STATUS OF SPENT FUEL STORAGE FACILITIES IN SWITZERLAND

P.C. BEYELER
Nordostschweizerische Kraftwerke

H.R. LUTZ
ZWILAG Zwischenlager Würenlingen AG

Baden,
Switzerland

W. von HEESEN
STEAG Kernenergie GmbH,
Essen,
Germany

XA9951786

Abstract

Planning of a dry spent fuel storage facility in Switzerland started already 15 years ago. The first site considered for a central interim storage facility was the cavern of the decommissioned pilot nuclear plant at Lucens in the French-speaking part of Switzerland. This project was terminated in the late 80ies because of lack of public acceptance. The necessary acceptance was found in the small town of Würenlingen which has hosted for many years the Swiss Reactor Research Centre. The new project consists of centralised interim storage facilities for all types of radioactive waste plus a hot cell and a conditioning and incinerating facility. It represents a so-called integrated storage solution. In 1990, the new company "ZWILAG Zwischenlager Würenlingen AG" (ZWILAG) was founded and the licensing procedures according to the Swiss Atomic law were initiated. On August 26, 1996 ZWILAG got the permit for construction of the whole facility including the operating permit for the storage facilities. End of construction and commissioning are scheduled for autumn 1999. The nuclear power station Beznau started planning a low level waste and spent fuel storage facility on its own, because in 1990 its management thought that by 1997 the first high active waste from the reprocessing facilities in France would have to be taken back. This facility at the Beznau site, called ZWIBEZ, was licensed according to a shorter procedure so its construction was finished by 1997. The two facilities for high level waste and spent fuel provide space for a total of 278 casks, which is sufficient for the waste and spent fuel of the four Swiss nuclear power stations including their life extension programme.

1. INTRODUCTION

About 60% of the electric power capacity in Switzerland is covered by nuclear and 40% by hydroelectric power. In terms of electricity generation the proportion is reverse, with approximately 60% of the electrical output being produced by hydroelectric stations and about 40% by the four Swiss nuclear power stations (5 reactors). The reactors have a total installed capacity of 3,077 MWe and have accumulated about 115 reactor years experience. There location of the stations can be found in Fig. 1 and they consist of:

- Beznau NPP, a twin-unit plant of 2x 365 MW commissioned in 1969/71;
- Mühleberg NPP, 355 MW commissioned in 1971;
- Gösgen NPP, 970 MW commissioned in 1979;
- Leibstadt NPP, 1,030 MW, upgraded to 1,060 MW commissioned in 1984.

The Swiss atomic law stipulates that the producers of nuclear waste be fully responsible for its treatment and interim storage as well as final disposal. Against the background of this legal requirement, the history of the planning of interim storage in Switzerland started already in the early eighties.

2. THE PROJECTED LUCENS INTERIM STORAGE FACILITY

Already in those days, the idea of a centralised Swiss interim storage facility was given preference over a decentralised storage solution at the reactor sites and since then Switzerland has basically adhered to the principle of centralised storage.

