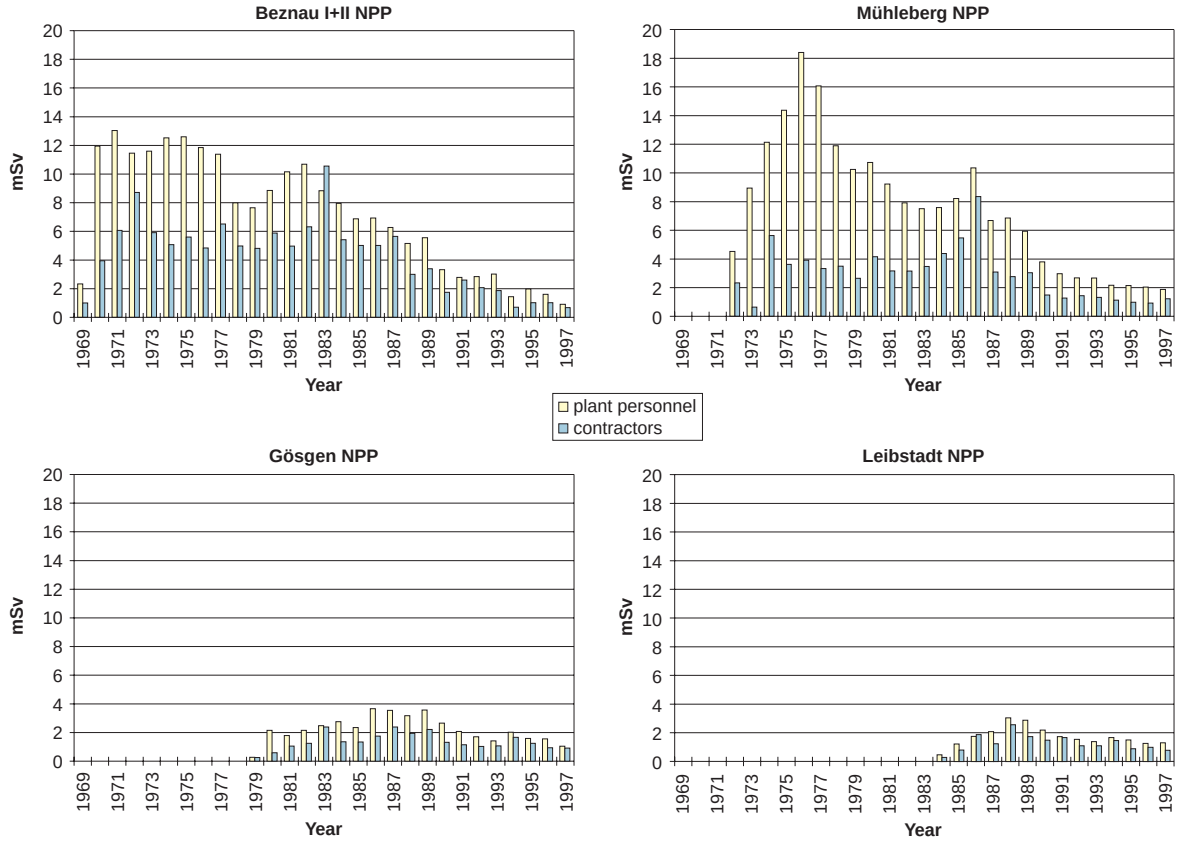


Figure 7: Mean individual dose of Swiss NPP personnel (plant personnel and contractors).

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

Table 2: Main dose reduction measures in Swiss LWRs.

Plant	Typical shutdown collective dose [Person·mSv]	Main dose reduction measures
Beznau NPP	700	Temporary lead shielding (70 tons). Low dose rate areas for personnel (< 0.005 mSv/h). Individual acoustic dose warning. Strong emphasis on training and motivation. Daily job-specific follow up of doses vs. planning. New steam generators. Remote tools for primary system inspection.
Mühleberg NPP	1100	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 total actual doses vs. planning doses. Iron feed in primary water in order to reduce crud deposition.
Gösgen NPP	900	Temporary lead shielding (20 tons). Highly compartmentalised containment with compartments made out of concrete

Plant	Typical shutdown collective dose [Person·mSv]	Main dose reduction measures
Leibstadt NPP	1200	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 recirculation loops. Zn-64-depleted zinc feed in primary water. Extensive mock-up training.

