# On-Site Disposal of Radioactive Waste as a Part of Finnish Radioactive Waste Management System - 14547

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## ABSTRACT

One feature of the Finnish radioactive waste management system is that there is no centralized national repository for low- and intermediate level waste. The reactor operators, Fortum Power and Heat Oy and Teollisuuden Voima Oyj, have their own disposal facilities at their Loviisa and Olkiluoto sites. The power plants personnel is responsible for the operation of the repositories, hence, no additional personnel is needed. The repositories are monitored from the control rooms of the plants, and maintained by the plant maintenance staff. The transportation of waste takes place within the power plant's area outside the public roads, again by the plant's own personnel. The repositories will later be expanded for the decommissioning waste. Preliminary plans for that are already available. The disposal of decommissioning waste was taken into account in the design. For example the access tunnel of the Loviisa repository is large enough for transportation of steam generators and reactor pressure vessels in one piece. The repositories have operating licences for disposal of the operator's own operational waste with minor exceptions. The licenses are valid until 2055 in Loviisa and 2051 in Olkiluoto. New licenses are needed for the extension of the repositories for decommissioning waste. The licensing process, including a new environmental impact assessment and construction of new disposal tunnels or vaults, takes about 10 years. The availability of an own disposal facilities near the plant plays an important role in reducing waste management costs, especially during decommissioning, since the waste can be transported directly to the repository.

## INTRODUCTION

One feature of the Finnish radioactive waste management system is that there is no centralized national repository for low- and intermediate level waste (LILW). The reactor operators, Fortum Power and Heat Oy and Teollisuuden Voima Oyj, have their own LILW disposal facilities at the Loviisa and Olkiluoto Nuclear Power Plant (NPP) sites. The repository at Olkiluoto has been in operation since 1992 and the repository at Loviisa site was taken into operation in 1999. Before the utilities made decisions about constructing their own repositories there were discussions about constructing a common repository either at one of the NPP sites or at a new site outside the power plant area. These negotiations never led to an agreement, partly due to the fact that the utilities wanted to avoid transportation of nuclear waste across the country (the distance between the Loviisa and Olkiluoto sites is about 370 km). In addition, there was no interest in opening a new nuclear site.

The repositories have operating licences for disposal of the operator's own operational waste only, with only minor excemptions. The repository at Loviisa has been designed for disposal of the waste from Fortum's two VVER-440 -units at Loviisa. The Olkiluoto repository match with the needs of the existing two boiling water reactor units (OL1 and OL2) at Olkiluoto. The repository at Olkiluoto will also be used for disposal of small amount of institutional waste too.

Both repositories can be expanded for the waste from the new plant units. In fact, the operating license of Olkiluoto repository has just been updated to cope with the waste from the new Olkiluoto 3 unit, which is under construction. Later the licences can further be expanded for the disposal of the decommissioning waste of the NPP units.

