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Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management

3rd Finnish National Report as referred to in Article 32 of the Convention

Säteilyturvakeskus
Strålsäkerhetscentralen
Radiation and Nuclear Safety Authority

STUK

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Executive summary

In accordance with the provisions of the Article 32 of the Joint Convention, this is the Finnish National Report to the 3rd Review Meeting of the Contracting Parties in May 2009. The report presents recent developments in the areas of spent fuel management and radioactive of waste management in Finland for the review of the contracting parties in the 3rd review meeting of the JC.

The safety of spent fuel managements and safety of radioactive waste management were intensively developed in Finland during the reporting period 2005–2007. Most of the activities, resources, progress and substantial results were related to the regulatory control and implementation of the spent fuel final disposal project.

Since per legislation spent fuel is considered as radioactive waste in Finland, the two nuclear power plants, the Loviisa and Olkiluoto NPPs, are the main generators of radioactive waste. The Loviisa plant comprises of two 488 MW_e(net) VVER units, operated by Fortum Power and Heat Oy, and the Olkiluoto plant two 860 MW_e(net) units, operated by Teollisuuden Voima Oyj. The Loviisa units were connected to the electrical network in 1977 (unit 1) and 1981 (unit 2) and the Olkiluoto units 1 and 2 in 1978 and 1980, respectively. In addition, a new nuclear power plant unit is being constructed at the Olkiluoto site (at the end of the reporting period, there were two more reactor units in the Environmental Impact Assessment Procedure; political decisions on their future are expected during 2009–2010*). At Olkiluoto and Loviisa sites there are interim storages for spent fuel as well as final repositories for medium and low level radioactive wastes. Furthermore, Triga Mark II research reactor is operated in Espoo by the VTT Technical Research Centre of Finland. During the reporting period, the Finnish fuel cycle policy continued to be based on the once-through option.

Overall, during the reporting period 2005–2007 the Finnish NPPs operated and produced spent fuel and radioactive waste as expected. The level of safety in spent fuel management and radioactive waste management was high and continued to be developed and improved in accordance with the Finnish national strategy, milestones and timetable. The licensees and the nuclear waste management company Posiva as a Decision-In-Principle holder, have shown good safety performance and rigorous safety management practices in carrying out their safety related responsibilities in the operation and in improving spent fuel and radioactive waste safety in existing NPP's as well as in developing the final disposal further.

* For the third reactor project, a preliminary site selection process was underway in 2007 and the EIA procedure was formally started when the programme for the EIA procedure was submitted to the Ministry of Employment and the Economy on January 30, 2008. The political decision on the future of this reactor project is also expected during 2009–2010.

During the reporting period 2005–2007, the highlights in Finland were as follows:

Spent nuclear fuel disposal project progressed as planned:

- The project proceeded as planned with major developments, good progress and substantial results. Despite of the complexity of the work and challenges involved, no unexpected delays or problems were encountered. To help the reader to get a good insight into the work, major achievements in the regulatory approach are presented in annex L.1 and those regarding the implementation work in annex L.2.
- The construction of the underground rock characterisation facility, ONKALO, which is foreseen to be used as a part of the repository, started in July 2004 and the access tunnel progressed to the length of 2600 m and to the depth of 250 m at the end of 2007. Also, two ventilation shafts were constructed to the depth of 180 m.
- Related to the spent fuel disposal, Posiva continued to expand and strengthen its activities and resources. Progress has been achieved in the areas of site studies; features, events, processes (FEPs); evolution studies (climate, site, and repository); scenarios; engineered barrier system (copper canister, bentonite buffer); radionuclide transport; biosphere; safety assessment and the safety case methodology. Posiva submitted a large number of RD&D and construction documents and materials to STUK for regulatory review.
- In the reference disposal design ("KBS-3V") spent fuel canisters are emplaced in vertical holes drilled in the floors of the deposition tunnels. In parallel with the disposal reference design, an alternative design (called "KBS-3H") is being studied. In this concept the canisters are emplaced in horizontal position in smaller-diameter deposition tunnels. A feasibility study of this horizontal variant of KBS-3 has been carried out as a joint project between Posiva and the SKB of Sweden during 2003–2007.

The regulatory system was strengthened

- STUK re-organized and expanded its staff and operations in response to expanding operations of Posiva in constructing the ONKALO and in preparing to review the disposal facility (encapsulation facility and repository) construction license application expected to be submitted in 2012. In particular, STUK developed and started implementing a new regulatory approach for inspecting ONKALO and Posiva's safety case activities. STUK's inspection program utilizes a graded approach based on safety importance of the repository's structures, systems and components.
- The Finnish nuclear legislation and regulatory guidance have been developed further. This work takes into account international guidance such as IAEA safety standards.

Progress was made in the spent fuel management

- Spent nuclear fuel from the Finnish NPPs is stored at the power plant sites until it will be disposed of. In Loviisa NPP, the installation of dense fuel racks was started in 2007 and will continue until 2018. The operating licence issued in 2007 allows storing spent fuel up to 1100 tU and this capacity will be adequate until the start of disposal of the spent fuel.
- At Olkiluoto site, where the construction of Olkiluoto 3 unit is ongoing, the design of the extension of the interim spent fuel storage started during the reporting period.

Management of LILW from nuclear facilities was improved

- The LLW disposal section of the Loviisa LILW disposal facility was taken in operation in 1998. The construction of the second stage of the facility – the cementation facility for solidification of wet ILW, and the ILW disposal cavern – was completed in 2007. The FSAR of the facility was accordingly updated and reviewed by STUK, and the commissioning is expected to be finalized in 2008.

Periodic safety reviews were done

- Periodic Safety Review, including spent fuel and radioactive waste issues, of the Loviisa NPP was carried out in 2005–2007 in connection with the extension of the plant's operating license for additional 20 years. The corresponding periodic safety review is expected to be completed at the Olkiluoto NPP by the end 2008.
- The periodic safety reviews of the LILW disposal facilities are done at 15 years interval. For Olkiluoto LILW disposal facility taken into operation in 1992, the periodic safety review was made in 2007. In the same context the suitability of the waste packages from the new Olkiluoto 3 NPP unit for disposal in the facility was evaluated.
- During the reporting period, no spent fuel or radioactive waste events in the Finnish NPPs were reported.

Technical support and competence were developed

- VTT Technical Research Centre of Finland continued to support effectively the regulatory body in safety assessment work, providing safety analysis capabilities and tools e.g. via the regulatory research programmes, and performing reviews of safety analyses.
- Management of competence, taking into account retirement of large post-war age groups born in late 1940's and early 1950's, is an overall concern also in Finland. During the reporting period, the Finnish nuclear safety community has succeeded well in recruiting new staff in response to the needs of the expanding nuclear sector. However, challenges remain in providing sufficient post-graduate education and training as well as funding for comprehensive knowledge transfer between the expert generations.
- International cooperation and transparency belong to the cornerstones of the development of the national solutions for spent fuel and waste safety in Finland. In addition to active participation in international and bilateral forums (IAEA, EU, WENRA, OECD/NEA), foreign consultants continued to participate both in regulatory reviews and Posiva's development work.

Challenges for future work

- Main challenges are related to keeping up with the timely progress made with the Olkiluoto spent fuel disposal project. R&D-programs have a major challenge to produce results which are related to Olkiluoto-site, EBS and safety case and are needed to justify the construction licence application planned to be submitted 2012. Posiva and STUK invest in their processes and resources to ensure that all safety related regulatory and implementation tasks are correctly scheduled and of high quality. The current development requires new research and development programmes and more resources. To develop and maintain Finnish competence in nuclear safety, STUK provides guidance to the national research programmes on operational safety of nuclear power plants and on the safety of nuclear waste management geological disposal.
- In Olkiluoto, a new NPP is under construction and three new reactors have been proposed. EIA procedures regarding extension of the planned disposal facility are under way.
- The European Commission has proposed to harmonise the general requirements for nuclear power plant safety and nuclear waste management in the EU. In Finland, the safety regulations that are within the scope of the Nuclear Energy Act will be updated in the current strategy period of STUK (-2012). The structure of the detailed safety requirements (YVL Guides) prepared and published by STUK are being updated.
- The European Commission promotes worldwide co-operation to further develop nuclear, radiation and waste safety through its INSC and former TACIS and PHARE programmes. STUK has been and will be a supporter of this European development and involvement. During the reporting period, three fourths of STUK's service volume comprises promotion of radiation and nuclear safety, including waste safety, in Eastern European countries.

- The retirement of post-war large age groups will affect public administration throughout, including STUK. The above activities require additional manpower and efforts from the nuclear power utilities and waste management company Posiva and regulatory body for strengthening their actives.
- Communication will become an increasingly important success factor for STUK, Posiva and power companies. Interest in radiation and nuclear safety topics will continue to increase. The media plays an important role in communication.

From the 2nd Review Meeting

The 2nd Review Meeting in 2006 identified challenges and items for follow-up, and recorded some planned measures to improve safety of nuclear waste management in Finland. On request of the Review Meeting these issues are included and responded in this 3rd National Report of Finland. These items were (in brackets the articles, in which the issues are addressed):

- maintaining and managing technical competence and the knowledge transfer (See Article 20 and 22)
- management of certain types of institutional waste (e.g. highly active sealed sources, smoke detectors) (See Article 28)
- establishment of clear separation between the role of operator of storage facility for sealed sources and supervisory authority (See Article 28)
- extension of storage capacity for spent fuel at both nuclear power plant sites (See Article 32)
- completion of the ONKALO project (See Article 13–15, annexes L.1 and L.2)
- development of disposal concept (e.g. vertical versus horizontal emplacement of fuel) (See Article 32, 14-15, annex L.2)
- new Research & Technical Development programme (See Article 32, 13–15, annex L.2)
- Olkiluoto 3 LILW management arrangements (See Article 32, 12, 16)
- update and amendments of nuclear legislation and regulations (See Articles 19, 32, Annex)
- suggestion to report on experience with current practice for managing NORM waste (See Article 12)

The Conclusion: In conclusion, Finland complies with the obligations and objectives of the Joint Convention. Challenges for the future are recognized, regularly reviewed and addressed. Efforts for continuous improvements are needed and taken.

Contents

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contents, continued

contents, continued

contents, continued

List of acronyms

BWR	Boiling water reactor
DiP	Decision-in-Principle by the Government
EIA	Environmental impact assessment
EPR	European pressurized water reactor
FPH	Fortum Power and Heat Oy (NPP utility)
FSAR	Final Safety Analysis Report
ILW	Intermediate level waste
LILW	Low and intermediate level waste
LLW	Low level waste
MEE*	Ministry of Employment and the Economy
MTI*	Ministry of Trade and Industry
NORM	Naturally occurring radioactive materials
NPP	Nuclear power plant
ONKALO	Underground rock characterisation facility for spent fuel disposal at Olkiluoto
Posiva	Posiva Oy (company for spent fuel disposal)
PSAR	Preliminary Safety Analysis Report
PWR	Pressurized water reactor
ST Guide	Safety regulation issued by STUK subject to radiation legislation
STUK	Radiation and Nuclear Safety Authority
TVO	Teollisuuden Voima Oyj (NPP utility)
VLLW	Very low level waste
VTT	Technical Research Centre of Finland
YVL Guide	Safety regulation issued by STUK subject to nuclear energy legislation

*) The Ministry of Trade and Industry (MTI) was reorganized and since the 1st of January 2008 the contact authority concerning nuclear waste management is the Ministry of Employment and the Economy (MEE).

SECTION A Introduction

The Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management was adopted on 29 September 1997 in the Vienna Diplomatic Conference. Finland signed the Convention on 2 October 1997 and deposited the tools of acceptance on 10 February 2000. The Convention entered into force on 18 June 2001.

The fulfilment of the obligations of the Convention and the developments after the second Review Meeting are assessed in this report. The self-assessment is mainly based on the Finnish legislation and regulations, on the situation at the Finnish radioactive waste disposal facilities and nuclear power plants (NPPs), and on the activities to develop and improve operational and long term safety. The assessments on the safety of the NPPs cover also the facilities for predisposal management of operational waste and storage of spent fuel. The plans for decommissioning of nuclear facilities are discussed shortly as well. The management of radioactive waste generated outside the nuclear fuel cycle is discussed as appropriate.

Main regulations in the field of spent nuclear fuel management as well as nuclear and other radioactive waste management are the Nuclear Energy Act and Decree, the Radiation Act and Decree, the Government Decisions on reactor operational wastes and spent fuel and the regulatory guides (YVL Guides and ST Guides) issued by the Radiation and Nuclear Safety Authority (STUK). The most essential safety regulations are listed in Section L.5.

Nuclear Energy Act (Section 5) requires that the use of nuclear energy, taking into account its various impacts, has to be in line with the overall good of the society. It provides (Section 6) that the use of nuclear energy must be safe; it shall not cause harmful effects to humans, or damage to the environment or property. Further (Section 7), it requires that sufficient physical protection and emergency planning as well as other arrangements for limiting nuclear damage and for protecting nuclear energy against illegal activities shall be a prerequisite for the use of nuclear energy. A new Chapter 2a of the Act gives general nuclear safety and security principles.

Radiation Act (Section 2) provides that the benefits accruing from the use of radiation and practices involving exposure to radiation shall exceed the detriment it causes; that the practice shall be organized in such a way that the resulting exposure to radiation hazardous to health is kept as low as reasonably achievable and that no person's exposure shall exceed the maximum values prescribed in the Radiation Decree.

These general safety principles, included in the Nuclear Energy Act and the Radiation Act, apply to management of spent nuclear fuel and of other radioactive waste arising from the use of nuclear energy and the associated nuclear fuel cycle. Radioactive waste produced in other activities is regulated solely by the Radiation Act.

Finland is a member state of the European Union. Thus, the regulations of the Union are in force in Finland. When necessary, the Finnish regulations have been modified to take into account the EU regulations. The EC Directives relate e.g. to radiation protection and transboundary movements of radioactive waste and spent fuel, whereas there are so far no regulations pertaining directly to safe management of spent nuclear fuel and radioactive waste.

In Finland, two NPPs, with a total capacity of 2 696 MWe(net), are currently in operation. The Loviisa plant includes two 488 MW_e PWR (WWER) units, operated by Fortum Power and Heat Oy (FPH) and the Olkiluoto plant two 860 MW_e BWR units, operated by Teollisuuden Voima Oyj (TVO). The NPP units were connected to the electrical network as follows: Loviisa 1 in 1977, Loviisa 2 in 1981, Olkiluoto 1 in 1978 and Olkiluoto 2 in 1980. A construction licence for a new PWR unit, Olkiluoto 3 of 1600 MWe was granted by the Government in February 2005. The unit is planned to be operational in 2011.

Both NPPs have storage facilities for fresh and spent fuel and facilities for treatment and storage of low and intermediate level radioactive waste (LILW). The disposal facility for LILW was taken into operation at the Olkiluoto site in 1992 and for LLW at the Loviisa site in 1998. At Loviisa site the cementation facility for solidification of wet ILW and the extension of the disposal facility for cemented waste are expected to be commissioned during 2008.

All spent fuel generated at the Olkiluoto plant is stored on-site. Previously the spent fuel of the Loviisa plant was transported to the Mayak facilities in the Russian Federation, after interim storage of a few years. An amendment to the Nuclear Energy Act was passed in 1994, stating that spent fuel and all other nuclear wastes generated in Finland have to be treated, stored and disposed of in Finland. Spent fuel shipments to the Russia were terminated at the end of 1996, and since then the spent fuel generated at the Loviisa plant has been stored at the plant. In 1995, a joint waste management company Posiva Oy was established by FPH and TVO for taking care of the disposal of spent fuel of the nuclear power plants they operate.

The Finnish fuel cycle policy is in practice based on the once-through option. In 1999 Posiva proposed, in a Decision-in-Principle (DiP) application, to site a disposal facility for spent nuclear fuel at Olkiluoto in Eurajoki, a couple of kilometres from the NPP (Figure 1). This application was reviewed and approved from safety viewpoint by STUK and approved by the municipality of Eurajoki in January 2000, the Finnish Government made the DiP in December 2000 and the Parliament endorsed it in May 2001. The DiP authorizes Posiva to construct a rock characterization facility "ONKALO" down to the actual disposal depth. ONKALO is constructed following the same type of

Figure 1. The access tunnel to the disposal facility of spent fuel under construction at Olkiluoto.

requirements as for a nuclear facility, because it is intended to later be used as a part of the repository. The application for the construction licence for the rest of the repository is scheduled to be submitted by the end of 2012 and the operating licence application around the year 2020.

In the connection with the ratification of the Decision-in-Principle concerning the fifth reactor in Finland in May 2002, the Finnish Parliament also ratified a separate Decision-in Principle on the extension of the Olkiluoto spent fuel disposal facility to provide repository space for the spent fuel from the new unit.

A research reactor FiR 1 (TRIGA Mark II, 250 kW) is situated in Espoo and operated by the VTT Technical Research Centre of Finland. It was taken into operation in 1962. VTT has also radiochemical laboratories and a small hot-cell for testing radioactive materials. Radiochemical and particle accelerator laboratories are also located at the universities of Helsinki, Turku and Jyväskylä.

Two pilot-scale uranium mining and milling facilities were operational in late 1950's – early 1960's. Small amounts of radioactive wastes arise from a number of facilities using radioactive sources in medical, research and industrial applications.

In the safe management of spent fuel and other radioactive wastes, international co-operation is of importance, and the Finnish regulatory authorities, nuclear power and waste management companies and research institutes have actively worked in co-operation with foreign organisations. In this respect, especially the activities of the IAEA, Sweden, OECD/NEA and the R&D framework programmes of the European Union are important.

This report has been structured in accordance with the Guidelines Regarding the Form and Structure of National Reports (INFCIRC 604). Reflecting the second Review meeting, this 3rd National Report includes essential elements of the content of the Finnish second National Report with more detailed information of the practical implementation of the articles of the Joint Convention during the review period 2005 - 2007. In Section B and Annex L.8, policies and practices of waste management in Finland are summarised as stipulated in Article 32, paragraph 1. In section C, the scope of application taking into account the Finnish circumstances is explained, as stipulated in Article 3. Section D provides information on spent fuel and waste management facilities in Finland and the inventories of spent fuel and radioactive waste, as stipulated in Article 32, paragraph 2. The implementation of each of the Articles from 4 to 28 of the Convention is separately evaluated in Sections E to J. Section K summarises planned activities to improve safety. Section L contains the annexes: Regulatory approach to the Olkiluoto spent fuel final disposal project (L.1), Programme for spent fuel disposal (L.2), List of spent fuel storages and inventory of spent fuel (L.3), List of radioactive waste management facilities and inventory of radioactive waste (L.4), List of laws, regulations, guides and other relevant documents (L.5), References to official national and international reports related to safety (L.6), References to reports of international review missions performed at the request of a Contracting Party (L.7), and Spent fuel and radioactive waste management policy (L.8).

SECTION B Policies and practices

Article 32 Reporting, paragraph 1

In accordance with the provisions of Article 30, each Contracting Party shall submit a national report to each review meeting of Contracting Parties. This report shall address the measures taken to implement each of the obligations of the Convention. For each Contracting Party the report shall also address its:

(a) spent fuel management policy;
(b) spent fuel management practices;
(c) radioactive waste management policy;
(d) radioactive waste management practices;
(e) criteria used to define and categorize radioactive waste.

B.32.1 Criteria used to define and categorize radioactive waste

Nuclear waste is defined in the Nuclear Energy Act (Section 3) as radioactive waste in the form of spent fuel or in some other form, generated in connection with or as a result of the use of nuclear energy, and materials, objects and structures which, having become radioactive in connection with or as a result of the use of nuclear energy and having been removed from use, require special measures because of the danger arising from their radioactivity.

Other radioactive waste than nuclear waste is regulated in the framework of Radiation Act. According to the Act (Section 10), the term radioactive waste denotes radioactive substances, and various items that have no use any more and have to be rendered harmless due to their radioactivity. The definition includes also equipment, goods and materials that are contaminated by radioactive materials. Radioactive substances and radiation appliances containing radioactive substance shall also be regarded as radioactive waste in case the owner of the substances or the appliances cannot be found.

The main sources of radioactive waste are nuclear wastes generated from the operation of the four power reactors and one small research reactor. Other radioactive wastes arise from a number of facilities using radioisotopes in medical, research and industrial applications. Respectively, the Finnish waste classification system includes two main categories: nuclear waste, and radioactive waste not originating from the use of nuclear energy and the associated nuclear fuel cycle. Waste classification according to disposal route is illustrated in Figure 2.

Spent fuel from nuclear facilities

The Nuclear Energy Act defines spent fuel from the operation of nuclear reactors as nuclear waste, destined for disposal in a permanent manner. Due to its high activity and heat generation, spent fuel is regarded as high-level waste.

Low and intermediate level waste from nuclear facilities

The classification system for the purpose of predisposal management of LILW from NPPs is based on activity concentrations, given in Guide YVL 8.3. Solid and liquid waste arising from the controlled area of a NPP that contain almost exclusively short-lived beta and gamma emitters, are grouped into the following activity categories:

- **Low level waste** contains so little radioactivity that it can be treated at the NPP without any special radiation protection arrangements. The activity concentration in waste is then not more than 1 MBq/kg, as a rule.
- **Intermediate level waste** contains radioactivity to the extent that effective radiation protection arrangements are needed when they are processed. The activity concentration in the waste is then from 1 MBq/kg to 10 GBq/kg, as a rule.

Guide YVL 8.2 provides for general and case-specific clearance of nuclear waste. Both clearance options are founded upon the criteria of triviality of dose; the radiation protection requirement for both clearance procedures is that the annual dose to any member of the public or worker processing the material, shall not exceed 10 µSv and that also otherwise the radiation exposure arising from the cleared material is as low as reasonably achievable.

Mass and surface concentration based activity constraints for general clearance are given in YVL 8.2. One set of constraints is for unlimited amounts of material and the constraints are taken from IAEA Safety Guide RS-G-1.7. Another set of constraints are applied to limited waste quantities not exceeding 100 tonnes per year for one NPP or other nuclear installation. In case-specific clearance the activity concentrations are determined on a case-by-case basis but care has to be taken that they do not exceed the exemption limits given e.g. in the Euratom Council Directive 96/92 and Guide ST 1.5.

Guide YVL 8.2 covers also clearance of regulated buildings and sites in the context of decommissioning of nuclear facilities. The radiation protection requirement for such clearances is that the annual individual dose shall not exceed a constraint between 10 µSv…100 µSv, to be determined on the basis of optimization. The relevant IAEA safety standards and guides have been used as reference for the guide.

Discharges from nuclear facilities

Some liquid and airborne discharges arise from the operation of nuclear facilities. The discharge limits are specific to nuclides or nuclide groups and they are in conformity with the dose constraint of 0.1 mSv per year to the member of the critical group among the general public.

Radioactive waste from medical use, research and industry

For small user waste, constraints for disposal in landfill or sewage system are provided in Guide ST 6.2. The criteria are based on the triviality of the dose as above in the case of clearance of nuclear waste.

According to Guide ST 6.2, liquid waste can be disposed of into a sewage system and solid waste can be delivered to a landfill site or an incineration plant, if the activities are below the nuclide specific

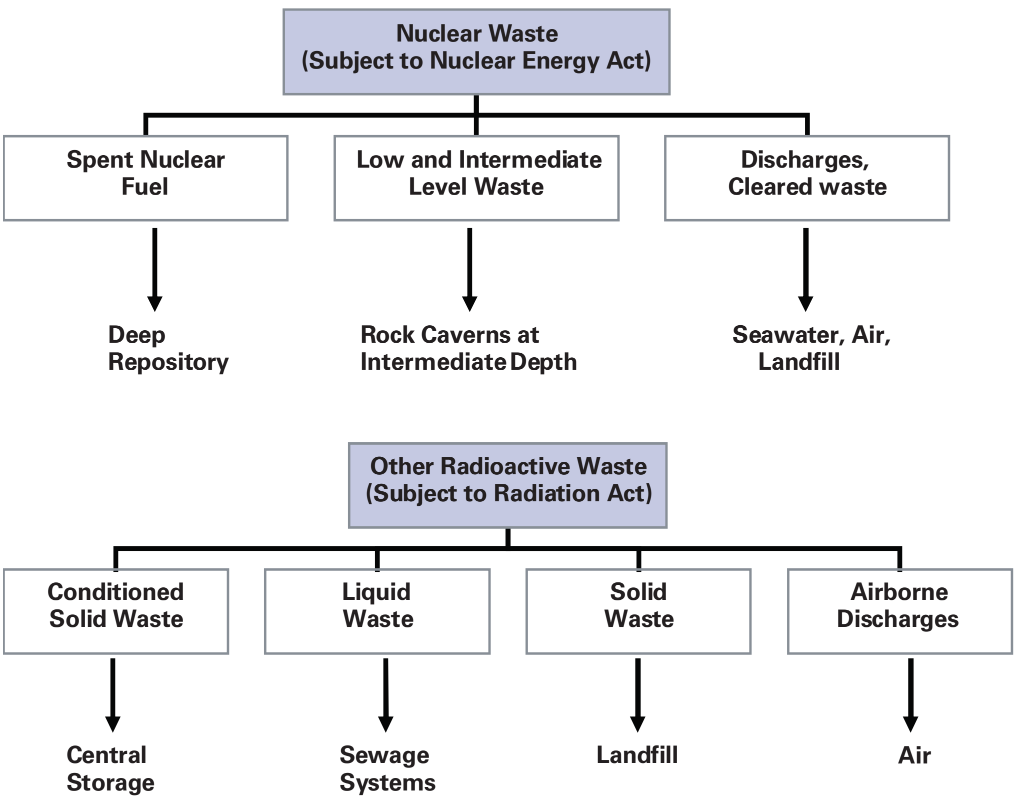


Figure 2. Classification of radioactive waste for disposal purposes

Nuclear and other radioactive waste management policy

Legislative basis

Nuclear waste is regulated by the Nuclear Energy Act and is defined as radioactive waste, including spent fuel, arising from the use of nuclear energy. Other radioactive waste is subject to the Radiation Act.

Political decision-making and public consultation

Construction of a major nuclear waste facility shall be in line with the overall good of the society, as judged by the Government and the Parliament. Consent of the proposed host municipality is required for the construction of such a facility. An environmental impact assessment procedure shall be conducted prior to the first authorization step of a major nuclear waste facility.

Responsibilities

Licensee of a nuclear waste management facility shall ensure its safe use including physical protection and emergency preparedness. Producer of nuclear waste is responsible for the implementation and expenses of his waste management and decommissioning activities, including the related planning, research and development work. The State is responsible for nuclear waste after its approved disposal and has the secondary responsibility in case that a producer of nuclear waste is incapable to fulfil his management obligation.

User of radioactive substances shall render harmless the radioactive waste arising from his operations, including those involved with natural radioactive substances. A financial security shall be furnished for a sealed source or other radioactive waste with substantial liability. The State has the secondary responsibility in case that a producer of radioactive waste is not capable to fulfil his management obligation.

Waste management and decommissioning principles

The Nuclear Energy Act states that nuclear waste generated in Finland shall be handled, stored and permanently disposed of in Finland. Nuclear waste generated elsewhere, shall not be handled, stored or permanently disposed of in Finland. A long-term overall schedule for the implementation of nuclear waste disposal in Finland was contained in the Policy Decision of the Government in 1983. Subsequently the Ministry of Employment and the Economy (MEE) has issued more detailed requirements on the implementation schedule.

The preferable management option for disused sealed sources is return them to the supplier/manufacturer. If this is not feasible, a disused sealed source or other small user waste can be transferred to a central storage operated by the Radiation and Nuclear Safety Authority (STUK).

Facilitation of decommissioning shall be considered already in the design of a nuclear facility. Decommissioning plans shall be regularly updated during the operation of the facility. Implementation of decommissioning shall not be unjustifiably postponed.

Safety principles and control

Safety of nuclear waste management facilities shall be kept as high as reasonably achievable and all actions justified by safety research and the progress in science and technology shall be taken to enhance safety. Nuclear waste shall be disposed of so that no radiation impact exceeding the currently acceptable level will occur in the future and so that ensuring long-term safety does not depend on the surveillance of the disposal site.

STUK is responsible for the safety judgement in authorization processes and for the control of the safe management of nuclear and other radioactive waste. The construction and operation licences for waste management are prepared by MEE and granted by the Government.

limits based on the Annual Limit on Intake values. The upper level of radioactivity for a sealed source eligible to be considered as solid waste and within these activity limits is 100 kBq. Sealed sources with higher radionuclide content and other radioactive waste not eligible for disposal to landfill have to be delivered to a site approved by STUK for storage and disposal.

B.32.2 Spent fuel and radioactive waste management policy

Main regulations in the field of nuclear energy are the Nuclear Energy Act and Decree, the Radiation Act and Decree, and the Decisions of the Government as well as the Regulatory Guides (YVL Guides) issued by the Radiation and Nuclear Safety Authority (STUK). Besides that, the long-term objectives for spent fuel and nuclear waste management are given in the decisions by the Ministry of Employment and the Economy. The most essential safety regulations and guides are listed in Annex L.5. The legislative and regulatory measures to fulfil the obligations of the Convention were discussed in detail in the first two reports. It was concluded that the Finnish regulatory framework fulfils the obligations of the Convention, and also the objectives of the Convention are complied with. There has been no change in the spent fuel and radioactive waste management policy during 2005–2007. A summary of the spent fuel and radioactive waste management policies are given on previous page and a more detailed text of the 2nd National Report is reproduced in Annex L.8.

B.32.3 Spent fuel and radioactive waste management practices

The management practices for nuclear waste and other radioactive waste are described in detail below. A concise overview of the management strategies is given on next page.

The main producers of nuclear waste are the NPP utilities Teollisuuden Voima Oyj (TVO) and Fortum Power and Heat Oy (FPH). They take care of interim storage of spent fuel, conditioning and disposal of low and intermediate level waste and of planning for the decommissioning of the NPPs. TVO and FPH have formed a joint company, Posiva Oy, which is responsible for the preparations for and later implementation of spent fuel disposal. The operator of the research reactor is the VTT Technical Research Centre of Finland. It takes care of the management of waste and spent fuel from the operation and future decommissioning of the reactor.

Producers of other radioactive waste perform some waste management operations, such as initial storage, clearance and disposal into landfill type sites. Small user waste that cannot be cleared, or, in the case of sealed sources, returned to the manufacturer, must be handed over to STUK against a fee that covers the interim storage and later disposal of the waste.

Spent fuel management

Spent nuclear fuel from NPPs is stored at the power plant sites until it will be disposed of. Initially, the fuel is cooled for one to two years in reactor pools. The Loviisa NPP has, in addition to the pools in the reactor buildings, an integrated pool type storage facility. The latest enlargement of the storage facility was commissioned in 2001. The installation of dense fuel racks was started in 2007 and will continue until 2018. The allowable total arising of spent fuel according to the renewed operating licence issued in 2007 is 1100 tU and the storage capacity will be adequate until the start of disposal of the spent fuel.

At the Olkiluoto plant the spent fuel is, after cooling in the pools at the reactor buildings, transferred to an on-site facility, commissioned in 1987, with a capacity of about 1200 tU. The current capacity is adequate until early 2014 and the planning for extension of the storage is underway. Storage of spent fuel from the Olkiluoto 3 unit, scheduled to be commissioned in 2011, will be taken into account in the design of the extension of the storage.