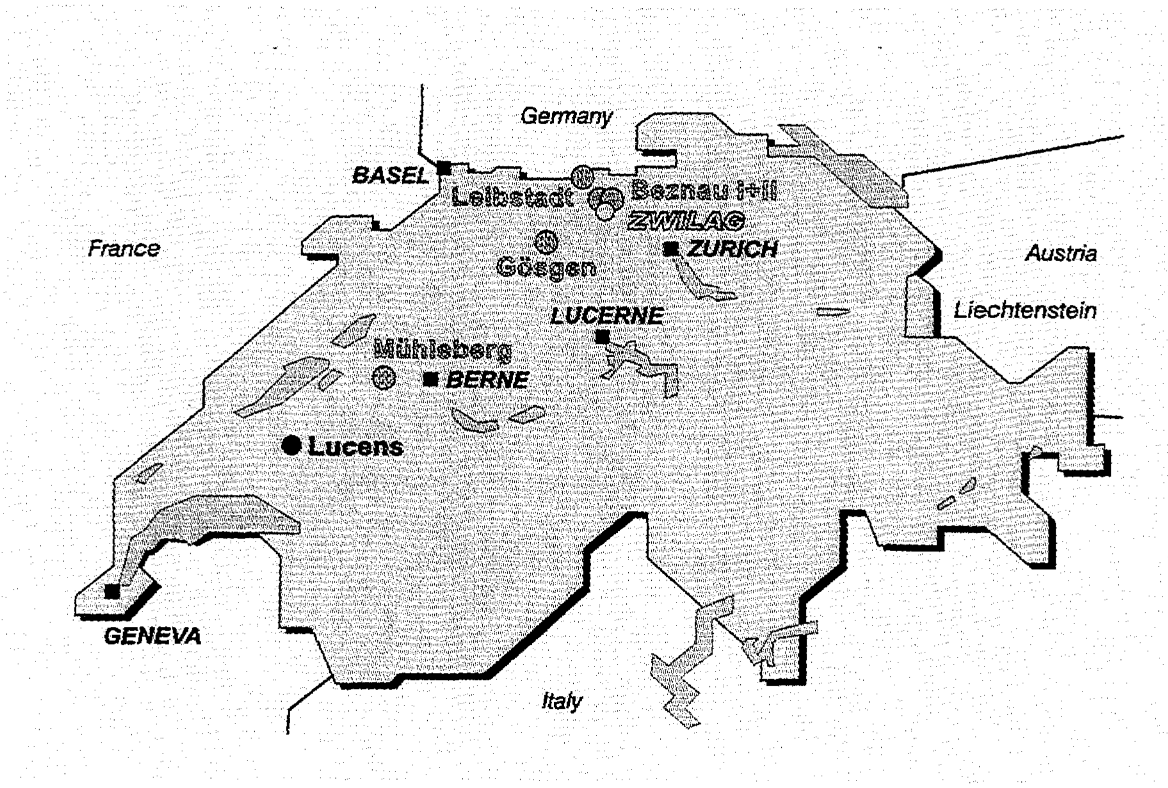

FIG. 1. Location of the Swiss nuclear facilities

In 1984, a pre-engineering study for a centralised Swiss interim storage facility in Lucens was presented. The town of Lucens was the site of the first Swiss test reactor which had to be decommissioned in 1971, following a core meltdown accident. In those days, the Lucens site was considered the optimum site for an interim storage facility, since public acceptance based on the familiarity with nuclear technology in the region was assumed. This first project was based on the concept of storing high-level, medium-level and low-level wastes in the same facility. The persuasive feature of the project was its compact layout, providing for cask storage of high-level wastes with heat removal by natural convection and for drum storage of the other waste types.

At the end of the eighties, however, it had to be recognised that, due to lack of public acceptance, the project could never be realised in the French-speaking part of Switzerland where no nuclear power plants are in service. The Chernobyl accident contributed further to the opposition to nuclear energy. This rejection was a severe setback to the project into which quite a great deal of effort, time and money had been invested.

The issue of centralised or decentralised interim storage was inevitably put again on the agenda by the search for a new site, all the more since for some plants the start of taking back high-level wastes from reprocessing was scheduled already for the mid-nineties. Optimisation of operational aspects, concentration of long-term interim storage at a single site and the pressure of the federal authorities were then the reasons for standing by the concept of centralised interim storage option originally pursued with the Lucens project.

A new possible site was found in the small town of Würenlingen, located in the valley of the river Aare, where the Paul Scherrer Institute (PSI) – in those days Swiss Reactor Research Centre – had done nuclear research already for decades. Compared to the rest of Switzerland, the acceptance of a nuclear interim storage facility by people and municipal authorities in the region seemed to be relatively high, due to the fact that, with the PSI and the two nuclear power stations at the Beznau and Leibstadt sites, a certain dependency on nuclear technology had emerged over the years.

3. THE BEZNAU-BASED ZWIBEZ INTERIM STORAGE FACILITY

As already mentioned, the failure of the Lucens project entailed a lot of trouble for the operators, because of the imminent return of radioactive wastes. In particular the management of the Beznau NPP had to assume that already in 1994 the first high-level wastes from reprocessing would be returned from reprocessing in La Hague.

Therefore, prior to the founding of a shareholder company for interim storage by the four nuclear power station operating companies, Baden-based Nordostschweizerische Kraftwerke decided to have a separate interim storage facility for high-, medium- and low-level wastes planned at the Beznau power plant site and to initiate the nuclear licensing procedure. Since this interim storage facility is located within the site boundaries of the nuclear power station, no time-consuming general licensing procedure had to be passed through, promising a considerably shorter licensing procedure.

