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THE CONTROL OF SAFETY OF RADIOACTIVE WASTE MANAGEMENT AND DECOMMISSIONING IN SWITZERLAND

1. NATIONAL FRAMEWORK FOR MANAGEMENT AND REGULATION OF RADIOACTIVE WASTE AND DECOMMISSIONING

1.1 National framework

1.1.1 Overview of national policy

Nuclear fuel cycle

The back-end of the nuclear fuel cycle is not prescribed by the Swiss legislation. The strategy which has been chosen by the nuclear power plant operators includes both reprocessing and storage of spent fuel in view of later reprocessing or disposal. The reprocessing takes place abroad, but the radioactive waste arising from it will return to Switzerland. Plutonium and uranium gained from reprocessing is used for fuel fabrication and recycled in Swiss nuclear power plants. Spent fuel is currently stored at the Central Storage Facility; additional storage capacity for spent fuel is under construction at two nuclear power plants.

Switzerland has ratified the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management.

Radioactive waste management

The responsibility for radioactive waste management lies with the waste producers. The legislation requires in principle disposal of Swiss radioactive waste in Switzerland. The option for the disposal of radioactive waste within the framework of a bilateral or multilateral project is kept open.

All radioactive waste is to undergo final disposal in repositories situated in suitable geological formations; near-surface disposal is not allowed. Two repositories are foreseen, one for mostly short-lived low and intermediate level waste and the other for high level waste and spent fuel as well as long-lived intermediate level waste mainly from reprocessing. Prior to the realisation of the repositories, the feasibility of safe and permanent disposal has to be demonstrated.

Since there is currently no repository available, all radioactive waste is stored in adequate storage facilities. Each nuclear power plant has the interim storage capacity for its own operational

waste. The radioactive waste from medicine, industry and research is stored at the Federal Storage Facility. Radioactive waste returning from reprocessing abroad is stored at the Central Storage Facility.

Decommissioning

Decommissioning of a nuclear facility is required when the facility is definitively taken out of operation. The preferred option today is immediate dismantling, but deferred dismantling is allowed, if justified. No nuclear power plants are intended to be decommissioned in the near future.

1.1.2 Overview of relevant institutions

Implementing bodies

The Federal State takes over the responsibility for the management of the radioactive waste generated by the use of radioisotopes in medicine, industry and research. The producers of radioactive waste, i.e., the operators of nuclear power plants and the Federal State (for the waste from medicine, industry and research) formed the National Co-operative for the Disposal of Radioactive Waste (Nagra) which is responsible for the disposal of all kinds of radioactive waste.

The company ZWILAG (Zwischenlager Würenlingen AG) is responsible for the Central Storage Facility in Würenlingen. The responsibility for spent fuel reprocessing abroad and for conditioning and interim storage of radioactive waste at the nuclear power plants remains with the operators which are also responsible for the decommissioning of their nuclear facilities.

Regulatory bodies

The licensing stages for nuclear facilities include general licence, construction licence, operation licence and decommissioning or closure order.

The general licence, which is initially needed for each nuclear facility, is granted by the Federal Council (federal government). The general licence has to be approved by the Parliament and is subject to a facultative referendum at national level. The Federal Council also issues the closure order for disposal facilities.

The licensing authority for the subsequent licences for nuclear facilities (construction and operation) is the Federal Department for Environment, Transportation, Energy and Communication (UVEK). UVEK also issues the decommissioning order.

The Department UVEK is supported in its decisions by the Federal Office of Energy (BFE) which manages the licensing procedures. BFE also issues the licences for transport, trade, import and export of nuclear fuel and radioactive waste.

The Swiss Federal Nuclear Safety Inspectorate (HSK) is part of the Federal Office of Energy. It is the competent authority for supervising the nuclear facilities. HSK also has the tasks to specify the detailed safety requirements and to review license applications.

The regulatory organisation is complemented by several advisory bodies. The Swiss Federal Nuclear Safety Commission (KSA) comments on licence applications and on fundamental nuclear safety and radiation protection issues. The Geological Commission on Nuclear Waste Management (KNE) is the advisory body on geological aspects of radioactive waste disposal. The Interdepartmental

Working Group on Radioactive Waste Management (AGNEB) prepares technical and political documents for governmental decisions.

1.2 National, technical regulatory organisation

1.2.1 Regulatory function

The Swiss Federal Nuclear Safety Inspectorate (HSK) is the government's supervisory authority for nuclear safety and radiation protection in the field of nuclear energy, including radioactive waste management. According to the institutional framework described in 1.1.2 above, HSK is not the licensing authority, but has the mission to supervise and judge the Swiss nuclear facilities right through from the planning stage, to construction, operation, and decommissioning or closure. HSK also supervises the transport of radioactive material to and from nuclear facilities and the geological investigations in view of radioactive waste disposal.

