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Disposal Facility in Olkiluoto, Description of above Ground Facilities in Lift Transport Alternative

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November 2006

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DISPOSAL FACILITY IN OLKILUOTO, DESCRIPTION OF ABOVE GROUND FACILITIES IN LIFT TRANSPORT ALTERNATIVE

ABSTRACT

The above ground facilities of the disposal plant on the Olkiluoto site are described in this report as they will be when the operation of the disposal facility starts in the year 2020. The disposal plant is visualised on the Olkiluoto site.

Parallel construction of the deposition tunnels and disposal of the spent fuel canisters constitute the principal design basis of the disposal plant. The annual production of disposal canisters for spent fuel amounts to about 40. Production of 100 disposal canisters has been used as the capacity basis. Fuel from the Olkiluoto plant and from the Loviisa plant will be encapsulated in the same production line.

The disposal plant will require an area of about 15 to 20 hectares above ground level. The total building volume of the above ground facilities is about 75000 m^3.

The purpose of the report is to provide the base for detailed design of the encapsulation plant and the repository spaces, as well as for coordination between the disposal plant and ONKALO. The dimensioning bases for the disposal plant are shown in the Tables at the end of the report. The report can also be used as a basis for comparison in deciding whether the fuel canisters are transported to the repository by a lift or by a vehicle along the access tunnel.

Keywords: Disposal facility, deposition of spent fuel, encapsulation plant and disposal canister for spent nuclear fuel.

OLKILUODON LOPPUSIJOITUSLAITOKSEN MAANPÄÄLLISTEN OSIEN KUVAUS HISSIKULJETUSVAIHTOEHDOSSA

TIIVISTELMÄ

Raportissa kuvataan Olkiluodon loppusijoituslaitoksen laitospaikkajärjestelyjä vuonna 2020, kun loppusijoituslaitos on aloittanut toimintansa. Loppusijoituslaitos on visualisoitu Olkiluodon laitospaikalle.

Loppusijoituslaitoksen suunnittelun lähtökohtana on ollut loppusijoitustilojen vaiheittainen rakentaminen ja polttoainekapseleiden samanaikainen loppusijoittaminen. Vuosittain tuotetaan noin neljäkymmentä polttoainekapselia. Kapasiteettina on käytetty sadan kapselin vuosituotantoa. Olkiluodon ja Loviisan laitosten polttoainetta kapseloidaan samalla linjalla.

Loppusijoituslaitoksen vaatima maanpäällisen alueen suuruus on noin 15 – 20 hehtaaria. Loppusijoituslaitoksen maanpäällisten rakennusten kokonaisrakennustilavuus on noin 75000 m^3.

Työraportti on tarkoitettu lähtökohdaksi kapselointilaitoksen ja loppusijoitustilojen yksityiskohtaisemmalle suunnittelulle sekä loppusijoitustilojen yhteensovittamiseksi ONKALOn kanssa. Raportin lopussa on esitetty loppusijoituslaitoksen mitoituksen lähtökohdat taulukkoina. Raporttia voidaan käyttää myös vertailuaineistona päätettäessä kuljetetaanko polttoainekapselit loppusijoitustilaan hissillä vai ajotunnelia pitkin.

Avainsanat: Loppusijoituslaitos, käytetyn polttoaineen loppusijoitus, kapselointilaitos ja loppusijoituskapseli.

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1 GENERAL

1.1 Background

The above ground site arrangements of the Olkiluoto disposal facility are described as they will be when the operation of the disposal facility starts in the year 2020. This report is an updated version of the previous site plan (Kukkola 2003). The plan is compliant with the Facility Description 2003 (Tanskanen and Palmu 2004). The conceptual visualization figures have been produced by Mr. P-E Rönnqvist from FNS.

The disposal facility is built on the Olkiluoto site, where a complete infrastructure exists for the nuclear power plants. The disposal plant forms an independent facility above the repository tunnels. It is assumed that the encapsulation plant will be above the repository (Kukkola 2002a). In an alternative design the encapsulation plant is integrated with the interim store of spent nuclear fuel (KPA-store), (Kukkola 2002b).

It is assumed that the repository spaces are constructed gradually with the fuel canisters deposited concurrently. The repository tunnels are excavated in campaigns as needed for the deposition of canisters. The fuel canisters are deposited and the deposition tunnels backfilled sequentially.

The underground rock characterization facility ONKALO (Kalliomäki 2003) is constructed before the deposition of fuel canisters starts. The research facility consists of a spiral access tunnel, ventilation and personnel shafts and underground technical rooms at the end of the access tunnel and the shafts.

Above ground, the ventilation shaft building is constructed above the lift shaft and the ventilation shaft. This building houses technical rooms, offices and laboratories. A special building for the needs of researchers is constructed with the necessary research facilities and a storage for the drilled cores. A building for tunnel technology, a washing plant for vehicles and a fueling station have been constructed close to the entrance of the access tunnel. ONKALO will be a part of the disposal facility.

The encapsulation plant produces forty fuel canisters annually on average. The material flow estimates are based on that production rate. Fuel from Olkiluoto and Loviisa plants is encapsulated in the same production line. The encapsulation plant is capable of encapsulating also fuel from the third Olkiluoto unit.

1.2 Site plan

The location of the disposal facility is mainly determined already during the design of the ONKALO. The buildings are located in block number 5 in the building plan area for Olkiluoto in the municipality of Eurajoki. The area is owned by TVO. The entrance to the access tunnel is close to the intersection of the roads running to Olkiluoto Port and to Olkiluoto Nuclear Power Plant (Olkiluoto NPP). The ventilation shaft is about 100 meters west of the access tunnel entrance, close to deep borehole number 4. The canister shaft and the personnel shaft are located about 400 meters north of the ventilation shaft, between deep boreholes number 10 and 14.

During ONKALO's construction phase new roads have been constructed, which will also serve the disposal facility at the operating stage. Broken rock from the OL3 construction site and from ONKALO is banked and crushed on the field close to OL2 (land plot of Vuojoki 428, estate no. 2:217). A concrete mixing plant is also constructed on the same field. When the disposal facility is in operation, broken rock will be banked and crushed close to the Olkiluoto Port area north of the 400 kV power transmission line.

The proposed building arrangement for the Olkiluoto disposal facility is shown in Figure 1. The encapsulation plant and the operating building are shown in the middle of the figure, southwest of the Korvensuo reservoir. The ventilation shaft building, the gate building, the storage, and the research building are shown south of the encapsulation plant. The building for tunnel technology and the repair shop are close to the tunnel entrance. The visitor centre is shared with the Olkiluoto NPP, and can be seen in the upper part of the figure. The visitor centre is located on the cape, at mid-point between the NPP and the disposal plant area.

The broken rock yard is north of the 400 kV power transmission line close to the shore-line. The broken rock yard consists of a broken rock storage, a crusher station, a crushed rock storage and a backfill material mixing station. The bentonite container storage area is close to Olkiluoto Port.

Figure 1. *Above ground site area of Olkiluoto disposal facility.*

2 DESCRIPTION OF SITE PLAN ARRANGEMENT

2.1 Principles of site arrangement

The existing infrastructure for OL1 and OL2, such as roads, water and sewage networks, power supply lines etc. will be exploited to the maximum. All the objects for ONKALO are to be utilized also as part of the disposal facility.

In the actual plant design, pipe and cable lengths as well as transporting distances are minimized. Producers and consumers are located close to each other. For example, power supply centers are close to power consumers, the crusher station is close to the broken rock storage, the repair shop is close to where the repair needs are, etc.

Work places are located so that undue walking around the plant is not needed and unnecessary crossing between the controlled and non-controlled boundaries can be avoided.

Functions are integrated, which produces savings in auxiliary systems. Unnecessary transport can also be avoided by integrating, for example by locating the intermediate storage for compacted bentonite blocks in the encapsulation plant. The heavy repair shop is integrated with the washing plant for vehicles at the tunnel entrance. The repair shop is designed for maintenance and repair works of heavy machineries and vehicles used in the repository.

The continuous flow of visitors is taken into account in the design of the disposal facility. Visitors are partly specialists, partly ordinary tourists. Visitors are welcome and able to see almost everything. This opportunity is provided without disturbing the disposal work. The size of visitor groups is 50 persons.

No new guest houses are needed in Olkiluoto, as the Olkiluoto NPP will have a sufficient capacity to provide accommodation services.

2.2 Disposal plant personnel

The team responsible for handling of the nuclear fuel has an operations base in the operating building where the access control point to the controlled area is also located. The personnel lift entrance to the controlled area of the repository is located in the operating building.

The ventilation shaft lift or the access tunnel is used by personnel entering the non-controlled area of the repository for purposes of repository construction and back-filling of the tunnels. Non-controlled area personnel have their operations base either in the ventilation shaft building or in the research building.

The crushing of broken rock is carried out by an outsourced contractor, for which a barracks and a camp are reserved. The rock is crushed in campaigns during summertime. The personnel that perform backfilling of the deposition tunnels have their operations base in the backfill material mixing station.

2.3 Power supply for disposal facility

The power for the disposal facility is supplied from the Olkiluoto NPP switchgear plant by a 20 kV buried cable connection. Back-up power supply is arranged from the open-wire line of Paneliankosken Voima Oy.