In 1989, engineering of the ZWIBEZ facility was taken up by the Consortium NOK Engineering (Baden) and STEAG Kernenergie (Essen), adopting for the high-level waste storage facility the storage principles of the Lucens project, in particular heat removal by natural convection, since STEAG had already been involved in drawing up the Lucens project. Construction and operating permits for the ZWIBEZ were already obtained by 1991. In the same year, construction work on the low-level waste storage building began which was commissioned in 1993. At the same time, the decision was taken to refrain from building the ZWIBEZ medium-level storage building and to store all medium-level wastes in the Würenlingen storage facility to be built, which meanwhile had entered the general licensing procedure.

A special feature of ZWIBEZ is the storage technology used in the low-level waste storage building, where the individual drums are stored in steel-lattice storage containers and then stacked up in stacks of 16 m height. This storage system developed by NOK/STEAG – designed to resist a 1000-year earthquake and remain stable even under such great horizontal and vertical impact – permits highly efficient storage and is recommendable for drum storage (Fig. 2). The same type of system has been adopted for storage of low-level and medium-level wastes in the Würenlingen interim storage facility.

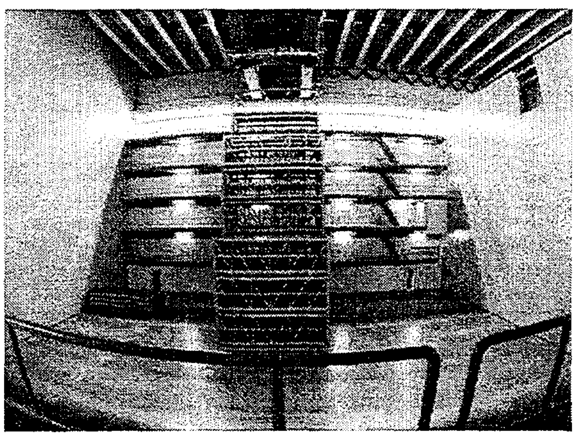

FIG. 2. Beznau low-level waste storage building
Stack storage of drums in steel-lattice containers

The high-level storage building has been designed to provide space for a total of 48 casks for high-level wastes and fuel elements. Moreover, this building provides space for the interim storage of replaced steam generators of the Beznau 2 nuclear power unit which are to be prepared in the storage facility for disposal. Construction of the high-level waste storage building commenced in 1996 and was completed in 1998.

On taking the decision in 1991 to build the facility, nobody could know that the date of return of casks with high-level waste from reprocessing which had originally been foreseen for 1994 has meanwhile been postponed to the year 2000. Obviously the return dates of wastes from reprocessing are rather difficult to forecast.

4. THE WÜRENLINGEN-BASED ZWILAG INTERIM STORAGE FACILITY

In January 1990, "ZWILAG Zwischenlager Würenlingen AG" (ZWILAG Interim Storage Co Ltd, Würenlingen) was established. The object of the company is the interim storage of the radioactive wastes of all categories arising from all Swiss nuclear power stations and to treat and condition low-level waste from the whole country. Shareholders of the company are:

• Leibstadt nuclear power station	33,8%
• Gösgen nuclear power station	31,2%
• Nordostschweizerische Kraftwerke AG (Beznau NPP)	24,3%
• Bernische Kraftwerke Beteiligungsgesellschaft AG	10,7%

ZWILAG is the first nuclear project in Switzerland licensed under the new Atomic Energy Act of 1978 (see Fig. 3 for a model of the facility). The legal procedures provide for a general licensing procedure, a construction licensing procedure and an operation licensing procedure for specific sections (conditioning, incineration). The nuclear licensing procedure described hereinafter took 6 years (from 1991 – 1996, see Fig. 4 for a detailed time schedule).