There exists a reporting requirement for jobs with an anticipated collective dose of more than 50 Person·mSv (HSK Guideline R-15). A detailed radiation protection optimisation proposal has to be presented to the Inspectorate well in advance of the start of the work. According to the Federal Ordinance on Radiological Protection, radiation protection is deemed to be optimised, provided:

- that appropriate different possible solutions have been individually assessed and compared;
- that the sequence of decisions that led to the particular solution is traceable;
- that due consideration has been given to the possible occurrence of incidents and the safe storage of radioactive sources which are not anymore in use.

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 Federal Ordinance on Radiological Protection. On this basis, the Inspectorate, in collaboration with the Federal Office of Public Health, has established the programme for the surveillance of every plant in the plant-specific rules 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 controls 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 laid down 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 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 HSK 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, as well as regular sampling and measurements of air, water, soil, plants and foodstuff.

The results of the first two stages are published in the annual report 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

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 they are centred around activities for which a collective dose of more than 50 Person·mSv can be anticipated. Other routine inspections are performed in every plant during operation in addition to specific inspections focused to special topics, like radiation instrumentation, contamination control etc.

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 (HSK/DSN), are required. The general requirements for emergency preparedness are based on the following Concept, Ordinances and HSK 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);
- Federal Ordinance on the Emergency Organisation in Case of Increased Radioactivity (1991);
- R-42: Responsibilities for decisions to implement particular measures to mitigate the consequences of a severe accident at a nuclear power plant;
- R-45: Planning and execution of emergency exercises in Swiss nuclear power plants.

On-site emergency organisation
Each NPP is therefore in possession of 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 (NAZ/CENAL).

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

Off-site emergency organisation
The off-site emergency organisation is based on the resources that have been built up within the frame of the total defence concept of Switzerland. These resources consist of a well developed shelter infrastructure and well trained troops for fire and disaster prevention. In the

case of a radiological emergency the so called Emergency Organisation in Case of Increased Radioactivity (EOR/OIR) co-ordinates use of civil and military help at the federal, cantonal and communal levels.

The legal basis for the EOR/OIR is given in the Swiss legislation on nuclear energy, radiation protection and special emergency regulations. The link to the Federal Council (government) is established by the Radiological Emergency Management Board (LAR/CODRA) consisting of the directors of all relevant federal offices. The EOR/OIR has a permanent team, the NAZ/CENAL, responsible for alerting, instructing and informing the public and for initiation of early countermeasures in case of all types of radiological accidents.

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

- The NPP staff is responsible for the recognition and assessment of the 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 the judgement on the adequacy of the on-site countermeasures implemented by the NPP staff. The Inspectorate also advises the NAZ/CENAL regarding potential off-site radiological consequences for the public.
- The NAZ/CENAL 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/CODRA is responsible for proposing appropriate measures to the government for aiding decision making and also 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.

An important responsibility is to prepare and distribute information and instructions to the public, given directly or through the media. Each of the above authorities has responsibilities for information in its own area of 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 power and the 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 injuries.

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

Protective measures to be applied during the cloud phase must be prepared in such a way that they can be prophylactically implemented 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 offers sufficient protection against radioactive cloudshine in the cloud phase of an accident and 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 and to the communities in Zone 2.
- Evacuation of parts of the population (especially in Zone 1) during the initial phase of an accident may be 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 informs the Inspectorate and the NAZ/CENAL. If the accident poses a threat to the public and the environment, a three-stage warning and alert procedure is set in motion: warning, general alert, radiation alert NPP. For efficiency, ideally 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 at latest issued when a high dose-rate is monitored inside the containment. The warning (by telephone) puts the federal, cantonal and community organisations (within Switzerland) on stand-by for a possible alert. The NAZ/CENAL also informs foreign organisations such as the IAEA and authorities in neighbouring countries.
- A **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 take countermeasures; instructions are given over the radio.
- The **radiation alert NPP** is given if a dangerously high release of radioactive materials is imminent or has already occurred. The radiation alert NPP (given by activating sirens) alerts the population and the emergency personnel to take immediate shelter in the nearest cellar or fallout-shelter.

The siren signals for general alert and radiation alert NPP, and their meanings, are described in the Swiss telephone directories.

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 organisations are aspects that are specially exercised and practised in a combined exercise every two years. In addition, each of the emergency teams, e.g. the fire brigade, has to absolve 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 have 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 1 of this Article.

