

# NUCLEAR WASTE MANAGEMENT OF OLKILUOTO POWER PLANT

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## ABSTRACT

Teollisuuden Voima Oy is responsible for the waste management of the Olkiluoto nuclear power plant. The utility has constructed an interim storage facility for spent fuel. Site selection of final repository for spent fuel is in progress. There are five site candidates where field studies are carried out. A final repository for low- and intermediate-level waste is under construction at the power plant site. Later, this repository will be extended for decommissioning wastes. For future costs of waste management, a fee is collected in the price of the electricity.

## INTRODUCTION

The Finnish power utility Teollisuuden Voima Oy (TVO) owns and operates at Olkiluoto two nuclear power plant units, TVO I and II (BWRs, 2 x 710 MW). These reactors produce about 20 % of the electricity consumed in Finland. TVO produces electricity to its shareholders consisting mainly of Finnish industrial companies.

The unit TVO I was commissioned in 1978 and TVO II in 1980. By the end of 1989, the total electricity production was about 103 TWh. The reactors have generated 415 tU of spent fuel and 1700 m<sup>3</sup> of low- and intermediate-level wastes. The estimated minimum lifetime of the reactors is 40 years. The estimate for the corresponding production is 427 TWh. The estimated total amounts of waste during 40 years are as follows from the two units: 1840 tU of spent fuel, 8000 m<sup>3</sup> (40 000 drums) of operating low- and intermediate-level wastes (LLW/ILW) and 25 000 m<sup>3</sup> of decommissioning wastes. The final waste amounts at Olkiluoto will be higher, if the lifetimes are longer or if new power plant units are constructed.

## RESPONSIBILITIES

Waste producer is according to the Nuclear Energy Act responsible for safe management of radioactive wastes. The government has defined objectives and time schedules for realization, as well as for R & D work. A decision will be made on the criteria of final disposal of LLW/ILW in 1990. The Nordic authorities have recently published joint recommendations for criteria of high-level waste disposal (1).

The authorities rule and supervise progress of programmes. The Ministry of Trade and Industry (KTM) is responsible for licencing of nuclear waste facilities and the Finnish Center for Radiation and Nuclear Safety (STUK) for supervision of safety.

Waste management cooperation between TVO and the other company producing nuclear energy, Imatran Voima Oy, is coordinated by the joint Nuclear Waste Commission of Finnish Power Companies (YJT). The Commission reports on the progress of each calendar year in the annual reports (2). Research institutes, universities and consulting companies participate as contractors in the research

programs of the utilities. Fig. 1 shows the organization of waste management in Finland.

## SPENT FUEL MANAGEMENT

A separate interim storage facility (the KPA store) has been constructed for spent fuel at the Olkiluoto power plant site (3). The operation was started in 1987. There are three storage pools in the facility having a total capacity of 1200 tU. The facility can be extended, if needed.

The alternatives for spent fuel management after the interim storage phase are (4)

- direct disposal of spent fuel in Finland
- foreign reprocessing and return of wastes to TVO
- foreign reprocessing including waste disposal, or foreign direct disposal services.

For being competitive, eventual foreign services have to be economical when compared with the domestic direct disposal. So far, no feasible services have been available. Preparations are made for direct final disposal of spent fuel in Finland. The time schedule of the domestic alternative is shown in Fig. 2.

The repository concept comprises horizontal tunnels with vertical holes in the floors at a depth of several hundred meters in the crystalline bedrock (5). Fuel assemblies are encapsulated in metal canisters before final disposal. The work for optimization of technical plans is progress. It concerns the encapsulation process, materials and the structure of the canister as well as internal the filling materials. The repository is planned to be constructed in the 2010's.

The safety assessments (5, 6, 7) have shown that the old Finnish crystalline rock is a very safe environment for the final repository of spent nuclear fuel. The safety assessments will be updated by the end of the year 1992.

## DEEP DRILLING PROGRAM

The site for the final repository of spent fuel will be selected by the year 2000 (8). Field investigations were started in 1987 at five areas located in the Kuhmo, Hyrynsalmi, Konginkangas, Sievi and Eurajoki communities (Fig.3). The programme consists of airborne surveys, deep and shallow drillings as well as of measurements and sam-