The nuclear legislation provides for disposal of nuclear waste into the Finnish bedrock. Posiva is implementing the spent fuel disposal programme with the following main goals, which are in line with the Government Policy Decision of 1983 and a further decision by the Ministry of Trade and Industry in 2003 (now the Ministry of Employment and the Economy, MEE):

- Disposal site selection in 2000 (The Olkiluoto site was proposed by Posiva in the Decision-in-Principle application of 1999; after a safety review by STUK and approval of the application by the host municipality in January 2000, the Decision was made by the Government in December 2000 and ratified by the Parliament in May 2001.)
- Start of construction of an underground rock characterisation facility (ONKALO) in Olkiluoto in 2004
- Preparedness for the application of the Construction Licence in 2012
- Readiness for operation of the disposal facility in 2020.

Nuclear and other radioactive waste management strategy

Responsibilities

Producers of nuclear waste (the NPP utilities TVO and FPH) take care of interim storage of spent fuel, conditioning and disposal of low and intermediate level waste and of planning for the decommissioning of the NPPs. A joint company by FPH and TVO, Posiva, is responsible for the preparations for and later implementation of spent fuel disposal. As an operator of the research reactor FiR 1, VTT takes care of planning and implementation of the waste management and decommissioning of the facility.

Producers of other radioactive waste manage their waste within the limits of their technical capability and ensuring safety and security. Small user waste that cannot be cleared, including spent sealed sources that cannot be returned to the manufacturer, must be handed over to STUK against a fee that covers the interim storage and later disposal of the waste.

Waste management and decommissioning objectives

Such low and intermediate level nuclear waste that meets the acceptance criteria for the repositories at the NPP sites will be disposed of without unnecessary delays. Waste that cannot yet be disposed of is stored safely. Also other low and intermediate level waste, such as decommissioning waste and small user waste, is envisaged to be disposed of in the rock cavern repositories at the NPP sites.

Disposal of spent fuel is under preparation in accordance with a strategic plan which is in line with the 1983 Government Policy Decision and the 2003 Decision of the Ministry of Trade and Industry (now the Ministry of Employment and the Economy). The goal for starting the disposal operations is the year 2020. The spent fuel disposal programme is subject to continuous regulatory review.

The implementation of decommissioning of the NPPs will be optimized taking into account the technical aspects, radiological impact, future use of the site, availability of competent workforce and the costs. The strategy takes advantage of options for clearance of very low level waste and structures of the plant and on-site disposal of decommissioning waste.

Financial liability system

A financing system for the costs of future waste management and decommissioning exists to ensure that the producers of nuclear waste bear their full financial liability on the coverage of those costs and that the costs can be covered even in case of insolvency of the waste generator. The pertinent license-holders submit annually for regulatory review the technical plans and cost calculations on which the liability estimates are based. After confirmation of the financial liabilities, the licensees pay fees to a State controlled fund and provide securities for the liability not yet covered by the funded money.

The various steps from siting until closure scheduled for the Olkiluoto disposal facility are illustrated in Figure 3. The construction of the underground rock characterisation facility (ONKALO) started in July 2004 and the access tunnel reached the length (chainage) of 2600 m and the depth of 250 m at the end of 2007. Also two ventilation shafts have been constructed until the depth of 180 m. Posiva's programme for spent fuel disposal is described in section L.2., and STUK's regulatory control of the spent fuel disposal project in section L.1.

The current estimate for the amount of spent fuel to be disposed of in Olkiluoto is 5640 tonnes of uranium: 1020 tU from Loviisa 1 and 2, 2620 tU from Olkiluoto 1 and 2, and 2000 tU from Olkiluoto 3. The estimates are based on the expectation that the units Loviisa 1 and 2 are operational until 2027 and 2030, respectively, Olkiluoto 1 and 2 until 2038 and 2040, respectively, and Olkiluoto 3 until 2070 (Figure 3). However, the operation licences of the NPPs are granted only for 10 to 20 years at a time with one or two periodic safety reviews in between.

Before disposal, spent fuel will be stored in water pools for 40 years on an average and thereafter transferred to the encapsulation and disposal facilities which will be located at Olkiluoto. Spent fuel is planned to be encapsulated in copper-iron canisters. The canister design consists of a cast iron insert as a load-bearing element and an outer container of oxygen-free copper to provide a shield against corrosion. The canisters will be emplaced in a network of tunnels, which will be constructed at a depth of

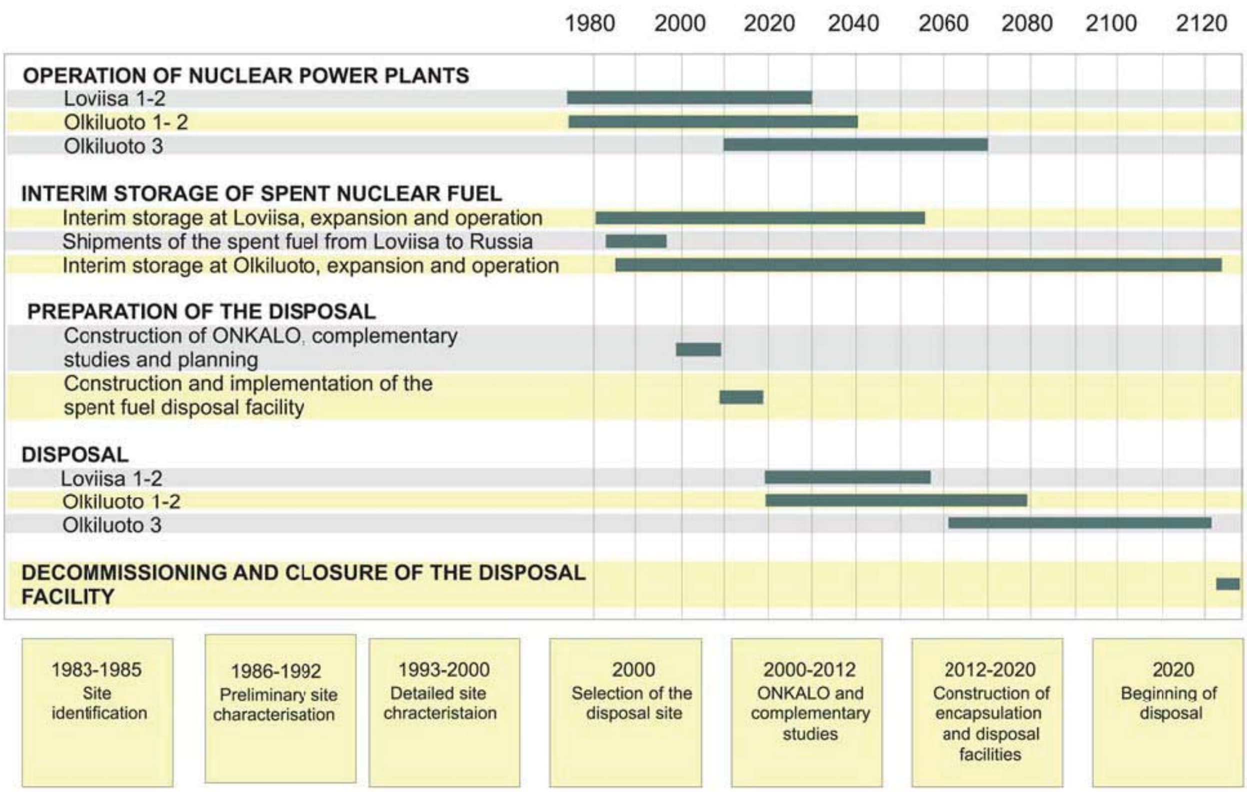


Figure 3. Timetable for the management of spent fuel from the nuclear power plants at Loviisa and Olkiluoto.

about 400 to 500 m in crystalline bedrock. The annulus between the canister and the rock wall will be filled with compacted bentonite. A schematic layout of the underground rock characterization facility and the network of disposal tunnels at Olkiluoto are illustrated in Figure 4 and an individual disposal tunnel with two canister emplacement variants in Figure 5.

The preliminary designs of the encapsulation and disposal facilities, operational and post-closure safety assessments and summaries of site characterisation were included in Posiva's Decision-in-Principle application and in the supporting documents. STUK's preliminary safety appraisal of the application was published in January 2000. Periodic updates of the design of the facilities and the other components of the Safety Case have been published by Posiva and reviewed by STUK as described in section L.1. Posiva's programme for spent fuel disposal is presented in section L.2.

Posiva Oy, Teollisuuden Voima Oyj and Fortum Power and Heat Oy published in late 2006 the triennial overview of the status and plans for R&D and technical design in the field of nuclear waste management. It is focused on the years 2007–2009. STUK reviewed extensively the report with the assistance of an external team of experts and suggested several improvements to the programme.

Spent fuel of the research reactor FiR1 is stored at the facility. The decision on the further use of FiR 1 is dependent on the outcome of the efforts to find an alternative, sustainable source of funding of its operation and maintenance. The first option for the management of spent fuel is interim storage at the facility and later on, disposal into the spent fuel repository at Olkiluoto. The second option would be to return the fuel to the United States. The operation of FiR1 could be continued until spring 2016 without losing the opportunity to return the spent fuel to the supplier.

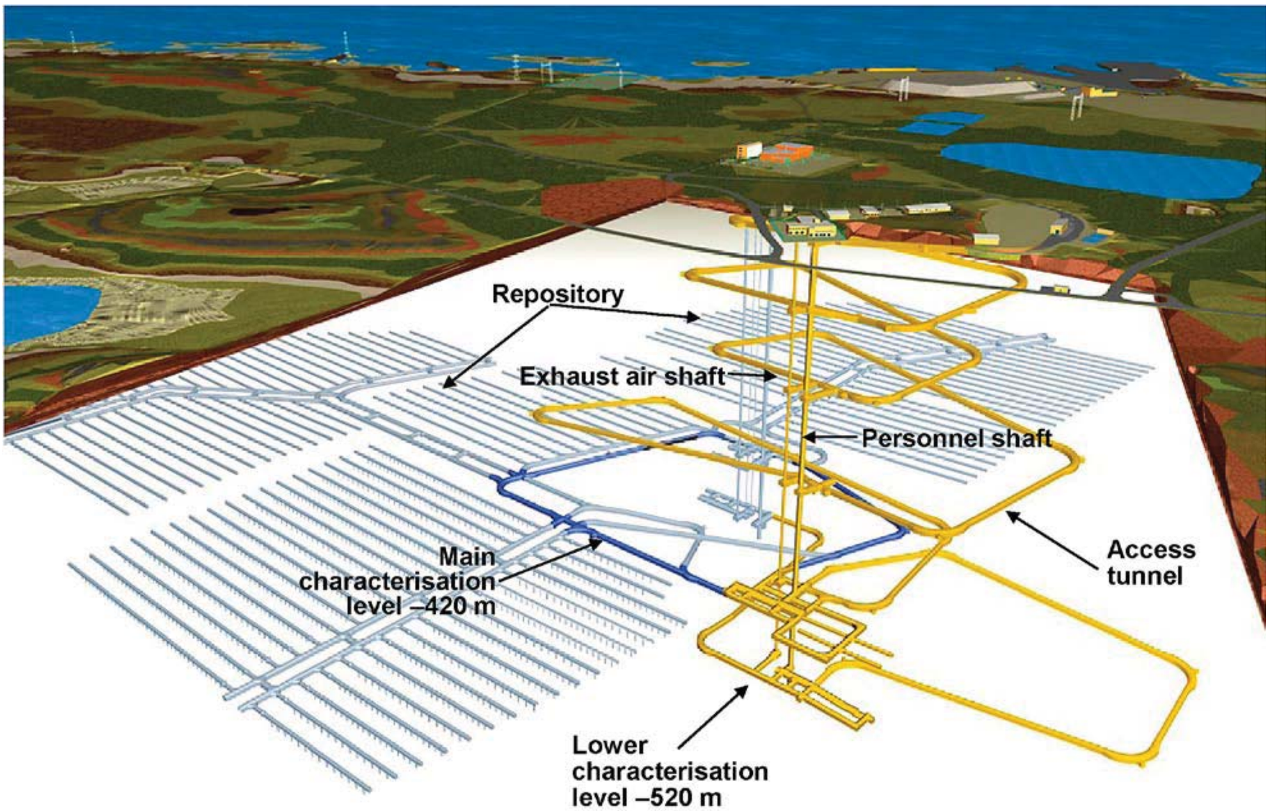


Figure 4. A schematic presentation of the layout of the underground rock characterization facility and the network of disposal tunnels (KBS3-V option).

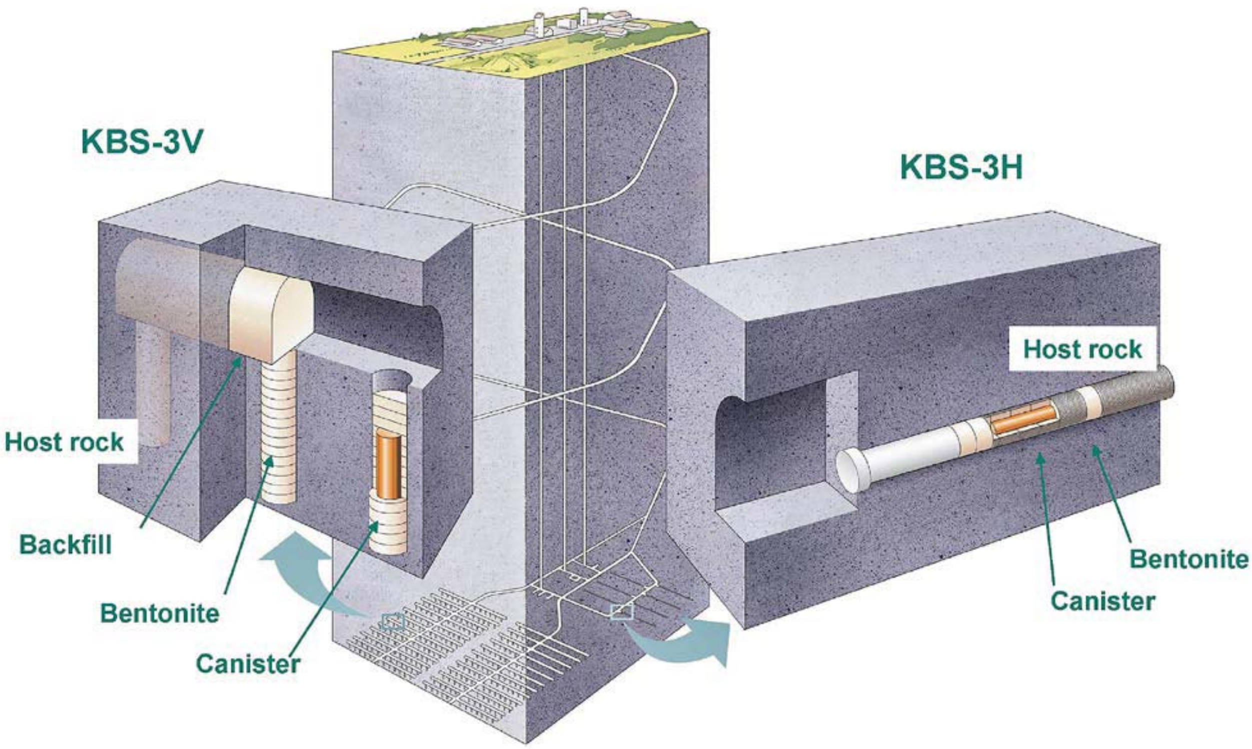


Figure 5. Disposal tunnel and canisters with both the vertical and horizontal disposal options depicted.

Management of LILW from nuclear facilities

Predisposal management of LILW takes place at the NPPs under their Operation Licences and other provisions. The wastes are segregated, treated, conditioned, packaged, monitored and stored, as appropriate, before they are transferred to the disposal facilities.

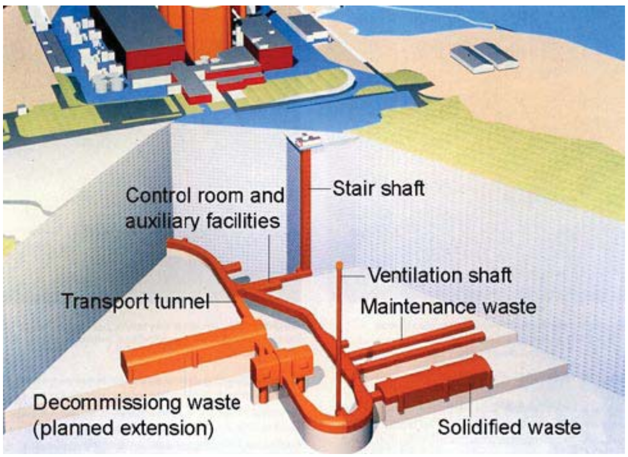
At Loviisa, wet LILW (radioactive concentrates, such as spent ion exchange resins, evaporator bottoms and corrosion sludge) are for the time being stored in tanks at the NPP. The plant uses an innovative selective ion exchange method to reduce the volume of liquid radioactive waste. The commissioning of a solidification facility is expected in 2008 and the operation will start with the cementation of evaporator bottoms. At Olkiluoto, wet LILW is immobilized in bitumen before transfer to the disposal facility. Sludge, radioactive concentrates and spent ion exchange resins from liquid waste treatment in Olkiluoto 3 are planned to be dried in drums.

At both NPPs, solid LLW is, after conditioning, transferred to the disposal facility. Options for very low level waste management are either general or case-specific clearance. Such waste can be reused, recycled or disposed at landfills. The Olkiluoto NPP has a landfill on site while the Loviisa NPP has an agreement with a regional landfill to dispose cleared waste.

Activated metal waste consists of irradiated components and devices that have been removed from inside of the reactor vessel. So far this kind of highly activated waste has not been conditioned but is stored at the NPPs and is expected to be conditioned and disposed of together with decommissioning waste of similar type.

According to the national policy, low and intermediate level wastes from reactor operations are disposed of in the bedrock at the power plant sites. The construction of the repository at the Olkiluoto site began in 1988 and the operation in 1992. At Loviisa, the construction of the repository site was started in 1993 and operation in 1998. The enlargement of the repository for the disposal of ILW is expected to be commissioned in 2008.

The Loviisa repository is located at the depth of approximately 110 m in granite bedrock. The repository consists of two tunnels for solid LLW and a cavern for immobilised ILW (Figure 6). Inside the cavern for ILW, the waste packages are emplaced in a pool-shaped structure made of reinforced concrete.



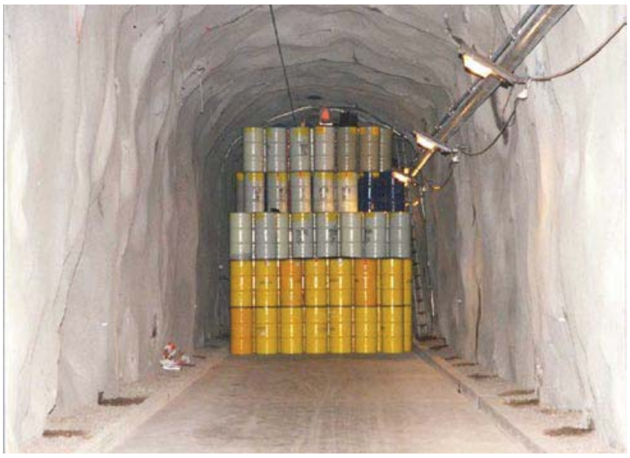


Figure 6. The Loviisa repository. Cross-sectional view of the repository for LILW and the planned extension for decommissioning waste (left) and drums of LLW from reactor operation waste in the repository tunnel (right).

The Olkiluoto repository consists of two silos at the depth of 60 to 95 m in tonalite bedrock, one for solid LLW and the other for bituminized ILW. The silo for solid LLW is a shotcreted rock silo, while the silo for bituminized waste consists of a thick-walled concrete silo inside a rock silo where concrete boxes containing drums of bituminised waste will be emplaced in. The LILW from Olkiluoto 3 will be disposed of in the same repository. The repository will be extended in the future, to be able to receive all the waste from Olkiluoto 1, 2 and 3 units during the planned 60 years of operation of the units.

LILW generated from the operation of the research reactor FiR 1 is stored at the reactor facility until decommissioning. Disposal of the operational and decommissioning waste from FiR 1 in the disposal facility at Loviisa site is under discussion. The additional wastes arising from the FiR 1 decommissioning were taken into account in the safety assessment by Fortum. However, no formal agreement or decision has yet been made between VTT and the utility.

Management of other radioactive waste

An applicant for a licence for the use of sealed sources is required to present a plan for the management of the disused sources. The two options are either return to the supplier/manufacturer of the source or delivery to a national long term storage operated by STUK's Department of Research and Environmental Surveillance. This role in operating the storage is defined in Radiation Act, Section 24 b. The Department of Research and Environmental Surveillance takes care of the conditioning and packaging of the sources and they are stored, under the regulatory control of STUK's Department of Nuclear Waste and Materials Regulation, in a separate cave in the LILW repository at Olkiluoto. The organisational structure of STUK clearly separates its duties in operating the centralised storage facility from its functions as the regulatory authority for the uses of radiation.

A licensee can be exempted from preparing a waste management plan if the operations are arranged such that the activity limits regarding gaseous or liquid discharges or solid-waste disposal established in the Guide ST 6.2 are not exceeded. However, even in this case STUK may order monitoring of discharges and reporting thereof, if this is considered necessary due to environmental considerations, nature of the work and the nature and amount of radioactive substances in use. In addition to being below the limits, all discharges to the environment shall be as low as reasonably achievable.

In practice, most of the wastes from the use of unsealed sources in Finland arise in such low activity concentrations or amounts that it is not necessary to arrange the final disposal of generated waste in the same way as e.g. for the sealed sources. A common practice is that radionuclide labo-

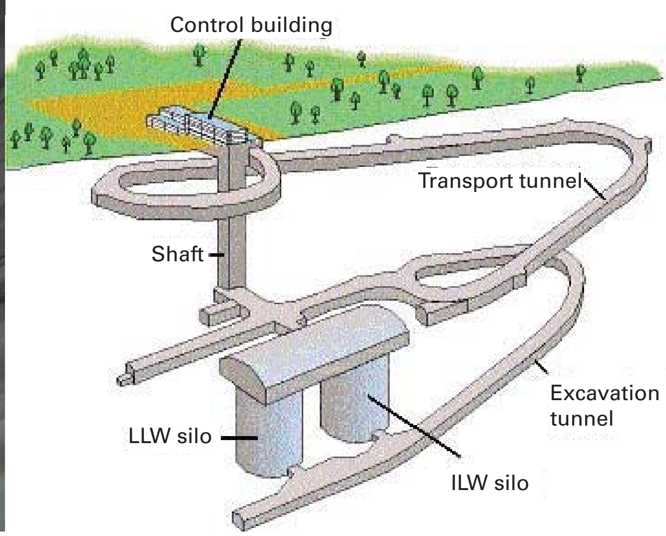


Figure 7. The Olkiluoto LILW repository. LLW drums in the disposal silo (left) and cross-sectional view of the repository lay-out (right).

ratories store their short lived radioactive wastes at their premises until they have decayed below the limits set for discharges in the Guide ST 6.2. However, some wastes resulting from radiochemical research at VTT are sent to STUK for storage in Olkiluoto. In addition, the wastes resulting from studies conducted by VTT on pressure vessel material behaviour for Loviisa NPP are returned back for disposal in the Loviisa LILW repository.

All radionuclide laboratories are inspected by STUK regularly, every 1–5 years, depending on the type and size of the practice, with storage and other activities related to waste management as a standard item in the inspection agenda.

A specific waste issue is arising from disused smoke detectors. There are currently over 3 million detectors in use, each containing about 40 kBq of ^{241}Am. The disposal of an individual detector in normal municipal waste is considered, from the radiological point of view, as the optimum waste management option. However, the Council Directive 2002/96/EC of 27 January 2003 defines disused smoke detectors as waste electronic equipment subject to recycling requirements. The arrangements for conditioning and final disposal of the disused smoke detectors being delivered to waste electrical equipment collection points are now under consideration.

B.32.4 Decommissioning of nuclear facilities

No nuclear power plants are currently being decommissioned and such decommissioning projects are neither foreseen in the near future. The VTT Technical Research Centre of Finland has started a more detailed planning of the shutdown and decommissioning of the research reactor they operate as a preparatory action to the possible decision of the closure of the facility. The decision to implement the plan is dependent on the outcome of efforts to arrange alternative, sustainable funding for continued operation.

The utilities are obliged to update the decommissioning plans of NPPs for regulatory review every five years. The next updates are carried out in 2008. The plan for the Loviisa NPP is based on immediate decommissioning while for the Olkiluoto NPP, a safe storage period of about 30 years prior to dismantling is envisaged. The disposal plans for wastes from decommissioning of the NPPs are based on the extension of the on-site repositories for LILW. Besides the dismantling waste, also activated metal components accumulated during the operation of the reactors could be disposed of in those repositories. The engineered barriers will be selected taking account of the radiological and other safety related characteristics of each waste type. A special feature of the decommissioning plans is the emplacement of large components, such as pressure vessels and steam generators, in the disposal rooms as whole, without cutting them in pieces.

The decommissioning plan of the research reactor FiR 1 is also updated every five year, the latest update being carried out in 2005. Studies are under way on the technical feasibility of disposing of the decommissioning wastes in the LILW repository at the Loviisa site.

SECTION C Scope of application

Article 3 Scope of Application

This Convention shall apply to the safety of spent fuel management when the spent fuel results from the operation of civilian nuclear reactors. Spent fuel held at reprocessing facilities as part of a reprocessing activity is not covered in the scope of this Convention unless the Contracting Party declares reprocessing to be part of spent fuel management.

This Convention shall also apply to the safety of radioactive waste management when the radioactive waste results from civilian applications. However, this Convention shall not apply to waste that contains only naturally occurring radioactive materials and that does not originate from the nuclear fuel cycle, unless it constitutes a disused sealed source or it is declared as radioactive waste for the purposes of this Convention by the Contracting Party.

This Convention shall not apply to the safety of management of spent fuel or radioactive waste within military or defence programmes, unless declared as spent fuel or radioactive waste for the purposes of this Convention by the Contracting Party. However, this Convention shall apply to the safety of management of spent fuel and radioactive waste from military or defence programmes if and when such materials are transferred permanently to and managed within exclusively civilian programmes.

This Convention shall also apply to discharges as provided for in Articles 4, 7, 11, 14, 24 and 26.

Finland has adopted the once-through nuclear fuel cycle. Thus, all spent nuclear fuel, after it has been permanently removed from the reactor, is in the scope of the Convention.

Airborne and liquid discharges from nuclear and radioactive waste management facilities, notably from NPPs, are included in the scope of this Convention.

No radioactive wastes of military or defence origin exist in Finland.

Waste outside the nuclear fuel cycle, containing only naturally occurring materials (NORM-waste), except sealed radium sources, is not declared as radioactive waste for the purposes of the Convention. However, some experience with current practice for managing NORM waste is reported in section H12.2.

SECTION D Inventories and lists

Article 32 Reporting, paragraph 2

This report shall (also) include:

(a) a list of the spent fuel management facilities subject to this convention, their location, main purpose and essential features;

(b) an inventory of spent fuel that is subject to this Convention and that is being held in storage and of that which has been disposed of. This inventory shall contain the description of the material and if available, give information on its mass and its total activity;

(c) a list of radioactive waste management facilities subject to this Convention, their location, main purpose and essential features;

(d) an inventory of radioactive waste that is subject to this Convention that:
- *is being held in storage of radioactive waste management and nuclear fuel cycle facilities;*
- *has been disposed of; or*
- *has resulted from past practices;*

this inventory shall contain the description of the material and other appropriate information available, such as volume or mass, activity and specific radionuclides;

(e) a list of nuclear facilities in the process of being decommissioned and the status of decommissioning activities at those facilities.

D.32.1 Spent fuel and radioactive waste management facilities

The locations, ownership, characteristics and inventories of spent fuel and radioactive waste management facilities in Finland are given in adjacent tables: spent fuel storages in Table D.1, predisposal waste management facilities in Table D.2 and disposal facilities in Table D.3. More specific inventory data is included in Annexes L.3 and L.4.

D.32.2 Small user waste

The licensing database maintained by STUK includes source-specific information on each sealed source in licensee's possession. This information is updated continuously according to licensees' notifications and observations made during the inspections. Small users of radioisotopes have in their premises radiation sources which are no longer in use but have not yet been declared as radioactive waste. Except of four old ^{60}Co therapy or irradiator sources ranging from 1 to 44 TBq, the activities in such sources are less than 1 TBq and typically in the range of 0.4-4 GBq (see also Chapter J.28.2.).

D.32.3 Waste from past practices

There are no significant amounts of waste from past practices requiring further management (see also Chapter H.12.2).

D.32.4 Decommissioning

No significant facilities subject to nuclear energy or radiation legislation are being decommissioned and no final decisions on such decommissioning projects have been made. In 2002, decommissioning of a sterilisation plant was completed in Ilomantsi, Eastern Finland. The strong ^{60}Co source was transported abroad for reuse. There was no contamination in the facility.

Table D.1 Spent fuel storage in Finland.

Loviisa nuclear power plant	
Owner:	FPH
Location:	Hästholmen island, town of Loviisa, Southern Finland
Purpose:	Interim storage of spent fuel
Capacity:	570 (effective*)
Inventory (end of 2007):	428 tU (3565 assemblies, maximum burnup 46 MWd/kgU)
Essential features:	Pool storages inside both reactor buildings Basket type pool storage in the NPP auxiliary building Rack type pool storage in the NPP auxiliary building
Olkiluoto nuclear power plant	
Owner:	TVO
Location:	Olkiluoto island, municipality of Eurajoki, South-Western Finland
Purpose:	Interim storage of spent fuel
Capacity:	1570 tU (effective*)
Inventory (end of 2007):	1142 tU (6750 assemblies, maximum burnup 45 MWd/kgU)
Essential features:	Pool storages inside both reactor buildings Pool storage in a separate facility at the NPP site
FiR 1 research reactor	
Operator:	VTT
Location:	Otaniemi, town of Espoo, Southern Finland
Purpose:	Interim storage of spent fuel
Inventory (end of 2007):	4.20 kgU (23 elements, maximum burnup 23 MWd/kgU)
Essential features:	Racks at the walls of reactor pool (10 elements waiting for cooling). After several years' cooling time the elements will be transferred to the well type storage. Well type storage under the reactor hall.

* The reserve capacity for exceptional unloading of the entire reactor core to storage pool, for storage pool repairs and space for dummy elements are excluded.

Table D.2. Predisposal management of radioactive waste in Finland.

Loviisa nuclear power plant	
Owner:	FPH
Location:	Hästholmen island, town of Loviisa, Southern Finland
Purpose:	Treatment, conditioning and interim storage of LILW
Inventory (end of 2007):	1651 m³
Essential features:	Pretreatment, compaction and packaging of solid LLW Pretreatment of liquid LILW Eight tanks, 300 m³ each, for storage of liquid LILW Solidification plant for liquid LILW Two storage rooms inside the NPP for packed LLW (Dry) storage well and pool storage for unconditioned activated waste On-site light built storage hall for waste candidate for clearance
Olkiluoto nuclear power plant	
Owner:	TVO
Location:	Olkiluoto island, municipality of Eurajoki, South-Western Finland
Purpose:	Interim storage of LILW
Inventory (end of 2007):	1334 m³
Essential features:	Pretreatment, compaction and packaging of solid LLW Pretreatment and bituminisation of liquid LILW Four buffer storage rooms for conditioned LILW Pools storage of unconditioned activated waste Treatment and storage buildings at the site for unconditioned LLW
FiR 1 research reactor	
Operator:	VTT
Location:	Otaniemi, town of Espoo, Southern Finland
Purpose:	Treatment, packaging and interim storage of LILW
Inventory (end of 2007):	6 m³
Essential features:	Storage room in the basement of a laboratory building
STUK's waste storage hall	
Owner:	STUK
Location:	Roihupelto, city of Helsinki, Southern Finland
Purpose:	Buffer interim storage of waste from small users
Inventory (end of 2007):	1.5 m³ (5 GBq)
Essential features:	Storage room in the basement of STUK's building
Storage for state owned waste	
Owner:	TVO/Ministry of Social Affairs and Health**
Location:	Olkiluoto island, municipality of Eurajoki, South-Western Finland
Purpose:	Long-term interim storage of sealed sources and other small user waste
Inventory (end of 2007):	50.5 m³ (22.4 TBq, dominant nuclides H-3, Cs-137, Pu-238, Kr-85, Am-241)
Essential features:	Rock cavern attached to the Olkiluoto disposal facility

** By an agreement made in 1996 between TVO and the Ministry of Health and Social Affairs, the waste is stored in a separate rock cavern in TVO's Olkiluoto LILW disposal facility. The waste is owned by the State, with the Ministry of Social Affairs and Health as the responsible organisation.