HSK is part of the Federal Office of Energy but acts, on the technical level, independently from the rest of the office and from the Department UVEK. HSK conducts its mission solely on the basis of safety criteria, exclusive of any political or economical considerations.

Formulation of safety requirements

HSK takes part in drawing up legislation concerning nuclear safety and radiological protection. It defines the safety requirements to be met by nuclear facilities, specifies the body of regulations (standards and rules) to be applied and issues its own guidelines. In the field of radioactive waste management, three specific guidelines are in force, R-14 on conditioning, R-29 on interim storage facilities and R-21 on the post-closure phase of a repository.

Many requirements previously set forth in HSK guidelines have been integrated into the new legislation on nuclear energy which came into force on 1 February 2005. The full set of HSK guidelines has to be adapted to the new legislation. This process will last several years.

Assessment of projects

HSK prepares the review reports at each stage of the licensing process for nuclear facilities and for geological investigations in view of radioactive waste disposal. The review reports make recommendations concerning the granting of licences and propose licence obligations.

Supervision of nuclear facilities

In its role as supervisory body, HSK verifies compliance with the legal requirements as well as with the obligations laid down by the licensing authority and issues permits for operations within the framework of the licence. For instance, each type of conditioned waste package needs an approval by HSK prior to routine production. Such an approval is issued on the basis of a detailed specification characterising the waste package and after Nagra has certified the suitability of this type of waste package for disposal in one of the repositories foreseen.

Information

HSK answers the questions posed by Parliament, political authorities and the general public relating to the safety of the nuclear facilities and to possible radiological implications for human health and the environment. HSK strives to serve as the people's expert advisor on these subjects. It has made a duty to respond to events of public concern by providing quick, complete and understandable information.

1.2.2 Organisation and resources

HSK employs currently 95 persons: physicists, mechanical, electrical and civil engineers, geologists, chemists and biologists, in addition to technical and administrative personnel. For particular tasks, HSK enlists the aid of experts from external organisations.

HSK is divided into four divisions:

- The Division for Reactor Safety with four sections:
  - Reactor, Fuel and Systems Engineering,
  - Electrical and Control Engineering,
  - Mechanical and Civil Engineering,
  - Probabilistic Safety Analysis and Accident Management.
- The Division for Radiation Protection and Emergency Preparedness with four sections:
  - Occupational Radiation Protection,
  - Radiation Measurement Technology and Radioecology,
  - Accident Consequences and Emergency Preparedness,
  - Human and Organisational factors.
- The Division for Transport and Waste Management Safety with two sections:
  - Transport and Waste Technology,
  - Geological Disposal.
- The Division for Support, Coordination and Communication with three sections:
  - Inspection Management,
  - Information, Safety Research and International Programmes,
  - Human Resources and Logistics.

HSK's transport and waste management division comprises 12 persons. It deals with matters concerning transport of radioactive materials, conditioning, storage and disposal of radioactive waste, and decommissioning of nuclear facilities. It evaluates the proposed methods for conditioning radioactive waste, issues the necessary execution permits and supervises the operation of the corresponding facilities. It has a leading function in HSK's review on the safety of facilities for storage and disposal of spent fuel and radioactive waste. It supervises the construction and operation of such facilities. It follows and appraises the geological investigations in preparation of radioactive waste disposal. In its role as the Swiss competent authority, it also issues the package and shipment approval certificates for the transport of radioactive material in Switzerland and supervises such transports to and from nuclear facilities.

HSK's annual budget is in the order of 35 million Swiss francs (i.e. about 22 million euros). Expenditure is met by the federal government. Most expenses of HSK are covered by fees which licence holders have to pay to the federal government.

In January 2004 HSK became a FLAG unit (FLAG = Management by Objectives and Global Budget) within the federal administration. HSK receives from the Federal Council a mandate with measurable performance goals which is valid for four years. Each year a detailed agreement on the annual outcome with a corresponding budget is fixed. FLAG has opened the way to greater independence and operational flexibility of HSK.

The Nuclear Energy Act requires that the supervisory body on nuclear facilities (HSK) be separated from the licensing authorities (UVEK and BFE, see 1.1.2). According to this requirement HSK, which is currently part of BFE, should become an independent organisation. The new status of HSK needs to be defined in a law which is currently under development. The new status is expected to enter into force by January 2008.