Notification abroad, in the case of an emergency in Switzerland, is performed by the NAZ/CENAL, in accordance with bilateral agreements with the neighbouring countries of Germany and France as well as in accordance with the Early Notification Convention of the IAEA. The NAZ/CENAL 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 IAEA and EC is mandatory.

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. In addition to this dose rate information in accident situations, the system makes available to the Inspectorate on-line access to approximately 25 of the most important plant parameters. A computer model for a quick diagnosis and prognosis of the plant state, with the help of these parameters, is being implemented.

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 border. The objective of all these efforts is to provide adequate emergency protection on both sides of the border. A bilateral agreement on these matters exists between the Swiss and German as well as between the Swiss and the French governments.

The international emergency exercise INEX-2-CH incorporated specific Swiss and German objectives. In addition to Swiss response organisations, more than 30 countries and international organisations participated. The objectives focused on the ability of international organisations and countries to deal with the various aspects of communication, decision making and public information.

The INEX-2-CH exercise 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.

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 issuance, 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), in particular:

- geology, seismology, hydrology (including flooding) and meteorology;
- population distribution, neighbouring industrial plants and installations;
- routes and frequency of transports by air, waterways and on the ground, as well as aviation flight corridors.

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

Fixed 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 near to the 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 densely populated country. The number and size of suitable sites for NPPs is therefore limited. Although, the concept of safety by distance is not applicable in the Swiss case, the existing NPPs are in fact 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 the individuals, society and the environment, is evaluated in the SAR 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 (DBA). The dose guideline values are graduated with the frequency of incident occurrence. The methodology and boundary

conditions for dose assessment in normal operation and accident analysis are established in the HSK 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 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. They are then taken into account in the safety review procedures. Among them, those reviews relevant to site factors are the periodic safety review (PSR), the review of DBA analysis and the review of probabilistic safety analysis (PSA).

They 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 of site specific factors on the safety. Such changes may result in appropriate measures being adopted.

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) are included in the comprehensive public consultation within the frame of the licensing procedure.

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.

Agreements concerning the exchange of information have been signed with France, Germany and Italy. A similar agreement is currently in preparation with Austria.

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 used at the time of their construction. These were, and are, internationally recognised and the principle of defence in depth is present. The various levels of defence are in place to ensure that for all design basis accidents the plant remains within the safety limits and individual dose limits for the 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 limited.

Within the frame of the **licensing procedure**, the design and construction of the Swiss NPPs are thoroughly assessed. 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 HSK Guidelines:

- R-101: Design criteria for safety systems of nuclear power plants with light water reactors;
- R-102: Design criteria for the protection of safety equipment in NPPs against the consequences of airplane crash;
- R-103: Plant internal measures against severe accidents.

After the granting of a licence, the design and construction of the existing NPPs are reassessed periodically. Deficiencies in the NPP, when compared to the current state of science and technology, have to be assessed. If they affect the safety, they have to be eliminated by means of appropriate backfitting.

The **first generation** of Swiss NPPs (Beznau I+II, Mühleberg) were constructed using designs from the late 1960's, before the establishment of the "General Design Criteria" (GDC), in 1972, from 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 since these NPPs also included several unique features in their designs, which were not standard at the time of construction:

- two turbines per plant;
- 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;
- pump back system from secondary to primary containment (Beznau);

- ground water as emergency feedwater system (Beznau);
- pressure retaining secondary containment with automatic pressure relief in an additional circumferential water pool (Mühleberg);
- containment size doubled in relation to reactor power (Mühleberg);
- hilltop reservoir to flood the core (Mühleberg).

However, two important deficiencies were identified. These deficiencies were:

- the insufficient protection from external events, especially earthquakes;
- the lack of separation of safety-relevant systems.

Therefore, in all first generation NPPs, a comprehensive analysis and backfitting programme has been carried out and certain improvements realised. The backfitting project was performed mainly by adding one or two completely separated shutdown and residual heat removal systems, including their support systems and protection against external events (see Article 6).

The **second generation** plants were based on US-American and German design criteria which included protection from external events. The US-American design of Leibstadt NPP had to be adjusted to satisfy specific Swiss requirements, according to the HSK Guidelines R-101 with regard to external events. To fulfil these additional requirements, a special emergency heat removal system was backfitted. The German design of the Gösgen NPP already fulfilled these requirements. In addition, in Leibstadt a steel construction was installed at the interface between the nuclear island and the turbine island which protected the nuclear island from the effects of multiple pipe breaks in the lower seismically qualified turbine island.