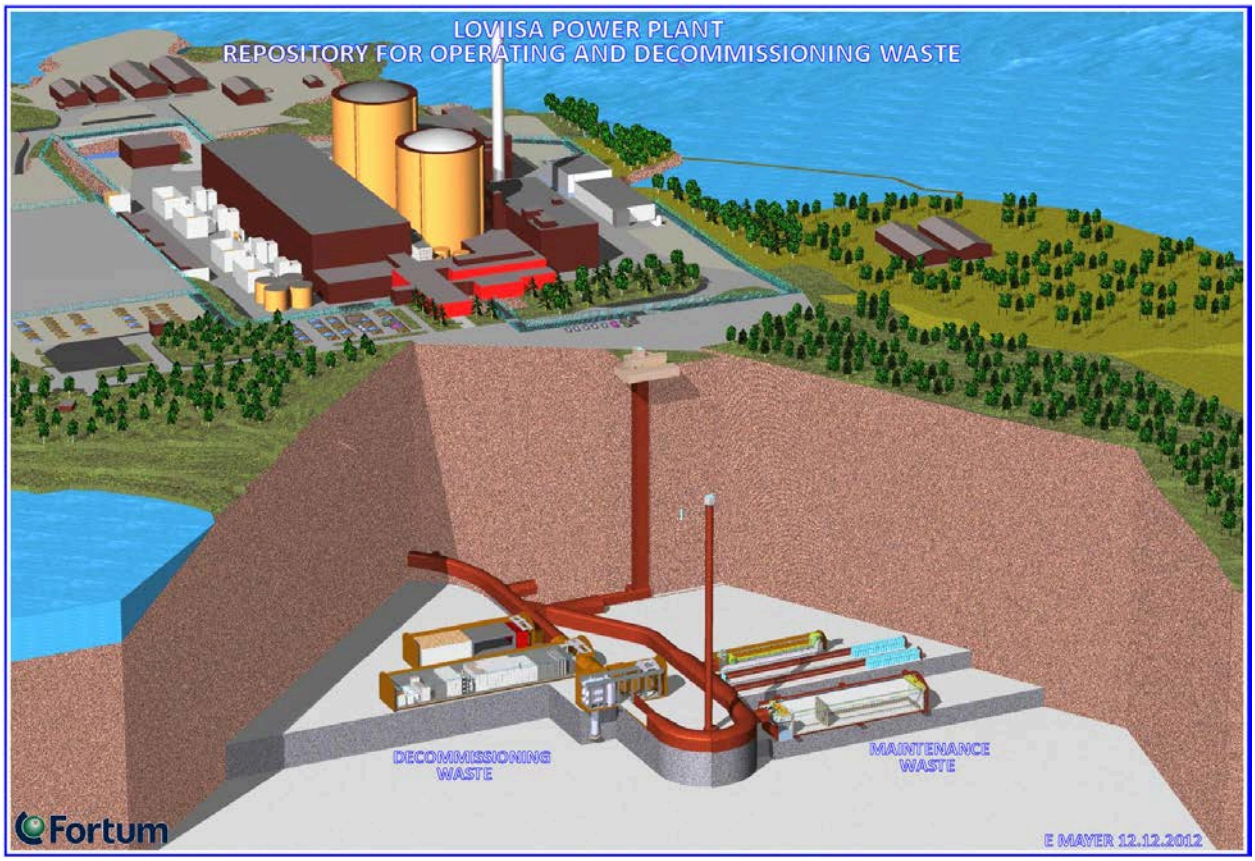


Fig. 1. LILW repository at the Loviisa Nuclear Power Plant site. Existing tunnels for maintenance waste in the right and the planned extensions for the decommissioning waste in the left.

## LOW- AND INTERMEDIATE LEVEL REPOSITORIES

### Loviisa

The low- and intermediate level waste repository (VLJ-repository) at the Loviisa site (fig. 1) was constructed between 1993 and 1998 and expanded later in two parts. The first expansion was completed 2007 and the second one 2012. The first construction phase included the access tunnel, two tunnels for low-level operational waste (HJT1 and HJT2) and the excavation of the hall for the intermediate-level solidified waste (KJT). During the first expansion phase the construction of the solidified waste hall (KJT) was completed with construction of a concrete vault and providing it with the necessary equipment (crane, operating point etc.). The second expansion phase included the construction of the third tunnel for the operational waste (HJT3, for sorting and storage purposes only, and constructing an additional loop to the end of the access tunnel to make the transportation of the waste easier. Fig. 1 shows both the existing disposal tunnels for the operational waste and the planned extensions for the decommissioning waste disposal.

The repository at the Loviisa site is located in a distance of about 400 m from the power plant units, at a depth of some 110 m in a crystallized rock (*rapakivi granite*). A transport tunnel of about 1,1 km leads down to the repository. The construction of the access tunnel was done taking into account the future decommissioning of the power plant units. The transport tunnel has dimensions large enough for transportation of all large components (reactor pressure vessel, steam generators) to the repository without cutting them.