2. REGULATORY ARRANGEMENTS

2.1 Primary legislation and general regulation

The Swiss legislation concerning radioactive waste management and decommissioning currently consists of the following acts (issued by Parliament) and ordinances (issued by the Federal Council, i.e. the federal government, or Departments, i.e. ministries):

- Nuclear Liability Act, 18 March 1983.
- Radiological Protection Act, 22 March 1991.
- Nuclear Energy Act, 21 March 2003.
- Ordinance on the Decommissioning Fund, 5 December 1983.
- Radiological Protection Ordinance, 22 June 1994.
- Ordinance on the Nuclear Waste Management Fund, 6 March 2000.
- Ordinance on the Collection of Radioactive Waste, 3 September 2002.
- Nuclear Energy Ordinance, 10 December 2004.

The new legislation on nuclear energy entered into force on 1 February 2005. The main features of this legislation concerning radioactive waste management and decommissioning are as follows:

- The generation of radioactive waste must be minimized.
- Radioactive waste generated in Switzerland must in principle be disposed of domestically.
- Export or import of radioactive waste for disposal is allowed only under an international agreement.
- The producers of radioactive waste are responsible for its safe management, including permanent disposal.

- The Federal State takes over the responsibility for the collection, conditioning, storage and disposal of radioactive waste generated by the use of radioisotopes in medicine, industry and research.
- Radioactive waste shall be disposed of in geologic repositories; the eventual closure of a repository is preceded by an observation phase; retrievability must be ensured until closure of the repository.
- The feasibility of permanent and safe disposal of all radioactive waste shall be demonstrated prior to the realisation of the disposal facilities.
- The operators of nuclear power plants have to submit a disposal programme which describes the steps for the disposal of all radioactive waste and evaluates the costs; the disposal programme has to be approved by the Federal Council.
- The operators of nuclear power plants have to pay yearly contributions to the Decommissioning Fund and to the Radioactive Waste Management Fund which are administrated by an independent Commission.
- A general licence, which fixes the site and the purpose of the facility, is required prior to further licences for a nuclear facility; the general licence is granted by the Federal Council, has to be approved by Parliament and may be submitted to a national referendum.
- Licences are required for construction and operation of radioactive waste management facilities, as for other nuclear facilities; the licensing authority is the Federal Department for Environment, Transportation, Energy and Communication (UVEK).
- Basic commitments regarding the feasibility of decommissioning of a nuclear facility must be stated with the application for the general licence. The licensee has then to present a decommissioning plan with the application for the construction licence. The decommissioning plan has to be regularly updated during the operation of the facility.
- The same development as for decommissioning is required regarding the closure of a disposal facility, i.e. a basic concept at the general licence stage, a plan at the construction licence stage and updating during the operational phase.
- Decommissioning of a nuclear facility is required after final shutdown. UVEK orders the owner to carry out the decommissioning project which has to be approved by the supervisory authority.
- After the end of waste emplacement in a disposal facility, the evolution of the system has to be monitored during a prolonged observation phase. The closure of the disposal facility is then ordered by the Federal Council according to a project which has to be approved by the supervisory authority.
- Geological investigations at a potential disposal site by deep drillings and exploratory shafts or galleries require a licence issued by UVEK.
- Domestic transport, import, export and transit of nuclear fuel and radioactive waste are subject to licence issued by the Federal Office of Energy (BFE).
- Shipment of spent fuel for reprocessing abroad is not allowed for a period of 10 years starting in July 2006.

- The supervisory authority with respect to nuclear safety and radiation protection is HSK; BFE is supervisory authority for other aspects of the legislation on nuclear energy (for instance physical protection).

The licensing process for nuclear facilities is conducted by BFE and consists in general of the following main steps:

1. Submission of the application with a description of the project and a safety analysis report.

2. Review of the project by the nuclear safety authorities.

3. Consultation of federal offices and cantonal governments.

4. Deposition of the licence application documentation and of the review reports for public consultation; individuals, communities and organizations can raise objections against the project.

5. Compilation by BFE of all the material collected and preparation of the decision.

6. Decision by UVEK, generally along with a list of licence obligations. Appeals against the decision may be filed with a board of appeals.

The procedure for the selection of a site for a disposal facility prior to the application for the general licence is not prescribed by the current legislation. The Nuclear Energy Ordinance however foresees that such a site selection procedure will be defined through a Sectoral Plan within the framework of the existing legislation on land use planning. The site selection procedure is currently in development under the leadership of BFE with a broad consultation of interested organisations, the cantons and neighbouring countries. It is based primarily on technical safety criteria, but land use, environmental and socio-economic aspects are also considered. The decision of the Federal Council on the site selection procedure is expected by summer 2007.