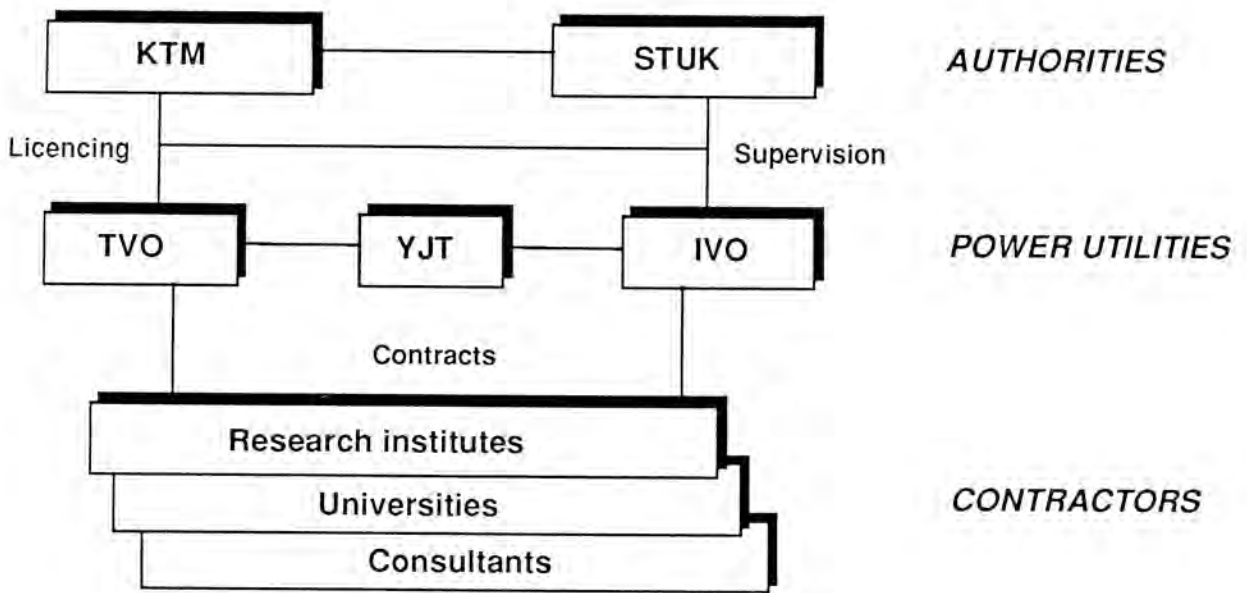


Fig. 1. Organization of nuclear waste management in Finland.

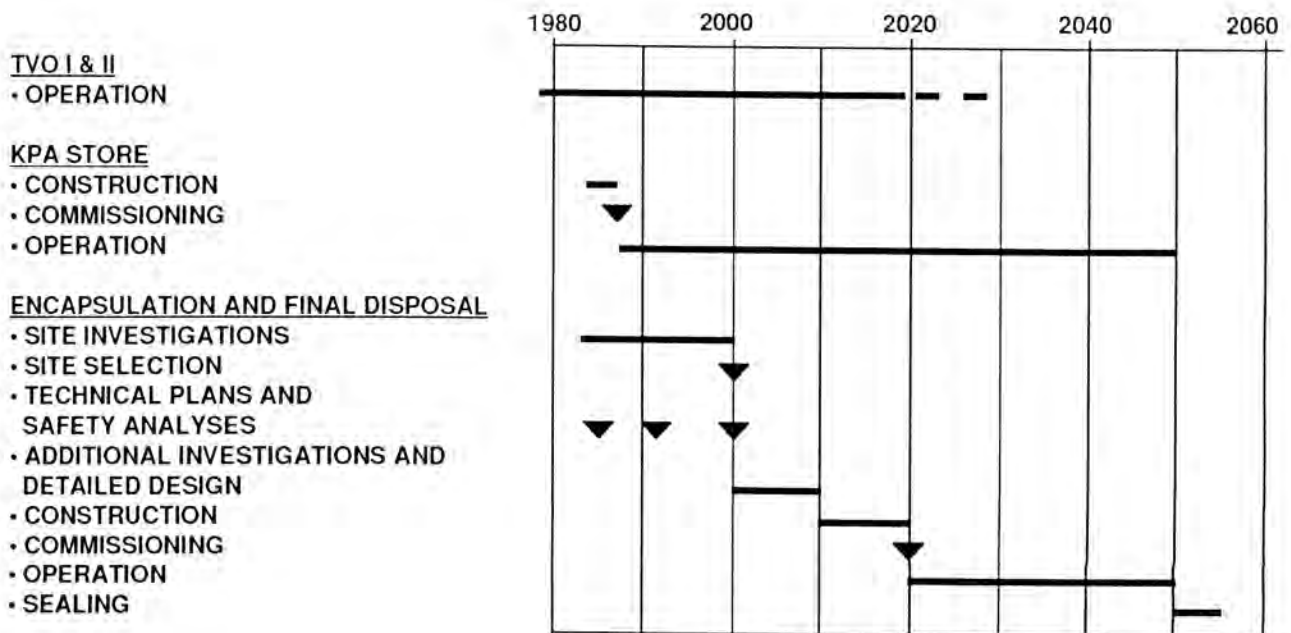


Fig. 2. The schedule for management of TVO's spent fuel.