The repository at the Loviisa NPP site has an operating licence for disposal of operational waste from the Loviisa NPP units only. Operating licences of the radioactive waste repositories, as well as the new YVL guides of the nuclear safety authority STUK, require a periodic safety review of the repository every 15 years. This work was completed for the first time at Loviisa at the end of 2013. It included, for example, a review of the operating experience and results of the monitoring programmes of the repository, as well as the evaluation of the status of the operational and long-term safety. A complete long-term safety case was not included in the review. The operating license is granted until 2055.

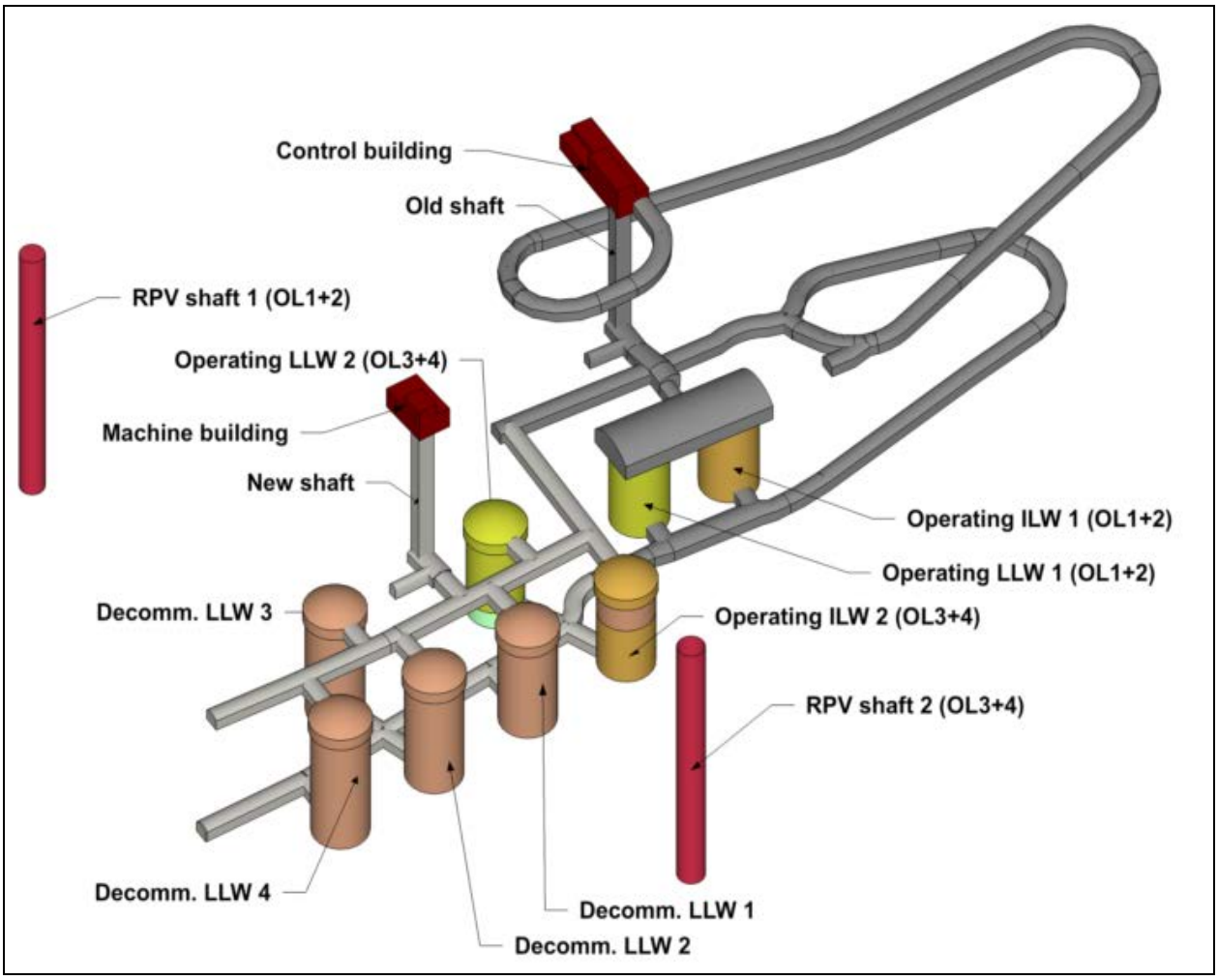


Fig. 2. LILW repository at the Olkiluoto site. Existing vaults for the operational waste from Olkiluoto 1 and 2 units and the planned extensions for the waste from Olkiluoto 3 and 4 units as well as for the decommissioning waste [1]

**Olkiluoto**

The low- and intermediate level waste repository (VLJ-repository) at the Olkiluoto site (fig. 2) was constructed between 1988-1992. The construction included the access tunnel and separate silos for low- and intermediate-level operational waste. The silo for the intermediate level waste includes a concrete wall as an additional release barrier. The operational waste from the plant is packed into drums which are then put into concrete boxes. Originally 12 or 16 drums of 200 l each were packed into one concrete box. Today the drums are compressed to half of the original volume, hence, the number of drums placed into one concrete box is doubled. See fig. 3 for a view into the silo at the Olkiluoto repository.

The operating licence of the Olkiluoto LILW repository is valid until 2051. The license was updated in 2012 to take into account the disposal needs of the new Olkiluoto 3 power plant unit. At the same time the disposal of small volumes of government-owned institutional waste to the Olkiluoto repository was licensed. This waste, including for example sealed radiation sources, has been stored for some years at the Olkiluoto repository in a separate storage room.

The repository at the Olkiluoto site is located at a distance of about half a kilometer from the power plant units. The top of the silos, which all are about 35 m high, is at a depth of some 60 m below the ground surface. The repository is located in a crystallized rock. A transport tunnel, about 665 m long, leads down to the repository.