The transformer stations are located in the encapsulation plant and in the ventilation shaft building as well as in controlled and non-controlled areas of the repository. One transformer substation is also needed close to the crusher station. Dry transformers are needed for the ventilation shaft lift, for the canister lift and for the personnel lift in the controlled area as well as for consumers in the repository spaces.

The buried cable network is used for power supply in the disposal plant site area. The power supply center of the encapsulation plant will supply power for the operating building and for the repository's controlled area. The power supply center in the ventilation shaft building supplies power for the ventilation shaft building, for the research building and for the non-controlled repository area.

A stand-by diesel generator unit will be located in the encapsulation plant, where need for back-up power may occur. The output of the stand-by diesel unit is about 350 kVA.

2.4 Heating, water supply and sewage for disposal facility

Three 450 kW electric boilers are acquired for ONKALO. The boilers are located in the ventilation shaft building. Two of the boilers are for the repository and one for the buildings. The repository is heated by heating the inlet air. The buildings are connected to the district heating system.

The heating capacity is increased for the operating phase by procuring two 450 kW electric boilers, which are located in the encapsulation plant. One of the boilers is used for heating the repository's controlled area. The second boiler is used for heating the encapsulation plant, the operating building and the buildings at the entrance of the access tunnel, with the help of the district heating system.

District heating pipes are installed in a trench that connects the above ground buildings. The maximum heating capacity is about 2 MW.

Potable water is taken from the water plant of the Olkiluoto NPP. Service water is taken from Korvensuo reservoir after removing organic impurities.

The sewage water treatment ensures that sewage waters are cleaner than the waters in the environment. Sedimentation pools for leakage waters are constructed during the ONKALO phase at the entrance of the access tunnel. From the pools water is pumped to the open trench and discharged into the sea. Oils are separated before water sedimentation.

Domestic sewage waters are led into the sewage water purification system of the Olkiluoto NPP, where organic materials are removed. Domestic waters from the repository spaces are removed with the help of a sewage suction truck.

Leakage water in the access tunnel is pumped up stepwise through shaft connections and via the ventilation shaft. Leakage water in the repository is pumped up in one stage via the ventilation shaft after settling and discharged into the sea. Ground water drainage waters and rainwater sewerage waters can be led directly to the sea.

2.5 Traffic arrangements

2.5.1 Principles of traffic arrangements

Heavy material transports to the repository site consist of the spent nuclear fuel, the empty fuel canisters, the raw bentonite and the bentonite blocks, diesel oil, heavy-duty machinery and building materials. Heavy material transports on the site include transport of broken rock up to the ground, to the storage, from the storage to the crusher station, and from crushing to the backfill material mixing station, transport of bentonite to the backfill material mixing station and transport of backfill material into the repository. If the encapsulation plant is attached to the KPA-store, the sealed fuel canisters are transported from the encapsulation plant to the canister receiving building.

Light material transports consist of different kinds of bulk materials and supplies as well as transport of waste material away from the disposal site.

The third traffic type is personnel traffic. Personnel traffic to and from the disposal site is based mainly on the use of passenger cars.

Heavy material transport, light material transport and personnel traffic are separated from each other as far as possible. Transports of broken rock, crushed rock and backfill material are also separated from other modes of traffic on the disposal plant site.

2.5.2 Heavy material transport

It is assumed that heavy materials are transported to the Olkiluoto site mainly by road; part of heavy transports takes place via the Olkiluoto Port.

The spent fuel is transported from the Olkiluoto KPA-store to the encapsulation plant along a separate non-public road inside TVO’s private area. The existing transport equipment of the Olkiluoto NPP can be used, as fuel transfer is concerned and not fuel transport. If the encapsulation rate is 40 canisters per year then the transport frequency is once in two weeks using the existing transport cask. For fuel transported from the Loviisa NPP using the Castor VVER 440/84 transport cask and for transport convoys consisting of two casks transport takes place once in every three months.

New fuel canisters are brought to the encapsulation plant every two weeks.

Bentonite is the major single material item transported to the disposal plant. Bentonite is shipped in containers by sea. The containers are stored in the bentonite container storage area. The consumption of bentonite is considerable. The compacted bentonite blocks are stored at the encapsulation plant before transport into the repository.

Diesel fuel is transported in tank trucks every two weeks. Heavy-duty vehicles are driven to the plant once a week. Building materials are brought in every day during the construction phase and once a week during the operating phase.

Heavy traffic on the plant site consists of hoisting of rock along the access tunnel, transport of broken rock to the storage and transport of rock to the crusher station as well as transport of back-filling material to the repository. The maximum annual amount of hoisted rock is about 15000 tons when 40 canisters are deposited. The maximum annual amount of crushed rock transported for back-filling is 9000 tons. Crushed rock not needed in the plant is either stored or sold out. If all extra crushed rock is sold out, the incoming and outgoing material transports are balanced.

If the encapsulation plant is attached to the KPA-store, the sealed fuel canisters are transported from the encapsulation plant to the canister receiving building once a week. The weight of the vehicle with the fuel canister is about 70 tons.

2.5.3 Light material transport

Transports of piece goods, food and post take place daily, maybe several times a day.

A private landfill is provided for the disposal plant for disposal of building scrap and mineral aggregate from water sedimentation as well as filtration dust. Organic wastes, such as food, are transported to the landfill of the municipality of Eurajoki. Transports take place once a week.

2.5.4 Personnel traffic

Personnel traffic to the disposal plant takes mainly place by passenger cars, partly by public transport. A pedestrian and bicycle road is also available. The operating building and the ventilation shaft building are provided with parking places.

Visitor groups travel by busses. Visitor groups are normally received in the visitor centre, which has a parking area right outside the building.

2.6 Above ground buildings and structures for disposal facility

The buildings of the disposal site facility are shown in Figure 2. The encapsulation plant and the operating building are on the right. The research building, the storage and the ventilation shaft building are in the lower center part of the figure. The building for tunnel technology and the repair shop with the vehicle washing plant are at the bottom of the figure.

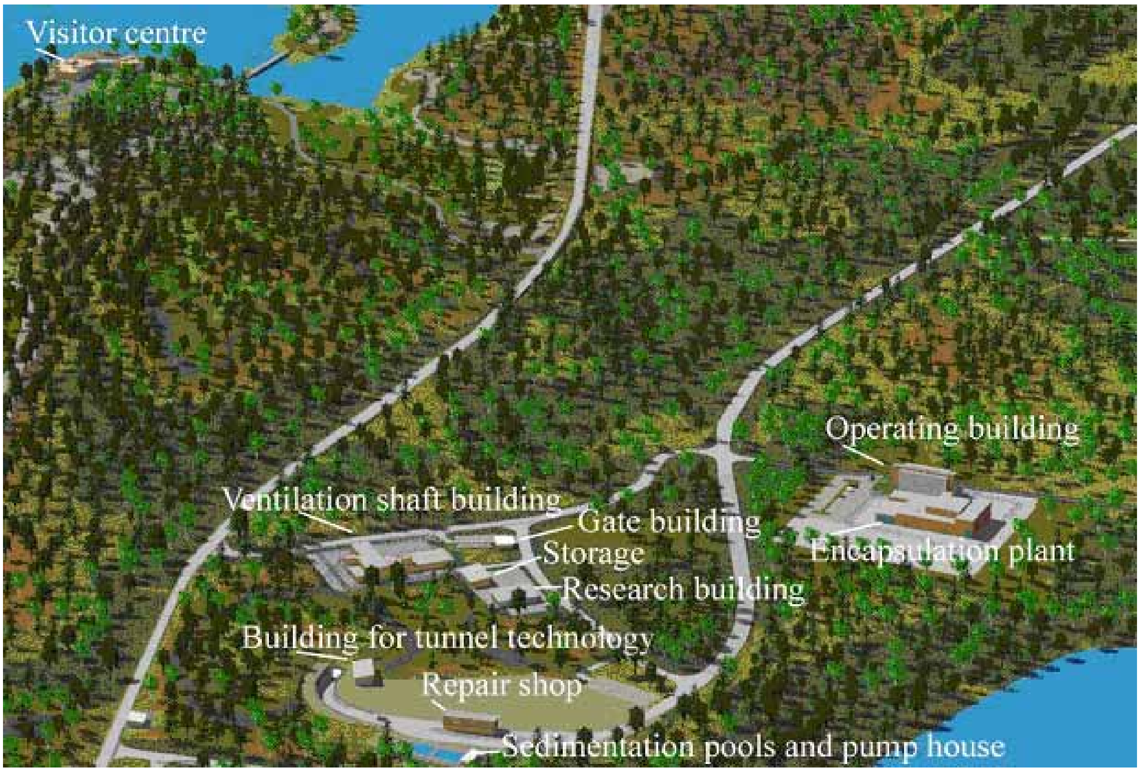

Figure 2. *Buildings in the disposal facility area.*

The buildings associated with the canister shaft are shown in Figure 3. The encapsulation plant is on the left and the operating building on the right. The bentonite block storage is integrated with the encapsulation plant.

If the encapsulation plant is attached to the KPA-store, the canister receiving building replaces the encapsulation plant, Figure 4.