Fig. 3. The investigation areas for the selection of repository site for spent fuel.

pling from the surface and in the boreholes. Field work is followed by laboratory studies and modelling and evaluation of the areas.

At the end of 1989 the site investigation status is as follows:

- Deep drillings (five boreholes with a length of 500 - 1000 m at each site) have been completed at Kuhmo, Hyrynsalmi, Konginkangas and Sievi. Drillings at Olkiluoto will be completed in 1990.
- Measurements and sampling at Kuhmo and Hyrynsalmi are practically completed. At the Konginkangas and Sievi areas the activities of the year 1990 will consist of installation of packers in the boreholes for head monitoring, test pumpings and groundwater sampling.
- Groundwater flow modelling of the Kuhmo and Hyrynsalmi areas is in progress.

At the end of 1992 a decision will be made on 2-3 areas, in which the programme will continue with detailed bedrock studies in order to select the repository site in 2000.

#### FINAL REPOSITORY FOR LLW/ILW

The low- and intermediate-level wastes are conditioned and stored at the Olkiluoto power plant site. Also the final repository for these wastes is constructed at the power plant site (9).

Dry wastes from maintenance work are compressed and packed in 200 liter drums. Spent ion-exchange resins are bituminized. Waste packages are stored in waste process

buildings of the power plant and in the two separate interim storage buildings at the site.

Construction of the final repository for low- and intermediate-level wastes (the VLJ repository) in the crystalline bedrock of Olkiluoto started in the spring 1988. The excavation work was completed in the summer 1989. Construction and installation work will proceed so that the repository will be commissioned in 1992.

The waste drums will be emplaced in the two silos of the repository at a depth of 70 - 100 meters (Figs. 4 and 5). The repository has a total capacity of 40 000 drums. The total excavated rock volume is 90 000 m<sup>3</sup> (silos, crane hall, tunnels, shaft).

#### DECOMMISSIONING STUDIES

The decommissioning plan of the units TVO I and II is based on the following principles:

- 30 years' cooling period between the end of service life and the start of dismantling segmenting of pressure vessels
- final disposal of wastes in the Olkiluoto bedrock (extension of the VLJ repository)
- final disposal of activated core components from operating time (fuel channels, control rods etc.) in the same repository according to the same schedule.

In 1987, TVO reported a preliminary decommissioning plan. A detailed dismantling plan including estimates for waste inventory and costs (dormancy period, dismantling, waste disposal) will be reported in 1990.

#### FUNDING ARRANGEMENTS

TVO funds money for future costs of nuclear waste management. An updated cost estimate, including spent fuel, low- and intermediate-level wastes and decommissioning, has to be presented to the authorities annually. On the basis of these estimates, the Ministry of Trade and Industry each year confirms a fee to be paid into a government-controlled fund.

The estimate comprises of the future costs of the waste management of the produced inventory. The present estimate confirmed by the authorities is FIM 4017 million (1 FIM = 0.25 USD). By the end of 1989, TVO had collected FIM 1750 million in the fund.

The total costs for TVO's waste management corresponding to the waste amounts given in the introduction (inventory of 40 years' operation, costs in the past and in the future) are FIM 6000 million in the price level of 1989 without discounting. This corresponds to about 0.014