Fig. 3. View to the low- and intermediate level waste silo at the Olkiluoto repository (Source: TVO).

## OPERATION OF THE REPOSITORIES

Having a repository on-site provides many advantages for the waste management operations during plant operation or for the future decommissioning of the power plant units. During operation the waste can be transported directly to the repository without storing it in an interim storage for a long time. The repositories on site do not need any additional personnel. The power plant's staff is available for operation and maintenance as well as for the guarding and transportation of the waste. During the decommissioning phase the large components and structures, such as steam generators or the reactor pressure vessels or concrete blocks from the biological shield, can be transported directly to the repository without keeping them in an interim storage. All transportations take place within the power plant area, hence, no public road will be used. Also during this phase the repository does not need additional staff since all the operations can be done by the decommissioning organisation.

### Loviisa

At the Loviisa NPP site the responsibility for the repository rests with the waste management team, comprising about 10 persons, which is a part of the plant's safety department. The waste management team takes care of the packaging of the waste, measures the waste drums going to the repository or to free release, and participates in the transportation of the waste to the repository. The plant maintenance and supporting services staff also participate in the repository operations as a part of their normal duties, for example during the transportation or lifting of the waste packages. The transportation of the waste is typically done in campaigns. The repository is normally not occupied, hence, there is no staff there all the time. The repository is monitored from the plant's control rooms and guarded by the power plant's security people. Separate monitoring and research programmes support the operation. Within this programme, for example, samples of ground water are taken and analysed, the leakage flow rate to the repository is measured, and conditions of the bedrock and the concrete structures are monitored. The plant own laboratory is used for taking and analysing the samples although external service providers are used for more specific analyses. The studies of the durability of the concrete structures play an important role in the monitoring programme since they form a part of the engineered barrier systems at the repository.