2.2 Regulations concerning specific activities or facilities

Radioactive waste management

Specific regulations are implemented in the licences granted by the licensing authority. In the field of radioactive waste management, licences have up to now been granted for various geological investigations and for the construction and operation of conditioning and storage facilities. The licences generally contain a series of obligations which also define the steps or activities which are subject to a permit by HSK.

All the licences for geological investigations required the formation of a supervisory commission constituted with representatives of the federal, cantonal and local authorities involved at the particular site, generally also including persons from groups opposing the project.

The operation licences for conditioning and storage facilities specify in detail the limits for effluent discharges from the facility. They also set the criteria for the acceptance of waste for conditioning or storage. The licence for the Central Storage Facility specifies the reference requirements which shall be met by the transport and storage casks foreseen for spent fuel and vitrified high level waste.

Decommissioning

The former atomic legislation did not contain detailed provisions regarding the decommissioning of nuclear facilities. The licences for the decommissioning of three nuclear facilities (see section 3.1.2) were granted on a case by case basis; they fixed the decommissioning and dismantling steps and the obligations of the operators. The new legislation on nuclear energy now specifies the obligations and procedures for decommissioning in detail.

2.3 Guidance on implementation

The guidelines issued by HSK state in detail how the Swiss nuclear safety authorities intend to carry out their legal tasks. The intent is to give advice to designers, constructors and operators of nuclear facilities regarding the criteria by which the nuclear safety authorities assess formal licence applications and supervise the facilities. The guidelines are not legally binding, but the fulfilment of the requirements set forth in the guidelines is a prerequisite for a positive assessment of a project by HSK.

With the total revision of the former atomic legislation many requirements contained in existing HSK guidelines have been moved and stated in the new ordinance on nuclear energy. The full set of HSK guidelines is currently adapted to the new legislation; this process will still last several years.

Three guidelines issued by HSK concern specifically radioactive waste management: R-14 on conditioning, R-29 on interim storage facilities and R-21 on the post-closure phase of a repository. According to the new legislation, further guidelines concerning specific aspects of radioactive waste management and especially disposal will have to be developed. No guidelines are yet planned regarding decommissioning

Guideline HSK-R-14: Requirements on the Conditioning of Radioactive Waste

Conditioning represents the first step on the way to the disposal of radioactive waste. Although disposal facilities do not yet exist in Switzerland, the conditioned waste packages must be suitable for interim storage as well as for disposal.

Radioactive waste should be conditioned in such a way that the resulting waste package can be subjected as a unit to the waste management stages of transport, storage and disposal. Subsequent packaging procedures (e.g., over-packing for transport or disposal) are admissible. To achieve this objective, requirements concerning the waste form, the packaging, the waste package, the data acquisition and the quality assurance are set. The procedure for obtaining the permit for the production of waste packages is fixed. A prerequisite for granting the permit is that Nagra, the organisation responsible for disposal, certifies the suitability of the type of waste package to be disposed of in one of the repositories foreseen.

Guideline HSK-R-29: Requirements on the Interim Storage of Radioactive Waste

The interim storage system comprising the store and the waste packages must equally fulfil two goals: (1) the protection of human health and the environment against emissions from the waste packages and (2) the protection of the waste packages against harmful effects. For this purpose, the following protection objectives must be met during the expected operational life of the interim storage system:

- The individual dose to the most exposed population group from normal operation, including events with a frequency of occurrence higher than 10^{-1} per year, shall not exceed 0.1 mSv per year (dose constraint).
- The dose in case of events with a frequency of occurrence between 10^{-1} and 10^{-2} per year shall not exceed 0.1 mSv.
- The dose in case of events with a frequency of occurrence between 10^{-2} and 10^{-4} per year shall not exceed 1 mSv.
- The radiological consequences of the crash of a Swiss military aircraft with full fuel tanks involving a fuel fire shall be evaluated as a bounding assessment of the consequences of an unlikely severe accident. The resulting dose shall not exceed 100 mSv.
- The integrity of the stored waste packages must be maintained completely during normal operation and to the highest possible degree in the event of incidents.

A series of technical measures are indicated, which are regarded as acceptable means for fulfilling the protection objectives.

Guideline HSK-R-21: Protection Objectives for the Disposal of Radioactive Waste

The guideline R-21 relates to the long-term safety in the post-closure phase of a repository. It applies to all methods of geological disposal and to all categories of radioactive waste.