Table D.3. Disposal of radioactive waste in Finland.

Loviisa disposal facility	
Owner:	FPH
Location:	Hästholmen island, town of Loviisa, Southern Finland
Purpose:	Disposal of LILW
Inventory (end of 2007):	1475 m^3 (0.40 TBq, dominant nuclides Co-60, Ni-63, Cs-137)
Essential features:	Rock tunnels for LLW
Olkiluoto disposal facility	
Owner:	TVO
Location:	Olkiluoto island, Municipality of Eurajoki, South-Western Finland
Purpose:	Disposal of LILW
Inventory (end of 2007):	4790 m^3 (56.4 TBq, dominant nuclides ^{60}Co, ^{63}Ni, ^{137}Cs, ^{90}Sr, ^{14}C)
Essential features:	Rock silo for bituminized ILW Rock silo for packed LLW

SECTION E Legislative and regulatory system

Article 18 Implementing measures

Each Contracting Party shall take, within the framework of its national law, the legislative, regulatory and administrative measures and other steps necessary for implementing its obligations under this Convention.

The necessary legislative, regulatory and other measures to fulfil the obligations of the Convention have been taken and are discussed in this report.

Article 19 Legislative and regulatory framework

Each Contracting Party shall establish and maintain a legislative and regulatory framework to govern the safety of spent fuel and radioactive waste management.

This legislative and regulatory framework shall provide for:

(a) the establishment of applicable national safety requirements and regulations for radiation safety;

(b) a system of licensing of spent fuel and radioactive waste management activities;

(c) a system of prohibition of the operation of a spent fuel or radioactive waste management facility without a licence;

(d) a system of appropriate institutional control, regulatory inspection and documentation and reporting; the enforcement of applicable regulations and of the terms of the licences;

(e) a clear allocation of responsibilities of the bodies involved in the different steps of spent fuel and of radioactive waste management.

When considering whether to regulate radioactive materials as radioactive waste, Contracting Parties shall take due account of the objectives of this Convention.

E.19.1 Safety requirements and regulations

In Finland, the legislation for the use of nuclear energy and for radiation protection was established in 1957. Since then, several amendments and new regulations have been issued.

Nuclear legislation and regulations

The current Finnish nuclear legislation is based on the Nuclear Energy Act from 1987, together with a supporting Nuclear Energy Decree from 1988. The scope of this legislation covers e.g.

- The construction and operation of nuclear facilities; nuclear facilities refer to facilities for producing nuclear energy, including research reactors, facilities performing extensive disposal of nuclear waste, and facilities used for extensive manufacture, production, use, handling or storage of nuclear materials or nuclear wastes;
- Mining and milling operations aimed at producing uranium or thorium;
- The possession, manufacture, production, transfer, handling, use, storage, transport, export and import of nuclear material and nuclear waste as well as the export and import of ores and ore concentrates containing uranium or thorium.

A significant amendment to the Nuclear Energy Act was passed in 1994, to reflect a new policy that emphasises the national responsibility to manage nuclear waste generated in Finland. In general, the export and import of nuclear waste, including spent fuel, is prohibited in the revised Act. A notable exception is allowed for the FiR 1 research reactor. According Nuclear Energy Act (Section 6a) the above provisions shall not apply to nuclear waste that has been generated in connection with or as a result of the operation of a research reactor in Finland.

In the amendment of the Nuclear Energy Act of 2008, general safety and security principles are added to the Act. This was implied by the new Constitution requiring that the general principles for the protection of the citizens shall be given on the level of Acts.

By definition, the provisions for the use of nuclear energy in the Nuclear Energy Act address also spent fuel and nuclear waste management. The Nuclear Energy Act sets forth the specific requirements on nuclear waste management (Sections 28–34) and for the financial provisions of nuclear waste management (Sections 35–53). These provisions address also spent fuel management.

At the end of the review period of the Convention, the rules and regulations published on the decree level were called Government Decisions. However, currently the following regulations are being revised and they will be formally named as Government Decrees:

- Government Decision 395/1991 on the General Regulations for the Safety of Nuclear Power Plants
- Government Decision 396/1991 on the General Regulations for Physical Protection of Nuclear Power Plants
- Government Decision 397/1991 on the General Regulations for Emergency Response Arrangements at Nuclear Power Plants
- Government Decisions 398/1991 and 478/1999 related to the Safety of Disposal of Nuclear Waste.

The present Government Decision 395/1991 on NPP safety (also being revised) also covers spent fuel and radioactive waste management at the NPP sites.

Detailed safety requirements on the management of spent nuclear fuel and radioactive waste resulting from the production of nuclear energy are provided in YVL Guides. YVL Guides also provide administrative procedures for the regulation. YVL Guides are issued by STUK, as stipulated in the Nuclear Energy Act. YVL Guides are rules an individual licensee or any other organisations concerned shall comply with, unless some other acceptable procedure or solution has been presented to STUK by which the level of safety stipulated in an YVL Guide is achieved.

STUK started in 2006 an overall reform of the YVL Guides.

Legislation and regulations for the use of radiation sources

The Radiation Act and Decree were revised in 1991 to take into account the ICRP Publication 60 (1990 Recommendations of the International Commission on Radiological Protection). The Radiation Act and Decree were further amended in 1998 to be in conformance with the European Community Radiation Protection Legislation including the Council Directive 96/29/EURATOM of 13 May 1996, on the Protection of the Health of Workers and General Public Against the Dangers Arising from Ionizing Radiation. The Council Directive 2003/1227 Euratom of 22 December 2003 on the Control of High-Activity Sealed Radiation Sources and Orphan Sources will be implemented by 31.12.2005 by revising the Radiation Act and Decree accordingly.

Detailed safety requirements on the management of radioactive waste, subject to the Radiation Act, are provided in STUK's ST Guides. The responsible party running a radiation practice is obliged to ensure that the level of safety specified in the ST Guides is attained and maintained.

E.19.2 Licensing

The licensing process is defined in the legislation. The construction and operation of a nuclear facility is not allowed without a license. The licences are granted by the Government. For an NPP, a spent nuclear fuel storage, a nuclear waste disposal facility or another significant nuclear facility the process consists of three steps:

- Decision-in Principle – granted by the Government and confirmed by the Parliament
- Construction Licence – granted by the Government
- Operating Licence – granted by the Government

The conditions for granting a licence are prescribed in the Nuclear Energy Act (Sections 19–20). The operating licences of a nuclear facility are granted for a limited period of time, generally for 10–20 years. In case the operating licence is granted for a longer period than 10 years, a periodic safety review is required to be presented to STUK. The periodic re-licensing or review has allowed good opportunities for a comprehensive safety review.

Before a Construction Licence for an NPP, spent fuel storage, nuclear waste disposal facility or other significant nuclear facility can be applied for, a Decision-in-Principle (DiP) by the Government is needed. An Environmental Impact Assessment (EIA) procedure has to be conducted prior to the application of the DiP and the EIA report annexed to the DiP application. A condition for granting the Decision-in-Principle is that the construction of the facility in question is in line with the overall good of the society. Further conditions are as follows:

- The municipality of the intended site of the nuclear facility is in favour of constructing the facility
- No factors have appeared which indicate that the proposed facility could not be constructed and operated in a safe manner.

The entry into force of the Government's Decision-in-Principle further requires ratification by the Parliament. The Parliament can not make any changes to the Decision; it can only approve or reject it as such. The authorization process is described in Figure 8. In the DiP stage the full process is required, while for the construction and operation licences the acceptance of the Parliament and the host municipality are not any more needed.

This procedure was applied during the period November 1999 – May 2001 when Posiva Oy applied for a Decision-in-Principle for the spent nuclear fuel disposal facility in Olkiluoto. The Government made the DiP in December 2000 and the Parliament ratified the decision in May 2001.

If the licensee intends to make such modifications in the systems, structures, components or operational procedures of a nuclear facility which could affect safety, the approval of STUK for the modifications is required beforehand according to the Nuclear Energy Decree (Section 112).

On the basis of the Nuclear Energy Act (Section 16), minor licences for spent fuel and nuclear waste management activities (export, import, transfer and transport licence and licences for operations) are granted by either Ministry of Employment and the Economy or STUK; the licensing authority in each case is specified in the Nuclear Energy Decree.

The licensing system for practises under the Radiation Act is described in Sections 16 and 17 of the Act. The use of radiation requires a safety licence, which can be granted by STUK upon application. A safety licence can be subject to extra conditions needed to ensure safety. In addition, the cases where a licence is not needed are identified, e.g. when the use of radiation or a devise is exempted.

E.19.3 Prohibition of operation without licence

The Nuclear Energy Act and the Radiation Act define the enforcement system and rules for suspension, modification or revocation of a licence. The enforcement system includes provisions for execu-

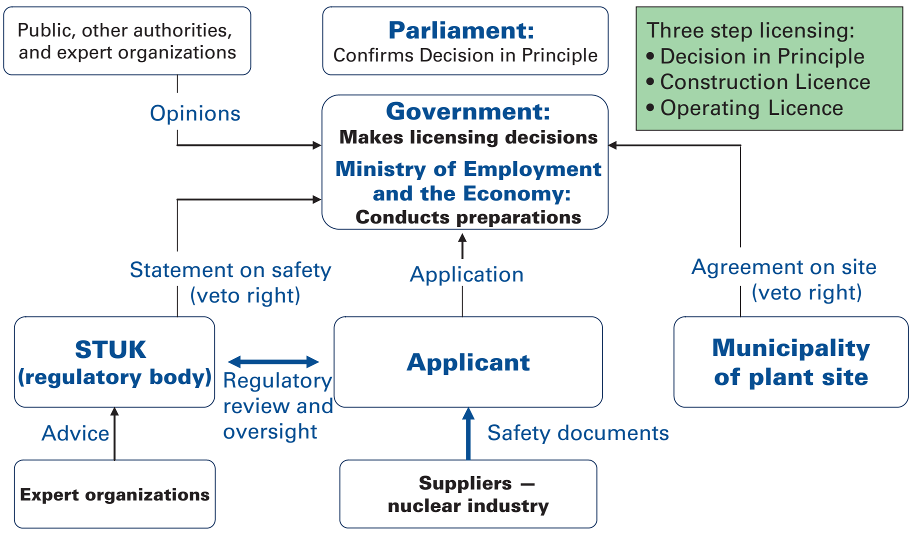


Figure 8. Authorization of nuclear facilities in Finland.

tive assistance if needed and for sanctions in case the law is violated.

E.19.4 Control and enforcement

According to the Nuclear Energy Act (Section 55), STUK is responsible for the regulatory control of the safety of the use of nuclear energy. The rights and responsibilities of STUK are provided in the Nuclear Energy Act (Sections 55 and 63). The regulatory activities include authorization, review and assessment, inspection and enforcement, development of regulations and guides, national registers and inventories, information and public communication.

The most important documents of the licensee, which shall comply with the regulations and other safety requirements and are reviewed be STUK, are the preliminary and final safety analysis reports (PSAR and FSAR), technical specifications and the operational manual. STUK's on-site inspections aim e.g. at verifying, that the actual operations at the nuclear facilities comply with the regulations and the documents of the licensee.

The Radiation Act (Section 6) provides that adherence to the Act and regulations issued in accordance with it shall be supervised by STUK. The supervisory rights of STUK are described in the Act (Sections 53–58).

E.19.5 Clear allocation of responsibilities

According to the Nuclear Energy Act (Section 9), a licensee, whose operation generates or has generated nuclear waste, shall be responsible for all nuclear waste management measures and their appropriate preparation, and is responsible for the arising expenses.

The NPP utilities FPH and TVO themselves take care of interim storage of spent fuel, of management of LILW including disposal, and of planning for the decommissioning of the NPPs. Their jointly owned company, Posiva, is taking care of the preparations for and later implementation of spent fuel encapsulation and disposal.

The Radiation Act (Section 50) provides for management of radioactive waste from non-nuclear applications. The responsible party (i.e. the licensee or any company or organization which uses radiation sources in its practices) is required to take all measures needed to render radioactive waste arising from its operation harmless. In case where the practice produces or may produce radioactive waste that can not be rendered harmless without considerable expenses, a financial security shall be furnished to ensure that these costs and those arising in performing any necessary environmental decontamination measures are met.

The state has the secondary responsibility in case that a producer of nuclear waste (Nuclear Energy Act, Sections 31 and 32) or other radioactive waste (Radiation Act, Section 51) is incapable of fulfilling its management obligation. STUK operates an interim storage of radioactive waste, where limited amounts of spent sealed sources and other radioactive waste are received upon compensation covering their further management costs.

The regulatory responsibilities are discussed under Article 20.

Article 20 Regulatory body

Each Contracting Party shall establish or designate a regulatory body entrusted with the implementation of the legislative and regulatory framework referred to in Article 19, and provided with adequate authority, competence and financial and human resources to fulfil its assigned responsibilities.

Each Contracting Party, in accordance with its legislative and regulatory framework, shall take the appropriate steps to ensure the effective independence of the regulatory functions from other functions where organizations are involved in both spent fuel or radioactive waste management and in their regulation.

E.20.1 Supreme authorities

According to the Nuclear Energy Act (Section 54), the overall authority in the field of nuclear energy is the Ministry of Employment and the Economy which has the responsibility of formulation of the national energy policy. The Act (Section 28) states that the Ministry shall decide, having consulted, when necessary, the Ministry of the Environment in the matter, the principles on the basis of which the waste management obligation is to be implemented. The Ministry prepares matters concerning nuclear energy, including the nuclear waste management, to the Government for decision-making and grants certain import and export licences for nuclear equipment and materials.

In the area of radioactive, non-nuclear waste management the Ministry of Social Affairs and

Health is the supreme authority on the supervision of practices involving exposure to radiation.

E.20.2 Regulatory authority for radiation and nuclear safety

STUK is an independent governmental organisation for the regulatory control of radiation and nuclear safety. The current Act on STUK was given in 1983 and the Decree in 1997. According to the Decree, STUK has the following duties:

- Regulatory control of safety of the use of nuclear energy, emergency preparedness, physical protection and nuclear materials safeguards
- Regulatory control of the use of radiation and other radiation practices
- Monitoring the radiation situation in Finland, and maintaining preparedness for abnormal radiation situations
- Maintaining national metrological standards for radiological measurements
- Research and development work for enhancing radiation and nuclear safety
- Providing information and publishing reports on radiation and nuclear safety issues, and participating in training activities in the field
- Producing expert services in the field
- Making proposals for developing the legislation and preparing the decisions of the Government in the radiation and nuclear safety fields, and issuing general guides in these fields
- Participating in international co-operation and taking care of international control, contact or reporting activities as enacted or defined.

STUK is administratively under the Ministry of Social Affairs and Health. Connections to various ministries and governmental organisations are described in Figure 9.

It is emphasised that the regulatory control of the safe use of nuclear energy and radiation is independently carried out by STUK and other Governmental bodies cannot take for their decision a matter that has been delegated by law to STUK. STUK has no responsibilities or duties which would be in conflict with regulatory control.

E.20.3 STUK's regulatory rights, competence and resources

STUK has the legal authority to carry out regulatory activities. The responsibilities and rights of STUK, as regards the regulation of the use of nuclear energy and the respective waste management, are provided in the Nuclear Energy Act and Decree. STUK's responsibilities and rights include the following main regulatory activities: authorization, review and assessment, inspection and enforcement, development of regulations and guides, national registers and inventories, information and public communication. In the Finnish terminology, nuclear safety includes nuclear safeguards and security. The regulatory control is described in detail in Guide YVL 1.1.

STUK does not grant construction or operating licences for nuclear facilities. However, no such licence can be issued without STUK's safety review and decision on the fulfilment of the safety regulations.

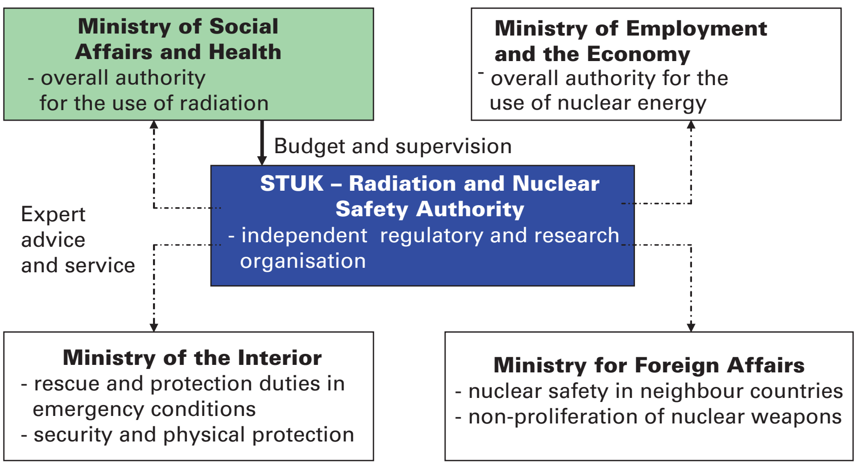


Figure 9. Co-operation between STUK and Ministries and other governmental organisations.

According to the Radiation Act (Section 16), STUK grants safety licences for the use of radiation. The regulatory rights of STUK are described in the Act (Sections 53–58).

STUK has adequate resources to fulfil its responsibilities. The total number of the personnel (in the end of 2007) was 344, of which more than 120 are directly involved with radiation and nuclear safety regulatory activities. In recent years STUK has substantially strengthened and reorganized its competence, staff and external expert support in the area of nuclear waste management. New hires, including experts in the areas of disposal and encapsulation technology, chemistry and safety assessment, have brought the number of STUK experts to 14. In addition, STUK has its own R&D programme (see Chapter E.20.4) supporting its regulatory needs related to nuclear waste safety, and has organized international expert support groups for safety issues of disposal site, technology and safety assessment. The organisation and staffing of STUK is described in the Figure 10.

The organisational structure and the responsibilities within STUK are provided in the Quality Manuals of STUK. Also procedures for regulatory control and other activities of STUK are presented in the manuals.

STUK's public communication is proactive, open, timely and understandable. Communication is a privilege and duty of all employees. Good cooperation with the media is emphasized in all communication. The general public and media can reach STUK's experts any time, including nights, weekends and holidays. A prerequisite for successful communication is that STUK is known among media and general public and the information given by STUK is regarded as truthful. Communication is always based on best available information. Even sensitive matters are openly communicated. STUK's web site is an important tool in communication. In recent years STUK has published various information materials and a series of books on radiation and nuclear safety. The books are intended to be used as handbooks for those who work in the field and for students.

STUK is participating actively in European and international co-operation in the field of nuclear waste and radiation safety. STUK's experts have participation, memberships and chairmanships in the OECD/NEA, IAEA, IRPA, ICRP and European Commission expert groups. STUK is also involved in the work of European Commission through High Level Group and its waste management sub-group, Atomic Questions Group, NRWG, CONCERT and RAMG-related PHARE- and TACIS- programmes, EBRD as well as through European regulators' association WENRA. In addition, there are regulatory co-operation with neighbouring Nordic countries, Lithuania, Estonia and Russia. With respect to the latter, cooperation is both bilateral and through the multinational Contact Expert Group (CEG) under the IAEA auspices.

In the area of regulatory control of waste management, STUK receives about 10% of its financial resources through the Government budget. Per legislation, the licence holders pay the regulatory

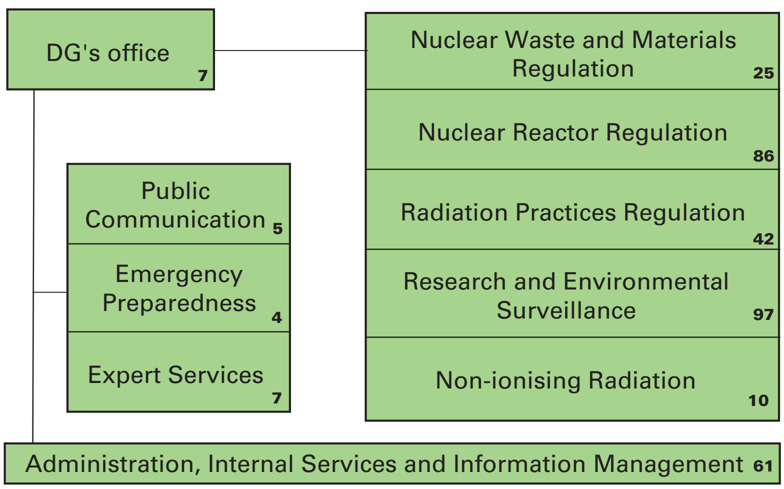


Figure 10. The organisation of STUK and number of personnel in different units at the end of 2007.

expenses to STUK. In 2007 the costs of the regulatory control of nuclear safety were 12 million €. The total costs of nuclear safety regulation were 13.2 million €. Thus the share of activities subject to a charge was 90.9 %.

E.20.4 Regulatory support organisations

The main technical support organisation of STUK in the field of nuclear waste management is the VTT Technical Research Centre of Finland. In VTT and other Governmental or University institutes, tens of experts are working in the area of spent nuclear fuel and radioactive waste management.

Three international expert groups have been established by STUK to support STUK's decision making process for the disposal of spent nuclear fuel issues and reviews. The groups are for the site investigations (SONEX), engineered barrier (AEGIS) and safety analysis (SAFARI).

There are three main R&D programs on nuclear waste management in Finland with the following main features:

- The program of Posiva Oy; the program is mainly aimed at planning and implementing the disposal of spent nuclear fuel in Finland
- The program of STUK; aimed at supporting the regulatory decision making of STUK while regulating Posiva and the power companies
- The KYT2010 program administrated by the MEE; KYT2010 program is aimed at supporting the further development and maintenance of the overall national competence and the sufficient and comprehensive expertise needed for regulatory purposes, and at assessing alternative solutions for long term management of spent fuel.

An international peer review of the KYT2010 program was organised by the MEE in 2007. As a general conclusion, the Evaluation Panel has found that the KYT2010 programme, as implemented and guided by the Steering and Support Groups, provides a reasonably balanced programme in areas supporting in a generic way the current Finnish nuclear waste management programme, the development and preservation of new competence, and possible alternative options. The panel gave also suggestions to develop the program further. The evaluation report (KYT2010 Review Report) can be found at TEM's website www.tem.fi). http://www.tem.fi/files/18650/temjul_2_2008_energia_ilmasto.pdf

Reports on the regulatory control of nuclear and radiation safety, including radioactive waste management, are published annually.

STUK's Advisory Committee on Nuclear Safety has been established by a separate decree. It has a special section for nuclear waste management issues. The Committee addresses important safety issues and regulations.

SECTION F Other general safety provisions

Article 21 Responsibility of the licence holder

Each Contracting Party shall ensure that prime responsibility for the safety of spent fuel or radioactive waste management rests with the holder of the relevant licence and shall take the appropriate steps to ensure that each such licence holder meets its responsibility.

If there is no such licence holder or other responsible party, the responsibility rests with the Contracting Party which has jurisdiction over the spent fuel or over the radioactive waste.

The responsibility for the safety rests with the licensee as prescribed in the Nuclear Energy Act. According to the Act (Section 9) each licensee, whose operations generate or have generated nuclear waste is responsible for all nuclear waste management measures and their appropriate preparation, and is responsible for their costs. If the licence holder is found not to be capable to carry out the waste management completely or partly, the Government shall order that such nuclear waste be transferred to the responsibility of the State. The waste management obligation of the licensee will expire when the disposal of nuclear waste has been completed and STUK has confirmed that the nuclear waste is permanently disposed of in an approved manner (Sections 31–34 of the Nuclear Energy Act). Furthermore, the licensee is responsible for such physical protection and emergency preparedness arrangements and other necessary arrangements for limitation of nuclear damages, which do not belong to the authorities. To ensure that the financial liability for the future management and disposal of nuclear wastes and for the decommissioning of nuclear facilities is covered, the licensees under a waste management obligation shall fulfil the financial provision obligation by payments into the National Nuclear Waste Management Fund, and shall furnish the State with securities as a precaution against insolvency. The Nuclear Waste Management Fund is independent of the State budget, but it is controlled and administered by the Ministry of Employment and the Economy.

As a precondition for granting a safety licence for the use of radiation the Radiation Act requires (Section 16) that the applicant presents a valid proof on safe management of any radioactive waste, which may be generated. Further, the Radiation Act (Section 50) provides that the responsible party shall organize the practice so that it meets all radiation safety requirements prescribed in the Act and take all measures needed to render radioactive waste arising from its operation harmless. The Act also provides for the responsibility of decontamination of the environment, if the radioactive material is released in such an extent that resulting health or environmental hazards requires action. According to the Act (section 50), in utilization of natural resources containing radioactive materials, the responsible party shall ensure that radioactive wastes do not pose any health or environmental hazards during the operations, including the final stages.

The Radiation Act (Section 51) provides that if the responsible party does not meet the requirements set for radioactive waste management, the State has the secondary obligation in managing the radioactive waste or residues. The same applies if the origin of waste is unknown, or no primary responsible party can be found.

It is the responsibility of the regulatory body to verify that the licensees fulfil their responsibilities set in the regulations. This verification is carried out through safety reviews and assessments as well as inspection programmes established by STUK.

Article 22 Human and financial resources

Each Contracting Party shall take the appropriate steps to ensure that:

(a) qualified staff are available as needed for safety-related activities during the operating lifetime of a spent fuel and a radioactive waste management facility;

(b) adequate financial resources are available to support the safety of facilities for spent fuel and radioactive waste management during their operating lifetime and for decommissioning;

(c) financial provision is made which will enable the appropriate institutional controls and monitoring arrangements to be continued for the period deemed necessary following the closure of a disposal facility.

F.22.1 Human resources

The licensee has the prime responsibility for ensuring that his employees are qualified and authorised to their jobs. According to the Nuclear Energy Act (Section 19), a necessary condition for granting a construction licence of a nuclear facility is the availability of the necessary expertise. According to the Nuclear Energy Act (Section 20), an operating licence of a nuclear facility can be granted if the applicant has available the necessary expertise and, in particular, if the operating organisation and the competence of the operating staff are appropriate. Furthermore, a nuclear facility must have a responsible manager and his/her deputy approved by STUK (Section 79 of the Nuclear Energy Act).

According to the Government Decision 395/1991, NPP personnel shall be well suited for its duties, competent and well trained. Initial, complementary and refresher training programmes shall be established for the personnel. For ensuring safety in all situations, competent personnel shall be available in a sufficient number. This decision covers also spent fuel storage and radioactive waste management at the NPP and on-site LILW disposal facilities. Government Decision on the safety of disposal of nuclear waste includes similar requirements. Accordingly, both utilities have special training programs including waste management for their personnel. Posiva has established their own training and education program to develop the resources needed in the geologic disposal of spent fuel. Staff training at Posiva is based on personal training and development plans and company-level plans which are updated annually. The company-level plan includes an orientation program specially structured for all new staff members. An elementary course dealing with the fundamentals in nuclear waste management is a part of the basic training for all technical and scientific staff. In 2006 a systematic competence development programme was launched which sets off from the assessment of existing skills and expertise, includes the assessment of the competences needed and implements the programme to meet these goals. Several specialised courses have already been arranged, one of them in cooperation with the International Training Centre (ITC).

Along with the construction of the underground characterisation facility ONKALO, increasing emphasis has been put on training to meet with the requirements on industrial safety, environment and quality at Posiva.

Posiva has formal bilateral co-operation agreements or understandings with ANDRA (France), DBE (Germany), DoE (USA), NAGRA (Switzerland), JAEA, NUMO and RWMC (Japan), NWMO and Ontario Power Generation (Canada), RAWRA (Czech Republic) and SKB (Sweden). Furthermore, Posiva participates in the nuclear waste management related research projects of the Nuclear Energy Research Programme of the European Commission. The long time scales associated with the spent fuel disposal underline the importance of the availability of qualified domestic experts in the field also for far future.

However, changes in energy markets and the fast development of technology will bring new challenges to the knowledge, and this requires special emphasis by all the parties. Also considerable share of Finnish nuclear experts both within the regulator, the operators as well as in research institutes and universities is retiring by mid-2010's and at the same time additional human resources are needed owing to the spent fuel disposal project, the Olkiluoto 3 project and other potential new NPP projects. The challenges are tackled by training young experts in the nuclear safety field as a specific co-operation programme of all Finnish nuclear related organizations. During 2003-2007 about 270 young experts have been trained during five 5–6 weeks training courses emphasizing safety of NPPs including some basic features of nuclear waste management. The 6th training course will be organized in 2008–2009. The intention is to continue with the training course on annual basis as long as there are enough participants who need the training. Training materials have been developed that can be used by the organizations in their internal training programmes as appropriate and for self-study via distance learning including text book, overhead materials, exercises and video lectures. The need for a similar national training course emphasizing nuclear waste management is being presently considered as well.

According to the Nuclear Energy Act (Sections 55 and 79), STUK is responsible for controlling the necessary qualifications of the persons engaged in activities important to safety. STUK has issued requirements on staff qualification and described the respective regulatory control procedures in Guides YVL 1.1 and YVL 1.7.

The Radiation Act (Section 14) prescribes that the responsible party is required to ensure that in safety related matters of the operations the expertise is available, taking into account the nature and the risks posed by the operation. The responsible party shall appoint a radiation safety officer. In a licence application the applicant shall provide information on the competence of the persons working with radiation.

STUK shall lay down the qualifications of the radiation safety officer and other persons, as applicable, and investigate that these qualifications are met (Section 18 of the Radiation Act). The licensee shall provide appropriate training for the employees. The Guide ST 1.4 sets the requirements for the organisation for the use of radiation including the competences needed. The Guide ST 1.8 further sets detailed requirements on radiation protection training for the radiation safety officers and qualified experts. The command that has to be demonstrated by an exam includes a general part covering basics of radiation protection and the appropriate legislation. Special requirements are attributed to different fields of applications of radiation.

F.22.2 Financial resources

The Nuclear Energy Act (Sections 35 to 53) provides detailed regulations for the financial arrangements for nuclear waste management and the Decree on the State Nuclear Waste Management Fund further specifies the financing system. Generators of nuclear waste are annually obliged to present justified estimates of the future cost of managing their existing waste, including spent fuel disposal and decommissioning of NPPs. The Ministry of Employment and the Economy (MEE) confirms the assessed liability and the proportion of liability to be paid into the Nuclear Waste Management Fund (fund target). The waste generators pay annually the difference of fund target and the amount already existing in the Fund, but can also be reimbursed if the funded amount exceeds the liabilities. The waste generators shall provide securities to MEE for the portion of financial liability that is not yet covered by the Fund.