Figure 3. *Buildings associated with the canister shaft. The encapsulation plant is on the left and the operating building on the right.*

Figure 4. *General view of the canister receiving building in case the encapsulation plant is attached to the KPA-store. The canister receiving building is on the left and the operating building on the right.*

The buildings associated with the ventilation shaft are shown in Figure 5. The ventilation shaft building is on the topmost right, the gate building, the storage, the research building and the office building on the right below the ventilation shaft building.

The building for tunnel technology is close to the tunnel opening and the repair shop is by the access tunnel road. The vehicle washing plant is integrated in the repair shop. The sedimentation pools are at the left of the figure.

Figure 5. *Buildings around the ventilation shaft building and the access tunnel.*

A view from north of the 400 kV power transmission line is shown in Figure 6. The broken rock storage dominates the view. The crusher station and the storage for crushed rock are close to the broken rock storage. The backfill material mixing station will be located close to the crushed rock storage. The bentonite container storage area is shown in blue almost in the center of the figure.

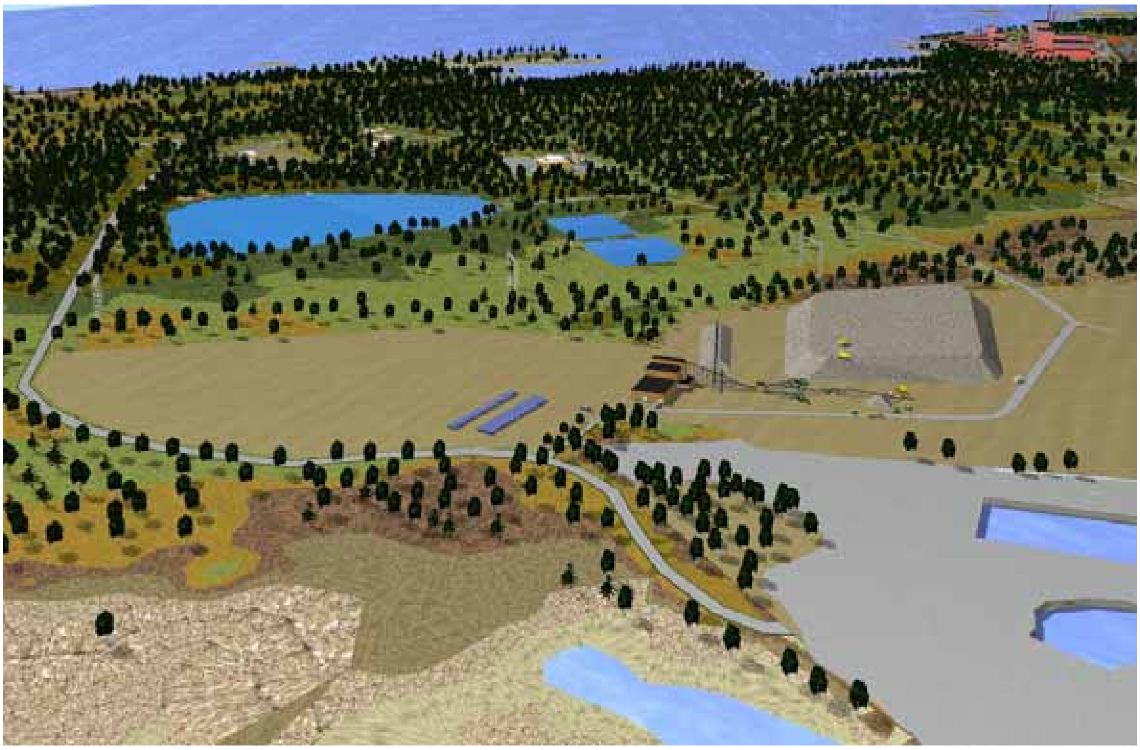

Figure 6. *View from north of the 400 kV power transmission line.*

In addition, the following reservations are needed on the disposal facility site:
- Storage for building materials
- Dumping area for building waste material and
- Area for future extension.

2.6.1 Encapsulation plant

The spent fuel is received and treated for disposal in the encapsulation plant. In the fuel handling cell, the spent fuel assemblies are unloaded from the spent fuel transport casks and loaded into the disposal canisters. The gas atmosphere of the disposal canister is changed, the bolted inner canister lid is closed, and the electron beam welding method is used to close the lid of the canister's outer envelope. The disposal canisters are cleaned and transferred into the buffer store after weld machining and after an inspection of the copper lid welds. From the buffer store, the disposal canisters are transferred into the repository by the canister lift. All the required operating stages are to be performed safely without any activity releases or significant personnel doses.

The encapsulation plant is the most important building of the disposal facility. The encapsulation plant is separated from the rest of the disposal site by a security fence because nuclear fuel is stored and handled in the encapsulation plant.

The compacted bentonite block storage is associated with the encapsulation plant. The bentonite blocks are transported into the repository with the canister lift. The bentonite blocks are acquired from vendors on the basis of competitive bidding.

Visitors are taken into account in the design of the encapsulation plant.

2.6.2 Operating building

Disposal facility administration is centralized in the operating building, where staff facilities for the encapsulation plant personnel are also provided.

The personnel canteen is located in the operating building, and shared by all disposal plant personnel working above ground.

The disposal facility does not have its own fire station. The fire safety of the disposal facility is supported by the local community fire and rescue station. However, security personnel are qualified in first-attack extinguishing.

2.6.3 Ventilation shaft building

The ventilation shaft serves for ventilation of the non-controlled repository area, for removal of leakage water and for supply of electric power. The personnel lift for non-controlled area traffic in the repository is also arranged in the ventilation shaft.

The ventilation shaft building is located above the ventilation shaft and the exhaust shaft. The staff facilities of the researchers in the repository's non-controlled area are provided in this building.

The rock mechanical laboratory and the chemistry laboratory are transferred from the research building to the ventilation shaft building at the operating phase of the disposal facility. Office facilities are also arranged in the ventilation shaft building. The personnel shelter is located in the ventilation shaft building.

2.6.4 Research building and storage

The research building is used by persons who work in the ventilation shaft building and in the non-controlled area of the repository. Borehole and water samples for site investigation purposes are examined and stored in this building.

2.6.5 Building for tunnel technology

The building for tunnel technology is constructed at the ONKALO phase. The transformer and the 20 kV power substations for the access tunnel power supply are located in this building.

Facilities for different kinds of access control and telecommunication systems are accommodated in the building for tunnel technology.

2.6.6 Repair shop

A washing plant for vehicles is constructed at the ONKALO phase. At the operating phase the plant will be extended to include the repair shop.

The heavy repair shop and the necessary storages for repair and maintenance of vehicles and machinery are needed, because the repository spaces are constructed with the help of the access tunnel. The excavation machineries are transported into the repository via the access tunnel.

2.6.7 Visitor centre

The visitor centre has been constructed for public relations and for use as a visitors' reception center. It is shared with the Olkiluoto NPP.

Permanent and variable exhibition rooms are provided in the visitor centre. The required meeting rooms, seminar rooms, an auditorium for 123 persons and a cafeteria are also located in this building.

2.6.8 Broken rock yard

The rock storage, the crusher station, the crushed rock storage and the backfill material mixing station are located in the broken rock yard. The broken rock is crushed at the crushing station so that the grain size is suitable for use as backfill material.

The backfill material mixing station is located close to the crushing plant. A backfill material loading station and a heated storage for at least five bentonite containers are needed in the mixing plant.

2.6.9 Fueling station and fuel storage tank

A fueling station is provided for the heavy-duty vehicles working on the disposal site. The largest fuel consumers are the loaders in the broken rock yard. A significant amount of fuel is also needed for broken rock and backfill material transports.

A suitable place for the fueling station is by the road running to the broken rock yard, close to the backfill material mixing station. Diesel oil is stored in an underground storage tank.

2.6.10 Other structures and reservations on the plant site

The district heating network and the potable water network follow the road lines as do also the ground water drainage network and the rainwater sewage network.

The main cable routes are run in trenches along the road line, which passes the production plants. The data communication network also uses the same route.

The bentonite container storage area is located on the road from the Olkiluoto Port. There is an open storing place for 100 twenty-foot containers. The storing place is asphalted. The containers are transferred by a straddle carrier.

A plot of land is reserved close to the crushing station for contractors. The contractors will provide their own barracks during excavation campaigns of the disposal facility.

Another area for contractors is reserved close to the access tunnel entrance already at the ONKALO phase.

Space is reserved for a storage hall for construction materials close to the bentonite container storage area. The need for the construction materials is limited during the operating phase.

The landfill area could be outside the disposal site area. The deposition hole drilling muck is transported to the landfill area or mixed with backfill material. The concrete structures removed from the deposition tunnels are transported to the landfill. Waste materials are recycled if possible.

3 ENCAPSULATION PLANT

A detailed description of the encapsulation plant is provided in reports Kukkola 2002a and b.

3.1 Purpose of encapsulation plant

The spent fuel is received and handled in the encapsulation plant for disposal. The spent fuel is unloaded from the spent fuel cask in the fuel handling cell. The fuel assemblies are enclosed in the fuel canister. The gas-atmosphere of the inner canister is changed, and the inner canister lid is closed. The copper canister lid is fixed by electron beam welding, the weld surface is machined, and the integrity of the weld is inspected. The fuel canister is cleaned and transferred into the canister buffer store to wait for transfer into the repository in the canister shaft lift. All operations in the encapsulation plant are to be carried out safely and without any significant activity releases and personal doses.