The overall objective of radioactive waste disposal and the principles to be observed which are stated in the guideline R-21 are derived from the internationally agreed IAEA Safety Fundamentals for radioactive waste management (SS 111-F, 1995). As a concretisation of the overall objective and the associated principles, the safety requirements are expressed in the form of three protection objectives:

- PO 1: The release of radionuclides from a sealed repository subsequent upon processes and events reasonably expectable to happen, shall at no time give rise to individual doses which exceed 0.1 mSv per year.
- PO 2: The individual radiological risk of fatality from a sealed repository subsequent upon unlikely processes and events not taken into consideration in PO 1 shall, at no time, exceed one in a million per year.
- PO 3: After a repository has been sealed, no further measures shall be necessary to ensure safety. The repository must be designed in such a way that it can be sealed within a few years.

One recognises the following main features:

- A basic deterministic approach is required for the safety assessment.
- Where useful or necessary, the deterministic calculations should be complemented by probabilistic analyses.
- The requirements apply to the disposal system as a whole.
- Calculations should be carried out at least as far in time as the maximum potential consequences (no prescribed cut-off time).

The guideline R-21 gives a number of indications concerning the safety assessment:

- A safety assessment is needed at each stage of the licensing process. The corresponding calculations must be based on information collected throughout the site characterisation, construction and operation phases.
- The results of calculations concerning the far future are not to be interpreted as effective predictions of radiation exposure of a defined population group. They are indicators for evaluating the impact of a potential release of radionuclides into the biosphere and are compared with the limits specified in the protection objectives.
- For such calculations, reference biospheres and an affected population with, from a current point of view, realistic living habits should be assumed. The population group most likely to be affected is meant to be a limited number of people. The calculation should pertain to the potential exposure of an average individual of that group.
- Processes and events with extremely low probability of occurrence or with considerably more serious non-radiological consequences, as well as intentional human intrusion into the repository system, are not required to be considered in the safety assessment.
- Each computer code used in the safety assessment has to be verified. Further, there has to be confidence that the models used are applicable for the specific purpose. The applicant has to give the possible ranges of variation in the data used in the models and of the results of the calculations. Where uncertainties remain, conservative assumptions must be made.

3. STATUS, STRATEGIES AND CURRENT ISSUES AT THE NATIONAL LEVEL

3.1 Status

3.1.1 Waste classification and quantities

The Radiological Protection Ordinance defines when material or waste is considered to be radioactive and falls within the scope of application of the legislation on radiological protection. Following classification of radioactive waste was introduced with the new ordinance on nuclear energy:

- High level waste: Vitrified fission product waste from the reprocessing of spent fuel, or spent fuel, if declared as waste.

- Alpha-toxic waste: Waste with a concentration of alpha-emitters exceeding 20’000 Bq/g of conditioned waste.
- Low and intermediate level waste: All other radioactive waste.

The main sources of radioactive waste in Switzerland are the nuclear power plants. There are 5 reactors in operation - 3 PWR (Beznau 1 and 2 and Gösgen) and 2 BWR (Mühleberg and Leibstadt) at 4 sites totalling around 3 200 MWe. This gives or eventually will give rise to following waste streams:

- Waste from the reprocessing of the spent fuel or the spent fuel itself, if not reprocessed.
- Operational waste.
- Decommissioning waste.

Further radioactive waste arises from the use of radionuclides in medicine, industry and research. Switzerland has no uranium mines and no enrichment, fuel fabrication or reprocessing plants.

At present, the following radioactive waste management facilities exist in Switzerland:

- Nuclear power plants:
  All four Swiss nuclear power plants have on-site installations for the conditioning and storage of their own operational waste.
- Central Storage Facility:
  This facility operated by the ZWILAG company in Würenlingen features storage buildings for spent fuel and all kinds of radioactive waste, conditioning installations and a plasma furnace for melting and incineration of low level waste.
- Separate storage facility ZWIBEZ at Beznau nuclear power plant:
  It consists of a hall for low level operational waste and a hall for the dry storage of spent fuel.
- National Collection Centre and Federal Storage Facility:
  These installations for radioactive waste from medicine, industry and research are operated by the Paul Scherrer Institute (PSI) in Würenlingen.

A separate building for wet storage of spent fuel elements is under construction at the nuclear power plant Gösgen. There are yet no radioactive waste disposal facilities in Switzerland.

The amounts of conditioned radioactive waste in storage in Switzerland by the end of 2005 are listed in the following table.

Facility	**Waste category**	**Quantity**
Beznau NPP (incl. ZWIBEZ)	Low and intermediate level	1084 m^3
Mühleberg NPP	Low and intermediate level	1036 m^3
Gösgen NPP	Low and intermediate level	168 m^3
Leibstadt NPP	Low and intermediate level	1445 m^3
Central Storage Facility	High level waste Low and intermediate level	196 canisters 260 m^3
Paul Scherrer Institute	Alpha-toxic waste Low and intermediate level	35 m^3 1074 m^3

Assuming an operation time of 50 years for the existing nuclear power plants a total volume of 85'000 m^3 of low and intermediate level waste (including decommissioning waste) is expected to arise. In addition to that and owing to the present situation, high level and alpha-toxic waste from the reprocessing of 1060 t spent fuel as well as 2420 t spent fuel will have to be disposed of in the repository for high level waste.