For the FiR1 research reactor somewhat modified practices are followed. The state has initially provided the funds on behalf of the operator (VTT). In the future the State will take care of the payments to cover the difference between the Fund target and the amount already existing in the Fund. The possible interest reimbursements exceeding the difference between the fund target and the previously funded amount are returned to the State.

The current estimates, including costs from management of existing waste quantities and from decommissioning of current NPPs and the research reactor, arise to about 1900 million Euros with no discounting. At the end of the period 2005–2007 the total cost estimate was increased by about 36%, mainly owing to the modification of the disposal plan of the spent fuel. Because of the outstanding increase, the payments to the Fund were divided into the period of five years. The difference between funded assets and the whole liability is covered by securities of the nuclear power companies. The fund targets and liabilities covered by securities of the nuclear power companies are shown in Figure 11. Only the liabilities regarding the management of waste resulting from the operation and decommissioning of the operating four reactors are illustrated here.

According the Nuclear Energy Act (Section 19), a Construction Licence for a nuclear facility can be granted only if the applicant has sufficient financial resources. This condition shall be complied with throughout the operation of the facility. For example, the licensee shall have adequate financial resources to enhance the safety of the facility based on operating experience and the results of safety research as well as on the advancement of science and technology. In particular, as provided in the Nuclear Energy Act (Section 20), the operation of the nuclear facility shall not be started until the Ministry of Employment and the Economy has ascertained that the provision for the cost of waste management has been arranged. Furthermore, the Nuclear Energy Decree (Sections 32 and 34) provides that the application for the construction and operating licence of a nuclear facility shall include information on the financial resources of the applicant, cost estimates and financial plan for the nuclear facility programme, as well as a description of the timetable of nuclear waste management and its estimated costs.

The financial provisions to cover the possible harms of a nuclear accident have been arranged according to the Paris and Brussels Conventions. Finland has participated in the international efforts to revise the Paris and Brussels Conventions for Nuclear Third Party Liability in order to raise the funds made available by the Contract Parties in case of accidents. Accordingly, the amendment of the Finnish Nuclear Liability Act was agreed upon by the Parliament in 2005 but it is pending the coming into force of the amendments of the Paris and Brussels Conventions. The amendments include an unlimited financial liability to licensees.

According to the Radiation Act (Section 19), the licensee shall furnish security to ensure that it will meet the costs of waste management or any decontamination measures, if the operations are liable to produce radioactive waste that cannot be rendered harmless without substantial cost. The need to furnish security and the amount of it shall be decided by STUK when the safety licence is granted (Section 15 of the Radiation Decree).

F.22.3 Financial provisions for post-closure

According to the Nuclear Energy Act (Section 32), a condition for the expiry of waste management obligation of a nuclear waste generator is that the waste has been permanently disposed of in an approved manner and a lump sum to the State for the further control of the waste has been paid. Thereafter, the State is responsible for the necessary waste management measures and incurred costs.

According to the Radiation Act (Section 51), the responsible party and others who have taken part in producing or handling the radioactive materials or waste shall compensate the State for the costs incurred by the measures taken to render the waste harmless and to decontaminate the environment.

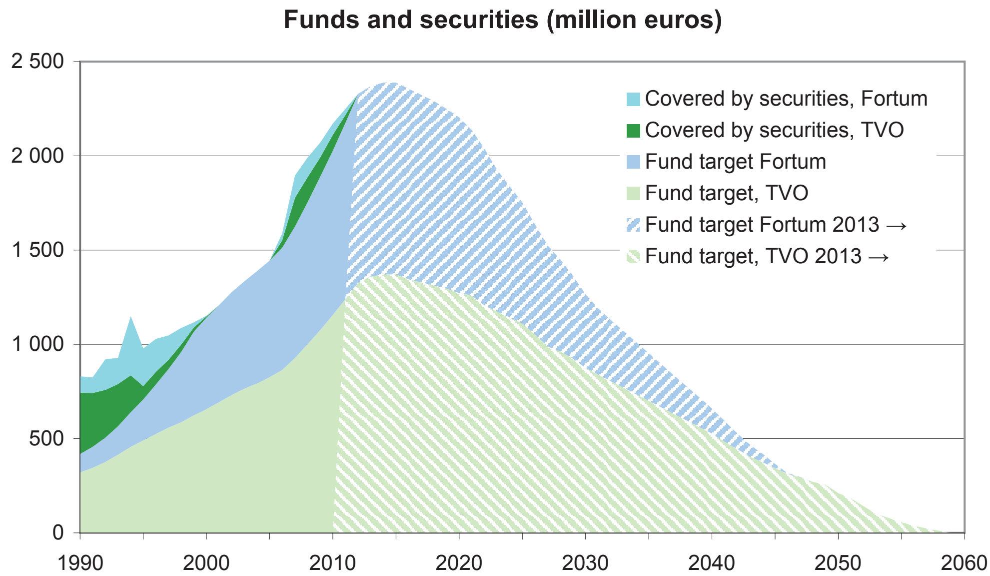


Figure 11. The fund targets (for the operating reactors) in the Nuclear Waste Management Fund and liabilities covered by securities. After 2012 the data are illustrative and take into account both the use of the funds for the implementation and additional inputs until the closing of the reactors.

Article 23 Quality assurance

Each Contracting Party shall take the necessary steps to ensure that appropriate quality assurance programmes concerning the safety of spent fuel and radioactive waste management are established and implemented.

Nuclear Energy Decree (Sections 35 and 36) requires that a quality management system for design and construction as well as for operation are required to be submitted to STUK when applying for a construction and operating licence of a nuclear facility, respectively. The general quality assurance requirements apply to the whole life of a nuclear facility.

According to the Government Decision 395/1991, the organisations participating in the design, construction, operation, and decommissioning of a nuclear power plant shall have a quality management system in place. The Government Decree under preparation widens this concept into Management System. The management system shall aim at ensuring that priority will always be given to safety and that the requirements for quality management are commensurate to the importance to safety of the action. The management system shall be systematically assessed and developed. A similar requirement is included in the Government Decision and Decree under preparation on the safety of disposal of nuclear waste. The quality management system requirements concerning nuclear facilities are provided in the recently updated Guide YVL 1.4 reflecting the updating of the IAEA guidelines and the recent development in the quality management in industry.

Quality management systems of the licensees/applicants and of the main suppliers are subject to approval by STUK. Furthermore, quality assurance programmes have to be established by all other organisations participating in activities important to safety of the use of nuclear energy. The implementation of these quality managements systems is verified by STUK. The operators of the NPPs, FPH, TVO, and the waste management company Posiva have adopted quality management systems consistent with the ISO 9001 standard. The quality management system of the ISO 9001 standard in TVO covers also the construction time of Olkiluoto 3. Moreover, FPH, TVO and Posiva have adopted environmental management system according to ISO 14001. Most of their contractors have also similar quality management systems and the others are currently developing their systems. The implementation of these quality assurance programmes is verified by STUK through audits and inspections. The Quality System of VTT Technical Research Centre of Finland has been granted in 2006 an ISO9001:2000 certificate that is regularly audited. Both NPP licensees have recently implemented new quality management systems. For the Olkiluoto 3 construction phase STUK has approved “The Quality Manual for Olkiluoto 3 Project”. The detailed assessment of the quality management system for the ONKALO facility construction is underway.

STUK has a Quality Manual that includes quality policy, description of the quality system, organisation and management, main and supporting working processes and personnel policy. The results of systematic internal audits, self-assessments and international evaluations are used as inputs for the enhancement projects of the Quality Management System at STUK. In addition to STUK’s Quality Manual, all main functions of STUK have their own more detailed Quality Manuals. In the quality management system, the process oriented approach has been implemented through out the whole organization in 2004. The quality policy of STUK will be updated in 2008. The Quality Manual prepared for the regulatory control of the use of nuclear energy has been benchmarked with other regulators under the auspices of OECD/NEA working groups and through bilateral contracts. The Quality Manual guides concerning nuclear waste management are revised during 2007–2008. Nine totally new guides are introduced and two other guides will be updated. Four of the new guides are dealing with regulatory control of disposal of spent nuclear fuel and the others deal with regulatory control of nuclear waste management in general, decommissioning plans, funding of nuclear waste management, recording and reporting of nuclear waste and implementation of Joint Convention. The updated guides are dealing with regulatory control of low- and intermediate-level waste from nuclear facilities as well as research, development and technical design programme for final disposal of spent fuel.

Article 24 Operational radiation protection

Each Contracting Party shall take the appropriate steps to ensure that during the operating lifetime of a spent fuel or radioactive waste management facility:

(a) the radiation exposure of the workers and the public caused by the facility shall be kept as low as reasonably achievable, economic and social factors being taken into account;

(b) no individual shall be exposed, in normal situations, to radiation doses which exceed national prescriptions for dose limitation which have due regard to internationally endorsed standards on radiation protection; and

(c) measures are taken to prevent unplanned and uncontrolled releases of radioactive materials into the environment.

Each Contracting Party shall take appropriate steps to ensure that discharges shall be limited:

(a) to keep exposure to radiation as low as reasonably achievable, economic and social factors being taken into account; and

(b) so that no individual shall be exposed, in normal situations, to radiation doses which exceed national prescriptions for dose limitation which have due regard to internationally endorsed standards on radiation protection.

Each Contracting Party shall take appropriate steps to ensure that during the operating lifetime of a regulated nuclear facility, in the event that an unplanned or uncontrolled release of radioactive materials into the environment occurs, appropriate corrective measures are implemented to control the release and mitigate its effects.

F.24.1 Basic radiation protection requirements

Basic requirements for the safe use of nuclear energy are given in the Nuclear Energy Act. The principles of justification, optimisation and dose limitation are included in the Radiation Act (Section 2). Occupational dose limits and dose limits for the general public are set forth in the Radiation Decree (Sections 3 to 5). These limits are in conformity with the ICRP 60 Recommendation (1990) and the Council Directive 96/29/EURATOM.

According to the Radiation Decree (Section 3) the effective dose from occupational exposure shall not exceed 20 mSv per year as an average over five years or 50 mSv in any single year. Medical surveillance of employees of NPPs and other working places where employees are engaged in radiation work is performed following Council Directive 96/29 EURATOM.

The Radiation Decree (Section 6) states that detailed instructions on the application of the maximum values laid down for radiation exposure and on the calculation of radiation doses shall be issued by STUK. It further states that notwithstanding the dose limits given in the Decree (Sections 3 to 5), e.g. the 1 mSv/a limit for the general public, STUK may, in individual cases, set constraints lower than the maximum values, if such constraints are needed to take account of radiation exposure originating from different sources and to keep the exposure as low as reasonably achievable.

F.24.2 Dose constraints

Government Decision 395/1991 includes regulations for limiting the radiation exposure of the general public and the releases of radioactive substances into the environment, arising from the normal operation of a NPP (including spent fuel storage and LILW treatment and storage facilities), as well as from anticipated operational transients and accidents. The constraint for the committed dose of the most exposed individual among the population, arising in one year from the normal operation and anticipated operational transients of a NPP, is 0.1 mSv. The individual dose constraint as a result of postulated accidents is 1 mSv, 5 mSv or 20 mSv from external radiation in the period of one year and the committed dose caused by radioactive materials intakes during the same period depending on the type and likelihood of the accident. The dose constraints are defined for the entire NPP, including all nuclear facilities on the site. Thus the future operation of Olkiluoto 3 will not increase the applied dose constraints at the site.

STUK has issued several YVL Guides dealing with radiation protection as regards the design and operation of NPPs (Guides YVL 1.0, YVL 7.1, YVL 7.9, YVL 7.10 and YVL 7.18). They cover also spent fuel storages and on-site waste management facilities, including the operational period of on-site disposal facilities for LILW. The Guides define the level of safety required and are the basis for regulatory review of license application as well as for review and inspection during commissioning and operation.

According to Government Decision (478/1999), a spent fuel disposal facility and its operation shall be designed so that as a consequence of undisturbed operation of the facility, discharges of radioactive substances to the environment remain insignificantly low. The radiological consequence of anticipated operational transients as annual effective dose to the most exposed members of the public shall remain below 0.1 mSv. The annual effective dose caused by postulated accidents shall remain below 1 mSv.

Notification limits for occupational collective doses for the NPP employees given in Guide YVL 7.9 is 2.5 manSv per 1000 MW_e as an average over two consecutive years. A more stringent target of 0.5 manSv per 1000 MW_e as an average over the whole lifetime of the plant is set in YVL 7.18 for the design of a NPP.

In the YVL Guides, reporting requirements concerning exceptional situations including exceptional releases are given. Release rate limits are also given in the Guides, ensuring actions already before a release limit would be reached. The Guides also give requirements concerning monitoring release pathways and environmental surveillance.

F.24.3 Operational experiences

Experience gained from operation of Finnish nuclear facilities shows that the dose constraints have not been exceeded, and that the ALARA principle has been followed. The results of environmental surveillance programmes show that the amount of radioactive materials in the environment of the NPP sites, originating from the Finnish nuclear facilities, has been very low. Calculated radiation exposures to the critical groups in the environment of the NPPs are currently less than one per cent of the dose constraint (Figure 12). The new NPP unit, Olkiluoto 3, will have advanced liquid and gaseous effluent treatment systems and it is expected that the discharges from the entire Olkiluoto NPP will remain at the current low level after the commissioning of the new unit. It should also be noted that the dose constraints and actual doses discussed above apply to the entire operation of the NPP and the contributions due to spent fuel storage and waste management are insignificant fractions of the total exposure: the occupational collective doses resulting from waste management, decontamination and spent fuel management activities at the both NPPs are of the order of some hundredths of manSv.

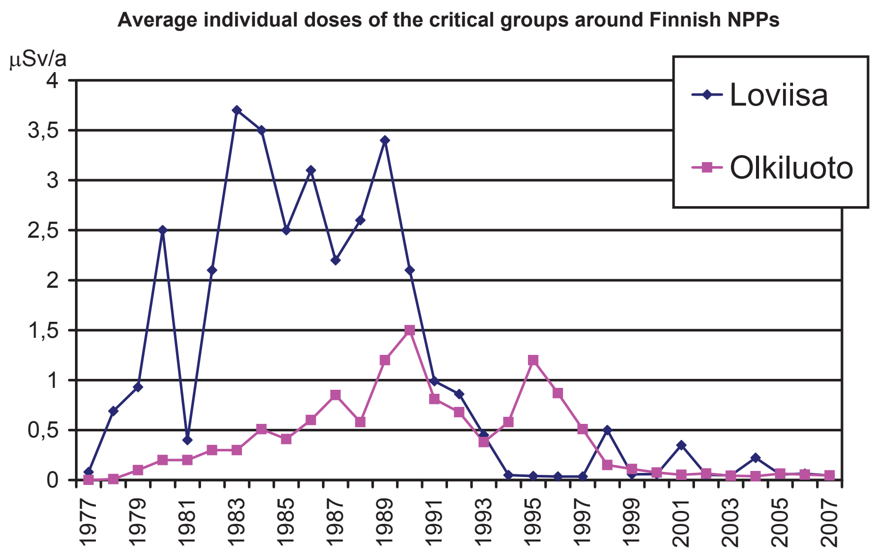


Figure 12. Committed doses (µSv/a) calculated by STUK to members of critical groups in the vicinity of the Finnish NPPs due to annual discharges of radioactive substances. The dose constraint is 100 µSv/a.

Article 25 Emergency preparedness

Each Contracting Party shall ensure that before and during operation of a spent fuel or radioactive waste management facility there are appropriate on-site and, if necessary, off-site emergency plans. Such emergency plans should be tested at an appropriate frequency.

Each Contracting Party shall take the appropriate steps for the preparation and testing of emergency plans for its territory insofar as it is likely to be affected in the event of a radiological emergency at a spent fuel or radioactive waste management facility in the vicinity of its territory.

F.25.1 On-site emergency preparedness

The emergency preparedness plans for spent nuclear fuel storages and radioactive waste management facilities are included in the plans for NPPs. According to the Nuclear Energy Act (Section 20), adequate on-site emergency preparedness arrangements are required before starting the operation of a nuclear facility. The basic regulations for on-site emergency preparedness for nuclear installations are given in the Government Decision (397/1991) and the detailed requirements by STUK in Guide YVL 7.4.

The licensee is responsible for the on-site emergency response arrangements. The Government Decision states e.g. that emergency planning shall be based on the analysis of NPP behaviour in emergencies and on the analysis of the consequences of emergencies. Action in an emergency shall be planned taking into account controllability of events as well as severity of their consequences. Therefore, emergencies are grouped into classes. The Decision requires also that appropriate training and exercises shall be arranged to maintain operational preparedness. Exercises shall be arranged in co-operation with the authorities concerned.

On-site emergency exercises are conducted annually so that at least the licensee personnel, local off-site emergency management group and STUK participate in them. There are always observers from STUK and several other organisations assessing the performance of exercising teams.

STUK carries out annual on-site inspections for verifying operational emergency preparedness. Among other things, the maintenance and adequacy of appropriate rooms and equipment, communication and alarm systems, computerised support systems as well as personnel training and qualifications are inspected.

Concerning the small users, the Radiation Decree (Section 17) stipulates that STUK has to be notified immediately in case of any abnormal occurrences, connected with the use of radiation that is substantially detrimental to safety, at the place where the radiation is used or in its environment. In addition, STUK has to be informed if a radiation source has disappeared, been stolen, lost or otherwise ceased to be in the licensee's possession.

F.25.2 Off-site emergency preparedness

In addition to the on-site emergency plans established by the licensees, off-site emergency plans are prepared by local authorities. The requirements for off-site plans and activities in a radiation emergency are provided in the Act and Decree of Rescue Services (2003) and in the Decree on Emergency Planning and Public Information issued by the Ministry of the Interior (2001, rev. 2007). Full scale off-site emergency exercises are conducted every third year. Smaller scale exercises are held annually at each site with participation of the staff of NPP, local authorities and STUK. In addition to exercises held with licensees, exercises with local, regional and national authorities are regularly organised. Some of these include scenarios concerning the late phase of nuclear or radiological emergency.

STUK actively takes part in international exercises. In 2005 STUK took part in the Convex-3 exercise sponsored by e.g. IAEA and the EC. Accident host was Romania and the duration was 39 hours. STUK emergency response organisation was operational throughout the whole exercise. In 2005 STUK also organised a late phase INEX 3 exercise sponsored by the OECD/NEA. Scenario was deliberate contamination of foodstuff in Finland. The participants represented authorities from governmental, regional and local administration. There was also a strong representation of various non-governmental organisations and private sector e.g. food industry. The EC organises annually exercises in which STUK takes part. STUK participated in 2006 as a co-player in the Swedish NPPs' and authorities' emergency exercises. In addition, STUK has actively taken part in exercises held in Russia (Kola NPP in 2006 and Leningrad NPP in 2007).

F.25.3 Early notification and communication

The on-site and off-site plans include provisions to inform the population in the case of an accident. In addition, written information on radiation emergencies, emergency planning and response arrangements have been provided to the population. Such information can also be found in the telephone directories of Finland. Citizens living near nuclear facilities are regularly provided with more detailed written information on nuclear accidents and protective measures needed during emergencies.

STUK is the National Warning Point and the National Competent Authority in Finland for any kind of situation which might result in actual or potential deterioration of radiation safety of the population, environment or society. STUK has established an Emergency Preparedness Manual for its own activities in the case of a nuclear accident or radiological emergency. STUK has an expert on duty for 24 hours a day, in order to be able to immediately give advice to local, regional and governmental authorities on needed emergency response actions. These actions can include, e.g. warning the population with a message which can be heard through all radio and TV channels. The message on an exceptional event (alarm) can be received from the operating organisations of the facilities, or automatically from the radiation monitoring network that is dense in the whole country, or from foreign authorities. In addition to the expert on duty for fast emergency response, STUK has a separate 24 hour contact point for media.

Finland is a Contracting Party to the International Convention on Early Notification of a Nuclear Accident, as well as to the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency, both done in Vienna in 1986. Furthermore, as a Member State of the European Union, the Commission Directives concerning accident situations apply in Finland. In addition, Finland has respective bilateral agreements with Denmark, Germany, Norway, Russia, Sweden and Ukraine. Accordingly, arrangements have been agreed to directly inform the competent authorities of these countries in the case of an accident. Similar arrangements ensure direct notification to the authorities of Estonia. The bilateral agreements also cover the exchange of relevant information on nuclear facilities.

Article 26 Decommissioning

Each Contracting Party shall take the appropriate steps to ensure the safety of decommissioning of a nuclear facility. Such steps shall ensure that:

(a) qualified staff and adequate financial resources are available;

(b) the provisions of Article 24 with respect to operational radiation protection, discharges and unplanned and uncontrolled releases are applied;

(c) the provisions of Article 25 with respect to emergency preparedness are applied; and

(d) records of information important to decommissioning are kept.

F.26.1 Regulatory provisions for decommissioning

The Nuclear Energy Act (Section 19) states that sufficient and appropriate methods for arranging the decommissioning of a nuclear facility have to be identified before the construction licence is granted. Guide YVL 1.0 requires that provisions for decommissioning of the NPPs shall be made already during the design phase. Limitation of radioactive waste generation and of the radiation exposure of workers and the environment arising from decommissioning shall be considered.

The general provisions for licensing and the waste management obligation included in the current nuclear energy legislation are so far adequate in the present situation when no concrete decommissioning project is underway or foreseen in the near future. A few supplementary requirements will be needed in future amendments to the Nuclear Energy Act and Decree. The Government Decisions related to nuclear and waste management safety are at the present under revision and the provisions are also applicable for decommissioning.

In addition, a YVL-Guide including requirements for decommissioning will be developed by STUK. The updated Guide YVL 8.2 on clearance covering the removal from regulatory control of materials arising from decommissioning of nuclear facilities and of previously licensed sites was issued in February 2008.

The licensees are responsible for the implementation of decommissioning. As described in Chapter F.22.2, assets are collected in the Nuclear Waste Management Fund, ensuring that financial resources are available for the licensee to implement decommissioning. In the event that a licensee is incapable of doing so, the state has the secondary responsibility. In this case, the costs are covered by assets collected in the Fund and by securities provided by the licensees. The financing of decommissioning of the research reactor FiR 1 and the management of resulting waste is also covered by assets in the Nuclear Waste Management Fund. The decommissioning of facilities subject to the Radiation Act is covered by the security referred to in Section 19 of the Act.

F.26.2 Decommissioning plans

The four nuclear power units in Finland have been in operation for 27 to 31 years and they are planned to be operated at least for two more decades. No nuclear power plants are currently being decommissioned and such decommissioning projects are neither foreseen in the near future. The current licence of FiR 1 research reactor is valid until 2011. Nevertheless, the operator of FiR1, VTT Technical Research Centre of Finland, has started more detailed planning of the shutdown and decommissioning of the research reactor as a preparatory action to the possible decision of the closure of the facility. The decision to implement the plan is dependent on the outcome of efforts to arrange alternative, sustainable funding for continued operation of the research reactor.

According to the Government policy decision of 1983 and later decisions by the Ministry of Trade and Industry (now the Ministry of Employment and the Economy), the licensees are obliged to prepare decommissioning plans for regulatory review and to update them every five years. These plans aim at ensuring that decommissioning can be appropriately performed when needed and that the estimates for decommissioning costs are realistic. The latest updates of the NPP decommissioning plans were published at the end of 2003. The next plan for the Olkiluoto NPP to be prepared by the end of 2008 will also include the decommissioning plan for Olkiluoto 3.

The decommissioning plans include assessments of occupational and off-site radiological safety of the operations. They include rather detailed descriptions of the required dismantling and waste management operations and estimates of workforce and other resources needed. The plans are based on the actual designs of the nuclear facilities and they take into account the activity inventories in the facilities. The contamination levels in the facilities are followed by means of specific monitoring and recording programmes.

The cost estimates of decommissioning depend on the amount of waste to be disposed as radioactive and thus on the limits to be applied for removal of material from regulatory control (clearance limits). Guide YVL 8.2 has been revised to cover also bulk amount of waste resulting from decommissioning and the premises for release from control of regulated sites.

The decommissioning plan for the NPP units Loviisa 1 and 2 is based on 50 years operation and immediate dismantling. Large and heavy reactor components, e.g. reactor pressure vessels and steam generators, will be removed intact without cutting them in pieces. The advantages of the method are saving of time and reduction of occupational radiation doses. Activated components accumulated during the operation will be packed into the reactor vessels which will thereby serve as additional release barriers. The waste will be disposed of in an extension of the current LILW repository in Loviisa. (C.f. Figure 6)

The next decommissioning plan for Olkiluoto 1 and 2 units will be based on 60 years of operation and 30 years of safe enclosure. For Olkiluoto 3, immediate dismantling is considered as an option as well. As in the case of Loviisa, the reactor pressure vessels of Olkiluoto 1 & 2 are planned to be removed and disposed as such, in one piece at Olkiluoto site.

The decommissioning plan of the research reactor FiR 1 is also updated every five year, the latest update being carried out in the year 2005. Studies are under way on the technical feasibility of disposing of the decommissioning wastes in the disposal facility for decommissioning wastes at the Loviisa site.

SECTION G Safety of spent fuel management

Article 4 General safety requirements

Each Contracting Party shall take the appropriate steps to ensure that at all stages of spent fuel management, individuals, society and the environment are adequately protected against radiological hazards. In so doing, each Contracting Party shall take the appropriate steps to:

(a) ensure that criticality and removal of residual heat generated during spent fuel management are adequately addressed;

(b) ensure that the generation of radioactive waste associated with spent fuel management is kept to the minimum practicable, consistent with the type of fuel cycle policy adopted;

(c) take into account interdependencies among the different steps in spent fuel management;

(d) provide for effective protection of individuals, society and the environment, by applying at the national level suitable protective methods as approved by the regulatory body, in the framework of its national legislation which has due regard to internationally endorsed criteria and standards;

(e) take into account the biological, chemical and other hazards that may be associated with spent fuel management;

(f) strive to avoid actions that impose reasonably predictable impacts on future generations greater than those permitted for the current generation;

(g) aim to avoid imposing undue burdens on future generations.

G.4.1 Scope and principal regulations

Finland has adopted the once-through strategy for spent nuclear fuel management as described in Section B. Spent fuel is currently stored at the NPPs while the operation of the final disposal facility is scheduled to commence in 2020. The discussion in this Section is limited to the interim storage of spent fuel whereas the final disposal plans for spent fuel are discussed in Section H, Safety of radioactive waste management.

The general regulations for the safety of spent fuel storage are included in Government Decision (395/1991). More specific technical requirements are given in Guides YVL 1.0 and YVL 6.8.

G.4.2 Criticality and removal of residual heat

According to Government Decision 395/1991, in handling and storage of spent nuclear fuel, maintenance of subcritical conditions, integrity of fuel cladding, adequate heat removal and radiation shielding shall be ensured with high certainty. Guide YVL 1.0 stipulates that a NPP shall have sufficient rooms and systems for the safe handling, treatment, storage and inspection of fresh and spent fuel. Fuel criticality shall be prevented primarily by the use of appropriate storage structures. Appropriate technical and administrative arrangements are to be made during fuel storage and transfer to prevent fuel damage. Spent fuel cooling must be possible even if a single failure occurs. Guide YVL 6.8 gives limits for the effective multiplication factor (k_{eff}<0.95) and coolant temperature in normal (<60ºC) and postulated accident conditions (<100ºC). The technical specifications of the facilities give more detailed requirements for criticality prevention and residual heat removal.

G.4.3 Waste minimization

Relevant to the objective of waste minimization is the requirement provided by the Guide YVL 6.8: the storage conditions shall be such that corrosion of fuel and storage equipment is minimized. The coolant shall be kept sufficiently clear and clean to facilitate e.g. checking of fuel identification. Requirements for safety related systems in the storage facility are also given. In Olkiluoto leaking fuel assemblies are placed in the fuel pool in hermetically closed capsules to minimize the Cs-activity in the fuel pool clean-up system and in effluents. In Loviisa, the cobalt content of the shielding elements (“dummy fuel elements”) has been decreased, which results in a smaller amount of activation products in the cooling water.

G.4.4 Interdependencies

The Finnish once-through spent fuel management scheme provides that the fuel is stored in pools at both power plant sites and is planned to be disposed of in Olkiluoto, in the vicinity of the largest present interim storage. Spent fuel transport, encapsulation and disposal plans have been adapted to the fuel types and storages at both the Olkiluoto and Loviisa NPPs. The plans need to be amended to take into account of the dimensions and other characteristics of the fuel of the new unit Olkiluoto 3. The implementing organisation for spent fuel disposal, Posiva, is owned by the NPP utilities. Thus, the interdependencies between different steps are taken into account in practice.

Though the current policy is based on the once-through option, reprocessing of spent fuel would be technically feasible later on due to the long interim storage period. The selected disposal concept would, to the great extent, be applicable to disposal of high level reprocessing waste as well. However, the present legislation requires that all processing of nuclear waste, such as spent fuel, needs to take place in Finland.

G.4.5 Protection of individuals, society and the environment

The operational radiation protection requirements for spent fuel storage are discussed under Article 24. Operating experiences as discussed under Article 9 indicate that spent fuel storage has caused practically no releases and occupational radiation exposures have been very low.

G.4.6 Biological, chemical and other hazards

The biological, chemical and other non-radiological hazards posed by the spent fuel storage are low compared to the potential radiological hazards. Such hazards are regulated by legislations related to general occupational safety and management of hazardous substances.

G.4.7 Protection of future generations and avoidance of undue burdens on future generations

Interim storage of spent fuel is envisaged to last only some decades. The current high level of safety can be maintained during that time by means of appropriate operational, maintenance and surveillance procedures. The future costs of storage will be covered by the assets collected in the State Nuclear Waste Management Fund. Thus the future generations are adequately protected and they will neither be imposed to any other undue burdens.

Article 5 Existing facilities

Each Contracting Party shall take the appropriate steps to review the safety of any spent fuel management facility existing at the time the Convention enters into force for that Contracting Party and to ensure that, if necessary, all reasonably practicable improvements are made to upgrade the safety of such a facility.

As described in Chapter D, the existing spent nuclear fuel storages in Finland are at the Loviisa and Olkiluoto NPPs and are covered by their Operation Licences. In addition, under the research reactor licence 23 spent fuel elements are stored at the FiR 1 either in the reactor pool or in a well under the floor of the reactor hall.

G.5.1 Safety reviews

The latest comprehensive safety assessments of the Loviisa and Olkiluoto NPPs, including the spent fuel storages, were carried out in connection with re-licensing of the operation of the plants in 2006–2007 and 1998, respectively. The next periodic safety review for the units 1 and 2 of the Olkiluoto plant is expected to be completed during 2008.

The comprehensive safety assessments for applications for the renewal of licences include updating e.g. the following safety relevant documents:

- Final safety analysis reports
- Quality assurance programmes for operation
- Technical specifications
- Programmes for periodic inspections
- Plans for nuclear waste management, including decommissioning and disposal

- Timetable of nuclear waste management and estimated costs
- Plans for physical security and emergency preparedness
- Administrative rules for the facilities
- Programmes for radiation monitoring in the environment of the facilities
- Licensee assessments of compliance with the regulations, including assessment of the fulfilment of YVL Guides
- Licensee assessments of how an adequate safety level has been maintained.

The periodic safety review report shall include the same update information, as appropriate.

The re-licensing safety reviews and statements of STUK given to the Ministry of Employment and the Economy concluded that, as regards radiation and nuclear safety, the conditions at the Loviisa and Olkiluoto NPPs comply with the Finnish nuclear energy legislation and regulations. In addition to the review of the above mentioned documents, STUK has also made independent safety assessments and annually a number of regular and topical inspections to the facilities.