The interim storage for the bentonite blocks is arranged in the encapsulation plant. The bentonite blocks are used as buffer material between the fuel canisters and the rock wall in the deposition holes.

The possibility of regular visitors has been taken into account in the design of the encapsulation plant. In principle, visitors can access the uncontrolled area and follow work in the controlled area either directly through radiation shield windows or on monitors.

3.2 Most important functions of encapsulation plant

3.2.1 Receiving of spent fuel

The spent fuel is transported by road to the canister loading area of the encapsulation plant. Spent fuel from the Loviisa NPP is transported in a cask that can accommodate 84 PWR fuel assemblies. The Olkiluoto NPP fuel transport cask has a capacity of 48 BWR fuel assemblies. The spent fuel transport cask is filled with water throughout the transport process.

The road transport trailer is driven to the front of the canister loading area of the encapsulation plant, where the weather guard is rinsed and removed. The trailer is driven into the canister loading area; the collision shock absorbers of the transport cask are removed. The transport cask is lifted in vertical position and either transferred into the storing area or lowered directly into the cask transfer corridor.

The cask loading area can be driven through even if transport casks are stored in the storing positions.

3.2.2 Spent fuel encapsulation

Empty canisters are received, stored and prepared in the same area where the spent fuel casks are received. The empty canister is lowered through an opening in the floor onto the canister transfer trolley.

The canister transfer trolley is driven below the canister docking position. The fuel canister is lifted up and docked tightly to the fuel handling cell. After tightness has been secured, the cover hatch is opened.

The fuel assemblies are lifted out one by one from the spent fuel cask, which is docked to the handling cell in the same way as the fuel canister. The fuel assemblies are transferred into a drying station, and after that the fuel assemblies are installed in the fuel canister. Before this the inner canister lid is opened and the protective sleeve is installed to protect the canister sealing. The atmosphere in the inner canister is changed with the help of the gas atmosphere-changing cap, the inner canister lid is closed and the tightness of the inner canister is checked.

After that, the cover hatch is sealed onto the docking penetration and the fuel canister sealing to the handling cell docking penetration is loosened, and the canister is lowered onto the canister transfer trolley. The copper lid is lifted on top of the fuel canister and the fuel canister is transferred into the welding chamber. The canister is docked into the vacuum chamber where the copper lid is welded by electron beam welding apparatus. The fuel canister is loosened from the vacuum chamber.

In the canister transfer corridor the welding surface is machined with a face-milling cutter. The water-filled sleeve structure is fixed onto the upper part of the canister and the weld is inspected with a multi-channel ultrasonic inspection device.

The canister is transferred and lifted to the X-ray inspection cell. The canister is rotated round its vertical axis and the beam of the X-ray cannon is fixed. After inspection the canister is washed and transferred into the buffer store prior to transfer to the repository.

The fuel canisters are transferred from the buffer store to the repository via the canister shaft. The canister is driven with an automatically guided vehicle into the canister lift cabin and further down to the repository level where the vehicle is driven out with the canister.

3.2.3 Handling of bentonite blocks

The compacted bentonite blocks are used as buffer material between the fuel canister and the rock surface of the deposition hole. The bentonite blocks are transported to the repository via the canister shaft. This is the reason why the bentonite block buffer store is located at the encapsulation plant. The bentonite blocks are purchased from external vendors on the basis of a competitive bidding process or produced in-house. The blocks are compacted from pretreated bentonite powder with 100 MPa pressure.

The bentonite blocks are transported to the interim storage in metal boxes. The boxes are opened in the store and the blocks are loaded on racks for transport to the repository. The racks with the bentonite blocks are transferred into the repository with the canister lift. An air lock separates the lift cabin and the interim store.

3.2.4 Control operations

The encapsulation process is controlled from the process control corridors and monitored from the control room of the encapsulation plant.

Nuclear material safeguarding is performed according to YVL Guide 6.1.

3.2.5 Handling and disposal of active wastes

The encapsulation process will produce some amount of solid and liquid active waste. In principle, the only places where active waste can be produced are the fuel handling cell and the cask transfer corridor where spent fuel cask decontamination takes place.

High level wastes are disposed of together with the fuel assemblies. In the handling cell, some crud, deposit, and possibly detached fuel fractions may be vacuumed and ultimately shed into free positions of the fuel canister before installation of the fuel assemblies.

Liquid waste is evidently generated when the outer surface of the spent fuel cask is washed. The washing water is purified of radioactivity and re-circulated. Filter resins are solidified by concreting and disposed of in the repository waste cavern.

Components removed from the fuel handling cell are decontaminated in the decontamination center before repair or maintenance. Filter resins from decontamination liquids are solidified in the same way as filters from washing waters. Components that are not repaired are emplaced in the repository.

Spent filters from active air-conditioning and handling cell filtration are packed in metallic drums and deposited in the repository.

The most waste is generated at the decommissioning stage of the plant. All fuel handling cell components are disposed of in the repository. The stainless steel lining of the handling cell will be decontaminated but not dismantled. All liquid wastes are solidified by concreting. The required total repository volume is about 5,000 m^3, including decommissioning waste.

3.3 Description of encapsulation plant

The encapsulation plant is the most important building of the disposal facility. The location of the other buildings is determined according to the encapsulation plant. The encapsulation plant is classified as a nuclear facility.

According to preliminary plans, the encapsulation plant is 65 meters long and 36 meters wide. The building is approximately 15 meters high and the building volume is approximately 40,000 m^3. The building will have six storeys.
The encapsulation process is shown in Figure 7.

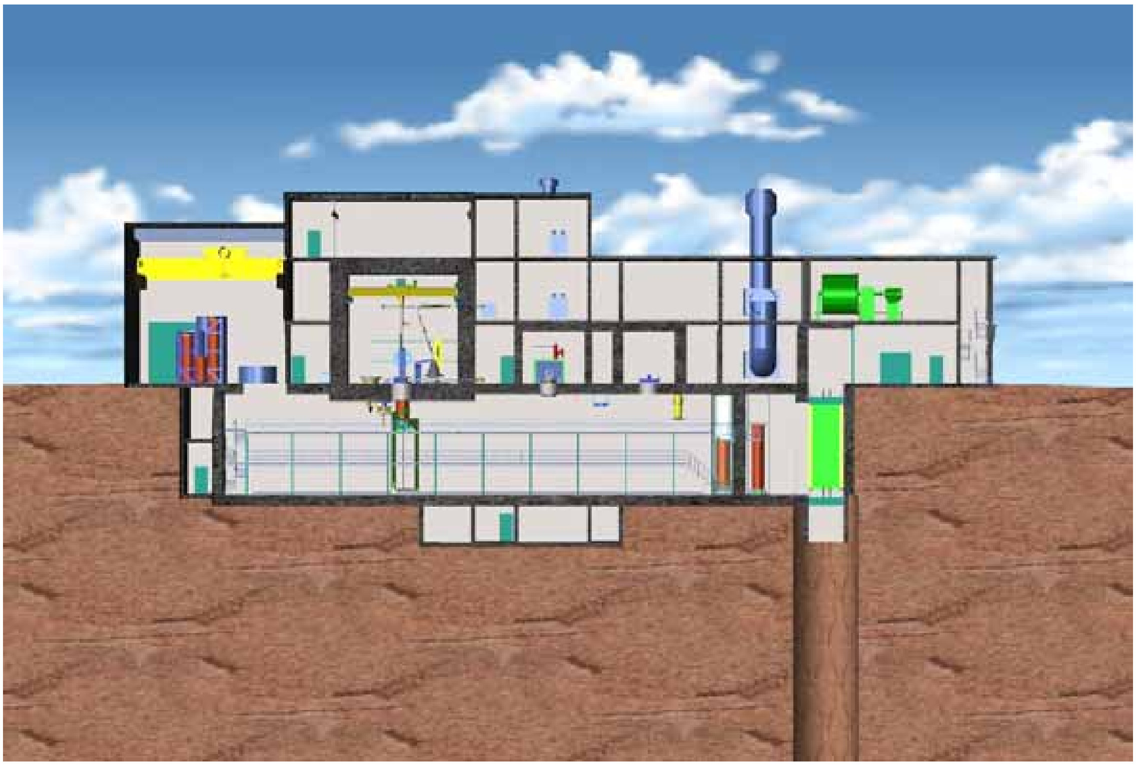

***Figure** 7. Longitudinal section of the encapsulation plant. On lowest level: Canister transfer corridor and canister shaft. On ground level from left to right: Spent fuel cask reception and storage area for empty canisters, fuel handling cell and repair shop above the handling cell. In the middle: welding chamber. To the right: inspection chamber and ventilation equipment room for the repository's controlled area.*

The collector tanks of the clean and the controlled floor drainage systems are located at level -5.00 in order to enable use of gravity based draining. The floor drainage system room contains the drainage water tanks and pumps.