3.1.2 Installations in a decommissioning phase

One experimental nuclear power plant has been dismantled. This facility, at Lucens in Canton Vaud, was shut down in 1969 following an accident and subsequently decommissioned. The last part of the site has been released from nuclear regulatory control in 2004. The radioactive waste resulting from the dismantling is stored at the Central Storage Facility.

Two research reactors at the Paul Scherrer Institute (PSI) are in the state of being decommissioned. The decommissioning activities started in 1994 respectively 2002 and are both in their final stage. Many premises of the former nuclear facilities are already used for other purposes. The waste is stored at the Federal Storage Facility.

3.2 National strategies

3.2.1 Waste management

The overall radioactive waste management policy is briefly described in section 1.1.1 above. The radioactive waste arising all over the country from the use of radioisotopes in medicine, non-nuclear industry and research is collected by the Paul Scherrer Institute (PSI), a federal research

establishment on behalf of the Federal Office of Public Health. It is then conditioned and stored until disposal at the Federal Storage Facility at PSI.

Radioactive waste arising from the operation of the nuclear power plants is conditioned and stored mostly on-site. Some low level operational waste had in the past been conditioned (e.g. incinerated) at PSI. This kind of waste is now shipped to the Central Storage Facility operated by ZWILAG for incineration and melting in the new plasma furnace. This installation started active test operation in 2004.

Up to now, most of the spent fuel has been sent for reprocessing to France (COGEMA) and the United Kingdom (BNGS, previously BNFL). The waste arising from reprocessing is eventually returned to Switzerland and stored at the Central Storage Facility which started operation in 2001. By the end of 2005, 7 transport and storage casks containing each 28 canisters with vitrified high level waste had been taken back from COGEMA.

Spent fuel is now stored in transport and storage casks at the Central Storage Facility. The decision, whether this spent fuel should be reprocessed at a later time or disposed of as waste, is presently kept open. By the end of 2005, the storage hall contained 16 transport and storage casks with spent fuel elements from the nuclear power plants Gösgen, Leibstadt and Mühleberg.

An existing storage hall at the ZWIBEZ storage facility of Beznau nuclear power plant is currently being equipped for the emplacement of transport and storage casks for spent fuel. In addition to that, a separate building for the wet storage of spent fuel elements is currently under construction at Gösgen nuclear power plant.

Two repositories are foreseen for the disposal of all Swiss radioactive waste. A repository for the expected large amount of mostly short lived low and intermediate level waste was planned at the Wellenberg site in the Canton Nidwalden in Central Switzerland. An application for the general licence was made in 1994. The granting of a mining concession by the Canton was rejected twice by the citizens of the Canton, first in June 1995 for the repository and then in September 2002 for the exploratory drift. The site of Wellenberg had thus to be abandoned. A new site selection has to be undertaken for the repository for low and intermediate level waste. For that purpose a site selection procedure providing opportunities for stakeholder participation is currently developed by the federal authorities.

The repository for high level and long lived intermediate level waste is foreseen to be located in a deep geological formation and would consist of a drift system with access by a shaft and a ramp. Two potential host rock formations, both in Northern Switzerland, have been investigated for that purpose, the crystalline basement and opalinus clay sediments. In December 2002, Nagra submitted to the authorities a project aiming at demonstrating the disposal feasibility for these kinds of waste. Such a demonstration is required by law prior to the realisation. The project is based on a repository in the opalinus clay of the Zurich Weinland region in northern Switzerland close to the German border. The safety case presented by Nagra was reviewed by an international team of experts under the auspices of NEA. The review by the competent Swiss authorities was concluded in August 2005. All official reviewing bodies came to the conclusion that disposal feasibility was demonstrated. They identified a number of issues that require further study in view of the realisation of the repository. The project documentation and the review reports were submitted to public consultation from September to December 2005; over 6800 statements have been received. The Federal Council took its decision in June 2006: It recognizes the demonstration of disposal feasibility and orders Nagra to address the identified issues. The site for the realisation of the repository will be selected according to the procedure currently developed.

3.2.2 Decommissioning

As described in section 3.1.2, one experimental nuclear power plant has been totally dismantled and two research reactors are in final stage of decommissioning. No decommissioning of further nuclear facilities is foreseen in the near future.