To mitigate the radiological consequences to the environment, in the case of a severe accident, a filtered containment venting system has been backfitted in the early 1990's in all Swiss NPPs.

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 subjected to rigorous control and scrutiny and regular testing to verify their fitness for service. The legal requirement that the Swiss NPPs have to be at the 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 ASME-Code for the design of the primary circuit, the containment, and the safety systems. Concerning the Gösgen NPP (German design), compliance with the ASME-Code was also required by the Inspectorate (HSK/DSN).

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 increased safety factors had to be developed and incorporated into the design.

The various components, systems and structures 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 are described in the following, as well as the steps taken by the Swiss NPPs to control, eliminate or mitigate the problems:

- In the late 1960's, the nickel-base material Alloy 600 was used extensively in primary circuits of NPPs since its manufacturing characteristics, corrosion and mechanical properties appeared favourable for the service requirements and conditions existing. However, despite earlier experience, it suffered stress corrosion cracking in LWR coolant. In Switzerland, the steam generator tubing of the NPP Beznau (Units I and II) have undergone stress corrosion cracking after only a few years in service. After years of sleeving and plugging the problem was solved by replacing the steam generators (Beznau I: in 1993 and Beznau II: planned in 1999). The new steam generators contain a material more resistant to stress corrosion cracking.
- The recirculation piping in the Mühleberg BWR NPP was made from stainless steel, corresponding to the normal practices and standards for this component-type. However, after 14 years in service, and in common with some other BWRs of similar design and construction methods, some areas of the welds underwent stress corrosion cracking. The problem has been addressed by replacing the recirculation piping with improved material.
- In 1990, after 18 years of operation, the NPP Mühleberg was, world-wide, the first BWR 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 environment and fabrication methods used lead to the long-term initiation and growth of cracks. The design did not allow for a simple replacement. As a precautionary measure, tie rods, however, have been put into place. World-wide, some 30 BWRs are affected by core shroud cracking.

Strategies for managing ageing-related problems, as an integrated part of a comprehensive ageing surveillance programme (ASP) are given 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 American or German designs and correspond therefore to the requirements of these countries concerning the reliable, stable and easily manageable operation, with specific consideration of human factors and the man-machine interface (MMI).

However, in the case of control rooms, which are the most important MMI, 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, like 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.

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 NPPs have 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 is comprised of:

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

Wherever appropriate the latter two reports propose the wording of directives to be combined with the requested licence for operation. For further information see Article 7.

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 has the implicit meaning 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 and on the results of the maintenance and refuelling activities during the shutdown period.

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 simultaneously considered in the following text.

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 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 the plant specific surveillance requirements as well. Concerning the structure of the Tech Specs, the licensees follow the formal set up by the reactor supplier. The LCO constitute boundary conditions for the procedures and instructions for normal operation.

For setting 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 performed regularly by the licensee, and the modified wording needs 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. The operation of the five units normally complies with the Tech Spec limitations and the other mandatory regulations. This is shown by the fact that since 1992 (since the INES classification is operational in Switzerland) only 4 INES-1 events occurred in Swiss NPPs and the annual number of reportable events according to HSK Guideline R-15 is low (see Figure 8).

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 passive systems, periodical examinations of electronic, electrotechnical and mechanical equipment, periodic functional testing of systems and components as well as an ageing surveillance programme. Recently a non-destructive testing qualification pilot programme was started in one Swiss NPP.

The regulatory surveillance of plant operation relies on the information obtained from the operating organisations by means of a reporting system and on the information collected within the frame of the Inspectorate's inspection activities and on its own measurements. In accordance with the reporting system, the operating organisations report periodically (monthly, annually, after refuelling outage) on the operational performance and on activities related to safety, among which modifications to plant equipment, procedures and organisation and doses to the personnel and the public are the most important. Specific attention is given on event reporting and investigation. Lessons learned and feedback from events are an essential contribution to operational experience. Safety relevant plant modifications require a permit by the Inspectorate.