The most important encapsulation works phases are performed at level -1.40. The spent fuel cask transfer corridor is equipped with a track wheeled trolley, which has a lifting device for docking the cask to the handling cell. The bolts of the cask's biological lid are opened in the cask transfer corridor. The spent fuel cask is docked from below into the handling cell.

The fuel assemblies are lifted from the spent fuel cask into the encapsulation process. Before encapsulation the fuel assemblies are dried in the drying station. The rooms for the auxiliary systems of the drying station are below the handling cell. There is a separate drying station for both Olkiluoto and Loviisa fuel.

The fuel canister is transferred from one working position to the next with a canister transfer trolley, which runs on rails in the cask transfer corridor. The canister transfer trolley has a lifting mechanism so that the canister can be docked to the fuel handling cell and to the welding chamber.

The weld surface is machined with a milling machine in the transfer corridor to eliminate interferences in ultrasonic inspection of the weld. The canister transfer corridor is equipped with a milling machine and an ultrasonic inspection device. If a defect is found in the weld, the canister lid can be machined off and the canister docked back to the handling cell. The weld volumetric inspection can be performed with X-ray apparatus in the canister transfer corridor.

Dust and dirt are washed off the canister surface at the end of the canister transfer corridor. The canisters wait for transfer to the repository in the buffer store, which is separated by labyrinth walls from the canister transfer corridor. The capacity of the buffer store is 12 fuel canisters. The canister is transported to the canister shaft lift by an automatically guided vehicle.

Level +2.80 is an intermediate level, which extends over only part of the building area. The maintenance corridor at this level is part of the non-controlled area. Visitors can follow the encapsulation work process through lead glass windows. Electric cabinet rooms are also located at this level.

On the ground level the spent fuel casks are received and stored in the spent fuel cask receiving area. Four storing positions are reserved for spent fuel casks from Loviisa. The receiving area is provided with a bridge crane with a lifting capacity of 140 tons for lifting and transfer of spent fuel casks. The empty fuel canisters are received and stored in the spent fuel cask receiving area. There is room for 24 empty canisters. The empty canisters are lowered with the bridge crane through a floor opening directly onto the canister transfer trolley in the canister transfer corridor.

The most demanding work phases are carried out in the ground level rooms, in the handling cell and in the welding chamber. The fuel handling cell is provided with a fuel-loading machine that can be used for unloading fuel assemblies from the spent fuel cask and for transferring the fuel assemblies into the drying station and into the fuel canister. The encapsulation process is controlled from outside of the fuel handling cell in a maintainable room, with visual communication arranged through lead glass windows.

The fuel handling cell is completely lined with austenitic stainless steel plates. The handling cell is provided with a vacuum ventilation system and an active particle filtration system. The vacuuming system of the fuel handling cell can be used for gathering any crud, fuel fractions or loose particles, which are then inserted into the fuel assembly positions of the fuel canister.

The welding chamber is above the canister transfer corridor rails, so that the fuel canister can be docked to the welding vacuum chamber. The copper lid of the fuel canister is welded in the vacuum chamber with the help of an electron beam welding device. The auxiliary systems of the electron beam welding system are located in the welding chamber. The vacuum chamber is radiation protected, which means the welding chamber is accessible during the welding operation. The X-ray inspection equipment is located adjacent to the welding chamber.

The liquid waste solidification plant is located at ground level. The active workshop, the electric power supply system rooms and the store and reserve rooms are also arranged at ground level.

The bentonite block interim store is at one end of the encapsulation plant. The bentonite blocks are transferred into the repository with the canister lift. The bentonite blocks are packed on a rack, which is transferred by a forklift truck into the canister lift. The canister lift has two stop points in the encapsulation plant.

Level +11.80 is another intermediate level that does not extend over the whole building area. The control room and the instrumentation and control (I&C) cubicles room of the encapsulation plant are at this level. The handling cell air cooling and filtration room is adjacent to the handling cell. The vacuuming system center of the controlled area is also located at this level as well as the canister lift machinery rooms.

The ventilation system equipment and are located at level +16.60.

The controlled area ventilation equipment of the repository is located above the ventilation shafts, which makes it possible to connect the ventilation ducts directly to the ventilation compartments without any horizontal penetrations through structures.

The handling cell decontamination center and the active workshop are located at level +16.60. The handling cell components to be repaired or replaced will first be brought into the decontamination center and, after that, to the active workshop, unless they are sent directly to the repository. There are lifting devices provided for this procedure.

3.4 Alternative with encapsulation plant attached to KPA-store

The encapsulation plant can also be attached to the KPA-store and connected directly with the fuel transfer channel of the fuel storage pools, Figure 8. The fuel from the Olkiluoto plant is transferred directly from the KPA-store fuel pools to the handling cell of the encapsulation plant. The spent fuel cask from the Loviisa plant is either docked directly to the handling cell or the fuel is transferred via the KPA-store to the encapsulation plant like fuel from the Olkiluoto plant.

The encapsulation line itself is identical regardless of whether the encapsulation plant is attached to the KPA-store or independent.

A separate fuel canister receiving building is needed in association with the fuel canister shaft to the repository, Figure 4. The ventilation system of the controlled repository area is also installed in the canister receiving building. The operating building is located close to the canister receiving building.

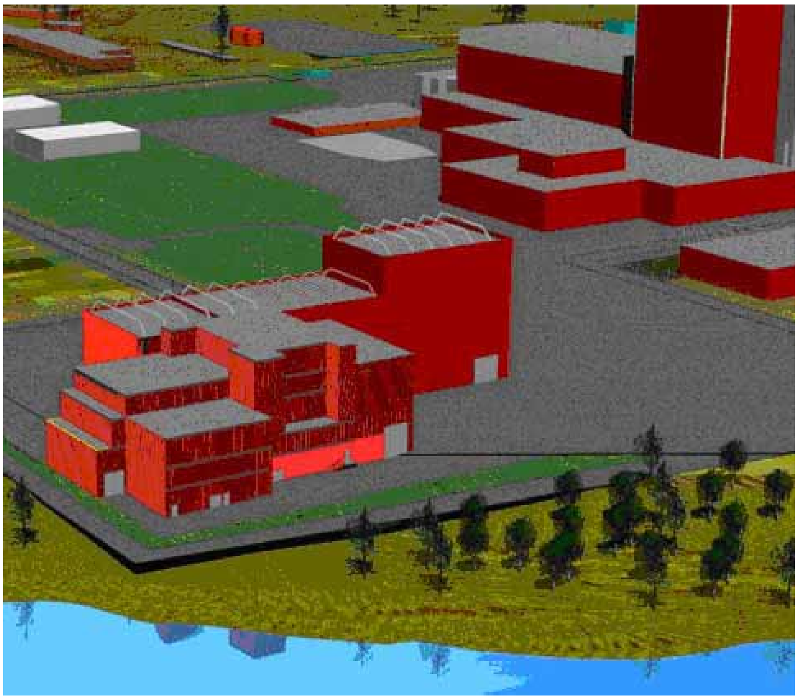

Figure 8. *General view of encapsulation plant attached to KPA-store.*

A transfer system from the encapsulation plant to the canister receiving building is needed. It is assumed that a similar radiation protected transfer vehicle as the one used in the repository can also be used above ground, Figure 9 (Pietikäinen 2003 and Poli 2006).

Figure 9. *Canister transfer and installation vehicle.*

The fuel canister is loaded in the canister transfer vehicle instead of in the canister lift, Figure 10. Note that a crane is needed to transfer and lower the fuel canister from the buffer storage to the canister loading area, Figure 11.