The safety of the FiR 1 research reactor was reviewed in the context of the renewal of the operating licence in 1999. The new licence is valid until the end of 2011. The safety of the FiR 1 reactor is continuously reviewed by means of STUK's periodic inspection programme and other regulatory control measures. Under the terms of reference of INFCIRC/18/Rev.1, an IAEA team last visited Finland in 1999 (INSARR mission) for evaluating the nuclear safety and radiation protection at the FiR 1.

G.5.2 Need for safety enhancement

Continuous safety assessment and enhancement approach applied in Finland is based on the Nuclear Energy Act (Section 7a) stating the safety of the use of nuclear energy shall be as high as reasonable achievable. To further enhance safety, all actions justified by operational experiences, safety research and the progress in science and technology shall be taken.

In conclusion, the safety review required by Article 5 of the Convention has already been carried out. Safety improvements have been annually implemented at the Loviisa and Olkiluoto plants including the facilities for spent nuclear fuel handling and interim storage since the commissioning. There exists no urgent need for additional improvements to upgrade the safety of these facilities.

Article 6 Siting of proposed facilities

Each Contracting Party shall take the appropriate steps to ensure that procedures are established and implemented for a proposed spent fuel management facility:

(a) to evaluate all relevant site-related factors likely to affect the safety of such a facility during its operating lifetime;

(b) to evaluate the likely safety impact of such a facility on individuals, society and the environment;

(c) to make information on the safety of such a facility available to members of the public;

(d) to consult Contracting Parties in the vicinity of such a facility, insofar as they are likely to be affected by that facility, and provide them, upon their request, with general data relating to the facility to enable them to evaluate the likely safety impact of the facility upon their territory.

In so doing, each Contracting Party shall take the appropriate steps to ensure that such facilities shall not have unacceptable effects on other Contracting Parties by being sited in accordance with the general safety requirements of Article 4.

G.6.1 Siting process and site-related factors

Spent fuel management facilities are nuclear facilities, either as an integrated part of a nuclear power plant or as a separate facility. All spent fuel management facilities in Finland are located on a NPP site. Requirements for the siting of a nuclear power plant and for an environmental impact assessment are provided in the Nuclear Energy Act and the Nuclear Energy Decree. The application for a Decision-in-Principle has to include e.g.:

- An outline of the ownership and occupation of the site
- A description of settlement and other activities and town planning arrangements at the site and its vicinity

- An evaluation of the suitability of the site and the restrictions caused by the nuclear facility on the use of surrounding areas
- An assessment report in accordance with the Act on the Environmental Impact Assessment Procedure (468/1994) as well as a description of the design criteria the applicant will observe in order to avoid environmental damage and to restrict the burden to the environment. More detailed requirements on the Environmental Impact Assessment are provided in the Decree (713/2006).

In the design of a nuclear plant, including spent fuel management facilities, site-related external events have to be taken into account. Decision 395/1991 provides as follows: "The most important nuclear power plant safety functions shall remain operable in spite of any natural phenomena estimated possible on site or other events external to the plant. In addition, the combined effects of accident conditions induced by internal causes and simultaneous natural phenomena shall be taken into account to the extent estimated possible". STUK issued in 2001 a Guide YVL 1.10, "Safety criteria for siting a nuclear power plant", that describes generally all requirements concerning the site and surroundings of a nuclear power plant, gives requirements on safety factors affecting site selection as well as covers regulatory control. Specific provisions against earthquakes are provided in Guide YVL 2.6.

Deterministic analyses are made to assess the impact of various natural phenomena and other external events. The probabilistic risk analysis (PRA) required as part of the safety review for Construction and Operating Licences provides information on the estimated frequency of and consequence brought about by internal and external events.

In connection with the construction of the Loviisa and Olkiluoto plants in the 1970s, principal safety requirements were defined for the siting of nuclear power plants and for the population density and human activities in the surrounding area. These requirements include also restrictions for industrial facilities and air traffic. In a sparsely populated country like Finland the safety requirements were quite easily and practically achievable.

G.6.2 Safety impact

The safety impact of a fuel management facility is analysed in safety analysis reports presented as part of construction and operation licence applications. The operating licences for nuclear facilities are granted for a limited period of time. For the licence renewal and Periodic Safety Review, a comprehensive re-assessment of safety, including the environmental safety of the nuclear facility and the effects of external events on the safety of the facility, shall be done. STUK reviews the licence applications, including all site-specific safety reports.

G.6.3 Availability of information

The availability of information in case of the siting process for a major nuclear facility is based on the Finnish legislation on the openness of information, notably on the Act on the Openness of Government Activities (621/1999). Further requirements are based on the Act and Decree on the Environmental Impact Assessment Procedure and the Nuclear Energy Act. The first step of consultation with the general public is the Environmental Impact Assessment (EIA) procedure. Public hearings are arranged both in the preparation stage of the EIA programme and during the actual assessment. The responsible contact authority for that procedure is the Ministry of Employment and the Economy. The EIA report must be attached to the application for the Decision-in-Principle.

The Nuclear Energy Act (Section 13) states that, before the Decision-in-Principle is made, the applicant shall make available to the public an overall description of the facility, of the environmental effects it is expected to have and of its safety. The Ministry of Employment and the Economy shall provide residents and municipalities in the immediate vicinity of the nuclear facility as well as local authorities chance to present their opinions in writing before the Decision-in-Principle is made. Furthermore, the Ministry shall arrange a public hearing in the municipality where the planned site of the facility is located and during this hearing the public shall have the opportunity to give their opinions either orally or in writing. The presented opinions have to be made known to the Government. The Act (Section 14) provides further that a necessary prerequisite for the Decision-in-

Principle is that the planned host municipality for the nuclear facility is in favour of siting the facility in that municipality.

G.6.4 Consulting of Contracting Parties

Finland is a party to the Convention on Environmental Impact Assessment in a Transboundary Context, done in Espoo in 1991. The Finnish policy is (Act 468/1994) to provide full participation to all neighbouring countries, which can be affected by the nuclear facilities in question.

Notable events during the review period 2005–2007 are listed below. Spent fuel management facilities are part of the nuclear reactor projects.

After applying a construction license for a new reactor unit (EPR) in Olkiluoto, STUK prepared the safety assessment of the new unit in early 2005. The construction licence was issued by the Government in February 2005 and the construction is ongoing.

In 2007, initiatives of building additional reactor unit(s) were taken. Programs for the Environmental Impact Assessment procedure of TVO for a possible Olkiluoto 4 unit and shortly afterwards of Fortum for a possible Loviisa 3 unit were prepared and launched for a review. STUK gave its statements to the Ministry of Trade and Industry (now Ministry of Employment and the Economy) in September 2007. The Ministry gave its statements on the EIA programs for Olkiluoto 4 and Loviisa 3 in September and October 2007, respectively. Comments have been requested from altogether nine countries near the Baltic See by the Finnish Ministry of the Environment.

A new nuclear power company Fennovoima was founded in 2007. The company started a preliminary site survey process, mainly in the area of the North West coast of Finland (Bay of Bothnia) and also on the southern coast in the neighbouring community to Loviisa (Gulf of Finland). Revision of Regional Plans of land use surrounding Olkiluoto and Loviisa NPP sites are also underway by the regional authorities and the municipalities concerned.

Article 7 Design and construction of facilities

Each Contracting Party shall take the appropriate steps to ensure that:

(a) the design and construction of a spent fuel management facility provide for suitable measures to limit possible radiological impacts on individuals, society and the environment, including those from discharges or uncontrolled releases;

(b) at the design stage, conceptual plans and, as necessary, technical provisions for the decommissioning of a spent fuel management facility are taken into account;

(c) the technologies incorporated in the design and construction of a spent fuel management facility are supported by experience, testing or analysis.

Regulatory approach

According to the Government Decision 395/1991, several levels of protection have to be provided in the design of a nuclear power plant. The general design of the nuclear facility and the technology used is assessed by STUK for the first time in the context of review of the application for a Decision-in-Principle and performing a preliminary safety appraisal of the facility. More detailed safety assessments are carried out by STUK when reviewing the applications for construction licence and operating licence. Design is reassessed against advancement of science and technology, when the operating licence is renewed.

G.7.1 Limitation of radiological impacts

According to the Nuclear Energy Act (Section 19) the prerequisite for granting a construction licence is that the location of a nuclear facility is appropriate with respect to safety of the planned operations and that environmental protection has been taken into account appropriately. The Nuclear Energy Decree (Section 32) requires that the construction licence application shall include a description of the effects of the nuclear facility on the environment and a description of the design criteria that will be observed by the applicant in order to avoid environmental damage and to restrict the burden on the environment. More detailed requirements are given in Government Decision 395/1991 and in Guide YVL 1.0.

The limitation of radiological impact is discussed in more details in Section F in the context of Article 24 (Chapters F.24.1 and F.24.2).

G.7.2 Provisions for decommissioning

The Nuclear Energy Act (Section 7g) states that provisions for decommissioning shall be included in the design of a nuclear facility. In the context of licensing requirements, the Nuclear Energy Decree (Section 32) lays down that the application for a construction licence has to include a description of the applicant's plans and available methods for arranging nuclear waste management, including the decommissioning of the nuclear facility and the disposal of nuclear wastes, and a description of the timetable of nuclear waste management and its estimated costs. More detailed requirements are given in Guide YVL 1.0. The requirements regarding decommissioning plans are discussed in Chapter F.26.2.

G.7.3 Tested technology

The requirement to use proven or otherwise carefully examined, high quality technologies is stated in the design requirements provided in the Government Decision 395/1991. Detailed requirements on the design of spent fuel handling systems are given in Guides YVL 1.0 and YVL 6.8. Spent fuel storage at the Finnish NPPs is based on water pool technology, of which extensive experiences exists worldwide.

G.7.4 Implementation during the review period

An assessment of the design of the facility and related technologies is made by STUK for the first time when assessing the application for a Decision-in-Principle. Later on, the evaluation is continued when the Construction Licence application is reviewed. Finally, a detailed evaluation of systems and equipment is carried out through their design approval process. The design of Loviisa plant units was reassessed by STUK in 2006-2007. The design of Olkiluoto plant units is being reassessed by STUK again in connection with the Periodic Safety Review which will be completed during 2008.

The new NPP unit under construction, Olkiluoto 3, has a pool type interim storage for spent fuel. The preliminary safety analysis report and other safety related documents for that facility were reviewed in 2004 as a part of the construction licence process. The fuel building, containing the interim storage of spent fuel, of the new unit is designed to withstand a large aeroplane crash.

Article 8 Assessment of safety of facilities

Each Contracting Party shall take the appropriate steps to ensure that:

(a) before construction of a spent fuel management facility, a systematic safety assessment and an environmental assessment appropriate to the hazard presented by the facility and covering its operating lifetime shall be carried out;

(b) before the operation of a spent fuel management facility, updated and detailed versions of the safety assessment and of the environmental assessment shall be prepared when deemed necessary to complement the assessments referred to in paragraph (a).

G.8.1 Regulatory approach

The license applications for a new licence or for the renewal of license include the documents required by the Nuclear Energy Decree: Preliminary or Final Safety Analysis Reports; Probabilistic Risk Analysis Reports, including Level 1 and 2 PRA analyses; Quality Assurance Programmes for Construction and Operation; Safety Classification Document, Operational Limits and Conditions Document (Technical Specifications); Programmes for Periodic Inspections; Plans for Physical Protection and Emergency Preparedness; Manuals for Accounting and Control of Nuclear Materials; Administrative Rules for the Facilities; Programmes for Radiation Monitoring in the Environment of the Facilities.

The design of the facility is described in the Preliminary Safety Analysis Report (PSAR) and in the Final Safety Analysis Report (FSAR). The reports are submitted to STUK for approval in connection with, respectively, the applications for Construction and Operating Licenses. According to the Nuclear Energy Decree, FSAR has to be continuously updated.

The requirements of performing the initial safety assessment and environmental impact assessment for nuclear facilities are discussed in the context of Article 6. A safety analysis needs to be included in the Decision-in-Principle application.

Government Decision 395/1991 requires that if compliance with the safety regulations cannot be directly ascertained from design documentation, the fulfilment shall be demonstrated. Safety of facilities for spent fuel storage and the design of the pertinent safety systems shall be substantiated by experimental and calculational methods, such as transient and accident analyses, strength analyses, fault and consequence analyses and probabilistic risk assessments. Analyses shall be maintained and revised when necessary, taking into account operating experience, the results of experimental research, plant modifications and the advancement of calculating methods.

The safety assessments are reviewed by STUK with support of independent safety analyses and/or by external experts. The licences and related safety documents of the on-site spent fuel storages are attached to those of the respective NPPs and also the renewal review processes take place concurrently.

G.8.2 Implementation

As dicussed under article 7, an assessment of the design of the facility and related technologies is made by STUK for the first time when assessing the application for a Decision-in-Principle. Later on, the evaluation is continued when the Construction Licence application is reviewed. Finally, the detailed evaluation of systems and equipment is carried out through their design approval process. The design of Loviisa plant units was reassessed by STUK in 2006–2007. The design of Olkiluoto plant units is being reassessed by STUK again in connection with the Periodic Safety Review which will be completed during 2008.

The preliminary safety analysis report and other safety related documents for Olkiluoto 3 facility under construction were reviewed in 2004 as a part of the construction licence process. The fuel building of the new unit is designed to withstand a large aeroplane crash.

Article 9 Operation of facilities

Each Contracting Party shall take the appropriate steps to ensure that:

(a) *the licence to operate a spent fuel management facility is based upon appropriate assessments as specified in Article 8 and is conditional on the completion of a commissioning programme demonstrating that the facility, as constructed, is consistent with design and safety requirements;*

(b) *operational limits and conditions derived from tests, operational experience and the assessments, as specified in Article 8, are defined and revised as necessary;*

(c) *operation, maintenance, monitoring, inspection and testing of a spent fuel management facility are conducted in accordance with established procedures;*

(d) *engineering and technical support in all safety-related fields are available throughout the operating lifetime of a spent fuel management facility;*

(e) *incidents significant to safety are reported in a timely manner by the holder of the licence to the regulatory body;*

(f) *programmes to collect and analyse relevant operating experience are established and that the results are acted upon, where appropriate;*

(g) *decommissioning plans for a spent fuel management facility are prepared and updated, as necessary, using information obtained during the operating lifetime of that facility, and are reviewed by the regulatory body.*

G.9.1 Initial authorisation

According to the Nuclear Energy Decree (Section 36), the Final Safety Analysis Report is required to be submitted to STUK when applying for an operating licence. More detailed requirements are given in Guide YVL 1.1. The requirements for safety assessment are discussed in detail under Article 8.

Requirements for the commissioning programme for NPPs and associated spent fuel storages are set forth in Guide YVL 2.5. According to the Guide, the purpose of the commissioning programme is to give evidence that the plant has been constructed and will function according to the design requirements. Through the programme possible deficiencies in design and construction can also be observed. The commissioning programme is described in the preliminary and final safety analysis reports, which are submitted to STUK for review and approval.

G.9.2 Operational limits and conditions

According to the Nuclear Energy Decree (Section 36), the applicant for an operating licence has to provide STUK with the technical specifications. They shall at least define limits for the process quantities that affect the safety of the facility in various operating states, provide regulations on operating restrictions that result from component failures, and set forth requirements for the testing of components important to safety.

Government Decision (395/1991) requires a control and maintenance programme to be established to ensure the integrity and reliable operation of systems, structures and components. The program shall define the inspections, tests, services, replacements and other procedures for the control of the operational reliability and impacts of the operating environment.

The technical specifications are subject to the approval of STUK prior to the commissioning of a facility. Strict observance of the technical specifications is verified by STUK through a regular inspection programme. Technical specifications are updated based on operational experiences, tests, analyses and plant modifications. Some recent incidents that have resulted to update of technical specifications are discussed in G.9.5.

G.9.3 Established procedures

Guide YVL 1.4 on management systems for nuclear facilities requires that documents and procedures for operation, maintenance, inspection and testing are established and that these documents are continuously kept up-to-date, mutually consistent and in accordance with the state of affairs. The responsibilities and administrative procedures indicating how to take care of these actions are described in the quality assurance programme of the facility. The procedures shall be approved by the licensee itself, and most of them are required to be submitted to STUK for information. Detailed requirements are presented in appropriate YVL Guides. STUK verifies by means of inspections and audits that approved procedures are followed in the operation of the facility.

G.9.4 Engineering and technical support

The staffing, training and qualifications of the personnel are discussed in general in Chapter F.22.1. The licensee has the primary responsibility for ensuring that his employees are qualified and authorised to their jobs and that the continuity of the expertise is secured for the operational lifetime of the facility. Guide YVL 1.7 specifies the expertise requirements for technical support staff. Guide YVL 6.8 requires specially that fuel may be handled only by personnel who has the appropriate training and whose competence has been ascertained. Fortum Nuclear Services Ltd is working as a technical supporting organization for the Loviisa NPP personnel also in waste management and nuclear fuel questions. For TVO the respective support organizations are sections of Nuclear Engineering and Power Plant Engineering.

Competence of the engineering and technical support is supervised by the licensee. In addition, STUK carries out inspections and audits by which also the competence of the support staff is evaluated.

G.9.5 Operating experiences, incident reports and evaluation

Government Decision 395/1991 requires that operating experience shall be collected and results of safety research shall be systematically followed and both shall be assessed for identifying chances for safety enhancements. Operational incidents important to safety shall be examined to find out the root causes and to define and implement the corrective actions. Technical safety enhancements provided by safety research shall be considered to the extent justified by technical aspects.

According to Guide YVL 6.8, a spent fuel condition surveillance program, subject to STUK's approval, shall be drawn up in order to monitor the effects of long-term storage on spent fuel.

Guide YVL 1.5 provides in detail the reporting requirements on incidents, operational disturbances and events, which have to be reported to STUK. It also defines requirements for the contents of the reports and the administrative procedures for reporting, including time limits for submitting of various reports. STUK publishes the operational events in its quarterly reports on nuclear safety that are also available to the general public through internet or paper reports in Finnish. STUK Annual Report on nuclear safety summarizes events from the whole year and is available to the general public through internet or paper reports both in Finnish and in English.

Leakages through the steel liners in spent fuel storage pools at the Finnish NPPs have been very infrequent. Over years only one leakage requiring repair works has been discovered in liners of a pool where spent fuel is being stored.

G.9.6 Decommissioning plans

The preparation and updating of decommissioning plans, as required in the Nuclear Energy Act (Section 19) and the Decision by Ministry of Employment and the Economy is discussed in Chapter F.26.

Article 10 Disposal of spent fuel

If, pursuant to its own legislative and regulatory framework, a Contracting Party has designated spent fuel for disposal, the disposal of such spent fuel shall be in accordance with the obligations of Chapter 3 relating to the disposal of radioactive waste.

According to the Finnish waste management policy, spent fuel is regarded as waste and shall be permanently disposed of in Finland. Therefore, disposal of spent fuel is discussed in Section H, in the context of safety of radioactive waste management.

SECTION H Safety of radioactive waste management

Article 11 General safety requirements

Each Contracting Party shall take the appropriate steps to ensure that at all stages of radioactive waste management individuals, society and the environment are adequately protected against radiological and other hazards.

In so doing, each Contracting Party shall take the appropriate steps to:

- *(a) ensure that criticality and removal of residual heat generated during radioactive waste management are adequately addressed;*
- *(b) ensure that the generation of radioactive waste is kept to the minimum practicable;*
- *(c) take into account interdependencies among the different steps in radioactive waste management*
- *(d) provide for effective protection of individuals, society and the environment, by applying at the national level suitable protective methods as approved by the regulatory body, in the framework of its national legislation which has due regard to internationally endorsed criteria and standards;*
- *(e) take into account the biological, chemical and other hazards that may be associated with radioactive waste management;*
- *(f) strive to avoid actions that impose reasonably predictable impacts on future generations greater than those permitted for the current generation;*
- *(g) aim to avoid imposing undue burdens on future generations.*

H.11.1 Scope and general regulations

In this Section, management of LILW from nuclear facilities, including disposal, management of other radioactive waste and the plans for spent fuel encapsulation and disposal are discussed. The relevant general regulations are, besides the Nuclear Energy Act and Decree, the Government Decision (398/1991) on the general regulations for the safety of a disposal facility for reactor waste, addressing the disposal of LILW from NPPs and the Government Decision (478/1999) on the safety of disposal of spent nuclear fuel. More detailed technical requirements on management, including disposal, of LILW and spent fuel are given in YVL Guides, most relevant of which are Guides YVL 8.1 to 8.5. Radioactive waste subject to Radiation Act is regulated by Guide ST 6.2.

H.11.2 Criticality and removal of residual heat

In Finland, the once-trough fuel cycle is adopted and requirements concerning criticality safety and residual heat removal for LILW management are not considered necessary.

The Government Decision (478/1991) requires that the formation of such spent fuel configurations that would cause an uncontrolled chain reaction of fission shall be prevented by means of structural design of systems and components.

Guide YVL 8.5 further specifies that transport casks, storage rooms and handling equipment as well as the waste canisters shall be designed so that no critical fuel concentrations may be formed in any operational situations, including anticipated operational transients and postulated accidents. The canisters emplaced in the geological repository shall retain their subcriticality in the long term, when the internal structures of the canisters may have corroded and the canisters may be partly filled with groundwater.

Posiva's spent fuel disposal canister and its loading have been designed so that the effective multiplication factor (k_{eff}) remains below 0.95. The criticality safety of the copper/iron canisters developed has been studied by Posiva with the MCNP4C Monte Carlo code. All the three types of spent fuel disposal canisters planned to be used for final disposal in Finland have been analysed. A study by

Posiva in 1995 showed that a contemporary canister design loaded with twelve fresh VVER 440 assemblies with an initial enrichment of 4.2% fulfils the criticality safety criteria. Also an earlier design of the BWR canister loaded with twelve fresh BWR assemblies with an initial enrichment of 3.8% and without burnable absorbers was shown to meet the safety criteria.

In a recent study (2005), the main emphasis was on the canister intended for the fuel to be used in the EPR-type Olkiluoto 3 reactor. This new canister type fulfils the criticality safety criteria only if the reactivity change due to burnup (burnup credit) is taken into account in calculations, as opposed to making calculations with non-irradiated fuel. The fuel bundles to be loaded in an EPR canister must be irradiated at least to a burnup of 20 MWd/kgU to fulfil the criteria. In the 2005 study, only a few calculations were carried out for the present versions of VVER and BWR canisters but the results are in good agreement with the previous calculations.

Residual heat generation of spent fuel is also required to be taken into account in the design of the encapsulation and disposal facilities. Guide YVL 8.4 prescribes that spent fuel disposal shall be implemented with due regard to long-term safety, and in doing so, one aspect to be considered is the reduction of the activity and heat generation prior to disposal. Guide YVL 8.5 requires the safety systems in the encapsulation facility, intended for the prevention of overheating of spent fuel assemblies, to be designed with regard to the single failure criterion.

As for the disposal canister, the surface temperature is required to be below 100ºC. This temperature, with a margin of 10ºC, is used in the repository dimensioning calculations. The maximum temperature of disposal canister surface is reached within 10 to 15 years after the disposal.

Thermal dimensioning including the detailed heat transfer phenomena in the near field and optimisation of the repository has been studied. The canisters are planned to be emplaced in disposal holes in tunnels with a separation of 8.6 m for VVER 440 canister, 11 m for BWR canister and 10.6 m for EPR canister. The distance between parallel disposal tunnels is 25 m in the planned reference case.

H.11.3 Waste minimization

Waste minimization is in the interest of the nuclear power companies, as less waste to be disposed of implies smaller disposal costs. Guide YVL 8.3 underlines that generation of waste shall be limited i.a. by proper planning of repair and maintenance and by means of decontamination, clearance and volume reduction practices. The Guide also refers to sound working methods for waste minimization, e.g. by volume reduction of waste, by avoiding transfer of unnecessary objects and materials in the controlled areas and by adoption of working processes that create little or easily manageable wastes.

Removal of very low level waste from control (clearance) is regulated by virtue of Guide YVL 8.2. Both conditional and unconditional removal from regulatory control is effectively used for waste minimization by the NPPs. Clearance criteria, limits and procedures are discussed in Section B.32.1.

The accumulation of LILW in the Loviisa and Olkiluoto NPPs is depicted in Figure 13. The average annual accumulation of LILW to be disposed of has been fairly low: about 85 m^3 per reactor. The accumulation of waste has in some years even turned to decline by effective waste minimization measures, such as radiochemical treatment of liquid waste and campaigns for removal of very low level waste from control and compaction of maintenance waste.

In the 1990's FPH developed, together with the University of Helsinki Laboratory of Radiochemistry, sophisticated selective ion exchange methods for purification of liquid waste (especially the removal of Cs, Sr and Co). The benefits of these methods, now in use at Loviisa NPP, can be seen in Figure 13 and also in the decrease of the doses to the critical group shown in Figure 12.

TVO has made a modification in both plants in the condensate polishing system in order to decrease the temperature and thus increase the lifetime of precoat resins. Consequently, the generation of spent ion exchange resins has decreased considerably. Low and intermediate level waste subject to long-term storage at the Olkiluoto plant mostly includes components removed from inside the reactor pressure vessels, which are stored in the fuel pools. The cutting up and final disposal of steam separators started in 2004.

In 2005–2007, one of the objectives in minimisation of waste generation at Olkiluoto has been the reduction of ion exchange resin consumption in the water purification systems. Resin qualities have been optimised regarding good separating capacities and long duty cycles. To minimise the volume of disposed metallic waste, a crusher was taken in use at the Olkiluoto site in 2004. Disposal containers can be filled more effectively, when crushed metal is placed in unused spaces of containers. Surface contaminated metal scrap is decontaminated in a new facility by blasting with glass marbles. Decontaminated metals are released from regulatory control, if activity levels below those for clearance are reached. The average accumulation of low and medium level waste at the Olkiluoto NPP has been about 85 m^3per reactor year. In addition, a total of 1000 $m^3$of metallic waste was generated due to the replacement of turbine system reheaters in 2005 and 2006. A storage facility for large, contaminated components was commissioned in 2005. The components stored are eventually decontaminated and separated into fractions set for clearance and disposal.

At the new Olkiluoto 3 NPP unit an in-drum drying facility is planned to be used for conditioning of liquid wastes, which is expected to provide an effective volume reduction.

The laboratories using radioactive sources in medical and research applications usually store their short lived radioactive waste at their premises until it has decayed below the limits set for discharges in the Guide ST 6.2. Only small amounts of waste need to be conditioned for disposal.

H.11.4 Interdependencies

Guide YVL 8.3 on treatment and storage of LILW from NPPs requires that a licence for a NPP unit must include an approved general waste management plan which takes into account e.g. the segregation, categorisation and conditioning of waste in an appropriate way with regard to its further management. The Guide also provides for the consideration of the requirements of waste packages related to their final disposal. These requirements may concern e.g. the structure of the waste packages, their physical and chemical composition, their resistance to external and internal loads and the amount and stability of radioactive substances in the waste packages.

Both power plants have their own LILW disposal facilities, thus the premises for considering interdependencies in the waste management chain are excellent. Interdependencies of the various steps in waste management are taken into account in the NPPs' Operational Manuals. In Loviisa all the waste treatment, conditioning, handling, storing, transport and disposal operations are carried

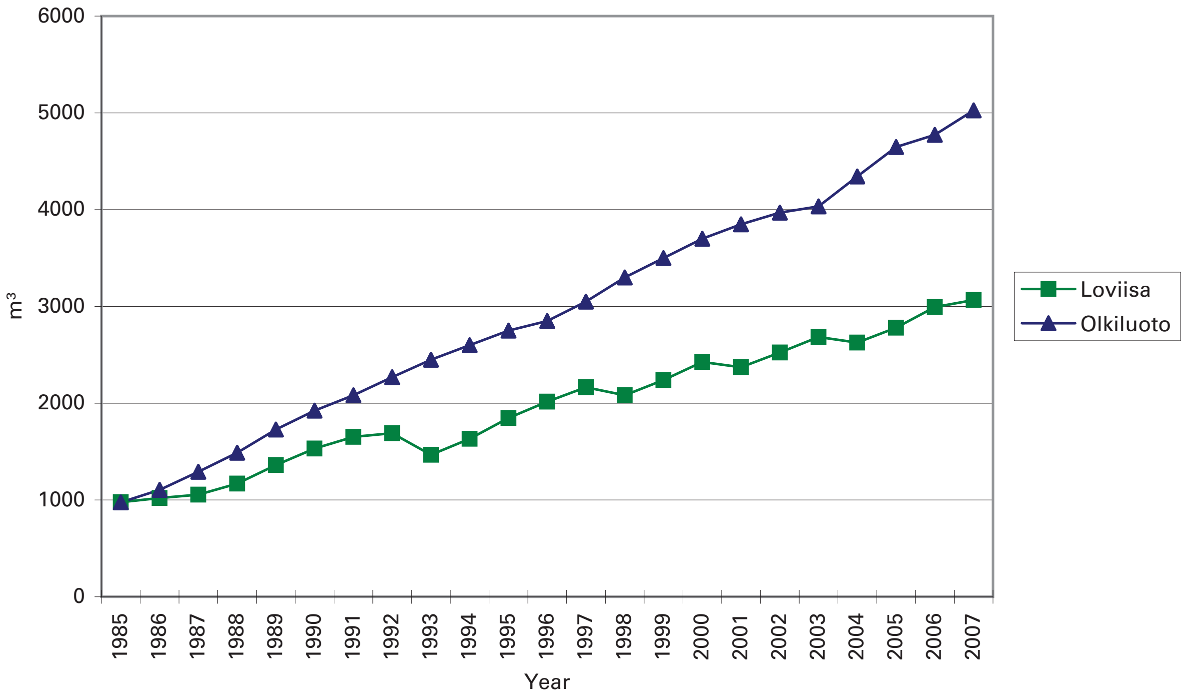


Figure 13. Accumulation of LILW in Loviisa and Olkiluoto NPPs.

out at the Loviisa NPP site (on Hästholmen) by the operators of the Loviisa NPP. Only the spent nuclear fuel will be transported for disposal from the Loviisa NPP site to the disposal facility at Olkiluoto. In case of the Olkiluoto NPP, all the steps of waste management take place at the site.

Interdependencies in the context of spent fuel management are discussed in Chapter G.4.4.

H.11.5 Protection of individuals, society and the environment

The operational radiation protection of radioactive waste management facilities is discussed under Article 24.

The Government Decision (478/1999) requires that a disposal facility for spent nuclear fuel shall be designed so that as a consequence of normal operation of the facility, discharges of radioactive substances to the environment would remain insignificantly low, that the annual effective dose to the most exposed members of the public as a consequence of anticipated operational transients remains below 0.1 mSv and as a consequence of postulated accidents below 1 mSv.

Regarding the long term radiation protection requirements for nuclear waste disposal, Government Decision (478/1999) requires that in the period of first several thousands of years the annual effective dose to the most exposed members of the public shall remain below 0.1 mSv and the average annual effective doses to other members of the public shall remain insignificantly low. Beyond that period the average quantities of radioactive substances over long time periods, released from the disposed waste and migrating further to the environment, shall remain below the nuclide specific constraints defined by STUK. These constraints are given in the Guide YVL 8.4 as limits for annual activity releases to the environment. They are defined so that, at their maximum, the radiation impacts arising from disposal are comparable to those arising from natural radioactive substances and, on a large scale, the radiation impacts remain insignificantly low.