1 Conditioning plant
2 Incineration and melting plant
3 High-level storage building
4 Medium-level storage building
5 Hot cell
6 Low-level storage building
7 Federal interim storage building
8 River Aare

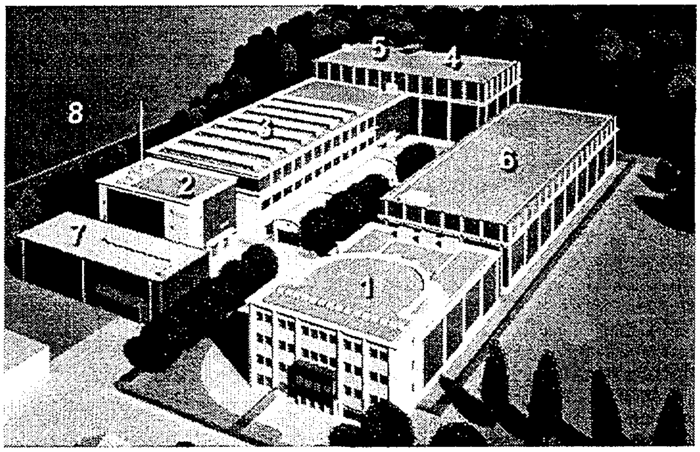

FIG. 3. Model of ZWILAG

In contrast to the first project in Lucens, which had been projected as an interim storage facility for high-, medium- and low-level wastes, the ZWILAG facility includes the following processes:

1. Storage of high-level wastes and spent fuel in transport and storage casks, space for a total of 200 casks;
2. Storage of medium-level wastes in drums, based on the earthquake-proof storage technology developed by NOK/STEAG using steel-lattice containers as in the above-mentioned ZWIBEZ facility;
3. Storage of low-level waste in drums, also based on the steel-lattice container storage technology;
4. Handling of radioactive material and fuel elements in a hot cell;
5. Conditioning of low-level wastes in a conditioning plant;
6. Treatment of radioactive wastes in an incinerating and melting furnace.

