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SUPPORTING MATERIAL FOR A PRESENTATION ON

"SWEDISH AND EUROPEAN INTERIM STORAGE EXPERIENCE AND PERSPECTIVES ON U.S. STORAGE ISSUES"

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INTERIM STORAGE SWEDEN

The Swedish program was firstly outlined in 1977 in the KBS1 and KBS2 reports, describing a complete system for the back end of the Swedish nuclear fuel cycle including handling, transportation, interim storage and final disposal. Each part of the system was described and safety assessments where presented. A schedule for implementation was also included. The reports where subject to extensive national and international review and "approved" by the government. "Updates" have been presented in the KBS3 report in 1982 and in R&D- Programs presented every third year to the government by the nuclear utilities through their jointly owned company SKB- Swedish Nuclear Fuel and Waste Management Co.

The KBS work established technical and political consensus in Sweden about how the radioactive waste was going to be handled. The program included:

- A sea based transportation system for all nuclear waste related transports. Casks according to IAEA standard.

- A central storage for spent fuel CLAB. Wet storage in rock cavern pools.

- A final repository for low and medium level waste, SFR.

- A deep geological repository concept for spent fuel based a long lived canister.

The transportation system is in operation for low and medium level waste and spent fuel since 1982. CLAB is in operation since 1985, with a current capacity of 5000t and SFR, the repository for reactor waste, is in operation since 1988. Two facilities are still to be sited and constructed in Sweden, namely the encapsulation plant for spent fuel and the deep geological repository.

A system exists for financing of the complete back end system including transportation, interim storage, disposal of low and medium level waste, disposal of high level waste and decommissioning of the reactors. All necessary RD&D efforts are also covered by this nuclear waste fund.

The encapsulation station is proposed to be co-located with CLAB and a final repository in demonstration scale is planned to be sited through a volunteer siting process. This process has been initiated in 1993. Several municipalities are currently discussing a feasibility study with the industry and one municipality have signed an agreement to conduct a joint study with the industry to be completed in the summer of 1994 (both local and national elections will take place in 1994 in Sweden).

A stepwise development of the final repository has been suggested by the Swedish authorities in 1990 and accepted by the industry in 1992. This shift in strategy is resulting in an earlier implementation of a demonstration size encapsulation facility and the deep repository but possibly later implementation of the full size repository. This new "staged" strategy may result in a longer operation of the CLAB interim storage facility.

Swedish experience

The following comments can be made about the Swedish experience:

- An early conceptual study was carried out resulting in consensus about the overall basis for the program, both technically and politically.

- The program has been developed through a process where the industry has been given the responsibility to develop and construct necessary facilities. Since 1981 the industry is required to present their future plans for review by the authorities every third year. The authorities have used extensive national and international support in these reviews. Occasionally as many as 50 national and 20 international organisations have participated in main reviews. The national review groups represents among others academia, national agencys, municipalities and environmental groups. The government has given the final approval of the plans this has given stability to the implementation work. Even if this process may appear cumbersome it has clearly contributed to consensus about the core of the program strategy. The process has contributed to that "extreme" criticism from minority groups about the program strategy and/or technical basis has been "sorted aside".

- Detailed legislation and criteria has been avoided with the rationale not to pre-judge the results of the ongoing RD&D programme. The Swedish approach has made it possible to use gained experience in continuos mid-course corrections of the program. The main course has however basically staid the same.

- In many instances "overkill" and use of roboust and proven technology has been preferred over new or optimised solutions with the argument that a clear acceptance by the public and the licensing authorities has been important in order to achieve timely solutions. This way sub - optimisation has been avoided. Examples are the selection of wet storage technology in rock caverns in the case of CLAB, the selection of rock silos 50 m under the Baltic sea for the reactor waste storage SFR and the selection of the copper canister.

The concept of having CLAB built in rock caverns and not on the surface was adopted for three major reasons:

- construction in rock can be carried out to about the same expense as building the corresponding size facility on the surface

- safeguard is no longer an issue

- scenarios such as aircraft impacts etc. can be ignored

From an institutional perspective the interim storage has played an important role in allowing for ample time for development of the technical concept for final disposal of spent fuel and even more important to find an acceptable site. Technically the 30 to 40 year storage period in CLAB will reduce the heat generation to about 10% compared to the generation 1 year after removal from the reactor.

A broad acceptance of geological disposal has still not been reached and current polls from June 1993 shows that 46% of the Swedish population still do not believe that we have a final solution for our spent fuel and 31% believe we do. These figures have continuously been shifting towards a larger acceptance since the early eighties but the change is slow.