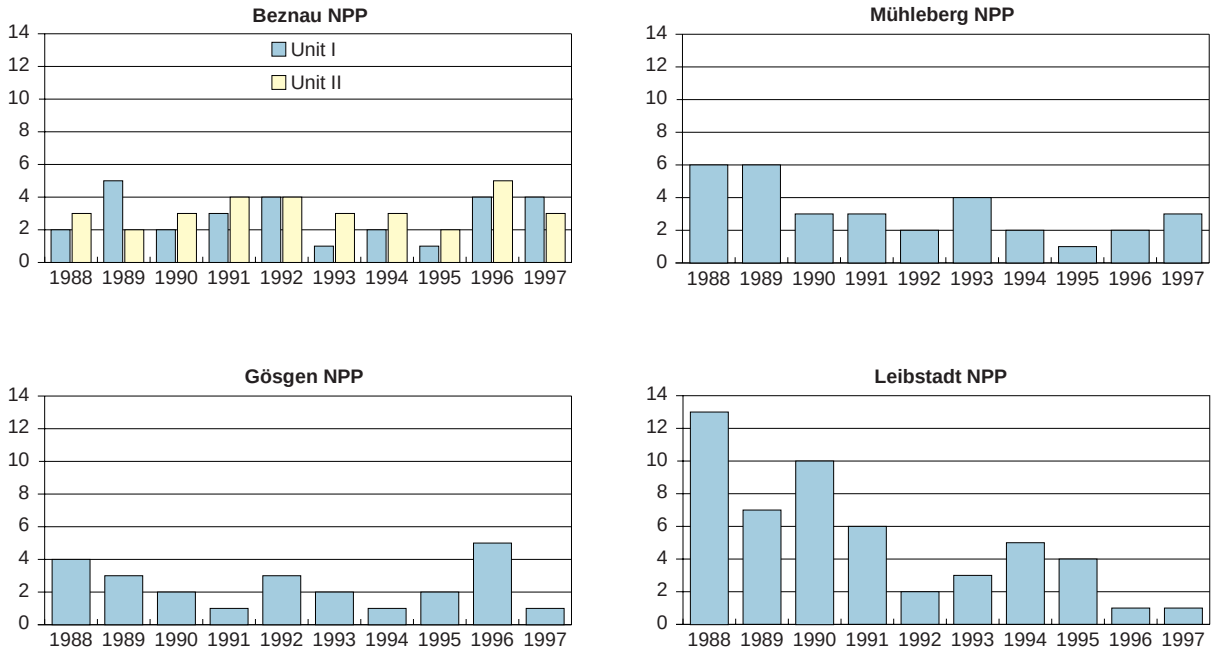


Figure 8:Annual number of reportable events in Swiss NPPs.

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. These procedures are required by the Inspectorate. Furthermore the need to extend the emergency operating procedures into the area of severe accident management guidelines is currently under review.

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 necessary on-site criteria for declaring an emergency and for alerting and alarming are contained in the NPP emergency procedures. Further information on alerting and alarm procedures is given in Article 16.

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 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 have 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. The tendency up to now was to increase the on-site capacity.

A problem to ensure technical support may arise in Switzerland in the future, if the tendency of diminishing nuclear know-how and capacity continues and research activities are further reduced at research institutes and universities. The Inspectorate is aware of this problem and follows the activities on this issue on international basis.

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

The mandatory procedure Guideline HSK-R-15 on reporting is the tool of the Inspectorate used to enforce the timely and comprehensive reporting of all abnormal events. Since several years, it has been the Inspectorate's practice to summarise these events in its the annual report.

The Inspectorate has established a special working group which discusses every abnormal event in detail. Experience gained by this working group is that the investigation of almost every anomaly requires expertise in nuclear, mechanical, electrical and system engineering, as well as in human factors and radiation protection. With the increasing maturity and reliability of technical equipment, the occurrences linked with human factors are becoming relatively more important.

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

The four managers of the Swiss NPPs have initiated and are monitoring the exchange of operating experience. In support to the managers, several working groups deal with issues such as licenced personnel, nuclear safety performance, surveillance of ageing, radiological and chemical plant performance, fire brigades and industrial safety etc.

A nuclear plant safety review committee or dedicated working groups at each site are in charge of the assessment of consequences of safety relevant events, plant modifications, special testing and for issues concerning quality management.