In addition, Guide YVL 8.4 gives due regard to the protection of the living nature requiring that disposal of spent fuel shall not detrimentally affect species of fauna and flora. This shall be demonstrated in the safety assessment by assessing typical radiation exposures of terrestrial and aquatic populations in the disposal site environment, assuming the present kind of living populations. These exposures shall remain clearly below the levels which, on the basis of the best available scientific knowledge, would cause decline in biodiversity or other significant detriment to any living population. Moreover, rare animals and plants as well as domestic animals shall not be exposed detrimentally as individuals.

H.11.6 Biological, chemical and other hazards

Other hazards than those posed by radiation are considered in the EIA reports in the same way as in the connection with other industrial activities but are not especially dealt with in the safety analysis of LILW repositories.

Disposed LILW consists of NPP's trash waste, scrap metal, filter elements and liquids and sludge. These materials and their immobilisation matrices are not harmful to the environment as such, but may contain harmful residues like heavy metals.

Some studies on radioactive nickel releases from repository have been carried out in Finland. The results show that the potential annual release is small. In the same way it can be argued that also the release rate of chromium and poorly soluble lead and cadmium will be small. The chemical effects of the Swedish LILW disposal facility (SFR) have been studied more thoroughly. SFR and the Finnish LILW facilities are similar regarding to structure and the type and content of disposed waste. Swedish studies indicate that the increase of heavy metal concentration in seawater would be negligible, mostly due to the barriers in repository.

If the waste is isolated properly, the discharges to the environment are quite small when compared with other forms of industry or other sources of hazardous wastes. At least as long as the engineered barriers are isolating the radioactive waste also the other harmful substances are effectively isolated from the environment. Furthermore, the LILW repositories are located in areas which do not contain exploitable groundwater reserves for communities.

Biological, chemical and other hazards may be related to some wastes arising from medical and research applications. The requirements of the relevant non-radiation related regulations, including those related to general occupational health, are applied as appropriate.

H.11.7 Protection of future generations and avoidance of undue burdens on future generations

The limitation of the potential hazard to future generations posed by disposal of LILW or spent fuel is discussed above under Chapter H.11.5. Section 7h of the Nuclear Energy Act states that nuclear waste shall be managed so that no radiation exposure will occur after disposal that would exceed the levels considered acceptable during the implementation of disposal.

The Finnish nuclear waste management policy is based on the ethical principle to avoid transferring undue burdens to future generations. Disposal facilities for LILW are operational at both NPP sites and are planned to host also decommissioning waste and waste from small users. Active institutional controls are not needed to ensure the safety of these disposal facilities in the post-closure period. Preparations for spent fuel disposal have progressed in accordance with the objectives set by the Government Decision in 1983. The costs of disposal of LILW and spent fuel as well as decommissioning of the NPPs and the FiR 1 research reactor are covered by assets collected in the Nuclear Waste Management Fund.

Nuclear Energy Act (Section 7h) requires that disposal of nuclear waste in a permanent manner shall be planned with due regard to safety and that ensuring long-term safety does not depend on the surveillance of the disposal site. Government Decision (478/1991) adds that the planning of disposal of nuclear waste shall take account of the decrease of the activity by interim storage and the utilisation of high quality technology and scientific knowledge and the need to ensure long-term safety by investigations and performance monitoring. However, the implementation of disposal shall not be unnecessarily delayed.

Article 12 Existing facilities and past practices

Each Contracting Party shall in due course take the appropriate steps to review:

(a) the safety of any radioactive waste management facility existing at the time the Convention enters into force for that Contracting Party and to ensure that, if necessary, all reasonably practicable improvements are made to upgrade the safety of such a facility;

(b) the results of past practices in order to determine whether any intervention is needed for reasons of radiation protection bearing in mind that the reduction in detriment resulting from the reduction in dose should be sufficient to justify the harm and the costs, including the social costs, of the intervention..

H.12.1 Existing facilities

The predisposal management facilities for low and intermediate level radioactive waste in Loviisa and Olkiluoto NPPs and the FiR 1 research reactor are covered by the respective Operation Licences of the reactors. The LILW disposal facilities have separate licences. The requirements for safety review are described in Chapter G.5.1. and the conclusions drawn are valid for LILW management as well.

Thorough assessments of the safety of the facilities were carried out by the licensees and reviewed by STUK in connection with the construction and operation licence applications. A periodic safety review of the LILW disposal facilities is made at a 15 years interval. The Olkiluoto LILW disposal facility was taken into operation in 1992 and consequently its safety assessment was submitted for review in 2007. In the same context the suitability of the waste packages from the new Olkiluoto 3 NPP unit for disposal in the facility was evaluated. The first stage of the Loviisa LILW disposal facility, the LLW disposal tunnel, was taken in operation in 1998. The construction of the second stage of the facility, the ILW disposal cavern, was completed in 2007 and the FSAR of the facility was accordingly updated and will be reviewed by STUK in 2008.

In conclusion, the safety reviews regarding the predisposal management of LILW at NPPs and research reactor required by Article 12 are carried out at the time of licensing, the safety analysis reports continuously being updated. In addition, periodical safety reviews are made. Safety improvements have been annually implemented at the Loviisa and Olkiluoto plants, including the facilities for waste management, since their commissioning.

H.12.2 Past practices

In 1958–1961, a company established by the Finnish industry carried out uranium mining and milling activities in a pilot scale in Paukkajavaara in the municipality of Eno in the Eastern part of

Finland. About 31 000 tonnes of uranium ore were excavated from small open mines and an underground mine. After the termination of the activities the mines were left open and the mine and mill tailings were left at the site.

The restoration of the site was carried out in 1992–1994 by the current owner of the area. The mine and mill tailings were covered with layers of clay and gravel and a soil layer on the top. Finally, trees were planted on top of the disposal site. Furthermore, the bottom sediment of a nearby lake was covered by an additional layer of soil and other material. STUK inspected the work and carried out environmental surveillance in the area. Five years after the completion of the restoration, STUK, having carried out further environmental studies, concluded that no radiation risk is posed to the human health by the disposed mining and milling waste and confirmed the waste to be permanently disposed of in accordance to the requirements of Nuclear Energy Act (Section 32–34). However, as an extra precaution restrictions for utilization of the site were imposed: any permanent occupancy, construction work or earthmoving is not allowed in the area.

Very small scale uranium mining and milling activities were carried out in 1956–1959 in Askola, Southern Finland; only about 1000 tonnes of ore was treated. The owner of the site did some restoration work in the area in late 1980's and reported to STUK in 1991. STUK's inspection and later investigations made by STUK in 2007 concluded that the restoration was not yet satisfactory and the case is still open. Even so, the area does not pose any immediate hazard to the nearby population or the environment.

Some wastes from non-uranium mining and ore processing contain elevated levels of uranium and thorium. In 1961–1972 lead was mined and processed in Korsnäs, on the West Coast of Finland. The average uranium and thorium concentrations of the 760000 tons of wastes are estimated at 700 Bq/kg (60 ppm) and 250 Bq/kg (60 ppm), respectively. Currently there is no foreseen use for the area and the area is surrounded with a fence. Possible remedial action is considered when the current owner (Municipality of Korsnäs) decides on the possible future use of the area. Also about 36000 tons of milled ore containing 1500–4500 Bq/kg uranium (120–360 ppm) and 1000–1500 Bq/kg (250–370 ppm) thorium remained at the mining area. In 1997, the heaps of ore were remedied by covering them with one meter thick layer of soil.

At the Vihanti Zinc mine, where mining activities ended in 1992, the wastes contain uranium 400 Bq/kg (30 ppm) on the average. The area has been covered with a thin layer of soil which, together with the increasing vegetation, prevents dusting and reduces external gamma radiation.

Article 13 Siting of proposed facilities

Each Contracting Party shall take the appropriate steps to ensure that procedures are established and implemented for a proposed radioactive waste management facility:

(a) to evaluate all relevant site-related factors likely to affect the safety of such a facility during its operating lifetime as well as that of a disposal facility after closure;

(b) to evaluate the likely safety impact of such a facility on individuals, society and the environment, taking into account possible evolution of the site conditions of disposal facilities after closure;

(c) to make information on the safety of such a facility available to members of the public;

(d) to consult Contracting Parties in the vicinity of such a facility, insofar as they are likely to be affected by that facility, and provide them, upon their request, with general data relating to the facility to enable them to evaluate the likely safety impact of the facility upon their territory.

In so doing, each Contracting Party shall take the appropriate steps to ensure that such facilities shall not have unacceptable effects on other Contracting Parties by being sited in accordance with the general safety requirements of Article 11.

In Finland, the siting decisions for the LILW repositories at NPP sites were made in 1983. In the context of the Decision-in-Principle process in 2000, Olkiluoto was selected as the site for a spent nuclear fuel disposal facility. In 2004 Posiva started the construction of the underground characterization facility ONKALO (Figures 14 and 15) in order to obtain confirmative data and information for the application of the construction license, planned to be filed with the Government by the end of 2012.

Concerning siting, design, construction and assessment of safety, details of the regulatory approach to ONKALO and the Olkiluoto spent fuel disposal project are described in Annex L.1.

The description of siting procedures, provided under Article 6 (Chapters G.6.1 – G.6.5) for NPPs (including spent fuel storages), is also applicable for facilities intended for predisposal management of LILW at the NPPs and for disposal of LILW or spent fuel and is not repeated here.

Concerning siting a disposal facility for spent nuclear fuel, Government Decision (478/1999) states that the geological characteristics of the disposal site shall be favourable for the isolation of the disposed radioactive substances from the environment. An area having a feature that is substantially adverse to long-term safety shall not be selected as the disposal site. Guide YVL 8.4 specifies generic site suitability criteria. Site investigations at the site have been going on since the 70's. These have included many kind of investigations from the air and surface, boreholes at different depths, and finally will include direct investigations at the disposal depth at the ONKALO facility to confirm the suitability of the site.

The various steps of the siting process concerning the final disposal of spent fuel are detailed in Table H.13.1.

Figure 14. The opening of the ONKALO tunnel in 2007.

Figure 15. The access tunnel of ONKALO.

Table H.13.1. Siting of the spent fuel disposal facility.

	Site characterisation phase
1983–1999	Site investigations and regulatory reviews • Countrywide site screening 1983–85 • Preliminary site investigations at five areas 1987–1992 • Detailed site investigations at four areas 1993–1999 • Regulatory reviews in 1986 and 1993
	Environmental impact assessment procedure
1997 **1998**	EIA Programme • 20 scoping workshops organised by Posiva in four municipalities • EIA programme report, February 1998 • Public hearings in four municipalities • Statements and written opinions to MTI* • Judgement by MTI, November 1998
1999	EIA Report • Report, May 1999 • Public hearings in four municipalities • Statements and written opinions to MTI • Judgement by MTI, November 1999
	Decision-in-Principle process
1999 **2000** **2001** **2002** **2004** **2012**	Application for DiP • DiP application submitted to the Government, May 1999 • EIA report annexed to the application Handling of application • Public hearing in Eurajoki municipality • Statements and written opinions to MTI • Preliminary safety appraisal by STUK, January 2000 • Consent statement by Eurajoki municipality, January 2000 • DiP by the Government, December 2000 • Ratification of the DiP by the Parliament, May 2001 Ratification to expand the DiP for the spent fuel from the 5th reactor unit Start of construction of the underground rock characterisation facility, ONKALO, with the aim of final confirmation licence of the site suitability Planned: Submission of application for the construction licence of the disposal facility

* During the EIA procedure and DiP process the statements were issued by the predecessor of MEE, i.e. the Ministry of Trade and Industry, MTI.

Article 14 Design and construction of facilities

Each Contracting Party shall take the appropriate steps to ensure that:

(a) the design and construction of a radioactive waste management facility provide for suitable measures to limit possible radiological impacts on individuals, society and the environment, including those from discharges or uncontrolled releases;

(b) at the design stage, conceptual plans and, as necessary, technical provisions for the decommissioning of a radioactive waste management facility other than a disposal facility are taken into account;

(c) at the design stage, technical provisions for the closure of a disposal facility are prepared; the technologies incorporated in the design and construction of a radioactive waste management facility are supported by experience, testing or analysis.

The discussion under Article 7 (Chapter G.7) is valid for predisposal management facilities for LILW, which are covered by the licence of the NPPs and Government Decision (395/1991).

The design requirements for LILW and spent fuel disposal facilities and the measures to limit radiological impacts from these facilities are discussed in Chapter H.11.6. An illustration of the repository of spent fuel at Olkiluoto is shown in Figure 4. The design of Loviisa and Olkiluoto LILW disposal facilities are illustrated in Figures 6 and 7, respectively.

According to Government Decisions, the design, excavation, other construction and closure of the underground facility shall be implemented in the best manner with regard to retaining the characteristics of the host rock important to long-term safety. The depth of the waste emplacement rooms shall be selected appropriately with regard to the waste to be disposed of and the local geological features. The objective shall be that the impacts of above-ground events, actions and environmental changes on long-term safety will remain minor and inadvertent human intrusion to the repository will be difficult. More detailed requirements on the design principles are given in Guides YVL 8.1, YVL 8.4 and YVL 8.5.

Conceptual plans for the closure of the disposal facilities have been included in their initial designs (e.g. the PSAR designs of the LILW repositories and the Decision-in-Principle design of the spent fuel repository). These closure plans will be reconsidered in the context of later licensing stages or periodic safety assessments.

Concerning siting, design, construction and assessment of safety, a more details of the regulatory approach to the Olkiluoto spent fuel disposal project is described in Annex L.1.

Article 15 Assessment of safety of facilities

Each Contracting Party shall take the appropriate steps to ensure that:

(a) before construction of a radioactive waste management facility, a systematic safety assessment and an environmental assessment appropriate to the hazard presented by the facility and covering its operating lifetime shall be carried out;

(b) in addition, before construction of a disposal facility, a systematic safety assessment and an environmental assessment for the period following closure shall be carried out and the results evaluated against the criteria established by the regulatory body;

(c) before the operation of a radioactive waste management facility, updated and detailed versions of the safety assessment and of the environmental assessment shall be prepared when deemed necessary to complement the assessments referred to in paragraph (a).

H. 15.1 Regulatory approach

The discussion under Article 8 on safety assessment of spent fuel storage is valid for predisposal management of LILW because both activities are covered by the licence of the NPP and Government Decision (395/1991)

Predisposal management of wastes subject to Radiation Act involves generally operations which may not cause any extensive hazards: handling of sealed sources, segregation and packaging of small amounts of LLW. Thus no comprehensive safety or environmental impact assessments are needed but the safety of the required operations is evaluated in the context of the licensing processes.

Regarding the final disposal of spent fuel, compliance with long-term radiation protection objectives as well as the suitability of the disposal concept and site shall, according to Government Decision, be justified by means of a compliance with the long-term radiation protection objectives as well as the suitability of the disposal concept and site shall be justified by means of a safety analysis that addresses both the expected evolutions and unlikely disruptive events impairing long-term safety.

According to Guide YVL 8.4 a safety analysis shall include:

- Description of the disposal system (waste canister, backfilling materials and sealing structures, excavated rooms, characteristics of host rock, groundwater and the disposal site) and definition of the barriers
- Analysis of the potential future evolutions of the disposal system (scenarios analysis)
- Definition of the performance targets for the barriers
- Functional description of the disposal system by means of conceptual and mathematical modelling and the determination of the input data needed in these models
- Analysis of the activity releases and resulting doses from radionuclides which are released from the waste, penetrate the barriers and enter to the biosphere
- Whenever practicable, estimation of the probabilities of activity releases and radiation doses arising from unlikely disruptive events impairing long-term safety
- Uncertainty and sensitivity analyses and complementary discussions on the significance of such phenomena and events which cannot be assessed quantitatively
- Comparison of the outcome of analyses with the safety requirements
- Documentation of the safety analysis.

The various phases of the safety analysis shall be carefully documented. Documentation shall target to

- Transparency, so that the approaches, methods, results and the coupling to the entirety in each part of the analysis can easily be discovered.
- Traceability, so that justifications for the adopted assumptions, input data and models can easily by found in the safety assessment report or its reference reports.

A safety analysis shall be included in the Decision-in-Principle application, preliminary safety analysis report, final safety analysis report and final closure plan. Furthermore, the safety analysis shall be updated in case that any new information has emerged which might crucially affect the outcome of the analysis in relation to the safety requirements.

A scenario analysis shall cover both the expected evolutions of the disposal system and unlikely disruptive events affecting long-term safety. The scenarios shall be composed systematically from features, events and processes, which are potentially significant to long-term safety and may arise from:

- Mechanical, thermal, hydrological and chemical processes and interactions occurring inside the disposal system
- Eternal events and processes, such as climate changes, geological processes and human actions.

The base scenario shall assume the performance targets defined for each barrier, taking account of the incidental deviations from the target values. The influence of the declined overall performance of a single barrier or, in case of coupling between barriers, the combined effect of the declined performance of more than one barrier, shall be analysed by means of variant scenarios. Disturbance scenarios shall be defined for the analysis of unlikely disruptive events affecting long-term safety.

In accordance with the Government Decision (Section 29), the computational methods shall be selected on the basis that the results of the safety analysis, with high degree of certainty, overestimate the radiation exposure or radioactive release likely to occur.

In order to assess the release and transport of disposed radioactive substances, conceptual models shall first be drawn up to describe the physical phenomena and processes affecting the performance of each barrier. Besides the modelling of release and transports processes, models are needed to describe the circumstances affecting the performance of barriers. From the conceptual models, the respective calculation models are derived, normally with simplifications. Simplification of the models as well as the determination of input data for them shall be based on the principle that the performance of any barrier will not be overestimated but neither overly underestimated.

The modelling and determination of input data shall be based on the best available experimental knowledge and expert judgement obtained through laboratory experiments, geological investigations and evidence from natural analogues. The models and input data shall be appropriate to the scenario, assessment period and disposal system of interest. The various models and input data shall be mutually consistent, apart from cases where just the simplifications in modelling or the aim of avoiding the overestimation of the performance of barriers implies apparent inconsistency.

The importance to safety of such scenarios that cannot reasonably be assessed by means of quantitative analyses shall be examined by means of complementary considerations. They may include e.g. bounding analyses by simplified methods, comparisons with natural analogues or observations of the geological history of the disposal site. The significance of such considerations grows as the assessment period of interest increases, and the judgement of safety beyond one million years can mainly be based on the complementary considerations.

Complementary considerations shall also be applied parallel to the actual safety analysis in order to enhance the confidence in results of the whole analysis or a part of it.

H.15.2 Implementation

Concerning safety after closure, Posiva has continued safety assessment work after the Decision in Principle with the goal to be ready to submit the construction licence application in 2012. A framework for the development of the safety case was reported in 2005. A set of ten main reports are published in an evolving series of versions:

- The *Site report* describes the present state and past evolution of the Olkiluoto site, as well as the disturbances caused by the construction of ONKALO and the first stage of the repository
- The *Characteristics of spent fuel, Canister design, and Repository design* describe the engineering aspects of the waste disposal system. The repository design report also discusses long-term safety features, manufacturing, and installation aspects of the buffer and backfill.
- The *Process* report describes features, events and processes potentially affecting the disposal system.
- The *Evolution* report describes the evolution of the disposal system, including the site, from emplacement of the first canisters until the far future.
- The *Biosphere assessment, Radionuclide transport* and *Complementary evaluations* reports address radiation safety and fulfillment of regulatory requirements.
- The *Summary* report draws together the key findings and arguments and concludes with a statement of confidence in the long-term safety of the waste disposal programme.

These reports are updated in average every three years or more often, if needed. STUK continuously reviews and assess Posiva's program, using also outside experts. The Safety Case Plan has been revised in 2008*.

An essential part of Posiva's spent fuel disposal program is the investigations to be carried out in an underground rock characterisation facility (ONKALO). These investigations aim at confirming the suitability of the bedrock for disposal and acquiring site characteristics data for the design of the disposal facility and for its safety evaluation.

STUK has implemented a regulatory oversight program for the ONKALO project and a programme for construction site inspections. These activities are described more in detail in Annex L.1. As part of oversight of ONKALO, STUK has approved safety classification, management system and safeguard handbook for ONKALO.

* The idea of the report portfolio has been retained, but a new main report has been added to the portfolio: The *Models and Data* report will describe the safety critical data and how they have been produced. One purpose of the revision of the plans is to enhance the quality management of the safety case activities.

Article 16 Operation of facilities

Each Contracting Party shall take the appropriate steps to ensure that:

(a) the licence to operate a radioactive waste management facility is based upon appropriate assessments as specified in Article 15 and is conditional on the completion of a commissioning programme demonstrating that the facility, as constructed, is consistent with design and safety requirements;

(b) operational limits and conditions, derived from tests, operational experience and the assessments as specified in Article 15 are defined and revised as necessary;

(c) operation, maintenance, monitoring, inspection and testing of a radioactive waste management facility are conducted in accordance with established procedures. For a disposal facility the results thus obtained shall be used to verify and to review the validity of assumptions made and to update the assessments as specified in Article 15 for the period after closure;

(d) engineering and technical support in all safety-related fields are available throughout the operating lifetime of a radioactive waste management facility;

(e) procedures for characterization and segregation of radioactive waste are applied; incidents significant to safety are reported in a timely manner by the holder of the licence to the regulatory body;

(f) programmes to collect and analyse relevant operating experience are established and that the results are acted upon, where appropriate;

(g) decommissioning plans for a radioactive waste management facility other than a disposal facility are prepared and updated, as necessary, using information obtained during the operating lifetime of that facility, and are reviewed by the regulatory body;

(h) plans for the closure of a disposal facility are prepared and updated, as necessary, using information obtained during the operating lifetime of that facility and are reviewed by the regulatory body.

The discussion on and references to nuclear energy legislation, general safety regulations and STUK's guidance discussed under Article 9 are also valid for predisposal management of LILW from NPPs and for the operational period of a LILW disposal facility. Therefore only some specific features related to disposal of LILW or spent fuel, as well as those related to radioactive waste from small operators, are presented here.

H.16.1 Initial authorization

The Nuclear Energy Decree requires that a number of documents, including the Final Safety Analysis Report shall be submitted to STUK when applying for an operating licence. More detailed requirements are given in Guide YVL 1.1, including STUK's review and inspection of commissioning of a nuclear facility. The requirements for safety assessment are discussed in detail above under Article 15.

In the context of the commissioning of a nuclear waste facility, the licensee shall ensure that the systems, structures and components as well as the entire facility function as planned. The licensee shall ensure that an appropriate organization, adequate skilled workforce and applicable instructions exist for the coming operation of the facility.

H.16.2 Operational limits and conditions

According to the Nuclear Energy Decree, Technical Specifications, which shall at least define limits for the process quantities that affect the safety of the facility in various operating states, provide regulations on operating restrictions that result from component failures, and set forth requirements for the testing of components important to safety, shall be submitted to STUK, when applying for a an operating licence for a nuclear facility.

Government Decision (478/1999) requires that technical and administrative requirements and restrictions for ensuring the operational and long-term safety shall be set forth in the technical safety specifications of the disposal facility.

H.16.3 Established procedures

According to Government Decision (478/1999) appropriate instructions shall exist for the operation, maintenance, regular in-service inspections and periodic tests as well as for transient and accident conditions. The reliable function of systems and components shall be ensured by adequate maintenance and by regular in-service inspections and periodic tests.

H.16.4 Updated assessment for post closure period

For the LILW repositories, both in Loviisa and Olkiluoto, there is a operation licence condition requiring a periodic update of the safety assessment. The Government Decree under preparation, concerning nuclear waste disposal, requires that the safety case shall be updated every 15 years, if not otherwise prescribed in licence conditions. The safety case shall be updated prior to the final closure of the disposal facility.

H.16.5 Engineering and technical support

The LILW repositories operate under NPP organisations and the requirement for adequate engineering and technical support in Guide YVL 1.7 applies. Concerning a disposal facility for spent nuclear fuel, the Government Decree on nuclear waste disposal, now under preparation, contains the corresponding requirement.

H.16.6 Characterization and segregation of waste, incident reports

The guidance and requirements for LILW characterization and segregation is provided in Guide YVL 8.3. STUK reviews plant procedures, the FSAR, and performs inspections waste management at the NPPs and the repositories to ensure compliance with requirements.

Incident reporting is required in Guide YVL 1.5.

H. 16.7 Decommissioning plans

The decommissioning plans for facilities for LILW and spent fuel management, other than repositories are part of the decommissioning plans of the NPPs. Decommissioning is discussed in more detail under Article 26.

H.16.8. Closure plans

In accordance with Government Decisions, a safety case for a disposal facility shall be included in the application for a construction licence and the operating licence. The safety case shall be updated every 15 years, if not otherwise prescribed in licence conditions. The safety case shall be updated prior to the final closure of the disposal facility. An investigation and monitoring programme shall be implemented during the operational period the disposal facility to obtain confirming information of the long-term performance of the barriers.

Article 17 Institutional measures after closure

Each Contracting Party shall take the appropriate steps to ensure that after closure of a disposal facility:

(a) records of the location, design and inventory of that facility required by the regulatory body are preserved;

(b) active or passive institutional controls such as monitoring or access restrictions are carried out, if required; and

(c) if, during any period of active institutional control, an unplanned release of radioactive materials into the environment is detected, intervention measures are implemented, if necessary.

H.17.1 Records

According to Government Decree under preparation

- A record shall be kept of the disposed waste which includes waste package specific information on waste type, radioactive substances, location in the waste emplacement rooms and other necessary data. STUK maintains a database where the nuclear waste data reported annually by the operators of the NPPs are stored. In 2007 STUK made a decision to improve the database, especially its user-interface and report generation. The implementation will be done in 2008.
- STUK shall arrange for the depositing the information about the disposal facility and disposed waste in a permanent manner. Guide YVL 8.1 adds that during the operational period the records referred to above shall be annually complemented and submitted to STUK. At the time of the closure of the repository, the record of the disposed waste and the relevant information in the FSAR will be converted into a national archive for long-term deposition.

H.17.2 Institutional control

Two types of institutional control can be implemented: restrictions in land use (passive control) and technical post-closure surveillance (active control).

According to the Nuclear Energy Act, Section 63, STUK's supervisory rights include issuing land use restrictions after the closure of the disposal facility when deemed necessary. Government Decree under preparation on nuclear waste disposal further provides an adequate protection zone shall be reserved around the disposal facility as a provision for the prohibitions on measures referred to in Section 63 of the Nuclear Energy Act. According to Guide YVL 8.1 it can be assumed that human activities, affecting the repository or the nearby host rock, are precluded for 200 years at the most by means of land use restrictions and other passive controls. It should also be noted that the Finnish repositories for LILW are located at 60–100 m depth in the bedrock and spent fuel repository is planned to be located at least 400m below the surface; the increased depth lessens the need for institutional controls.

H.17.3. Potential intervention measures

After approval of the closure of a LILW or spent fuel repository, the State bears the responsibility of the waste repository and all intervention measures that may be needed (Nuclear Energy Act, Section 34). Such measures are unlikely because the repository concepts are based on passive safety; multiple engineered barriers ensuring effective long-term containment of the disposed waste.

SECTION I Transboundary movement

Article 27 Transboundary movement

Each Contracting Party involved in transboundary movement shall take the appropriate steps to ensure that such movement is undertaken in a manner consistent with the provisions of this Convention and relevant binding international instruments.

In so doing:

(a) a Contracting Party which is a State of origin shall take the appropriate steps to ensure that transboundary movement is authorized and takes place only with the prior notification and consent of the State of destination;

(b) transboundary movement through States of transit shall be subject to those international obligations which are relevant to the particular modes of transport utilized;

(c) a Contracting Party which is a State of destination shall consent to a transboundary movement only if it has the administrative and technical capacity, as well as the regulatory structure, needed to manage the spent fuel or the radioactive waste in a manner consistent with this Convention;

(d) a Contracting Party which is a State of origin shall authorize a accordance with the consent of the State of destination that the requirements of subparagraph (c) are met prior to transboundary movement;

(e) a Contracting Party which is a State of origin shall take the appropriate steps to permit re-entry into its territory, if a transboundary movement is not or cannot be completed in conformity with this Article, unless an alternative safe arrangement can be made.

A Contracting Party shall not licence the shipment of its spent fuel or radioactive waste to a destination south of latitude 60 degrees South for storage or disposal.

Nothing in this Convention prejudices or affects:

(a) the exercise, by ships and aircraft of all States, of maritime, river and air navigation rights and freedoms, as provided for in international law;

(b) rights of a Contracting Party to which radioactive waste is exported for processing to return, or provide for the return of, the radioactive waste and other products after treatment to the State of origin;

(c) the right of a Contracting Party to export its spent fuel for reprocessing;

(d) rights of a Contracting Party to which spent fuel is exported for reprocessing to return, or provide for the return of, radioactive waste and other products resulting from reprocessing operations to the State of origin.

I.27.1 Regulatory approach

Regulations on transport of all kinds of dangerous goods are laid down in Act and modal Degrees on Transport of Dangerous Goods. As far as radioactive material is of concern, additional requirements are given in Radiation Act and Decree as well as Nuclear Energy Act and Decree. When transboundary movement of radioactive material is of concern, the Regulation 93/1493/EURATOM on shipments of radioactive substances between Member States shall be applied. The requirements are also in accordance with the European Council Directive 92/3/EURATOM on the supervision and control of shipments of radioactive waste between Member States and into and out of the Community. This Directive is replaced with the Council Directive 2006/117/Euratom of 20 November 2006 on the supervision and control of shipments of radioactive waste and spent fuel. The new directive will be implemented by 25.12.2008 by revisions to the Nuclear Energy

Act and the Radiation Act and by a new regulation issued by STUK. Further guidance is given in the Guide YVL 6.5.

With respect to the illicit trafficking, regulatory measures have been taken in mid 1990's to address and prevent illicit trafficking of nuclear and other radioactive materials across Finland's boarders. For example, fixed monitors for vehicles and railway traffic have been installed to all major crossing points at the Finnish–Russian border and at Helsinki harbour. Other crossing points have portable monitors at their disposal.

I.27.2 Experiences

According to an agreement between Finland and the Soviet Union spent fuel was to be shipped from the WWER type Loviisa power plant to the Soviet Union/Russian Federation. Subsequent to the amendment of the Nuclear Energy Act approved by the Finnish Parliament in 1994, the transportation was ceased in 1996. During the years 1981–1996 altogether about 330 tU was returned. The spent fuel was transported by a special train in TK-6 transport casks under special safety arrangements.

Besides the shipments of spent fuel discussed above, there have been few cases of transboundary movements of small quantities of radioactive waste, notably for research purposes.

Regarding illicit trafficking, the systematic border control for monitoring radioactive materials has produced substantial results over the years. In 1997, the top year, 23 shipments were stopped at the border. After that the number of turned-back shipments and enhanced cooperation with Russian counterparts, the number of cases has fallen drastically and no illicit radioactive material was detected at the Finnish border control between 2001 and 2007.

SECTION J Disused sealed sources

Article 28 Disused sealed sources

Each Contracting Party shall, in the framework of its national law, take the appropriate steps to ensure that the possession, remanufacturing or disposal of disused sealed sources takes place in a safe manner.

A Contracting Party shall allow for re-entry into its territory of disused sealed sources if, in the framework of its national law, it has accepted that they be returned to a manufacturer qualified to receive and possess the disused sealed sources.

J.28.1 Regulatory control of sealed sources

Regulatory control of radioactive sources is based on the Radiation Act and regulations issued pursuant thereto, into which the provisions of the European Union radiation protection directives (Council Directive 96/42 EURATOM, and Council Directive 97/43 EURATOM etc.) have been implemented. Other EU regulations are applicable as well, e.g. the Council Regulation 1494/93/ EURATOM on shipments of radioactive substances between the Member States.