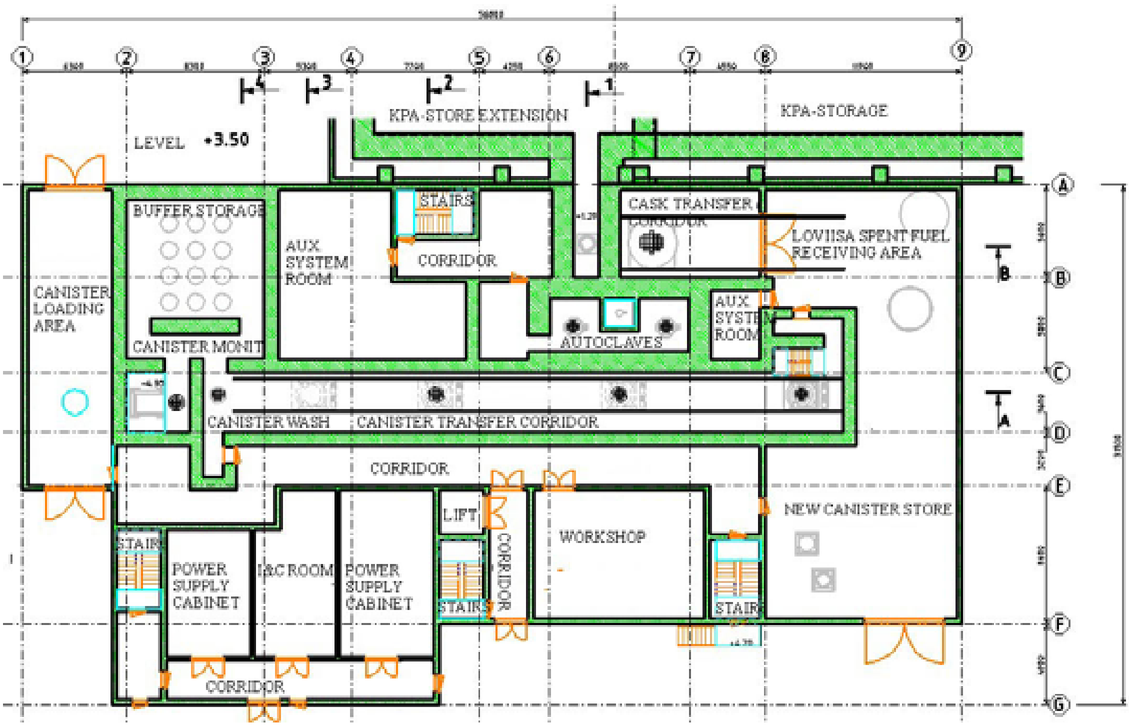

Figure 10. *Level +3.50. Plan drawing.*

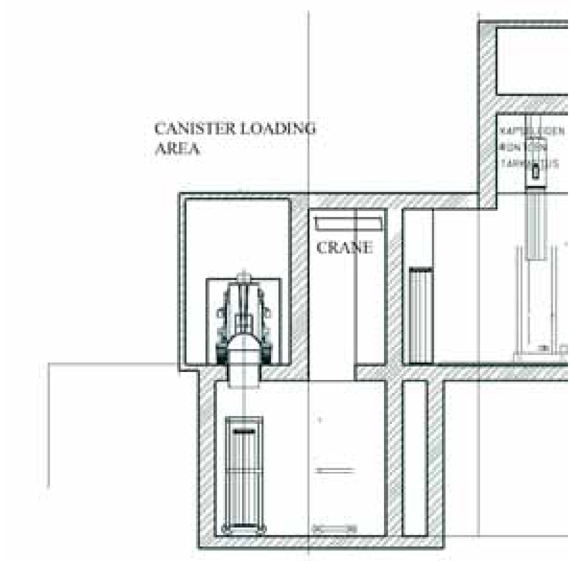

Figure 11. *Canister loading area.*

4 OPERATING BUILDING

4.1 Purpose of operating building

The administrative functions of the disposal facility are centralized in the operating building as are also the operating, repair and maintenance services of the encapsulation plant. The building houses also the personnel canteen and the first aid center. The controlled area lift to the repository is joined to the building. Visitors to the controlled area are received in the operating building that also contains dressing rooms for visitors.

4.2 Most important functions of operating building

Design and control activities for the encapsulation processes are carried out in the operating building where also staff facilities are provided for the encapsulation plant personnel. The facilities of the operating personnel are separate from visitors' facilities.

The controlled area of the repository is accessed with a lift through the control point of the operating building. The visitors change their clothes in a special room at basement level where a lobby is also arranged as a meeting point.

Access to the operating building takes place via the access control point, which is immediately after the main entrance. After the control point it is possible to enter the rest of the disposal site area or to go into the office section of the building or to the non-controlled area of the encapsulation plant. The entrance to the controlled area, to the encapsulation plant or to the repository is in the basement, one floor below the ground floor.

The encapsulation plant can be accessed through two corridors. The underground corridor is used for access into the controlled area and the above ground corridor for access into the non-controlled area.

Dose control is centralized to the same point as access control. Personnel doses are registered whenever a control area boundary is crossed. The dosimeters are read in the control point at basement level.

The disposal facility does not have its own fire station; the facility relies on the local community's fire and rescue services. Security staff is trained in first-attack extinguishing. The fire alarm center is in the central control point.

4.3 Description of operating building

The design of the operating building is based on the pre-design for the 1999 disposal facility concept (Kukkola 1999).

The operating building is located next to the encapsulation plant in the direction of the ventilation shaft building. The length of the building is 42 m and the width is 15 m. The bottom floor is at level 3.60 m and the height of the building is 18.0 m. The building volume is about 11000 m^3.

The locker rooms and the technical rooms as well as the control point for entrance to the controlled area are located on the basement floor.

After the control point the underground corridor leads to the controlled area of the encapsulation plant as well as to the lift that runs to the repository's controlled area. A staircase and a lift are provided for in-house personnel traffic.

The entrance hall and the control point as well as the personnel canteen with a function room for visitors are located at the ground level. The first aid center, toilets and the vehicle control point are located at ground level.

The next floors are reserved for the maintenance group, for the technical group and for the administration group.

Individual office rooms are preferred over an open-plan office. Conference rooms, rest rooms and meeting rooms are provided on all floors.

The office floor arrangement could be as given below:
- One third of the floor area is reserved for office rooms. Standard size rooms are 6 x 6 m and 6 x 3 m. Standard furniture could include a writing desk, a conference table for four persons, filing shelves and a clothes locker.
- Another third of the floor area is reserved for archives, meeting rooms, rest rooms, stairs, the lift shaft and toilets.
- The final third of the floor area is reserved for corridors and variable spaces.

The air-conditioning plant is located at roof level.

4.4 Special features of operating building

4.4.1 Entrance hall

The two-storey tall entrance hall is so spacious that all guests can be accommodated in the building. A sufficient number of toilets as well as water coolers should also be provided.

4.4.2 Building architecture

Figure 12 presents a view of the operating building.

Figure 12. *Operating building view. Operating building to the left and encapsulation plant to the right.*

5 VENTILATION SHAFT BUILDING

The ventilation shaft building will be constructed already at the ONKALO phase.

5.1 Purpose of ventilation shaft building

At the operating stage of the disposal facility research and planning work for repository extension is carried out in the ventilation shaft building.

The locker rooms serve the building personnel and those working in the non-controlled area of the repository.

Ventilation of the repository's non-controlled area, removal of leakage water, and electric power supply are implemented through the ventilation shaft. The fuel tank in the repository is filled with the help of a pipeline located in the ventilation shaft.

The building comprises a visitors' reception room with necessary lockers. Personnel traffic to the non-controlled area of the repository takes place by a lift for 26 persons.

5.2 Most important functions of ventilation shaft building

5.2.1 Shaft technical functions

Power supply to the repository is led along the lift shaft. The cables are fire resistant.

Leakage water is pumped up via the lift shaft. Domestic water supply to the repository is led along the lift shaft.

A separate exhaust ventilation shaft is raise-bored for ventilation of the repository's non-controlled area. Inlet air is led through the ventilation shaft.

5.2.2 Switchgear plant

The separate switchgear plants for service consumers and for the repository's needs are located in the ventilation shaft building. The distribution board for the disposal facility is located in this building.

5.2.3 Ventilation plant rooms

The repository's non-controlled area ventilation plants are located at ground level +7.00 m. The ventilation plants comprise inlet and outlet fans, smoke ventilation fans, heating boilers and radiators, a heat recovery unit, moisture separators as well as inlet air filters and outlet air silencers.

Inlet air is heated with electric boilers that have a heating capacity of 3 x 450 kW.

5.2.4 Operating functions

The measured geotechnical data from the repository are logged and pre-processed in this building. It is also possible that preliminary rock characterization, geotechnical modelling and updating of the model will take place in this building, as well as computational fluid dynamics (CFD) analyses.

5.2.5 Maintenance and service functions

The staff facilities for the researchers in the non-controlled area are arranged in the ventilation shaft building as are also locker rooms for visitor groups. The visitors' locker rooms are separated from the staff facilities. The maximum size of visitor groups is 50 people at a time. A sufficient number of toilets are reserved also for visitors' needs.

5.2.6 Storages

The storage of core samples on shelves is arranged at the bottom level of the building. The boxes of core sample are piled on pallets, which are handled by a fork-lift truck.

5.2.7 Laboratories

The laboratories are at level +10.80 m. The samples are brought to the laboratories by a lift. The core samples are photographed and detailed investigations are made. The chemical and physical laboratories as well as the backfill material laboratory are located in the building. The instrument workshop is incorporated with the laboratories.

5.3 Description of ventilation shaft building

The location of the ventilation shaft building is determined already at the ONKALO phase. The ventilation shaft building is above the ventilation shaft and the exhaust raise.

The rock mechanical laboratory and the chemistry laboratory are transferred from the research building to the ventilation shaft building at the operating stage of the disposal facility. The personnel shelter is located in the ventilation shaft building.

The maximum length of the building is about 60 m and the maximum width 50 m. The building bottom is at ground level +7.00 and the roof level is +14.00 m. The building volume is about 5000 m^3 and the building area is 1500 m^2. The diameter of the ventilation shaft is 6.2 m and the diameter of the exhaust ventilation raise is 3.5 m.

Heavy equipment are located at ground level +7.00 m. In addition, storages, laboratories and an instrument workshop as well as locker rooms are located at ground level.

Office and meeting rooms as well as the idler wheel of the personnel lift for the non-controlled area of the repository are at level +10.40 m.

6 RESEARCH BUILDING

6.1 Purpose of research building

The research building is constructed already at the ONKALO phase.

The rock mechanical laboratory and the chemical laboratory as well as the core sample laboratory are located in the research building. The building is one storey high, Figure 13.

A separate one-storey storage building is constructed for the research building.