Selection of interim storage strategy and technology

The following alternatives for interim storage where theoretically available in the late seventies:

- centralised interim storage

- decentralised expanded storage at the reactor sites.

- international contracts on storage and reprocessing

- no interim storage but direct disposal to be initiated in the eighties

All these alternatives included risks as follows:

- siting of an interim storage facility may not have been feasible

- decentralised storage may result in a diffuse picture both concerning responsibility and control. The central concept, financed by the waste fund, and managed by one organisation is a more solid solution in the case of Sweden. A decentralised solution may also be connected to the decision to phase out of the nuclear reactor's by 2010. Less flexibility can thus be foreseen if delays occur for the final repository due to development of alternative technical solutions or problems with siting or licensing of the deep repository.

- international contracts have continuously been less favoured politically in Sweden due to non proliferation arguments and an awareness that international solutions may also result in pressure that Sweden should take waste from other nations because of its stable rock and sparse population.

- direct disposal initiated at an earlier stage in Sweden would most likely not have been feasible due to the focus of political debate and large questioning of the nuclear issue. Siting efforts would most likely have created large protests and political conflicts at both national and local level. The nuclear debate was at its peak in Sweden in the late seventies and early eighties (a referendum was held in 1980) and most likely siting of a deep repository could not have taken place in this climate.

For siting of CLAB initially three sites where considered namely Forsmark, Oskarshamn and Studsvik. All three sites are so called "nuclear islands" and even if CLAB vas sited during the most heated nuclear debate in Sweden almost no opposition was noted against the siting in Oskarshamn.

Cost for interim storage

The total cost for interim storage of 7700 t/U in Sweden is based on a phase out of all reactors by the year 2010. The total estimate for interim storage is 9.639 MSEK or 1.205 MUSD. The cost per metric ton of spent fuel is then 1.252.000 SEK (156.000 USD). The marginal cost for interim storage is about 550.000 SEK/t (68.500 USD/t).

The cost of interim storage constitutes less than 15% of the total back end cost. The cost per kWh is thus 0.30 öre (0.04 cent) for interim storage.

All figures are based on an exchange rate of 1 dollar = 8 SEK.

OTHER INTERIM STORAGE PROGRAMS IN EUROPE

Other European national programs have selected different strategies for interim storage. Countries like Great Britain and France with large reprocessing programmes of necessity have large interim storage facilities at the reprocessing plants both for storage of spent fuel as well as solidified waste. Great Britain operates a Vitrified Product Store (VPS) at Sellafield and France is operating similar facilities at La Hague.

Switzerland is planning to commission a dry interim storage in 1997 (ZWILAG) for both spent fuel and reprocessed vitrified waste returning from France. The government is expected to grant a permit for construction in 1994.

Finland have an operational wet interim storage (KPA-Storage) for spent fuel similar to the CLAB in Sweden but above ground. Spain have plans to construct a dry interim storage for spent fuel (CENTAURO) before the year 2000 using a cask suitable both for storage and transportation.

The Netherlands are planning to construct dry interim storage's for vitrified waste also to be commissioned before the year 2000.

Belgium has an operational small interim storage for vitrified waste from EUROCHEMIC reprocessing waste and is in the process to constructing a second larger interim storage for vitrified waste returning from France.

Germany has two dry interim storage facilities one at Gorleben and one at Ahaus (Ahaus is operational since 1973 using a forced air cooled dry cask). Both the German facilities have 1.500 t capacity but the Gorleben facility has not yet been taken in to operation due to legal requirements that an operational licence has to be presided by a demonstration that an absolute need is at hand. The German concept at Gorleben is a dry storage concept based on the CASTOR storage cask. The CASTOR cask is used both for storage and transportation.

A reevaluation of the reprocessing option is currently taking place in several European countries (in particular Germany and Switzerland). Two factors are currently working against reprocessing namely comparatively high costs and a halt for new reactor programs due to political decisions and/or because of a lower electricity consumption than predicted.

Most likely the trend will force development of more dry storage capacity for spent nuclear fuel in several European countries to replace the "free" buffer capacity currently used at the international reprocessing facilities.

The selection of wet storage in the case of Sweden and Finland are decisions taken 10 to 15 years ago and at that time the wet technology was proven but dry storage technology under development. Today dry storage technology is proven.

Dry storage for spent fuel is thus available in Germany and under way in Spain and Switzerland. Countries in Asia such as Korea and Taiwan are also considering to develop dry interim storage facilities for spent nuclear fuel.