Every NPP is a member of a working group (or owners group) of the reactor supplier. In these working groups, even minor problems are discussed. In the case of a reportable event, it is necessary that the reactor supplier and its contractors are quickly informed and solutions are prepared, should the same problem occur in other plants. Examples are the cracking of the

core shroud of BWRs, the break of PWR reactor coolant pump shaft, the failure and incorrect testing of a PWR reactor trip breaker and coolant temperature stratification in a BWR feedwater line.

For more exchange of operational experience, the licensees are also members of the World Association of Nuclear Operators (WANO). The operational experience feedback of WANO and of the reactor suppliers are screened and given to the appropriate technical departments for analysis, determination of corrective actions as well as for use for maintenance activities and further improvement of operational performance in general. In addition, the licensees use the WANO performance indicators. For root cause analysis of event investigation, each licensee makes use of an appropriate method; the methods are different from NPP to NPP.

Switzerland had already two reviews by Operational Safety Review Teams (OSART) (see Article 10) and contributes to the IRS, according to the IAEA reporting rules, by submitting, for information, reports on relevant events that have occurred in Swiss NPPs.

The Inspectorate delegates members of its staff to the OECD/NEA/CSNI Principal Working Group 1 on Operational Experience and Human Factors as well as to the subgroup "Extended Task Force on Human Factors". The Inspectorate also participates in the regular IAEA meetings which co-ordinate the activities about the IRS.

IRS events from abroad are systematically followed by the Inspectorate staff and evaluated in terms of relevance for Swiss NPPs. Information on incidents that may be of some interest to the Swiss nuclear industry is circulated for comments and, if appropriate, for further consideration and possibly proposals for preventing similar incidents in the Swiss NPPs.

Switzerland applies the INES for the publication of information on abnormal occurrences and follows the reporting rules established by the IAEA. The Inspectorate takes part in the regular IAEA meetings on the INES system.

The following shows two examples of feedback of operational experience from outside of Switzerland. Based on the Generic Letter 89-10 of 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 NPP.

After the incident in Barsebäck 2 (Sweden) on July 28, 1992, which basically was the clogging of the suction line strainers in the suppression pools, the Inspectorate started an action programme consisting of short term actions and measures for final resolution of the problem for all NPPs. Short term actions included inspections and detailed review of thermal insulation types employed, clogging analysis of the strainers and the preparation of accident management measures for BWR-plants. The final solution of the problem consisted in the replacement of all emergency core cooling system suction strainers in the BWRs (Mühleberg and Leibstadt) during their shutdown periods in 1993, by new ones with a considerably enlarged strainer area. For the PWRs, retrofitting actions were found to be not necessary.

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 Order to the Atomic Energy Act implements the principle that the producer 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 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 legislation does neither prescribe nor interdict reprocessing of the spent fuel. The operators of the NPPs have contracts with foreign companies for reprocessing a major part of the total amount of spent fuel expected to arise. The rest of the spent fuel will be stored at a centralised interim storage facility which is presently under construction until a decision on further steps (later reprocessing or direct disposal) is taken.

The generation of radioactive waste at NPPs is kept at a low level. This is made possible by virtue of fuel quality and cleanliness. The waste arising is collected and segregated. As a general rule, radioactive waste is conditioned as soon as practicable, partly on site, partly externally. Temporary storage of waste takes place on site under appropriate and adequate conditions. Waste with such low activity levels that the radiation protection legislation does not apply, is cleared from regulatory control under the supervision of the Inspectorate.

Conclusion

The Swiss Party complies with the obligations of Article 19.

Outlook

The ongoing Swiss activities are dedicated to further enhance nuclear safety. Another aspect worth mentioning is the total commitment to the world-wide surveillance of new developments in nuclear power safety technology and, where appropriate, to legally enforce the implementation of such improvements, where applicable, on the Swiss NPPs. The continued participation of the Inspectorate and the operators in international co-operation projects and schemes such as in the various IAEA and OECD-NEA activities and in the international reporting system and adherence with the nuclear events levels scheme in the international nuclear event scale are additional points. All such co-operative activities indicate the wish to further enhance the level of safety in Swiss NPPs.

The Inspectorate’s support of both domestic and international nuclear safety research activities marks the commitment to be informed about all aspects concerned with nuclear safety in view of the legal requirement that at any time, the Swiss NPPs correspond to the state of science and technology.