Part of the laboratory activities will be transferred to the ventilation shaft building before the operating stage of the disposal facility.

6.2 Most important functions of research building

The core samples are studied in the research building. The core samples are subjected to a preliminary study using a roll spreader table and analysed in the laboratories. The building also contains an instrument workshop and different kinds of accessories and tools.

The storage where the pallet shelves are arranged for the core samples is located on the opposite side of the research building. The pallets are handled with a fork-lift truck. Also different kinds of rods, plugs, hose pipes, valves and cables are stored in the building.

Groundwater analyses are made in this building. At the operating stage of the disposal plant water sample analyses will be performed in the ventilation shaft building.

Figure 13. *Research building seen from the west (Photo Posiva Oy).*

7 BUILDING FOR TUNNEL TECHNOLOGY

The building for tunnel technology is constructed already at the ONKALO phase. The building for tunnel technology is located close to the access tunnel entrance, Figure 14.

7.1 Purpose of building for tunnel technology

The building for tunnel technology contains rooms for telecommunication, power supply and access control.

7.2 Most important functions of building for tunnel technology

The transformer and the 20 kV feeder switchboards for access tunnel power supply are located in the building.

The building for tunnel technology comprises rooms for access control and telecommunication.

Figure 14. *Building for tunnel technology (Photo Posiva Oy).*

8 REPAIR SHOP

The washing plant for vehicles is constructed already at the ONKALO phase, close to the access tunnel entrance, Figure 15. The repair shop will be realized as an extension of the washing plant.

8.1 Purpose of repair shop

The repository spaces are constructed with the help of the access tunnel. All the excavation machineries are transported into the repository via the access tunnel. Broken rock is also transported out of and backfill material into the repository via the access tunnel. For this reason, a heavy repair shop and necessary storage facilities for repair and maintenance of vehicles and machinery are needed.

8.2 Most important functions of repair shop

Repair and maintenance works on repository machinery are carried out in the repair shop, especially precision repair work that cannot be performed in the repository's repair shop. Broken rock transport equipment, rock crushers, crushed rock conveyors and heavy-duty vehicles are also repaired and maintained in the heavy repair shop.

Electric equipment will also be repaired in this heavy repair shop.

A separate machinery washing plant is needed in the repair shop with an effective high-pressure washer.

The repair shop is equipped with a 20-ton bridge crane as well as with the required welding, inspection and machining apparatus. The floor drainage system is equipped with an oil trap well.

The repair shop office is located adjacent to the outer wall of the building so that a window that opens outward can be arranged as well as a window that opens inward to the adjacent storage room.

Figure 15. *Washing plant to be extended into the repair shop (Photo Posiva Oy).*

9 VISITOR CENTRE

9.1 Purpose of visitor centre

The purpose of the visitor centre is to serve as the base of the information services and also as the receiving centre of visitors to Olkiluoto. The visitor centre is shared with the Olkiluoto NPP.

Permanent and variable exhibition rooms are located in the visitor centre. The exhibitions and publicity materials are designed in this building. Visits and international contacts are also organized in this building.

The visitor centre has a restaurant. The kitchen could be common with the canteen in the operating building.

9.2 Description of visitor centre

The length of the L-shaped visitor centre is about 75 m and the width about 22 m. The bottom level of the building is at ground level and the height of the building is 5.50 m. The building volume is about 12600 m^3.

An auditorium seating 123 persons is in the northern part of the building. The restaurant, the kitchen and the toilets are located in the mid-section of the building. Offices and permanent exhibition rooms are located in the next part of the building. The building also houses office rooms and seminar rooms.

The building has a spacious glassed-walled terrace. Figure 16 shows a view of the visitor centre.

Figure 16. *View to the visitor centre.*

10 BROKEN ROCK YARD

10.1 Broken rock storage

Broken rock is transported up from the repository with heavy trucks along the access tunnel and unloaded in the broken rock storage.

The base area of the broken rock storage could be about 55000 m^2. Stack height is about 10 m and slope is 40^o. The volume of broken rock in the stack is about 350000 m^3, which corresponds to the volume hoisted in one and a half years.

The broken rock storage, the crusher station and the crushed rock storage are shown in Figure 17.

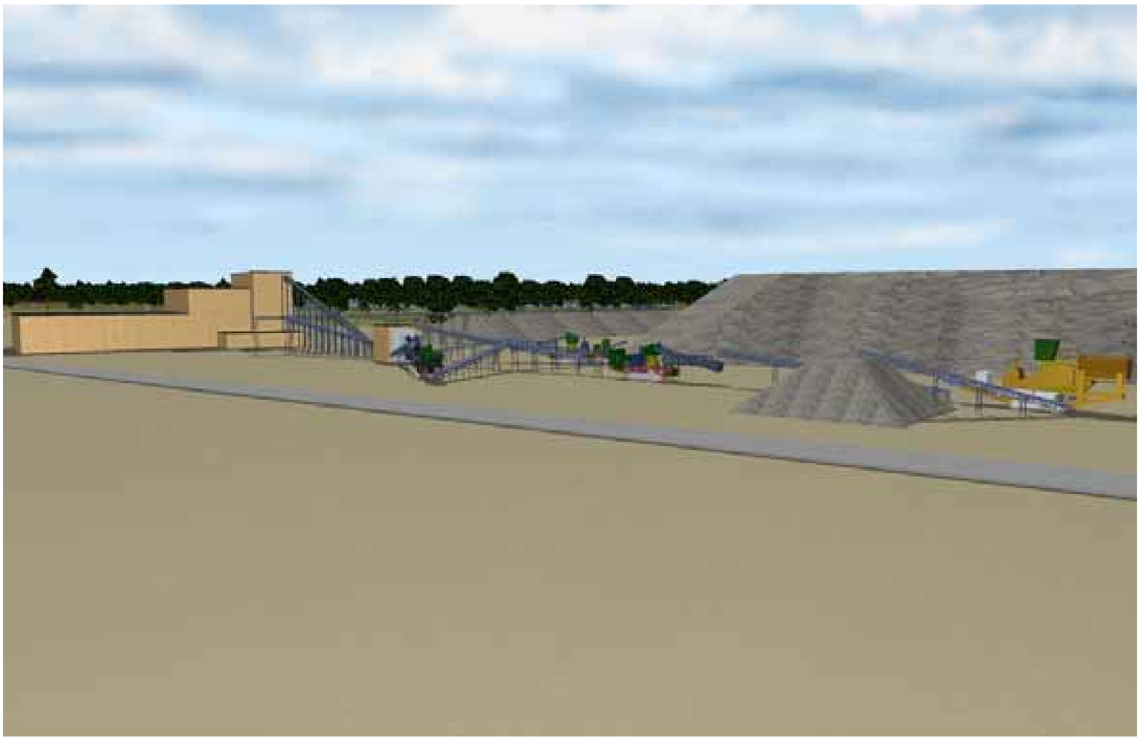

Figure 17. *Broken rock storage on the right, crusher station in the center and crushed rock storage in the background. The backfill material mixing station is on the left in the figure.*

10.2 Crusher station

The crusher station is mobile. The conveyors are fixed. The crushing contractor is in charge of transferring the rock to the crushing plant. A land area is reserved for the crushing contractor close to the crushing plant. The crushing contractor arranges his own barracks for his needs.

Rock may be crushed periodically or continuously as required. Generally rock crushing takes place in the summertime. The duration of the crushing period is two months, every other year. Generation of dust is prevented by water spraying. The broken rock is washed before crushing by a high-pressure washer in order to prevent organic material from mixing into crushed rock. The crushing process and the timing should be optimized when the composition of the backfill material is known.

10.3 Crushed rock storage

Crushed rock can be stored in one stack. The width of the stack could be for example 20 m, top width 6 m and length 200 m. A stack height of 6 m equals a crushed rock volume of 15000 m^3, which corresponds to one and a half months' backfill material need. It may be necessary to somehow protect the crushed rock storage to prevent dusting and crushed rock particle segregation.

The crushed rock is transferred with mine loaders to the silo of the backfill material mixing station. The size of the silo could be for example about 20 m^3.

10.4 Backfill material mixing station

Backfill material for the deposition tunnel is produced in the backfill material mixing station at ground level. The final composition of backfill material has not been decided on, yet. One alternative is to use the compacted blocks and pellets as backfill material, which is referred to as the reference concept. The second alternative for use as backfill material could be a mixture of crushed rock and bentonite. The use of binder agents is not excluded.

The backfill material mixing station is located close to the crusher station. A backfill material loading station and heated storage space for at least five bentonite containers are needed in connection with the mixing station.

If the cross-sectional area of the deposition tunnel is about 15 m^2 and the distance between deposition holes about 10 m, the need of backfill material for one fuel canister is about 150 m^3. If the bentonite content is 30%, about 45 m^3 of bentonite is needed for each canister. This is equivalent of 85 tons of bentonite, if the filling material is compacted to a density of 1.9 kg/liter. A maximum of 20 tons can be loaded in one 20-foot container, which means that about four containers of bentonite are needed for one deposition hole. The bentonite is packed in a flexible intermediate bulk container that has a volume of 1.5 m^3 and a weight of 2000 kg.

Tap water is used to moisten the backfill material. If 10 vol% of water is added, 15 m^3 of water is needed for every deposition hole.