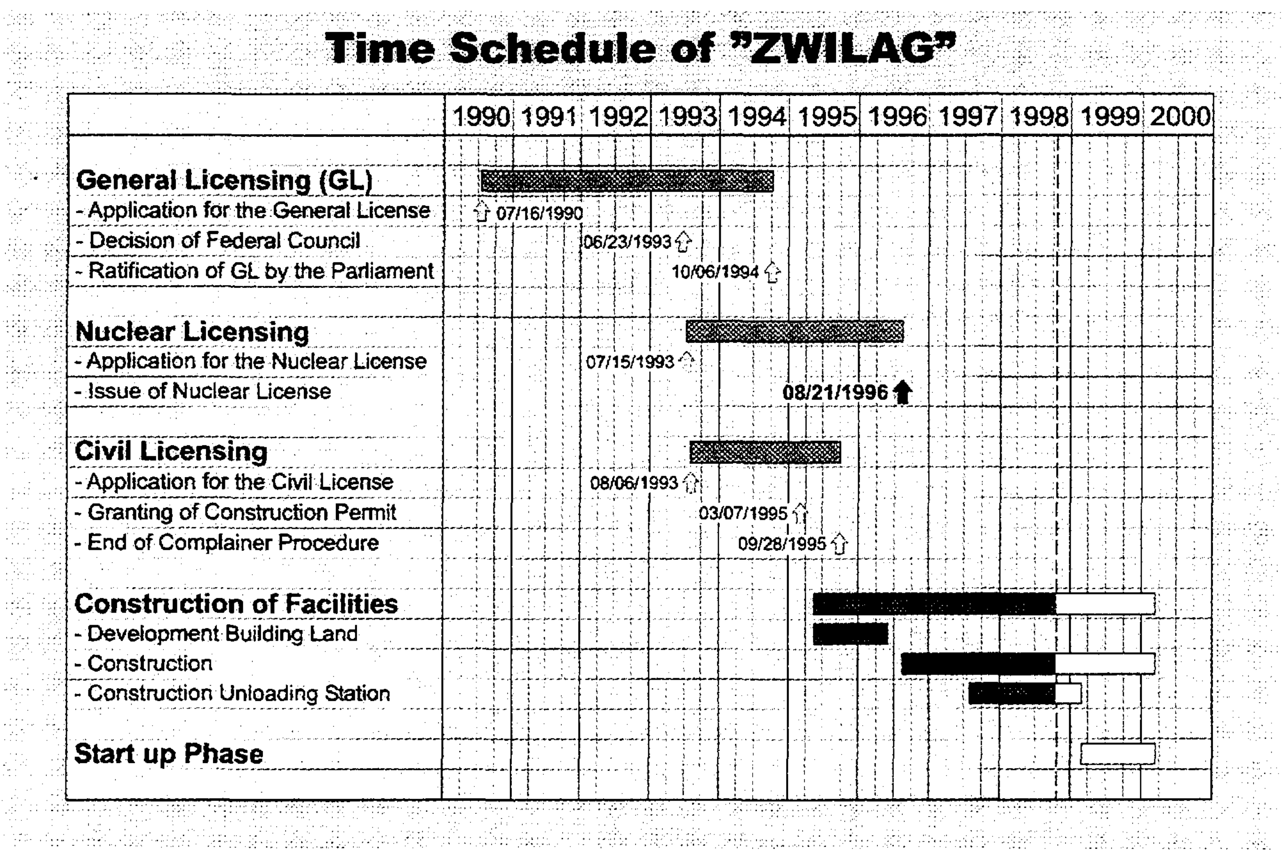

FIG. 4. Time schedule of ZWILAG

Construction work on the overall plant started in August 1996. Step-by-step, commissioning of the overall plant is scheduled for fall 1999. With an implementation time of about 38 months and a capital expenditure of approximately 320 million Swiss francs, excluding capital costs and costs of owner-rendered services, an average of 8 million francs per month were turned over, a figure that underlines the great performance by the enterprises involved. Below, specifically the storage facility for high-level wastes is described:

Casks loaded with high-level waste arrive mainly by rail transport via a transfer station at a distance of approx. 1.5 km from the storage facility. In the transfer station, similar to Gorleben, Germany, the casks are transferred onto special transport trucks and then transported on the road to the storage facility. In the acceptance hall the casks are removed from the truck by means of a crane. Following checking of leak-tightness and preparation for storage, the casks are transferred into the storage hall and placed in the provided positions.

The storage hall of ZWILAG has a dimension of 68 m x 41 m x 18 m and is designed to provide space for 200 casks of different types. It is based on the principle of heat removal by natural convection. With ZWILAG's 200 cask positions and the above-mentioned 48 positions in the ZWIBEZ facility of the Beznau nuclear power station, storage space for a total of 248 is available in Switzerland. Thus, there is sufficient storage capacity available in Switzerland to discontinue reprocessing if required, and to accommodate all wastes arising from the nuclear power stations throughout the planned operating period.

6. ZWILAG DESIGN FEATURES

Compared to the centralised interim storage facilities in the Federal Republic of Germany, the ZWILAG facility includes some specific design features:

- Acceptance area and hot cell;
- Design against external impact;
- Security concept.

The storage building for irradiated fuel elements, the storage building for medium-level wastes and the hot cell for handling of fuel elements and radioactive waste have a **common acceptance area**. In this area, transport trucks are unloaded and transport casks transferred to the transport systems of the specific storage facility. The acceptance area includes work stations for preparing the transport casks for unloading or storage. The specific facilities are functionally independent, except for the common acceptance area.

The integrated **hot cell** allows:

- Reloading of fuel elements from transport into storage casks;
- Reloading of fuel elements for required repair work on transport or storage casks;
- Inspection of fuel elements and HAW.

Thus, with regard to handling possibilities, the ZWILAG facility is independent from the further operation of the nuclear power stations after their decommissioning. The hot cell enables economic optimisation of cask management with regard to fuel element storage, particularly by reloading fuel elements into economically more efficient storage casks with higher capacities. Additional equipment provided in the hot cell permits basically the treatment of medium-level and high-level wastes.

All buildings and all safety-relevant components and systems have been given an **earthquake-proof design**. The other aspects of safety design of the specific facilities against external impact vary depending on the different storage technologies used:

- In case of the cask storage facility, protection against airplane crashes is provided by the storage casks. The required proof has to be rendered for each specific cask type.
- In case of the hot cell and the MAW storage facility, protection against airplane crash is provided by the building structures. Design against airplane crash does also cover the effects of other types of external impact.

Security issues are seldom discussed in symposiums although they have become a factor that considerably pushes up costs and are in some cases as decisive for the design as the nuclear requirements. It even seems that no longer the technical issues are in the focus of applied nuclear technology but rather the security issues. Further reference to the problems with the transports in Germany or the occupation of railway tracks in Switzerland will not be necessary here. It goes without saying that no confidential facts can be discussed in public, so this presentation is limited to discussing the obvious security features.