According to the Radiation Act (Section 16) prior authorization is required for all activities with radioactive sources, e.g. for the use, manufacture, trade in, holding and disposal of sources. A safety licence is granted by STUK upon written application. General conditions for granting a licence are laid down in the Radiation Act and the licensing procedure is prescribed in more detail in the Radiation Decree (Sections 14-20). All premises where radioactive sources are employed are inspected by STUK regularly, every 1–5 years, depending on the type and extent of the practice. For sealed sources the inspection frequency is normally once in 5 years. The main objective of an inspection is to validate that radioactive sources are used and stored safely and other conditions set in the safety licence preserve. The inspector shall identify each sealed source. Any discrepancies to licensing information concerning placing of sources, new sources and sources taken out of use are recorded for amending the licence accordingly.

The Radiation Decree (Section 17) provides that STUK has to be notified immediately, if a radiation source has disappeared, been stolen, lost or otherwise ceased to be in the licensee's possession. Licensing information is stored in a database maintained by STUK, including also source-specific information on each sealed source in licensee's possession. Source-specific information is updated continuously according to licensees' notifications and observations made during the inspections. Some low-activity radioactive sources, such as calibration sources employed in laboratories as well as sources in the storages of dealers (e.g. importers of radioactive sources) are not individually registered into STUK's database. However, records of transfers of sources maintained by dealers are reported to STUK annually and they are also subject to inspection by STUK at any time.

J.28.2 Handling of disused sealed sources

The Radiation Act (Section 10) states that radioactive sources that have no further use must be rendered harmless owing to their radioactivity are radioactive waste. Guide ST 5.1 dealing with sealed sources specifies that disused sources shall not be stored unnecessarily. In practice, however, it is sometimes difficult to define whether a stored source might have some use in the future. The annual fee for holding a licence depends on the number of sources in licensee's possession and, therefore, there is some financial incentive to transfer disused sources back to the provider (and thereof to the manufacturer) or to the central storage managed by the State. The number of unused sources stored in the premises of various licensees is currently about 600, i.e. 9% of the total number of sealed sources in use (total number of licensed sources is about 6500).

In the year 1996, the Ministry of Health and Social Affairs made an agreement with the TVO power company to lease for 100 years storage space located in the LILW disposal facility at Olkiluoto for a long-term storage of non-nuclear radioactive waste, which are in the possession of the Government. The waste inventory limits included in the agreement are currently being discussed. Disused sources are collected to the laboratory of STUK's Department of Research and Environmental Surveillance where they are repacked, as necessary, and then transferred to the storage at Olkiluoto. The safety of the operations is supervised by STUK's Department of Nuclear Waste and Materials Regulation.

When new sources are authorized for use, STUK requires the applicant to present a plan on measures to be taken when it becomes a disused source. Essentially there are two main options; either to have an agreement with the provider on returning the source or that the source will be transferred to the central disposal storage at the costs of the licensee. The first option is preferred and it is foreseen that in the future an agreement on returning the source to the provider shall be required for all sources.

Sources manufactured in Finland can be returned to Finland once they have become disused sources.

J.28.3 Orphan sources

According to the Radiation Act (Section 50) the licensee is required to take all the measures needed to render harmless radioactive wastes arising from its operations. If the origin of the waste is unknown, like in case of orphan sources, the State has the obligation to render the radioactive waste harmless (Section 51). In such case, the licensee – if identified later – shall compensate the State for the costs incurred in such action.

With respect to the orphan sources and boarder controls, please see section I.

All important users of scrap metal have installed fixed monitors at the gates of their installations. STUK co-operates with the Customs and the metal industry in questions such as measurement arrangements and training of personnel. STUK also provides expert help in cases where exceptional radiation is detected.

On an average, about 1–2 sealed radioactive sources have been found among imported scrap metal annually. Orphan sources, whose owner can not be identified, are delivered to the State interim storage at Olkiluoto.

SECTION K Planned activities to improve safety

There are two major and eight important challenges foreseen, where activities are planned to improve safety.

Intended final disposal of spent fuel in the Olkiluoto bedrock continues to be the first major task in the nuclear waste management. Self-evidently, the main challenges are related to keeping up with the good and timely progress made with the project. Posiva and STUK continue to invest in their processes and resources to ensure that all safety related regulatory and implementation tasks are correctly scheduled and of high quality.

The current phase of the disposal project also requires continued and new research and development programmes, projects and resources. As stipulated by the Nuclear Energy Act of Finland, the producers of the waste are solely responsible for the safe handling, management and disposal of their wastes. This responsibility includes the needed R&D and all costs arising. For regulating the safe management of nuclear wastes, responsibilities with MEE and STUK include also independent R&D. Accordingly; there continue to be three main R&D programs with the following main features:

- The R&D-program of Posiva; the program is mainly aimed at planning and implementing the spent fuel disposal project;
- The R&D-program of STUK; the regulatory R&D program aims at supporting the regulatory decision making of STUK;
- The KYT2010 program administrated by MEE; the program aims at supporting the creation and maintenance of the overall competence and the basic abilities needed, and at assessing alternative solutions for long term management of spent fuel.

Posiva's R&D-program is clearly the largest and has the major challenge to produce results which are related to Olkiluoto-site, EBS and safety case and are needed to justify the con-struction licence application planned to be submitted 2012. To develop and maintain public sector competence in nuclear and waste safety, STUK provides direction and guidance to the national KYT2010 program. The R&D program of STUK on waste management safety and the KYT2010 program are both currently under reorganization in order to improve their effectiveness and usefulness in supporting regulatory activities.

The second major challenge is that ONKALO construction continues and can be completed in such a manner that allows STUK to conclude that ONKALO can be used as a part of a nuclear facility, i.e. the spent fuel repository.

In Finland, one new reactor unit, Olkiluoto 3, is under construction. For two other optional new units (Olkiluoto 4 and Loviisa 3), environmental impact assessments were formally ongoing at the end of the review period (2007). With respect to spent fuel disposal facility, (i) updating of the existing EIA covering the spent fuel from six reactors up to 9000 tU, and (ii) the EIA extension to cover spent fuel up to 12 000 tU were started in 2008. Also exten-sion of the Decision-in-Principle for the spent fuel disposal facility in Olkiluoto corresponding spent fuel from the proposed new reactors will be needed to be done in the future. In addition, a new company with the aim to construct a nuclear power plant in Finland has been established, and it has started its site selection process. If all these projects materialize, current resources for waste safety have to be clearly increased.

The European Commission has proposed that the general requirements for nuclear power plant safety and nuclear waste management be harmonised in the EU. In Finland, the safety regulations that are within the scope of the Nuclear Energy Act are under revision.

The structure of the detailed safety requirements (YVL Guides) published by STUK is being updated. This includes also new guidance on decommissioning.

Plant lifetime extensions of existing nuclear power plants require renewal of systems and components and modernization of technologies, including those related to the radioactive waste and spent fuel management. The regulation of existing nuclear power plants emphasises the management of ageing and the quality of plant operations. International cooperation for learning lessons from experiences in nuclear power plant operation, including waste and spent fuel management, must be improved so that risks identified anywhere can be controlled efficiently everywhere.

Security arrangements in nuclear energy field and the use of high-activity radiation sources also call for efficient supervision. One must be prepared for the possibility that nuclear materials, waste or other radioactive substances are used in international terrorism. The procedures, preparations and information exchange involved in antiterrorism activities will be enhanced worldwide. As concerns nuclear material control in Finland, this will mean a stronger focus on security arrangements, border control, import and export control, security arrangements for other radioactive materials and research in the field. Development is carried out in cooperation with other authorities.

In a public discussion about uranium exploration, STUK is frequently asked to provide information on radiation safety of this activity, in particular from NORM viewpoint. The need for more intensive cooperation with other authorities is also becoming obvious. STUK must enhance its knowledge and develop analysis methods in order to be well prepared for evaluating potential mining projects at the investigation stage.

The European Commission promotes worldwide co-operation to further develop nuclear, radiation and waste safety through its INSC- and former TACIS- and PHARE-programmes. STUK has been and will be a supporter of this European development and involvement. Currently, three fourths of STUK's service volume comprises promotion of radiation and nuclear safety in Eastern European countries.

The retirement of large post-war age groups will affect public administration throughout, including STUK. The above activities require additional manpower and efforts from Posiva, nuclear power companies and regulatory body for strengthening their activities. Ageing manpower and organizations optimized for operation and control of current nuclear and radioactive waste management facilities require further development in organizational arrangements and activities. Human resources will have to be allocated with great care in the future. STUK's resources are to be developed in such a way that the key tasks in radiation and nuclear safety can be taken care of at all times. Education and training programmes are emphasised.

Communication will become an increasingly important success factor for STUK, Posiva and power companies. Interest in radiation and nuclear safety topics will continue to increase. The media plays a growing important role in communication.

As a rule, Posiva, nuclear power companies and STUK aim at continuous improvements of safety. These cover activities related to LILW and NORM management which are, however, less challenging than the spent fuel disposal project.

In order to ensure the quality of its program, to improve safety, to promote international co-operation and transparency, STUK intends to organise an international peer review on its regulatory approach and activities related to the spent fuel disposal project during 2009.

SECTION L Annexes

L.1 Regulatory approach to the Olkiluoto spent fuel disposal project

From a regulatory viewpoint, the Olkiluoto spent fuel final disposal project can be divided into the following main phases:

1. Research phase from the late 1970's to the "Decision-in-Principle" licensing phase (DiP),
2. Design and R&D phase including construction of an underground rock characterization facility (from DiP to Construction licence (CL)),
3. Construction phase (from CL to operating licence OL),
4. Operating phase
5. Decommissioning and closure phase.

In the year 2000, the Finnish Government made the DiP that final disposal of spent fuel into the Olkiluoto bedrock was in the overall benefit of the society. The DiP also stated that the project is allowed to proceed by constructing the ONKALO underground rock characterization facility in Olkiluoto. From a legal standpoint, the DiP thus included a permit to start the limited construction of the repository. ONKALO may be later used as a part of the actual repository and therefore the regulatory approach to ONKALO construction is the same as is for the rest of the repository.

In addition to constructing the ONKALO, the DiP also talks about more detailed RD&D. namely, the Government, and the Parliament through ratifying the DiP, called for the continuation of the research, development and design work to elaborate further the disposal project's safety justifications for the purposes of the next licensing stages. This is consistent with the general structure of the Finnish licensing process. After the DiP the start of the actual construction requires a specific construction licence granted by the Government.

These activities of Posiva, which company was the applicant and the recipient of the DiP, to fulfil the DiP are regulated by the MEE and STUK.

In the regulatory control of Posiva's spent fuel final disposal project (including construction of ONKALO), STUK's day to day activities are those related to approvals, review and assessment, and inspection. Other functions, such as establishing, updating or adopting safety principles, regulations, guides, are developed parallel with RD&D work.

L.1.1 Regulatory approach to the construction of ONKALO

The main safety functions of the Olkiluoto disposal facility are (1) ensuring the integrity of the containment of the disposed waste i.e. (engineered) containment and (2) maintaining sub-criticality. The secondary safety function is the effective limitation of the release of radioactive nuclides (retardation as well as protection from external impacts).

Therefore, for long term safety it is vital that such chemical and mechanical conditions are maintained in the bedrock that the safety functions are not jeopardized over a long period of time in a variety of normal and abnormal circumstances.

Construction of ONKALO to the planned disposal depth (c.a. –430m) disturbs the geo-environment and conditions in a variety of ways. The purpose of STUK's regulatory control of ONKALO construction is primarily to ensure that the design, location, orientation and construction are carried out in such a manner that the geo-environment retains its favourable characteristics and conditions needed for the safety functions.

In particular, this implies the minimization of:

- Host rock responses to excavation, excavation disturbed areas and zones
- Groundwater leakages to the ONKALO tunnels and shafts

- Introduction of foreign, potentially harmful substances to ONKALO during (cement and other grouting materials, reinforcement materials, explosives etc.).

STUK's regulatory activities (approvals, review and assessment, inspection,) are implemented in a stepwise approach. All the structures, systems, component, processes, features and activities relevant to safety functions are classified based on their significance to safety functions (safety classes 1, 2, 3, 4 and to those which are not nuclear safety important).

Since the management of the construction and related safety culture affect directly the safety and quality of the work and its long term results, Posiva's management system is also subject to STUK's regulatory control.

L.1.1.1 Review and assessment

STUK has defined in Regulatory Guide YVL 4.1 which documents are required to be submitted to STUK for review and approval. These documents include description of the constructing organization, staff competences, regulations, codes and standards to be used in the construction, quality system (QA and QC, results of QC measures), design data, drawings, construction documentation, in-service inspection plan etc.

In addition, Posiva was required to submit to STUK a plan how the company intends to communicate to STUK the progress of the construction work. The purpose of this document is to facilitate for STUK well planned, timely and properly targeted and resourced regulatory activities synchronized with the actual construction activities. This documentation includes schedules, realization reports, as-built materials, test results, information about research planned to be performed in ONKALO during construction, and information about ONKALO's unclassified systems.

Review and assessment criteria are presented in regulatory YVL Guides. These guides are more performance based than prescriptive.

In its review and assessment process for ONKALO construction, STUK uses its own experts and external consultants. All the results and regulatory decisions, including their justifications, are documented and published.

L.1.1.2 Inspection activities

ONKALO inspection activities cover all areas of STUK's responsibilities. Inspections are carried out in order to ensure that Posiva is in compliance with regulations, conditions and approvals of STUK in a high quality manner. Inspection activities can be divided into the following three areas, which are discussed in the following:
- Construction Inspection Program (CIP),
- Inspections concerning the readiness to begin excavation and work phases, and
- Inspection concerning construction works on site.

STUK's inspectors prepare reports of their inspection activities and findings, which are fed back into the regulatory process.

Construction Inspection Program (CIP)

STUK has established a planned and systematic CIP-program. CIP is prepared, approved and implemented annually as a continuous process.

The main levels of CIP are:
- Management system (ONP-A): Dealing with issues such as managing ONKALO construction, organization, safety culture, quality assurance, competence of staff, communication with STUK
- Main Operations (ONP-B): construction project management and resources, safety issues, quality assurance for construction work, monitoring program, related R&D
- Functions and Activities (ONP-C): Posiva's inspections and QC, excavation and excavation disturbed zone, drillings, mapping of features and construction impacts to safety functions (to geochemistry, rock mechanics, hydrogeology, groundwater leakages to ONKALO, introduction of foreign potential hazardous materials to ONKALO, grouting, enforcement works and materials), physical protection and emergency preparedness.

Inspections concerning the readiness to begin excavation and work phases

The ONKALO construction is divided into different phases. The purpose of these inspections is to ensure that all the arrangements and conditions at the construction site are in order for the next construction phase to start (previous phase is properly completed).

Examples of this type of inspections are inspecting the preparedness to begin shotcreting of a specified tunnel section, and inspecting the preparedness to start a new excavation piece-work.

Inspection concerning construction works on site

Inspections are targeted to excavation work processes, methods and practices, and their quality and compliance with approvals. Inspections are carried out at least once in two weeks.

L.1.2 Regulatory approach for Posiva's RD&D activities

In the framework of the DiP, STUK's regulatory control of Posiva's RD&D activities is targeted primarily to the safety functions of the disposal system and their safety justifications, as well as the related management system (incl. QM) of Posiva. The regulatory horizon in terms of level of details and uncertainties is the next licensing phase, i.e. main construction permit in the year 2012.

STUK's regulatory activities related to Posiva's RD&D activities are mainly those related to review and assessment and authorization. Inspection activities are mostly related to Posiva's management system (incl. QA) as well as management of RD&D contractors and their performance.

Regulations, guides and regulatory decisions are developed and taken parallel with the proceeding RD&D work. Currently, efforts are devoted to develop further regulatory position, requirements and guides for the repository's safety functions. The safety functions mentioned above (integrity of the container, sub-criticality, limitation of release) have been divided into several sub-safety functions for canister, buffer, backfill and geosphere. The set of conditions, parameters, characteristics and circumstances needed for each sub-safety function to perform their duties over a long period of time create the needed safety envelope, in which the repository needs to perform. The robustness of the repository system is then assessed against how the repository system can tolerate deviations from normal conditions as well as abnormal situations.

RD&D work is a stepwise process. Results, documentation and other RD&D material is periodically updated and submitted to STUK, usually with intervals of one to three years.

In support of its regulatory staff, STUK has currently organized the following three international experts groups for

- Olkiluoto site safety investigations (SONEX-group)
- Engineered Barrier System and Technology (AEGIS-group)
- Safety Assessment (SAFARI-group).

The above mentioned regulatory activities are targeted to the following Posiva's ongoing RD&D activities:

A. Above the ground level safety issues:
- Safety of the encapsulation plant: design basis, design basis accidents (DBA), safety classification, PSAR, deterministic safety analysis, use of PRA, safety functions, layout, operational conditions, operational safety, physical protection, emergency preparedness
- Spent fuel transportation safety; risk analysis.

B. Below the ground level safety issues:
- Spent fuel to be disposed of: fuel types, quantities, irradiation characteristics, criticality, fuel dissolution, cladding behaviour, release fractions, effects of water chemistry, radiolysis
- Disposal canister: design basis, sealing, manufacturing, QC, damage tolerance, stresses, corrosion, ductility
- Buffer: design basis, properties, behaviour, fabrication, emplacement, QC, THMCB evolution, saturation, swelling pressure, interaction with cementitious materials, erosion and piping, freezing and permafrost damage
- Backfill and plugs: design basis, concept, materials, handling, manufacturing, installation, plugging of tunnels and boreholes, swelling pressure, compressibility, density, hydraulic conductivity
- Host rock: surface conditions, geology, rock mechanics, hydrogeology, hydrogeochemistry, impact of ONKALO construction, chemical and mechanical stability.

C. Safety analysis and safety case issues

- Operational and long term safety, DBAs, accident analysis
- Features, events, processes
- Evolution (climate, site, repository)
- Scenarios
- EBS
- Radionuclide transport
- Biosphere
- Repository's system behaviour and robustness
- Natural analogues and other complementary evaluations
- Radiation safety; dose and release constrains
- Uncertainty management.

L.1.3 Regulatory approach for Nuclear Safeguards

As ONKALO is foreseen to become a part of the future final disposal facility for spent nuclear fuel, STUK decided in 2003 to start implement safeguards to ONKALO. Subsequently, Posiva was obliged to implement safeguards from the beginning of ONKALO excavation to the closure of the final disposal site. Per STUK's regulations, Posiva has prepared, documented all necessary safeguards procedures and measures in quality manual called "Safeguards Handbook" and submitted it regularly to STUK for review and approval.

Safeguards activities for final disposal in Finland have four main objectives:

- To ensure that all safeguards relevant information about the final disposal facility will be available in due time
- To be able to confirm that there are no undeclared activities relevant to safeguards at or near the final disposal site
- To enable the IAEA to perform integrated safeguards in Finland
- To enable the IAEA and the European Commission to plan for their future safeguards activities.

STUK's current safeguards activities consist of auditing Posiva's safeguards implementation, reviewing Posiva's safeguards relevant reports and confirming by on-site inspections that ONKALO in compliance with Posiva's as-built documentation.

STUK audit to Posiva's safeguards implementation includes review of the documented results and the observations made throughout the year in connection with report reviews and on-site inspections. Result of STUK audits are fed back to STUK's regulatory process and to Posiva.

L.2 Programme for spent fuel disposal

General

According to the Government Decision-in-Principle, endorsed by the Parliament in 2001, the spent fuel from the Loviisa and Olkiluoto Nuclear Power Plants will be disposed of in a KBS-3 type geological repository at the Olkiluoto island in the municipality of Eurajoki. Posiva Oy, the company responsible for the implementation of disposal, is carrying out a research, development and design programme that aims at submission of the application for the construction licence of the disposal facility in 2012. The reference repository design is based on the idea of emplacing the spent fuel canisters in vertical position in floors of the repository tunnels, but in parallel to the reference design the feasibility of horizontal deposition of the canisters is being studied. The site investigations continue now both on the surface and in the underground rock characterization facility, ONKALO, the construction of which was started in 2004. Studies into the long-term safety aim at producing a full safety case in the form of a portfolio of reports in 2012.

ONKALO

The first overall site characterization programme for a nuclear spent fuel repository in Finland was launched in 1982. This programme already suggested that the final stage of site investigations, called *the site confirmation stage* according to the IAEA vocabulary then, should include characterisation of the bedrock performed in an underground rock characterisation facility. International views have also emphasised the importance of underground rock characterisation before the decision to construct the repository is taken. Generic underground laboratories have been and are still operating in several countries (Stripa, Grimsel, URL, Äspö, Bure). The development and full-scale testing of the disposal concept conducted at these have shown the significance of site-specific properties for the design of the disposal systems.

The excavation of the underground rock characterisation facility, ONKALO, is now well underway at Olkiluoto. Unlike the generic rock laboratories the ONKALO is being constructed at the actual repository site, and this means that the construction and operation of this facility should not cause major disturbances to the properties of bedrock that are important for the long-term safety. In addition, it should be possible to use the ONKALO later as a part of the repository. This means that the construction of the facility should comply with the rules and requirements applicable for nuclear facilities.

At the main drawings stage, the design and plans for the underground facility were reported at the level of detail needed for a construction permit in 2003. This meant description of the location, final structures and final systems. The report has now been updated to describe the design changes made after start of the excavations in 2004. The main changes are the two new shafts added to the facility – which originally were supposed to be drilled later at the time of repository construction. Also the layout and the depth of the auxiliary rooms at the main characterisation level have been updated to match with the current bedrock information. The present design of the facility is shown in Fig. 16.

The main characterisation level is located at the depth of –420 metres and auxiliary rooms at a depth of –437 metres. The demonstrations related to the repository technology will be mainly carried out on the main level. A tentative plan is also made for a lower characterisation level to study the variation of the bedrock properties with depth.

The construction of the ONKALO was started in 2004 and will be completed in 2014. The total underground volume of the ONKALO will be approximately 410 000 m^3, the combined length of tunnels and shafts being 10.8 km. The access tunnel from the surface to the lower level consists of approximately 5.6 km of tunneling with an inclination of 1:10. The shafts are excavated to the lower level. The personnel shaft will be equipped with a man-cage for personnel transport. Connecting tunnels from the access tunnel to the personnel shaft at every 1 to 1.5 km will make it easier to ventilate and evacuate the ONKALO facility. The engineering design of the ONKALO is continuing on-line.

More than 3 km of tunnel length has been excavated by spring 2008 until the depth of 300 metres. In addition, two of the shafts have now been bored to the depth of 180 metres. The underground investigations run parallel to the excavation work.

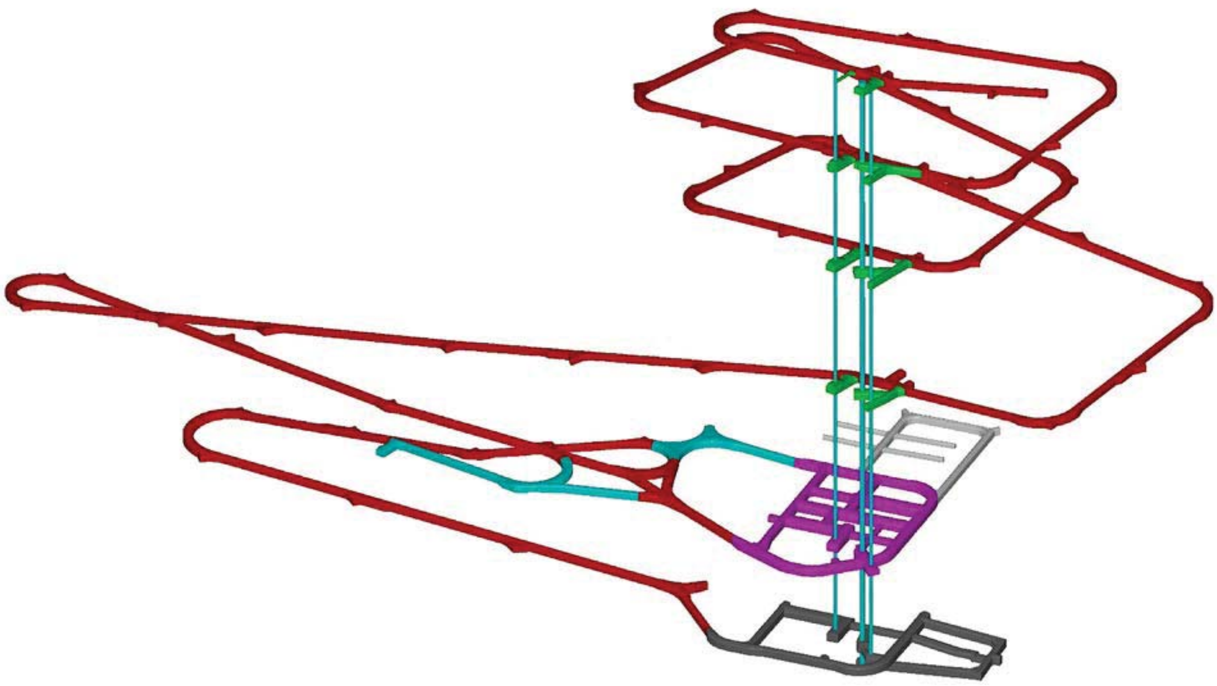


Figure 16. ONKALO layout in 2007. Figure by Esa Parviainen/Saanio & Riekkola Oy.

Site investigations

The main goal of the present site investigations is to demonstrate that the preliminary conclusions of the site suitability can be validated by the underground investigations carried out at the disposal depth and suitable volumes of rock can be identified for the repository tunnels and deposition holes. Major activities are now focused on the underground characterization facility, ONKALO, but surface drillings are still continued as well. The present focus of the surface is on the characterization of the northern- and easternmost parts of the island, where the existing data density is so far quite low. Altogether nine new deep diamond-cored drillholes were drilled at the site in 2006–2007, with the drillhole length varying from 400 to 1000 meters. In addition, two investigation trenches were excavated in the eastern part of the island in order to get a continuous sampling profile of the bedrock and to check the location of previously modelled brittle deformation zones and the lithological distribution at the location. Surface outcrop mappings were also continued in the western part of island, where new outcrops were exposed during ongoing construction work of the new nuclear power plant. In 2006–2007, three pilot holes were drilled within the ONKALO access tunnel in order to check the rock quality and the exact location of modelled hydrological zones in advance of the excavation. In all drillholes, extensive geophysical, geological and hydrological loggings were carried out. Consequently, the data have been used in site descriptive modelling. Detailed geological mapping of the ONKALO tunnel is systematically being carried out approximately hundred meters behind the excavated tunnel front.

In 2006, a test 3D seismic campaign was carried out in the central, well-characterised part of the island and, after promising results, another campaign was performed in the eastern part in 2007. The data will be used in modelling work and the first interpretations of the 3D seismic data will be provided in Site Descriptive Model report 2008.

The main emphasis in the rock mechanical investigations has been to measure in-situ rock stresses. The first underground stress measurement campaign took place in 2006 at the depth level of 120 m. The results indicated the major principal stress to be 12–16 MPa and trending about east-west. The second field measurement campaign started in spring 2008 at the depth level of 240 m.

The rock response measurements have been conducted in two ONKALO shafts at level –180 m. The measurements consisted of convergence measurements around the ventilation and personnel shaft and extensometer measurements around the personnel shaft (Figure 17). Primary outcome is to

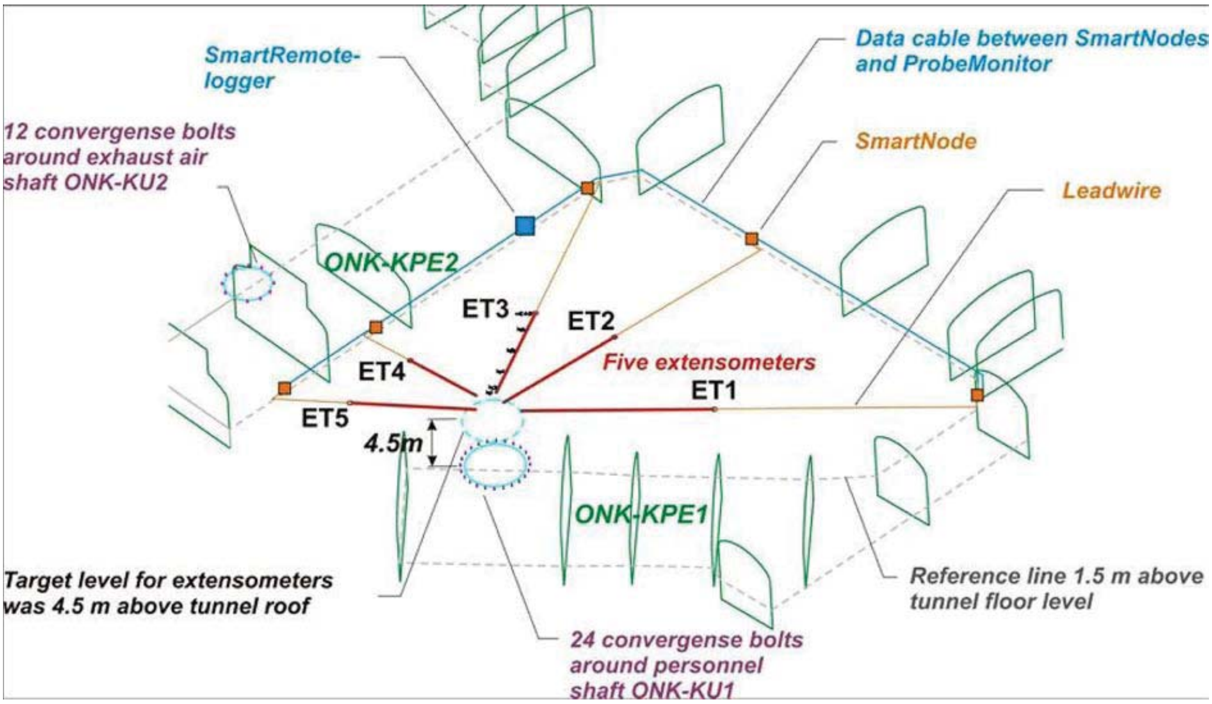


Figure 17. Layout of the rock response measurements at the level of –180 m in the ONKALO.

get the orientation of the horizontal in situ stress field and secondly the magnitudes of the horizontal principal stresses. This was also the first "real" rock mechanics Prediction-Outcome study in which the predicted rock displacements were compared to the measured ones.

Additional methods to estimate the rock stresses have also been utilized such as Kaiser Effect (KE) method, borehole breakout study and visual stress induced observations from the ONKALO tunnels.

Further work has been conducted to determine the different rock properties. They have included laboratory loading tests for the altered rocks, Schmidt hammer tests on the ONKALO tunnel walls, point load tests on the drill cores, shear tests on the rock joints at the laboratory and rock mass classifications (Q-system). A new TERO probe has been constructed to determine thermal properties of rock.

Using the existing rock strength and stress data scatter, statistical analyses have been performed to estimate the probability of the excavation induced rock spalling (i.e. visual damage) at the depth level of 200–500 m. The results tell e.g. that the probability for spalling at 400 m level is 1–16% and at 500 m 3–22% depending on the tunnel orientation in respect to the major principal stress.

Hydrogeological investigations concentrated on measuring the flow properties of the bedrock both in new and old drillholes. The Hydraulic Testing Unit (HTU) device was maily applied in the depth interval representative to the depth of planned repository (300 to 600 metres) to investigate hydraulic fractures and zones. A new instrument, cross-flow meter, has been extensively applied in the group of drillholes in which several pumping tests have been carried out in earlier years. Slug measurements were carried out in shallow percussion holes and groundwater pipes.