Appendices

- Appendix 1: List of abbreviations used in the present report
- Appendix 2: List of the Inspectorate’s (HSK/DSN) Guidelines presently in force
- Appendix 3: List of annexes

Appendix 1: List of abbreviations used in the present report

ASME	American Society of Mechanical Engineers
ASP	Ageing surveillance programme
BAG/OFSP	Federal Office of Public Health
BFE/OFEN	Federal Office of Energy
BWR	Boiling water reactor
CFS	French-Swiss Nuclear Safety Commission
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
EOR/OIR	Emergency Organisation Radioactivity
EPFL	Swiss Federal Institute of Technology Lausanne
GDC	General Design Criteria
GSKL	Swiss Society of NPP Managers
HSK/DSN	Swiss Federal Nuclear Safety Inspectorate
R-xy	Reference number of guidelines prepared and established by the HSK/DSN
I&C	Instrumentation and control
IAEA	International Atomic Energy Agency
ICRP	International Commission on Radiological Protection
INES	International nuclear event scale (NEA and IAEA)
INEX	International emergency exercise
IRS	Incident reporting system (NEA and IAEA)
ISO	International Standards Organisation
KSA/CSA	Swiss Federal Nuclear Safety Commission
LAR/CODRA	Radiological Emergency Management Board
LCO	Limiting conditions of operation
LWR	Light water reactor
MADUK/ANPA	Automatic dose rate monitoring and emergency response data system
MMI	Man-machine interface
NAZ/CENAL	National Emergency Operation Centre
NEA	Nuclear Energy Agency of the OECD
NPP	Nuclear power plant
NRPB	National Radiological Protection Board, Harwell (UK)
OECD	Organisation of Economic Co-operation and Development
OSART	Operational Safety Review Teams (IAEA)
PSA	Probabilistic safety analysis
PSI	Paul Scherrer Institute
PSR	Periodic safety review
PWR	Pressurised water reactor
QM	Quality management

RHR	Residual heat removal
SAR	Safety analysis report
SER	Safety evaluation report
SIA	Swiss Society of Engineers and Architects
SNS/TNS	Section for Nuclear Technology and Security
SVA/ASPEA	Swiss Association for Atomic Energy
SVTI/ASIT	Swiss Association for Technical Inspections
Tech Specs	Plant technical specifications
US-NRC	United States Nuclear Regulatory Commission
Uni BS	University of Basel
UVEC/DETEC	Federal Department of Environment, Transport, Energy and Communication
VBS/DPS	Federal Department of Defence, Civil Protection and Sports
WANO	World Association of Nuclear Operators

Appendix 2: List of the Inspectorate's (HSK/DSN) Guidelines presently in force

Status: as of end 1997
Languages: All guidelines originally written in German; guidelines noted /E, /F or /R translated into and available in English, French or Russian. For guidelines denoted with " * ", only the title has been translated into English.

Guideline	Title of Guideline	Date of current issue
R-04*	Supervisory procedures governing the construction of nuclear power plants: Design of buildings (Aufsichtsverfahren beim Bau von Kernkraftwerken: Projektierung von Bauwerken)	December 1990
R-05*	Supervisory procedures governing the construction of nuclear power plants: Mechanical equipment (Aufsichtsverfahren beim Bau von Kernkraftwerken: mechanische Ausrüstungen)	October 1990
R-06*	Safety classification 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*	Guideline for radiation protection zones in nuclear installations (Richtlinie für den überwachten Bereich der Kernanlagen und des Paul Scherrer Institutes)	June 1995
R-08*	Safety of buildings for nuclear installations: Federal supervisory procedures for the construction (Sicherheit der Bauwerke für Kernanlagen, Prüfverfahren des Bundes für die Bauausführung)	May 1976
R-11*	Objectives of the protection of persons from ionising radiation in the vicinity of nuclear power plants (Ziele für den Schutz von Personen vor ionisierender Strahlung im Bereich von Kernkraftwerken)	May 1980
R-12*	Dosimetry for occupationally radiation exposed personnel of nuclear installations (Erfassung der Dosen des beruflich strahlenexponierten Personals von Kernanlagen)	December 1979
R-14/E R-14/R	Conditioning and interim storage of radioactive wastes (Konditionierung und Zwischenlagerung radioaktiver Abfälle)	December 1988
R-15*	Reporting guideline concerning the operation of nuclear power plants (Berichterstattung über den Betrieb von Kernkraftwerken)	August 1996
R-16*	Seismic plant instrumentation (Seismische Anlageninstrumentierung)	February 1980
R-17*	Organisation and personnel of nuclear power plants (Organisation und Personal von Kernkraftwerken)	August 1986