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APPENDIX TABLES

Appendix table 1. *Specific consumptions.*

Water consumption:
Water consumption in work places: 150 l/person/day.
Domestic water consumption: 250 l/person/day.
Proportion of hot water: 25 %.

Heat consumption:
Office buildings: 50 kWh/m^3/a.
Industrial buildings: 75 kWh/m^3/a.
Rock caverns: 13.5 kWh/m^3/a.
Storages: 20 kWh/m^3/a.

Electric power consumption:
Domestic electricity consumption: 4 kWh/m^3/a

Electric power installations	Lighting W/m^2	Wall sockets W/m^2
Office rooms, normal	15	70
Office rooms, meeting rooms	20	70
Office building, executive office	15	70
Office building, shop	15	70
Workshop, mechanical production	15	250
Workshop, electrical installation	15	250
Industrial facility, storage	10	40
Industrial facility, production plant	15	150
Residential house, apartment	5	100
Residential house, storage	10	40
Average values	13.5	111
Repository spaces	5	2
Street, courtyards	0.5	1

Fuel consumption:
Diesel engines: 0.200 kg/kWh.

Waste accumulation:
Domestic waste to landfill: 10 l/person/day.

Material densities:

Material	Ton/m^3
Compacted bentonite	2.0
Loose bentonite	1.5
Bentonite in back-filling material	1.9
Crushed rock in back-filling material	1.9
Solid rock	2.7
Broken rock	1.6
Crushed rock	1.6

Appendix table 2. *Building volumes and dimensions.*

	Building volume	Building area	Floor area	Length	Width	Height 1)	Floors
Building	m^3	m^2	m^2	m	m	m	
Encapsulation plant	38370	2340	4500	63	36	20	6
Operating building	10590	657	2429	42	15	18	5
Ventilation shaft building	5000	1500	3000	60	50	7	2
Research building	5580	930	885	40	30	6	1
Building for tunnel technology	1800	320	300	20	15	6	1
Repair shop	7200	850	800	40	20	9	1
Visitor centre 2)	6540	684	1449	48	18	11	3
Total	75080	7281	13363				
Disposal site area			150000				
Repository spaces (open)	400000	95000	95000	18300	4	5	1

1) For building volume determination.

2) Posiva's share

Appendix table 3. *Water consumers.*

		Average	Total
Object	Consumer	m^3/day	m^3/a
Encapsulation plant	Process water	0.99	361
	Potable water	1.35	493
	Washing water	0.50	183
Operating building	Potable water	7.80	2847
Ventilation shaft building	Washing water	0.50	183
	Potable water	1.20	438
Research building	Potable water	4.05	1478
Building for tunnel technology	Process water	0.50	183
Repair shop	Washing water	0.86	314
Visitor centre 1)	Potable water	3.30	1205
Backfill material mixing station	Process water	3.82	1394
Crusher station	Sprinkler water	3.18	1161
Repository spaces	Washing water	3.70	1351
	Potable water	2.10	767
	Excavation	17.26	6300
	Deposition hole drilling	2.32	847
Total		53.43	19502

1) Posiva's share

Appendix table 4. *Waste water producers and waste water treatment.*

			Waste water treatment		
		Waste water production	Settling and filtering	Oil separation	Biological purification
Object	Source	m^3/day			
Encapsulation plant	Washing water	1.35			X
	Floor drains + process leaks	1.49	X		
Operating building	Washing water	7.8			X
Ventilation shaft building	Washing water	1.2			X
	Floor drains	0.5	X		
Research building	Washing water	4.05			X
Building for tunnel technology	Floor drains	0.50		X	
Repair shop	Washing water	0.86	X	X	
Visitor centre 1)	Potable water	3.30			X
Crusher station	Sprinkler water	3.18	X		
Backfill material mixing station	Washing water		X		
Repository spaces	Rock leakages	800.00	X		
	Washing water	3.70		X	X
	Excavation	17.26	X		
	Deposition hole drilling	2.32	X	X	
Total		847.51			
Total except rock leakages		47.51			

1) Posiva's share

Appendix table 5. *Electric power consumers***.**

Object	Consumer	kW	h/a	MWh/a
Encapsulation plant	Canister lift	980	60	60
	Electron beam welding device	50	60	3
	Ventilation fans for controlled area repository	113	8760	991
	Bridge cranes	150	60	9
	Conveyors	20	1500	30
	Building electrification	675	1500	1013
	Lighting	68	2000	135
Operating building	Personnel lift to the repository	140	150	21
	Building electrification	170	1500	255
	Lighting	36	2000	73
	Personnel lift	28	150	4
Ventilation shaft building	Ventilation fans, non-controlled repository	145	8760	1272
	Personnel lift	140	150	21
	Building electrification	183	1500	275
	Lighting	18	2000	37
Research building	Building electrification	73	1500	110
	Lighting	16	2000	31
Building for tunnel technology				
	Building electrification	8	1500	12
	Lighting	2	2000	4
Repair shop	Pumps	10	1500	15
	Bridge crane	10	150	2
	Welding machines	10	100	1
	Building electrification	4	1500	6
	Lighting	1	2000	2
Backfill material mixing station	Mixers	60	720	43
	Building electrification	7	1500	11
	Lighting	2	2000	4
Visitor centre 1)	Kitchen	10	1500	15
	Building electrification	101	1500	152
	Lighting	22	2000	43

Object	Consumer	kW	h/a	MWh/a
Crushing station	Rock crushers	783	350	274
	Crushed rock conveyors	52	350	18
	Spraying	12	350	4
Crushing station	Rock crushers	75	4000	300
Repository spaces	Building electrification	77	1500	115
	Lighting	192	2000	384
	Leakage water pumps	62	8760	540
	Cranes	20	150	3
	Drilling machine for deposition holes	333	720	240
	Investigation drilling machines	65	720	47
	Drilling jumbos	160	720	115
	Shotcreting machine	65	350	23
	Total	5148		6712

1) Posiva's share

Appendix table 6. *Heat consumers***.**

Specific heat of oil is 0.11 kg/kWh

Encapsulation plant	Building volume m^3	Specific consumption $kWh/m^3/a$	Annual consumption MWh/a
Operating building	38370	75	2878
Ventilation shaft building	10590	50	530
Research building	5000	75	375
Building for tunnel technology	5580	50	279
Repair shop	1800	50	90
Encapsulation plant	7200	50	360
Visitor centre 1)	6540	50	327
Total	75080		4838
Repository spaces	400000	13.5	5400
Grand total			10238

1) Posiva's share

Appendix table** 7. Traffic tonnages.**

<u>*Heavy transports to the disposal site*</u>

Material	Vehicle	Annual	Monthly	Unit load	Frequency	
		tons (net)	tons (net)	tons (net)	monhly	daily
Spent fuel	Special vehicle	1152	105	120	0.9	0.0
Bentonite containers	Trailer truck	4218	383	40	9.6	0.4
Diesel oil	Tank truck	160	15	40	0.4	
Building materials*	Trailer truck	4817	438	20	21.9	1.0
Fuel canisters	Truck	800	73	20	3.6	0.2
Total		**11146**	**1013**			

Note: Transports are average values. The frequency may vary depending on the transporting method. Table is based on an annual production of 40 canisters.

*During construction phase.

<u>*Heavy transports at site*</u>

Object	Vehicle	Annually	Monthly	Unit load	Frequenc y	
		tons (net)	tons (net)	tons (net)	monthly	daily
Broken rock*	Dumper	16189	1472	10	147.2	6.7
Broken rock to crushing	Dumper	16189	1472	5	294.3	13.4
Crushed rock to backfill	Dumper	7975	725	5	145.0	6.6
Sold crushed rock	Trailer truck	8215	747	20	37.3	1.7
Bentonite blocks	Trailer truck	800	73	20	3.6	0.2
Bentonite to back-filling	Straddle carrier	3418	311	20	15.5	0.7
		52785	**4799**			

* Could be stored.

Light material transports to and from the site

Object	Vehicle	Annually tons (net)	Monthly tons (net)	Unit load tons (net)	Frequency monthly	daily
Goods	Van	242	22	0.5		2
Food	Van	242	22	0.5		2
Waste	Truck	220	20	5	4	
Post	Van	24	2.2	0.1		1
Total		**728**				

Personnel traffic to disposal site

Object	Vehicle	Frequency monthly	daily
Encapsulation plant	Passenger car		50
Ventilation shaft building	Passenger car		20
Kitchen and service	Passenger car		10
Visitors	Bus	10	
Specialists	Passenger car	10	

Appendix table 8. *Rainwater and groundwater sewage.*

	m^2	l/s/
Design depth of rainfall ($l/s/m^2$)		150
Covered area on disposal site	25364	
Water flow		380
Crushed rock heap area	8000	
Water flow		120
Excavated rock pile area	55000	
Water soaked in rock pile		825
Surface water drainage		
Specific disposal site area	15336	
into rainfall water drainage		153
soaked into ground		77
Rock and crushed rock area	12000	
into rainfall water drainage		120
soaked into ground		60
Rainfall water drainage total		774
Soaked into ground total		962
Fraction collected by drainage	0.667	
Fraction soaked into ground	0.333	