### Olkiluoto

At the Olkiluoto NPP site the responsibilities for the repository are divided between several disciplines at the site organization. Concerning everyday operation, the packing, transportation and disposal of the waste is done by the plants fuel- and waste handling team, which is a part of the operations department. In the similar manner, like at Loviisa, there is no permanent staff in the repository. The transportation of waste takes place inside the power plant area and it is typically made in campaigns. See fig. 4 for the transport vehicle used at Olkiluoto for transportation of the low- and intermediate level waste. A monitoring and research programme supports the operation of the repository. In addition to taking groundwater samples and analysing them, leakage flow rates and conditions of the bedrock are studied and monitored. TVO has also some long term experiments under way at the Olkiluoto repository. One of them is dealing with long-term durability of concrete in local groundwater conditions. Another is studying gas generation from the operational waste after closure of the disposal facility. In this experiment 16 drums of operational waste have been put into a concrete box in a container filled with local

ground water and the gas generation has been measured. The experiment started about 15 years ago and the planning of the termination of the test is now under way.


Fig. 4. Transportation of waste to the Olkiluoto repository (source: TVO/Korpi-Hallila).

## FUTURE EXPANSIONS OF THE REPOSITORIES

Before the decommissioning of the power plant units begins, a new licencing process for the repository extension shall be started. In the case of the Loviisa LILW repository, it is estimated that it takes about 10 years to licence and construct the new tunnels or vaults for the decommissioning waste disposal. This process, which includes an environmental impact assessment and a new political decision, the so called decision in principle, from the Finnish parliament, shall be started in early 2020s, if the plant unit's operational lifetime is not extended beyond the current 50 years.

### Loviisa

The repository at Loviisa will later be expanded for the decommissioning waste of the power plant units. Preliminary plans for the extensions are available and they have been used as a basis for the decommissioning planning and cost estimation. Two new vaults and a cavity for large components and reactor pressure vessels are needed for the decommissioning waste from the two operating VVER-440 units of the Loviisa NPP. See the left side of fig. 1 for location of the decommissioning waste tunnels and vaults. Further expansion is also possible, if new NPP units will be built in the future at the Loviisa site or if the plant’s operational life is expanded beyond the current 50 years. A very preliminary expansion plan for this additional extension was done

some years ago, when Fortum applied for a license to build a new plant unit at the Loviisa site. This expansion study presented two alternative ways for the expansion of the repository, if it is needed in the future.

### Olkiluoto

Preliminary plans have also been made for the future extensions of the Olkiluoto LILW repository for the decommissioning waste from the currently operating Olkiluoto 1 and 2 units, and for the pending units 3 and 4 currently being under construction or planned, respectively. The future expansions also provide more space for the operational waste from the existing and new units. A preliminary sketch of the extensions is shown in fig. 2. Two new silos will be needed for the operational waste from unit 3 (under construction) and 4 (planned), and four silos for the decommissioning waste from all four existing and planned plant units. The extension of the repository at Olkiluoto for the operational waste is needed in 2030s and the extension for the decommissioning waste is planned for around 2060s or 2070s.

## SUMMARY AND CONCLUSIONS

The availability of an operator-owned waste-disposal facility on each of the two Finnish NPP sites plays an important role in reducing waste management and decommissioning costs of Finland's NPP operators Fortum and TVO. The on-site repositories operate without additional staff as a part of the respective power plant organisation. External contractors are used when needed for construction works or special services in the repositories. Transportation of the waste to the repository is done within the power plant's area. This guarantees low operational costs of the repository, including mainly the necessary waste packages, electricity and water, maintenance and monitoring costs of the repository, and only a part of the respective power plant's waste management, operation and security team's personnel costs. During the pending decommissioning of the power plant units the large components can be transported directly to the repository in large pieces, without cutting or storing them in an interim storage. Also during this period the repository will not need additional personnel. Both repositories may be further expanded if needed, for example due to the construction of new NPP units or due to the extension of the operational life of the current plant units.

## REFERENCES

1. Posiva Oy, "Nuclear waste management of the Olkiluoto and Loviisa nuclear power plants Summary of operations in 2012", Posiva Oy. 2012. (http://www.posiva.fi/files/3197/YJH_2012_Engl_LOW.pdf )