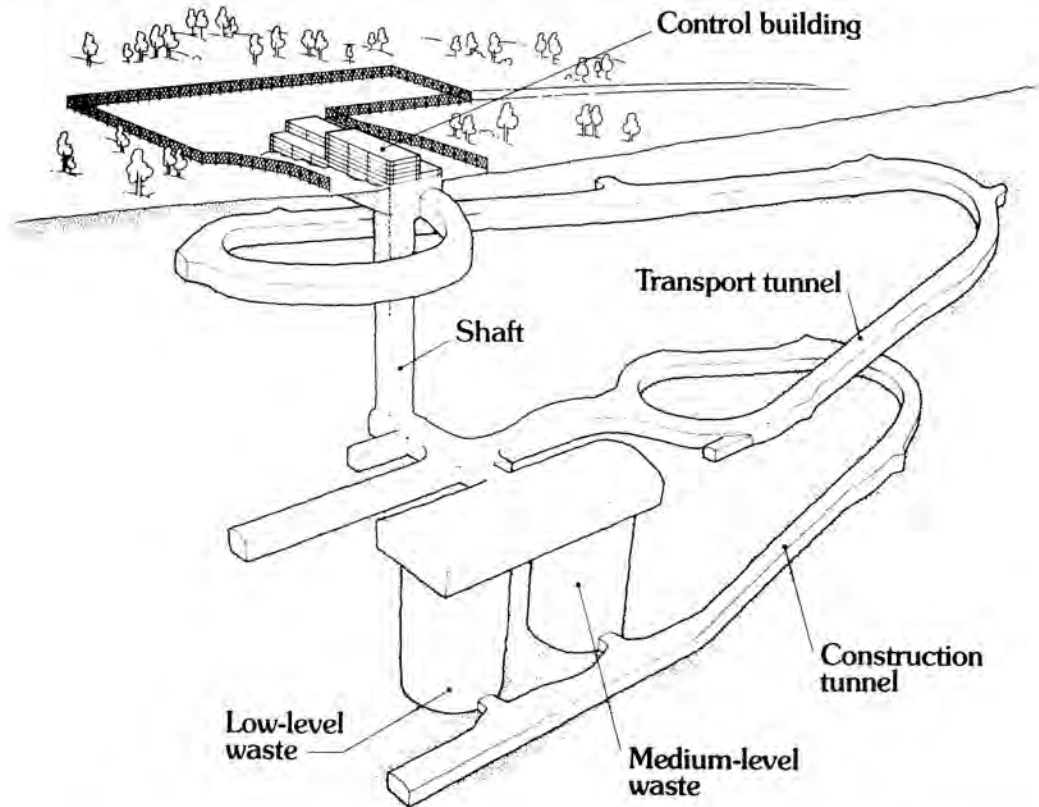


Fig. 4. The repository for LLW/ILW (the VLJ repository) is under construction at Olkiluoto.

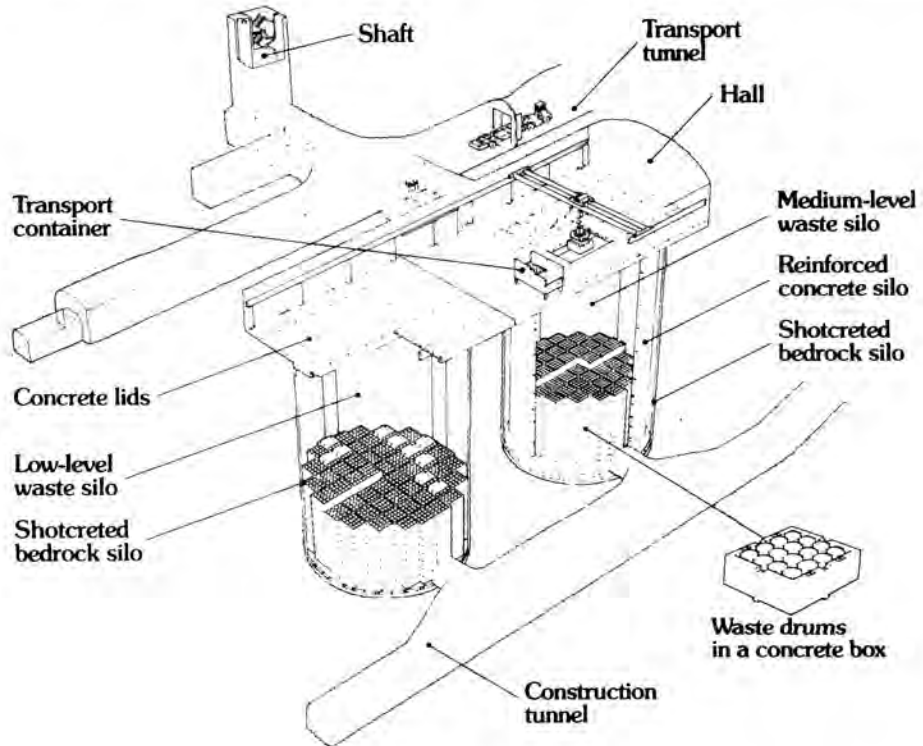


Fig. 5. The silos of the LLW/ILW repository.

FIM/kWh, which is about 10% of the price of electricity produced at the Olkiluoto power plant.

#### PUBLIC ACCEPTANCE

In addition to licenses of the government and the authorities, an approval of the location community is needed for the construction of a nuclear waste facility in Finland. For the repository of spent fuel, a local approval will be needed after the year 2000. There is already now a great need for information activities in connection with the site selection studies of spent fuel repository.

TVO's program for information activities is described in Ref. (10).

#### CONCLUDING REMARKS

TVO, a utility operating two nuclear power plant units, has prepared plans for the safe management of the radioactive wastes from its own reactors. As to operational LLW/ILW and decommissioning wastes, the plan is based on final disposal at the power plant area. In the spent fuel management, an alternative to the domestic direct disposal is the use of eventual foreign services.

TVO's waste management programme - the facilities already realized and plans for the future - shows that radioactive wastes can be taken care of in a technically feasible way with moderate costs even in a small nuclear energy system.

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