The owners of the nuclear power plants submitted detailed decommissioning studies in 1980. The corresponding cost estimates served as basis for establishing the yearly contributions to the Decommissioning Fund. Totally new decommissioning studies with corresponding cost estimates for all nuclear power plants have been submitted to the authorities in 2001. From its review, HSK concluded that the technical aspects were up-to-date and that the cost estimates were adequate. The yearly contributions to the fund have been readjusted to the new cost estimates.

3.3 Issues at national level

3.3.1 Waste management

An issue relates to the fundamental question, whether geologic disposal is the right way to solve the problem of radioactive waste. The Nuclear Energy Act, which was democratically promulgated, requires geologic disposal. This requirement is based on the recommendations of an independent Expert Group on Disposal Concepts for Radioactive Waste (EKRA). The report of the expert was presented in February 2000 and was very well received by the media. Despite this, several non-governmental organisations and politicians still claim that disposal cannot ensure the necessary long term safety. One should therefore keep the waste indefinitely under control in a storage facility.

Also the reprocessing of spent fuel is strongly criticised by some groups because of an alleged environmental pollution attributed to the reprocessing plants in France and United Kingdom. The Nuclear Energy Act has introduced a ten years moratorium on reprocessing which started in July 2006.

Because the Wellenberg site had to be abandoned, a new site for the repository for low and intermediate level waste has to be selected. A site has also to be selected for the repository for high level waste. The procedure for such site selections is not fixed by the legislation. The lessons learnt indicate that an early involvement of the local authorities and population is necessary. The federal authorities under the lead of the Federal Office of Energy are currently developing a corresponding site selection procedure. The elaboration of the procedure is carried out with a broad consultation of interested citizens and organisations, the cantons, as well as the authorities of neighbouring countries. The first challenge in this respect is to get the procedure accepted by most parties which could eventually be affected (unanimity would not be reachable). The second challenge will then be to carry out the procedure and to arrive at accepted sites for both disposal facilities.

3.3.2 Decommissioning

There are currently no plans for decommissioning nuclear power plants in the near future. Both the operators and regulator are following the developments on decommissioning in the international scene. There are for the time being no issues regarding decommissioning worth to be mentioned.

4. CURRENT ISSUES AND PRIORITIES FOR THE REGULATOR

4.1 Waste Management

4.1.1 Issues and priorities

A difficulty for the regulatory body is the following: The regulator wants to defend the concept of geologic disposal, which is considered to be sound in the radioactive waste management community. On the other hand, the same regulator has to remain the neutral and independent supervisory authority regarding specific disposal projects. When defending the concept, the regulator may appear to political authorities and to the general public as being a promoter of disposal projects and lose its credibility. The regulator has to convince the general public that it is possible to advocate the general concept, but to preserve the independence of view when judging specific projects.

The observation from contacts with the public is that the existence of HSK, i.e. of a regulatory body supervising the activities of the implementers, was not well known. HSK is frequently seen by the general public as being closely linked to the operators of nuclear power plants and to Nagra, the implementing organisation for radioactive waste disposal. It is, at least in Switzerland, a challenge for the regulator to be known by the public as neutral and independent Authority with the unique objective to ensure safety.

HSK currently participates in the elaboration of the site selection procedure for geological disposal facilities. As safety authority, HSK has the responsibility to establish the selection criteria regarding safety and technical feasibility and to fix the way how to apply the criteria. Hearings show that local authorities and the general public would like to see a set of clear quantitative and easily measurable criteria regarding the suitability of a site. In contrast to that, such a simple system cannot be established in a meaningful way for two reasons. First, the long term safety of a disposal facility does not rely on single parameters, but on the complex interaction of many parameters; these interactions have to be taken into account in the safety analysis. Secondly, the parameters are not known site specifically when starting the site selection process; they will be determined by subsequent site investigation and characterisation. At the beginning of the procedure, the criteria for the selection can thus be only of qualitative nature. It is a challenge for the regulator to explain that situation to the public and to reach acceptance.

4.1.2 Development in policy and regulation

A totally new legislation on nuclear energy which addresses specifically radioactive waste management and decommissioning entered into force on 1 February 2005. The Nuclear Energy Ordinance incorporates several requirements which were previously set forth in HSK guidelines; it also instructs the supervising authority to develop specific guidelines. The full set of HSK guidelines has thus to be brought in line with the new legislation. This process is on-going and will still last several years.

4.2 Decommissioning

The transition from the operational phase of a nuclear power plant to the final shut-down poses several questions regarding the organisation and the staff. Safety has to be ensured during this phase too. Despite the fact that no decommissioning of a nuclear power plant is in view, HSK is preparing to answer these questions.