Security provisions of nuclear facilities, including the reference plant in Ahaus or the Gorleben facility are normally based on a fortified fence, difficult to surmount and arranged at a sufficient distance from the buildings of the facility. So, already the fence prevents potential agitators from accessing the area. A person climbing over the fence would be detected, set off the alarm activating numerous guards before additional external assistance would be called.

ZWILAG pursues a different concept, licensing of which was possible owing to the flexibility of the competent authorities. The ZWILAG facility will not be surrounded by a heavy fence fortified with barbed wire, water-cannons or the like. Only a simple fence of wire mesh marks the area's legal boundaries. Access to the ZWILAG will thus be similar to accessing a normal, fenced-off industrial estate. This is very interesting for the operation of the entire facility, since beyond the security-relevant area of the interim storage facility, the facility includes also the conditioning and incineration plants, operations which require optimum, i.e. free access conditions (see Fig. 5).

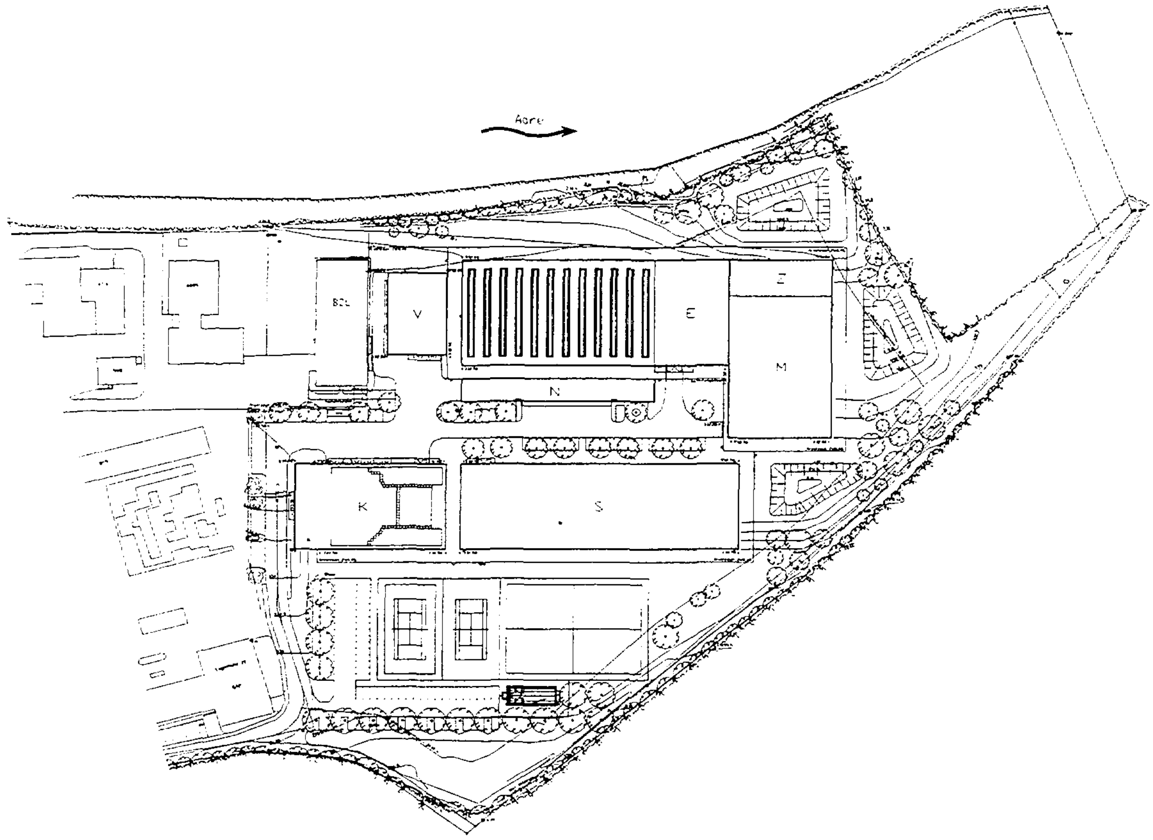

FIG. 5. Overall view of the ZWILAG facility, with secured area around the H/E/Z/M building complex

Around the security-relevant building complex, however, where the high-level wastes will be stored, a restricted-access zone close to the buildings will be demarcated by an additional fence. Any movement in this area is detected by electronic systems. So, what about security against intrusion of aggressors into the secured area? On the one hand, security is ensured by the concrete building structure with a suitable thickness and exhibiting the necessary resistance and by heavy grating in the openings, and, on the other hand, by additional detection systems at the building shell, providing for electronic area surveillance, which, of course entail a certain investment of capital. In addition, the acceptance area had to be designed as an access lock system.