No country in Europe is considering direct disposal of spent fuel from reactors without interim storage. Unlike in the USA the debate in Europe has not considered interim storage to violate the timely development of a final repository nor is the possibility discussed that the interim storage may be turned in to a "final solution". The dates given for initiation of final disposal in most European countries are between 2020 and 2060.

Finally it can be noted that most European interim storage facilities are mostly sited in connection with existing nuclear installations including reactors (CLAB in Sweden andKPA in Finland), reprocessing plants (Sellafield, La Hague) or major laboratories (ZWILAG at the Paul Scherer Institute in Switzerland). An exception is the Gorleben interim storage in Germany.

Public opposition has been limited against interim storage facilities in Europe with one major exception namely Gorleben, sited close to the site currently studied for disposal of high level waste, where violent demonstrations took place in the early to mid eighties.

INTERIM STORAGE

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CONTENT

1/The Swedish Experience

A/ History

The general history of the Swedish waste management program:

- a program wide conceptual study the first step, KBS 1, in 1977
- consensus building through national and international review (50 national 20 international organisations.)
- final approval by government

1/ The Swedish Experience

A/ History

Major components of the Swedish program:

- a transportation system based on sea transport using IAEA standard for cask design (operational since 1982)

- an Interim storage in rock cavern pools, CLAB (operational since 1985, reactor island siting)

- a final repository for L&MLW (operational 1988, reactor island siting)

- a final disposal for spent fuel in crystalline rock using copper canisters (volunteer siting initiated 1993, the encapsulation plant proposed to be sited at the CLAB interim storage)

1/ The Swedish Experience

C/ Why Interim Storage?

- on-reactor storage to run out in the mid eighties

- industry felt a central storage to be a more optimum solution than several reactor site storage's

- an expedited implementation of a geological disposal was not favoured by industry or by society

- the future for reprocessing versus direct disposal was unclear Interim storage was thus giving full flexibility

1/ The Swedish Experience

D/ Why Wet Storage Technology?

- construction cost for rock caverns is comparable to construction cost for a surface facility in Sweden
- advantages in terms of safeguard
- several scenarios such as aircraft impact can be ignored
- loss of pool water not likely

1/ The Swedish Experience

E/ Cost for interim storage in Sweden

- total cost for CLAB for 7700 t of spent fuel including construction and operation 6.639 MSEK (1.205 MUSD)

- cost per metric ton 1.252.000 SEK (156.000 USD). Marginal cost 550.000 SEK(68.500 USD)

- interim storage cost represents less than 15% of total back end cost.

- cost per kwh is 0.30 öre (0.04 cent)

2 Other European interim storage facilities

A/ Reprocessing Nations

- "free" space at the reprocessing facility
- sending nations operate or are in the process to develop national facilities for interim storage of vitrified waste
- often siting at existing nuclear facilities
- spent fuel transportation casks of IAEA standard
- casks suitable both for storage and transportation exist (e.g. the German CASTOR)

2 Other European interim storage facilities

B/ Direct Disposal Nations

- all nations planning on direct disposal as a prime or secondary option are operating or are in the process to develop interim storage facilities for spent nuclear fuel
- early facilities are either of wet or dry type
- modern facilities are of dry type
- transport casks according to IAEA standard

2/ Other European Interim Storage Facilities

C/ Trends for the future

- reprocessing less attractive due to low price on uranium, high costs and limited plans for new reactor projects

- several European nations currently having reprocessing contracts can be expected to shift towards direct disposal resulting in needs for new interim storage capacity for spent fuel

- dry storage technology proven

- casks both for transportation and interim storage

- longer interim storage times due to stepwise final disposal programs

3/ Conclusions and lessons learned

- most European programs have interim storage's or are in the process of developing such facilities
- no country in Europe is planning on direct disposal without interim storage
- siting at "nuclear islands" has been used successfully
- robust and timely more important than latest technology and optimisation
- interim storage cost is typically 10-20 % of total back end cost
- dry storage technology is chosen for modern facilities

- forceful development of final disposal planned for operation 2020 to 2060 has resulted in public trust that interim storage will not be a final solution

A last observation on US storage issues

The overriding problem for the USA is assumed to be that 20% of the production capacity for electricity may be disturbed if the spent fuel can not be removed in a timely and safe manner from the reactors

Three observations:

1 Experts say "we can finally dispose spent fuel in geological formations". The public believes we can not. We must gain public confidence.

2 Interim storage is a proven technology and if a site can be found it could be implemented today. "Nuclear Island Siting" should be considered to mitigate public distrust.

3 Deep disposal is not avaliable for implementation today. Implementation is going to require development of detailed site information, demonstration of technology and a public acceptance.