Guideline	Title of Guideline	Date of current issue
R-21/E R-21/F	Protection objectives for the disposal of radioactive waste (Schutzziele für die Endlagerung radioaktiver Abfälle)	November 1993
R-23*	Revisions, testing, replacement, repair and modification of electrical equipment in nuclear installations (Revisionen, Prüfungen, Ersatz, Reparaturen und Änderungen an elektrischen Ausrüstungen in Kernanlagen)	December 1993
R-25*	Reporting Guideline concerning the nuclear installations of the Swiss Confederation, of the Cantons, of PSI and the decommissioned Lucens experimental nuclear power plant (Berichterstattung der Kernanlagen des Bundes, der Kantone, des PSI sowie des stillgelegten Versuchsatomkraftwerks Lucens)	May 1990
R-27*	Selection, training and examination of NPP staff requiring a licence (Auswahl, Ausbildung und Prüfung des lizenzpflichtigen Betriebspersonals von Kernkraftwerken)	May 1992
R-30*	Supervisory procedures for construction and operation of nuclear installations (Aufsichtsverfahren beim Bau und Betrieb von Kernanlagen)	July 1992
R-31*	Supervisory procedures governing the construction of nuclear power plants: E1 classified electrical equipment (Aufsichtsverfahren beim Bau von Kernkraftwerken, E1 klassierte elektrische Ausrüstungen)	January 1994
R-32*	Guideline for meteorological measurement on sites of nuclear installations (Richtlinie für die meteorologischen Messungen an Standorten von Kernanlagen)	September 1993
R-35*	Supervisory procedures governing the construction of nuclear power plants: System engineering (Aufsichtsverfahren beim Bau und Änderungen von Kernkraftwerken, Systemtechnik)	May 1996
R-37*	Recognition of courses for radiation protection controllers and chief controllers; examination regulations (Anerkennung von Kursen für Strahlenschutz- Kontrolleure und -Chefkontrolleure; Prüfungsordnung)	May 1990
R-38*	Interpretation of the term "derived guideline value for surface contamination" (Interpretation des Begriffs "abgeleiteter Richtwert für Oberflächenkontamination")	July 1987

Guideline	Title of Guideline	Date of current issue
R-39*	Registration of radiation sources and material testers on a nuclear installation site (Erfassung der Strahlenquellen und Werkstoffprüfer im Kernanlagenareal)	January 1990
R-40*	Filtered containment venting for light water reactors: design requirements (Gefilterte Druckentlastung für den Sicherheitsbehälter von Leichtwasserreaktoren, Anforderungen für die Auslegung)	March 1993
R-41*	Calculation of environmental radiation exposures due to emissions from nuclear installations (Berechnung der Strahlenexposition in der Umgebung aufgrund von Emissionen radioaktiver Stoffe aus Kernanlagen)	July 1997
R-42/E	Responsibilities for decisions to implement particular measures to mitigate the consequences of a severe accident at a nuclear installation (Zuständigkeiten für die Entscheide über besondere Massnahmen bei einem schweren Unfall in einer Kernanlage; Februar 1993)	March 1993
R-45*	Planning and execution of emergency exercises in Swiss nuclear power plants (Planung und Durchführung von Notfallübungen in den schweizerischen Kernkraftwerken)	July 1997
R-100*	Nuclear power plant conditions (Anlagezustände eines Kernkraftwerks)	June 1987
R-101/E	Design criteria for safety systems of nuclear power plants with light water reactors (Auslegungskriterien für Sicherheitssysteme von Kernkraftwerken mit Leichtwasser-Reaktoren)	May 1987
R-102/E	Design criteria for the protection of safety equipment in NPPs against the consequences of airplane crash (Auslegungskriterien für den Schutz von sicherheitsrelevanten Ausrüstungen in Kernkraftwerken gegen die Folgen von Flugzeugabsturz; October 1986)	December 1986
R-103*	Plant internal measures against severe accidents (Anlageinterne Massnahmen gegen schwere Unfälle)	November 1989

Appendix 3: List of annexes

Inspectorate’s (HSK/DSN) annual report for 1996.

Inspectorate’s (HSK/DSN) annual report for 1997.

Inspectorate’s (HSK/DSN) descriptive booklet.