The feasibility calculation shows that investment into the secured area immediately surrounding the building makes sense if it permits a reduction in operating costs. Security-related operating costs are mainly incurred by the guards payroll. Any investment into systems and buildings must thus bring forth a reduction in the number of guards. This was possible in ZWILAG by keeping the number of guards very small, owing to the installed electronic systems.

7. LICENSING PROCEDURE

The revised Swiss Atomic Energy Act divides the nuclear licensing procedure into 2 or 3 steps. In a first phase the so-called "*Rahmenbewilligung*" (general license) has to be applied for. This license specifies the site, and covers the proof that the facility is needed and the general layout. The formal application of the future owner and the expert opinion of the licensing bodies HSK and KSA are both open to the public for objections. In the case of ZWILAG, these procedures took place in 1990 and 1992. The federal government granted this first permit in June 1993. It was ratified 16 months later by the parliament.

The second phase was dedicated to the actual nuclear licenses for construction and operation. ZWILAG got the 2 licenses in one step on August 21, 1996 for the storage complex (high, medium and low level storage buildings including acceptance area, hot cell and railway transfer station). For the conditioning and the incineration plants only the construction license was issued at that date. The operation license is subject of a separate procedure now in progress. According to the latest predictions, the government will take its decision in fall 1999. ZWILAG is the first Swiss nuclear installation, which will be licensed entirely under the new law. The total delay of approximately 1-½ years as against the original time schedule can therefore at least partly be attributed to this pioneer role.

In parallel to the nuclear licensing process, a regular conventional license for construction granted by the town of Würenlingen had to be issued. It involved the town council and the general assembly of the voters and dealt mainly with the building layout, facades, electric power and water supply and sewage water treatment. The assembly of the citizens accepted this license without opposition. This was mainly due to the contract, which had been signed six years earlier between ZWILAG and the town of Würenlingen. This 35-year contract provides, among other things, for a yearly compensation payment of 1 Million Swiss francs and another 600 000 francs for the 4 neighbouring villages, paid by the ZWILAG company.

8. ZWILAG FINANCING

The total investment for the ZWILAG complex, including interest, taxes, fees, compensation payments etc. will amount to 500 million Swiss francs. It has been paid out of provisions of the 4 shareholder companies. These provisions have been accumulated over the last 15 years for waste storage and disposal.

The Swiss Confederation has paid an investment amount of 30 Million Swiss Francs, entitling the Confederation to use the conditioning and incineration facility without paying capital costs. Having paid for the total investment without using borrowed money, the shareholders can use all the facilities with no capital costs either.

In the case of the high-level storage building, each shareholder owns a certain number of positions for their casks. They only pay for handling and operating costs pro rata to the number of stored casks. A preliminary calculation shows that these costs break down as follows:

1.	Unloading and transport to the acceptance area	Sfr.	4,500.--	per cask
2.	Inspection and transport to the storage position	Sfr.	5,000.--	per cask
3.	Operating costs per year (incl. security measures and other fixed costs, assuming 100 stored casks)	Sfr.	40,000.--	per cask

The chosen financing mode ought to have the advantage of low capital taxes, owing to the low shareholder capital. In reality, however, the state tax authorities do not accept this relatively low-capitalised company balance sheet. ZWILAG will have to pay taxes on a fictitious shareholder investment, which still is subject to negotiation.

9. CONCLUSIONS

The countdown is on for spent fuel interim storage in Switzerland, with the aim to store in fall 1999 the first cask in the new storage hall. Some years after decommissioning of the Leibstadt nuclear power station around the year 2024, occupying should by completed. However, after starting to take back the wastes from reprocessing, occupation of storage positions will initially proceed rapidly.

The ZWILAG interim storage facility in the Swiss town of Würenlingen provides the link between the production of nuclear wastes in the nuclear power stations and their final disposal. Thus, also in Switzerland, interim storage of wastes arising from today's generation of power plants is ensured.