5. RESEARCH AND DEVELOPMENT PROGRAMME BY THE REGULATOR FOR BOTH WASTE MANAGEMENT AND DECOMMISSIONING

5.1 Functions

R&D on radioactive waste management is performed mostly at the Paul Scherrer Institute (PSI) and at the underground rock laboratories (Grimsel and Mont Terri), but also at some universities. A substantial part of this R&D is funded by Nagra, the organisation responsible for the disposal of radioactive waste. A further important part is financed by governmental funds. HSK, the regulatory body for nuclear energy, initiates and funds safety related regulatory R&D. A small amount of HSK's R&D budget is devoted to radioactive waste management. HSK also follows and comments the work done at PSI.

There is currently no R&D programme on decommissioning in Switzerland.

5.2 Contents of R&D plans

5.2.1 Waste management

The waste management R&D activities at PSI are performed at the Laboratory for Waste Management. The activities are in fundamental repository chemistry, chemistry and physics of radionuclides at geological interfaces and radionuclide transport and retardation in geological media and engineered barriers. The work performed is a balanced combination of experimental activities in dedicated laboratories for handling radioactive elements and in the field, and theoretical modelling. The work is directed towards repository projects and the results find their application in comprehensive performance assessments carried out by Nagra.

The R&D work at PSI can be grouped into the following areas:

- Geochemical modelling (thermodynamic databases and software, solid solution thermodynamics, etc).
- Transport mechanisms (coupled transport phenomena, modelling migration experiments, etc).
- Diffusion processes (in conditioned clay, natural rocks and cements) and organic ligands (complexation).
- Clay systems (sorption measurements and databases, mechanistic sorption models, etc).
- Cement systems (sorption studies, co-precipitation, etc).

- Colloid chemistry (colloid sampling in clay and marl groundwaters, global colloid properties).

The Grimsel rock laboratory (granite site) groups 17 international partner organisations. The main emphasis is currently on the implementation of phase VI (2003 – 2013). The projects relate mainly to the understanding of engineered barrier systems under realistic conditions on a 1:1 scale and to the transport behaviour of radionuclides in granitic rocks.

The Mont Terri rock laboratory (clay site) is also an international project with partners from several countries. The experiments at the Mont Terri rock laboratory relate particularly to diffusion and retention of radionuclides in clay, thermo-hydro-mechanical behaviour of clay, gas flowpaths and self-sealing of fissures. HSK is funding an experiment on the characterisation and modelling of the excavation disturbed zone carried out by the engineering geology unit of the Federal Institute of Technology.

5.2.2 Decommissioning

There is currently no R&D programme on decommissioning in Switzerland.

6. FINANCING OF RADIOACTIVE WASTE MANAGEMENT AND DECOMMISSIONING

Two funds are established by law:

- The Decommissioning Fund covers the costs for the decommissioning and dismantling of nuclear facilities.

- The Radioactive Waste Management Fund covers the costs for the management of radioactive waste which will arise after final shut-down of the nuclear power plants.

Both funds are administrated by an independent Commission appointed by the Federal Council.

The yearly contributions to the Decommissioning Fund paid by the owners of the nuclear power plants and of the Central Storage Facility are based on specific decommissioning plans with corresponding cost estimates. The decommissioning plans have been reviewed and approved by HSK from a technical and financial point of view. The plans and cost estimates have to be periodically updated. The yearly contributions grow with inflation rate. By the end of 2005, the capital of the Decommissioning Fund amounted to 1252 million Swiss francs (approximately 800 million euros).

The costs for the current management of spent fuel and radioactive waste (i.e. conditioning and storage) as well as for the preparations for later disposal (i.e. work of Nagra) are paid continuously by the waste producers. In addition to that, the operators of the nuclear power plants have to pay yearly contributions to the Radioactive Waste Management Fund. Cost estimates serving as basis for the contributions have been presented by the operators, and reviewed and approved by HSK. They are periodically reassessed. The capital of the Radioactive Waste Management Fund amounted to 2762 million Swiss francs (more than 1700 million euros) by the end of 2005.

ACRONYMS AND ABBREVIATIONS

AGNEB	Interdepartmental Working Group on Radioactive Waste Management
BFE	Federal Office of Energy
EKRA	Expert Group on Disposal Concepts for Radioactive Waste
FLAG	Management by Objectives and Global Budget
HSK	Swiss Federal Nuclear Safety Inspectorate
KNE	Geological Commission on Nuclear Waste Management
KSA	Swiss Federal Nuclear Safety Commission
Nagra	National Co-operative for the Disposal of Radioactive Waste
PSI	Paul Scherrer Institute
UVEK	Federal Department for Environment, Transportation, Energy and Communication
ZWILAG	Zwischenlager Würenlingen AG, company operating the Central Storage Facility