In the ONKALO, the total inflow rate is measured one or two times per month. The inflow measurements also include a few weirs at different chainges. The average total inflow rate in 2007 was about 22 litres per minute. Moreover, the walls and roof of the ONKALO was visually inspected twice a year in order to locate the inflow spots and to detect possible changes in them. The largest inflow points are located within the first 1000 metres of the ONKALO.

The hydrogeological flow model, developed upon the basis of the brittle deformation model and hydrogeological data supporting the inter-zonal hydraulic connections, extensively utilizes accumulated investigation data, with an objective of a consistent description of evolution of the site's hydrogeological evolution since the Littorina Sea stage (Andersson et al. 2007).

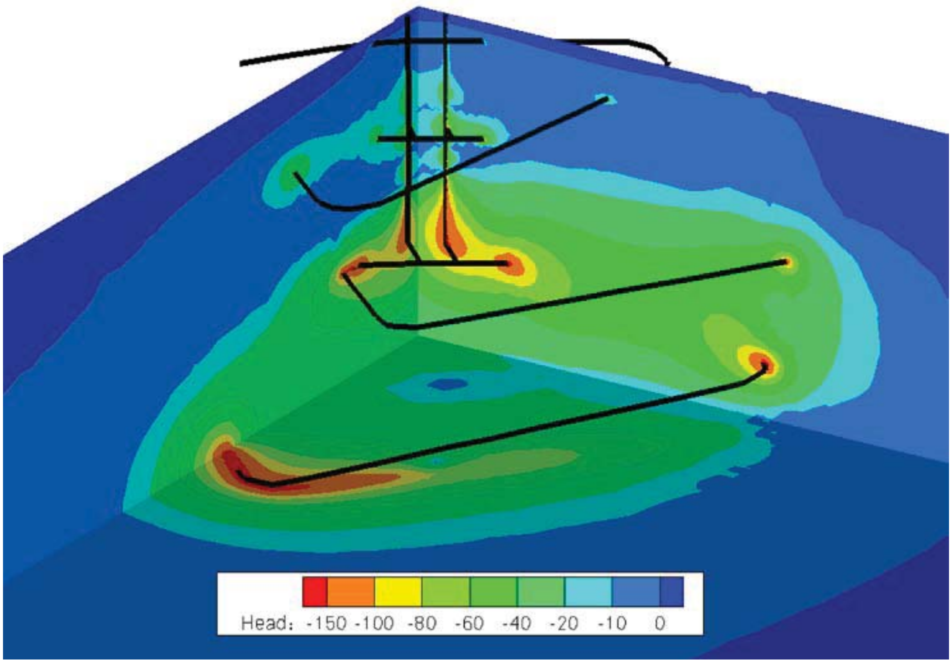


Figure 18. Modelled impact of ONKALO (thick black line) on the groundwater pressure (expressed in terms of hydraulic head [m]) on three perpendicular cross sections when the rock excavations have reached the depth of 250 metres. Influence of the groundwater salinity is ignored (Andersson et al. 2007).

In 2007 the hydraulic site modelling also included the calculation of the site superficial water balance components with surface hydrological flow model. The results of this model indicated that the recharge of bedrock groundwater at Olkiluoto corresponds to about 1.5% of the precipitation (550 to 600 mm annually) at the site (Karvonen 2008).

As part of the hydrogeological modelling efforts, the future evolution of the groundwater flow field under the influence of ONKALO is being forecast (an example of results in Figure 18). Earlier predictions have overestimated the impact of the ONKALO, which indicates that the technical means to reduce the inflow water rates have been more effective than could be assumed in advance. Hydrogeochemical site investigations have been extensive and cover the ONKALO construction area and surroundings comprehensively. Site investigations in drillholes started before the ONKALO construction and, therefore, the natural groundwater state is well known in Olkiluoto. There are a few well known hydrogeological fracture zones in Olkiluoto, which have been found from various drillholes. These fracture zones are continuously monitored. Hydrogeochemical groundwater analysis includes large selection of chemical, gas and microbial analysis, which allow us to compare the present results with the baseline results. A long-term pumping test was initiated in one of the drillholes in 2001. The aim of the test is to obtain information on the potential connections via fractures both to the sea and to deep saline groundwater. In addition to drillhole investigations, shallow groundwater is also extensively investigated. At the moment an infiltration experiment is starting. The aim of this experiment is to find information about infiltration rate in the ONKALO area.

Hydrogeochemical investigations in the ONKALO include, for example, groundwater sampling, gas- and microbial sampling from drilled pilot holes, groundwater stations, special drillholes (such as cement grout monitoring holes) and from leaking fracture zones. Many in situ experiments are also about to begin, such as sampling of slightly conductive ($T<10^{-7}m^2/s$) fractures.

Development of the engineered barrier system

Spent fuel will be stored in water pools for some decades and thereafter transferred to the encapsulation and disposal facilities which will be located at Olkiluoto. Spent fuel would be encapsulated in copper-iron canisters each containing 12 BWR or PWR (Loviisa 1 & 2) fuel assemblies. The canisters for Olkiluoto 3 reactor (EPR) fuel are planned to contain 4 PWR fuel assemblies. The canister design consists of a cast iron insert as a load-bearing element and an outer container of oxygen-free copper to provide a shield against corrosion. The canisters will be emplaced in a network of tunnels, which will be constructed at a depth of about 400 to 500 m in crystalline bedrock. The annulus between the canister and the rock wall will be filled with compacted bentonite. A schematic layout of the underground rock characterization facility and the network of disposal tunnels at Olkiluoto are illustrated in Figure 19 and an individual disposal tunnel with canisters surrounded by the bentonite buffer in Figure 20.

The canister development work has been conducted on issues concerning canister design, canister manufacturing, canister sealing and canister inspection. The Design Report for disposal canister has been published in 2005 covering the basic requirements of the canister, canister materials and their properties, mechanical and thermal-mechanical dimensioning of the canister, radiation shielding, criticality safety and description and dimensions of the canisters for BWR, PWR and EPR fuel (Raiko 2005).

The copper overpack of the canister, which varies for different fuel types only in length,can be manufactured by several methods. The present methods under development are extrusion, pierce & draw and forging. By these methods Posiva, together with SKB, has during the three past years manufactured 20 full-size copper canisters. The properties of the manufactured canisters have been studied by non-destructive tests and by canisters that fulfil their requirements can be manufactured by these methods. More than 20 nodular cast iron inserts for BWR and PWR fuel have been cast in several foundries in Finland, Sweden and Germany for Posiva and SKB jointly.

The reference sealing method for the Posiva canister is the high-vacuum electron beam welding. The method is an industrial welding method for steel and copper components but the wall thickness of the disposal canister brings its challenge to the sealing of the canister. Posiva has conducted

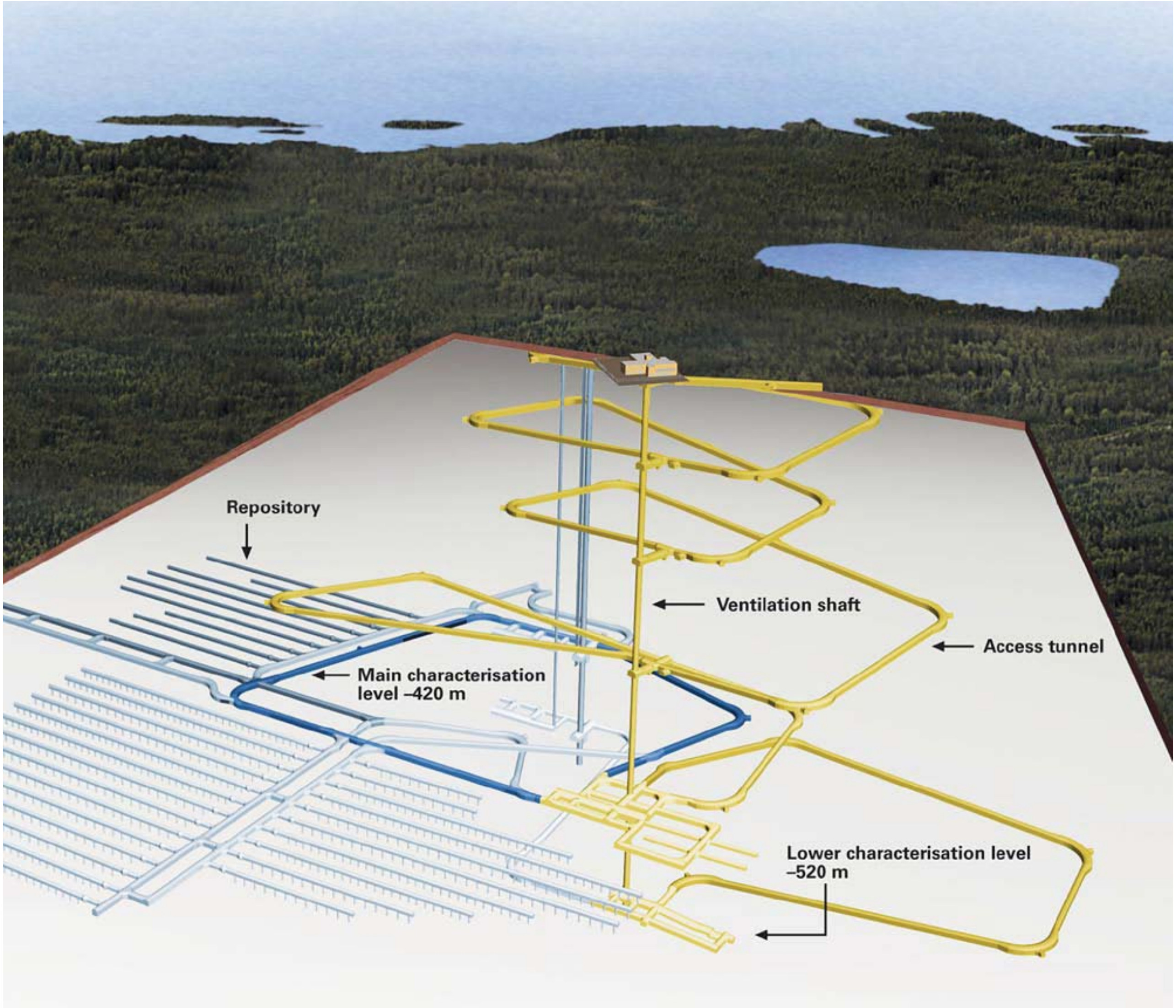


Figure 19. A schematic presentation of the layout of the underground rock characterization facility and the network of disposal tunnels (KBS-3V option).

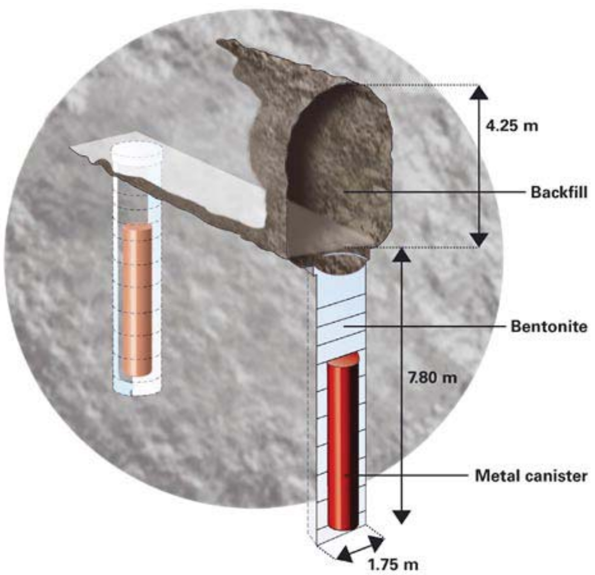


Figure 20. Disposal tunnel and canisters according to the reference design.

an extensive development programme mainly aiming at finding suitable process parameters and construction for the lid weld. The tests have been performed with full-size lids assembled to a short tube. The properties of the welds such as corrosion resistance, ductility and intactness have been studied by non-destructive testing methods and by metallographic, destructive studies.

To prove that the canister to be disposed is initially intact, non-destructive testing of the canister components and the lid weld has been developed focusing mainly on the radiography for volumetric inspection, and on phased-array ultrasonic method for more detailed detection and sizing of possible defects.

The bentonite buffer that surrounds the canister is emplaced in the disposal hole in form of compacted blocks. For the block manufacturing uniaxial and isostatic compaction technologies have been developed. The focus has been on the mould design, properties of the bentonite raw material such as suitable humidity and handling before and behaviour during the compaction. The manufactured blocks are used for bentonite performance studies (Tanskanen 2007).

The planning of the installation of the blocks in the disposal hole is in progress as well as the filling of the gap between the bentonite blocks and the bedrock, which is envisioned to be done with bentonite pellets.

The main target for backfill development has been to identify a backfill concept that is technically feasible but also acceptable from the long-term safety point of view. The main focus of the current studies has been in studying a backfill concept where the backfill consists of pre-compacted clay-rich blocks and bentonite pellets.

One part of the backfill studies has focused on processes to which the block backfill is exposed to during its installation and early saturation, such as saturation, erosion and formation and sealing of piping channels. Other important processes that have been studied include homogenisation of the backfill and mechanical interaction with the buffer in different saturation stages. The work performed has consisted of laboratory studies, small-scale field tests but also modelling. All of these studies have aimed mainly at studying the performance of the block backfill and as the result design specification is updated for the backfill (Keto & Rönnqvist 2007).

Beside the studies focusing on performance of the backfill, small scale testing has been implemented with the focus on technical feasibility and development. These studies include testing the manufacturing and emplacement of backfill materials into tunnels (Gunnarsson et al. 2006).

For closure of the disposal facility an Olkiluoto specific solution has been discussed and a preliminary proposal for different type of sealing structures has been stated.

In the reference design (“KBS-3V”) the canisters are emplaced in vertical holes drilled in the floors of the deposition tunnel. In parallel with the reference design an alternative design (“KBS-3H”) is being studied in which the canisters are emplaced in horizontal position in smaller-diameter deposition tunnels (Fig. 21; Autio et al 2006). A feasibility study of this horizontal variant of KBS-3 has been carried out as a joint project between the SKB of Sweden and Posiva in 2003—2007 and the conclusions of the study have been reported in early 2008.

In the KBS-3H studies it was demonstrated that it was possible to excavate horizontal drifts that would fulfill most of the stringent requirements on geometry established by using present standard technology. Two drifts, 15 m and 95 m long, were excavated at

Äspö HRL. It was further demonstrated that it is possible to emplace a 46-ton supercontainer in a deposition drift using the water-cushion technology. It was concluded that the KBS-3H buffer design should be made more robust for the site-specific conditions foreseen at Olkiluoto. The most significant functional uncertainties and problems were related to buffer behavior where heterogeneous groundwater inflow and uneven saturation of the buffer could cause displacement or deformation of the distance block, and piping and erosion of the buffer. Design changes have been proposed to relieve such uncertainties.

The preliminary long-term safety assessment based on the preliminary KBS-3H design focused on the differences between KBS-3V and KBS-3H to check whether those differences have the potential to lead to unacceptable radiological consequences

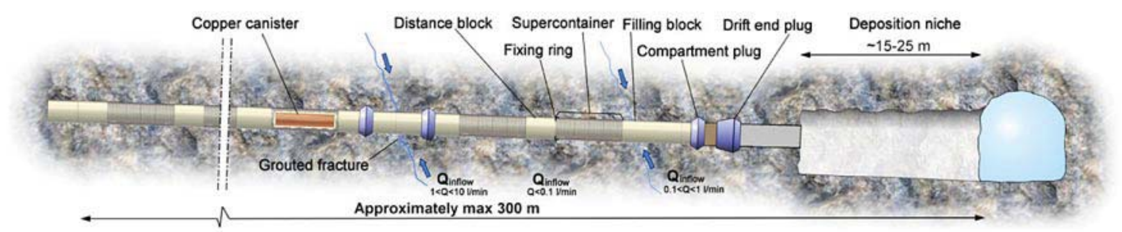


Figure 21. Horizontal variant of the KBS-3 design for spent fuel repository (“KBS-3H”).

(Smith et al. 2007). Olkiluoto was used as the reference site for the study. The main conclusions from the safety assessment conducted were that features or processes that are specific to KBS-3H have mostly minor impacts on the safety functions of the host rock, the buffer or the canister and their evolution over time. In spite of several limitations in the present safety assessment, it can be concluded that the KBS-3H design alternative offers potential for the full demonstration of safety for a repository at Olkiluoto site and for the demonstration that it fulfills the same long-term safety requirements as KBS-3V. A tentative decision has been made by both Posiva and SKB to continue the development of the horizontal option of KBS-3.

Assessment of long-term safety

A safety assessment determines whether the repository satisfies the requirement on long-term safety by describing the initial state and examining the possible long-term changes at the repository. The safety assessment uses a scientific methodology and obtains knowledge concerning long-term changes from research, such as performance analyses, which are aimed to study the functioning of engineered barriers and to adapt the details of the final disposal concept to the conditions at Olkiluoto. The performance analyses also provide background material and basic data for safety assessments and design of the disposal system.

Posiva's safety assessment work continues according to the framework defined in 2005 (Vieno & Ikonen 2005). The effects of the repository on human health and the environment are estimated by systematically collecting and updating the information relevant to long-term safety in a portfolio of reports, referred to as "Safety Case" * portfolio. The safety case portfolio is composed of ten main reports, as follows: The *Site report* describes the present state and past evolution of the Olkiluoto site, as well as the disturbances caused by the construction of ONKALO and the first stage of the repository. The *Characteristics of spent fuel, Canister design*, and *Repository design* describe the engineering aspects of the waste disposal system. The repository design report also discusses long-term safety features, manufacturing, and installation aspects of the buffer and backfill. The *Process* report describes features, events and processes potentially affecting the disposal system. The *Evolution* report describes the evolution of the disposal system, including the site, from emplacement of the first canisters until the far future. The *Biosphere assessment, Radionuclide transport* and *Complementary evaluations* reports address radiation safety and fulfillment of regulatory requirements. The *Summary* report draws together the key findings and arguments and concludes with a statement of confidence in the long-term safety of the waste disposal programme. These reports are updated in average every three years or more often, if needed. The safety case portfolio is illustrated in Figure 22.

The first report addressing the expected (previously referred to as "normal") evolution of the repository at the earlier four candidate sites, including Olkiluoto, was published in 1998 (Crawford & Wilmot, 1998). A more detailed description on the evolution of a KBS-3V type repository specific to the Olkiluoto site was published in 2006 (Pastina & Hellä, 2006). The first process report was published in 2004 (Rasilainen 2004). This report discusses processes specific to the disposal system at Olkiluoto adapted from SKB's SR 97 Process report (*SKB 1999*). The Process report was updated the end of 2007 (Miller & Marcos 2007). The work for Radionuclide release and transport report in now ongoing and the report will be published in 2008.

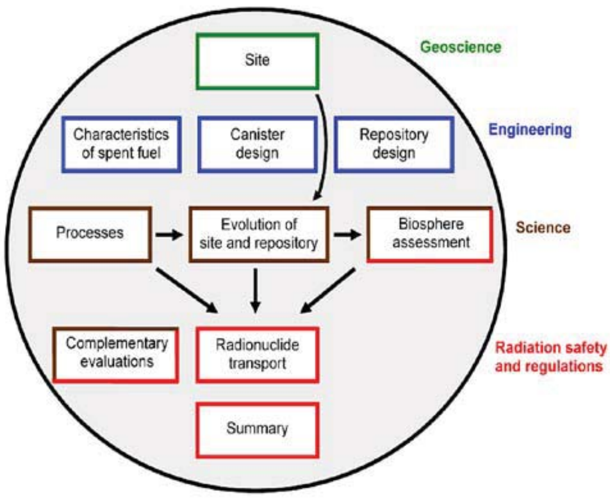


Figure 22. Main reports in the Safety Case portfolio. The colours of the boxes indicate the nature of the reports (geoscience, engineering, science, radiation safety and regulations). The arrows show the most important transfers of knowledge and data (Vieno & Ikonen 2005).

* Posiva's Safety Case Plan has been updated in 2008.

The results of the assessments have been referred to other safety assessments done by other countries, such as SKB's SR-Can Safety Assessment (SKB TR-06-09).

The Biosphere Assessment (Ikonen 2006) is organised into a sub-portfolio having folders for reports on specific topics: *Site and evolution* describes the past, present and future conditions of the surface system of the Olkiluoto site. *Biosphere processes* contain descriptions of processes prevailing at the site now and in future. *Module Descriptions* document the radionuclide transport models. *Biosphere Assessment Data* reports the parameter data used in the assessment with full references to their origin. *Cases and variants* provide mainly the simulated concentrations in the environmental media as a part of the actual assessment. *Exposures of total environment* draw conclusions on the dose and effect implications on the basis of the concentrations provided in Cases and variants. Finally, the biosphere assessment is consolidated in the *summary report* providing the needed high-level information to the main Safety Case and referring to the individual background reports for the details.

The engineered barriers constitute an important factor in ensuring the long-term safety in Posiva's safety concept. The concept states that safety is primarily based on the long-term isolation of radionuclides in waste canisters and on the engineered barriers that ensure the integrity of these canisters as well as on the natural conditions and processes. The performance studies have therefore been focused on establishing the behaviour of the copper canister and its protective bentonite and on examining the harmful processes. The studies are dealt with in Posiva's own investigations and in studies conducted as international joint projects and the bilateral studies with SKB.

Posiva has participated in several international projects related to the bentonite studies during the past four years, such as LOT (Long-Term Test of Buffer Material), ABM (Alternative Buffer Materials), NF-PRO, ECOCLAY II, LASGIT, EBS Task Force and THERESA. Posiva has also launched a new programme "BENTO" that aims at developing new expertise in bentonite matters in Finland. The purpose is to raise both the experimental and the theoretical and modelling capabilities to address the uncertainties and issues concerning the buffer processes. Experimental studies will be combined with theoretical research into the THMC (thermo-hydro-mechanicochemical) behaviour of bentonite by establishing a dedicated facility for bentonite research. The purpose is to gather sufficient knowledge and expertise to demonstrate the performance of the buffer in the Safety Case and to provide the basic information for the manufacturing and installation work for both the KBS-3V and the KBS-3H concepts.

UO_2 dissolution studies have continued in cooperation with SKB. The mixed potential model for prediction of the long-term corrosion behaviour of the copper in compacted sulphide-containing bentonite is under development.

Studies into migration phenomena have continued in domestic and international projects, such as in the Task Force for Groundwater Flow and Solute Transport arranged by Äspö Hard Rock Laboratory. Posiva has also taken part in the FUNMIG (Fundamental Processes of Radionuclide Migration) project and in the work of the second phase of the NEA's "Sorption Forum" project and in the TDB (Thermodynamic Data Base) project. A new code ("MARFA") has been developed for the radionuclide transport in far-field together with SKB. The aim is to obtain the state-of-the-art computer code for use in the safety assessment projects. The work is carried out at the Southwest Research Institute.

The effects of permafrost on long-term safety of disposal system have been studied in Canada within an international project led by Geological Survey of Finland. The project 'Weichselian climate variability in Scandinavia based on a unique sediment sequence preserved at Sokli' continues, aiming at a detailed climate reconstruction from two different time intervals of the Weichselian Period based on the Sokli sediment samples from the Finnish Lapland.

Posiva is participating in PAMINA (Performance Assessment Methodologies in Application to Guide the Development of the Safety Case) project, which is included in the EU's 6th Framework Programme. The aim is to improve and harmonise methodologies and tools for demonstrating the safety of deep geological disposal of long-lived radioactive waste and spent nuclear fuel in different geological environments.

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L.3 List of spent fuel storages and inventory of spent fuel

Loviisa NPP		
	Inventory (end of 2007)/ storage capacity	
Storage	**Mass (tU)**	**Fuel assemblies**
Pool storage in Loviisa 1 reactor building	27.5/57	222/481
Pool storage in Loviisa 2 reactor building	26.6/58	222/485
Basket type pool storage at the NPP	57.6/57	480/480
Rack type pool storage at the NPP	315.9/433	2641/3640
Total inventory/storage capacity (gross)	427.6/605	3565/5086
Total effective* storage capacity	570	4820
Olkiluoto NPP		
	Inventory (end of 2007)/ storage capacity	
Storage	**Mass (tU)**	**Fuel assemblies**
Pool storage in, Olkiluoto 1 reactor building	86.4/269	524/1520
Pool storage in Olkiluoto 2 reactor building	94.6/276	568/1560
Separate storage facility at the NPP site	960.8/1204	5658/7146
Total inventory/storage capacity (gross)	1141.8/1749	6750/10216
Total effective* storage capacity	1570	9240
FiR 1 research reactor		
	Inventory (end of 2007)	
Storage	**Mass (kgU)**	**Fuel elements**
Spent fuel racks in the reactor pool	1.83	10
Well under the floor of the reactor hall	2.37	13
Total inventory	4.20	23

* In the effective capacity the reserve capacity for exceptional unloading of the entire reactor core to storage pool, for storage pool repairs and space for dummy elements are excluded (cf. Table D.1 in section D.32.1).

L.4 List of radioactive waste management facilities and inventory of radioactive waste

Loviisa NPP		
	Inventory (end of 2007)	
Storage	**Volume (m³)**	**Activity (TBq)**
Storage room for LLW inside the NPP	199.8	0.20
Storage room for ILW inside the NPP	5	not measured
Tank storage for wet LILW	1290 **	18.4
Storages for activated metal waste	33.8	high (not measured)
On-site storage hall for VLLW	119.0	low
Olkiluoto NPP		
	Inventory (end of 2007)	
Storage	**Volume (m³)**	**Activity (TBq)**
Buffer storage rooms inside the NPP	174	8.1
On-site storages for scrap metal	1098	low
Storages for activated metal waste	53	high
Spent oil candidate for clearance	4	low
Interim storage for state owned waste	50.5	22.4
FiR 1 research reactor		
	Inventory (end of 2007)	
Storage	**Volume (m³)**	**Activity (TBq)**
Waste storage in the laboratory building	6	0.002
STUK's waste storage		
	Inventory (end of 2007)	
Storage	**Volume (m³)**	**Activity (TBq)**
Storage room in STUK's building	1.5	0.51

** Tank storage for wet LILW includes sediment matter on the bottom of the tanks estimated to be about 60 m³.

L.5 List of laws, regulations, guides and other relevant documents

Most of the regulations can be found in English at http://www.edilex.fi/stuklex/en/.

Law, decrees and general safety related regulations

- Nuclear Energy Act (990/1987)
- Nuclear Energy Decree (161/1988)
- Decree on the State Nuclear Waste Management Fund (162/1988)
- Act on Third Party Liability (484/1972)
- Decree on the Implementation of Third Party Liability (486/1972)
- Radiation Act (592/1991)
- Radiation Decree (1512/1991)
- Act on the Finnish Centre for Radiation and Nuclear Safety (1069/1983)
- Decree on the Radiation and Nuclear Safety Authority (618/1997)
- Decree on Advisory Committee on Nuclear Safety (164/1988)
- Act on the Environmental Impact Assessment Procedure (468/1994)
- Decree on Environmental Impact Assessment Procedure (713/2006)
- Act on the Openness of Government Activities (621/1999)
- Act on Rescue Services (561/1999)
- Decree on Rescue Services (857/1999)
- Decree of Ministry of Interior Concerning Planning for Nuclear or Radiological Emergences and for Informing the Public about Radiation Hazards (774/2001)
- Act on Transport of Dangerous Goods (719/1994)
- Decision in Principle of 10th November 1983 by the Government on the Objectives to be Observed in Carrying out Research, Surveys and Planning in the Field of Nuclear Waste Management, Nuclear Law Bulletin, No 33 (1984) pp. 42–44
- Decision of the Government on Financial Provision for the Costs of Nuclear Waste Management (165/1988)
- Decree of the Government on the General Regulations for the Safety of Nuclear Power Plants (Earlier Decision 395/1991)
- Decree of the Government on the General Regulations for Physical Protection of Nuclear Power Plants (Earlier Decision 396/1991)
- Decree of the Government on the General Regulations for Emergency Response Arrangements at Nuclear Power Plants (Earlier Decision 397/1991)
- Decree of the Government on the Safety of Disposal of Nuclear Waste (Earlier Decisions 398/1991 and 478/1991)

Relevant EU Directives and Regulations

- Council Directive 96/29/EURATOM of 13 May 1996 on the protection of the health of workers and general public against the dangers arising from ionizing radiation
- Council Directive 97/43/EURATOM of 30 June 1997 on health protection of individuals against dangers of ionizing radiation in relation of medical exposure, and repealing Directive 84/466EURATOM
- Council Directive 92/3/EURATOM of 3 February 1992 on the supervision and control of shipments of radioactive waste between Member States and into and out of the Community
- Council Directive 2003/122/EURATOM of 22 December 2003 on the control of high-activity sealed radioactive sources and orphan sources
- Council Directive 2006/117/EURATOM of 20 November 2006 on the supervision and control of shipments of radioactive waste and spent fuel
- Council Regulation 93/1493/EURATOM of 8 June 1993 on shipments of radioactive substances between Member States.

Guides issued by STUK (only Guides relevant to this report included)

- YVL 1.0 Safety criteria for design of nuclear power plants, 12 January 1996
- YVL 1.1 Regulatory control of safety at nuclear facilities, 10 February, 2006
- YVL 1.4 Management systems for nuclear facilities, 9 January 2008
- YVL 1.5 Reporting nuclear power plant operation to the Radiation and Nuclear Safety Authority, 8 September 2003
- YVL 1.7 Functions important to nuclear power plant safety, and training and qualification of personnel, 28 December 1992

- YVL 1.8 Repairs, modifications and preventive maintenance at nuclear facilities, 2 October 1986
- YVL 1.9 Quality assurance during operation of nuclear power plants, 13 November 1991
- YVL 1.10 Requirements for siting a nuclear power plant, 11 July 2000
- YVL 1.11 Nuclear power plant operating experience feedback, 22 December 1994
- YVL 2.5 The commissioning of a nuclear power plant, 29 September 2003
- YVL 2.6 Seismic events and nuclear power plants, 19 December 2001
- YVL 6.1 Control of nuclear fuel and other nuclear materials in the operation of nuclear power plants, 19 June 1991
- YVL 6.3 Regulatory control of nuclear fuel and control rods, 28 May 2003
- YVL 6.5 Transport of nuclear material and nuclear waste, 4 April 2005
- YVL 6.8 Storage and handling of nuclear fuel, 27 October 2003
- YVL 7.1 Limitation of public exposure in the environment of and limitation of radioactive releases from nuclear power plants, 22 March 2006
- YVL 7.4 Nuclear power plant emergency preparedness, 9 January 2002
- YVL 7.9 Radiation protection of nuclear power plant workers, 21 January 2002
- YVL 7.10 Monitoring of occupational exposure at nuclear power plants, 20 January 2002
- YVL 7.18 Radiation safety aspects in the design of a nuclear power plant, 26 September 2003
- YVL 8.1 Disposal of low and intermediate level waste from the operation of nuclear power plants, 20 September 2003
- YVL 8.2 Clearance of nuclear waste and decommissioned nuclear facilities, 18 February 2008
- YVL 8.3 Treatment and storage of low and intermediate level waste at a nuclear power plant, 29 June 2005
- YVL 8.4 Long-term safety of disposal of spent nuclear fuel, 23 May 2001
- YVL 8.5 Operational safety of a disposal facility for spent nuclear fuel, 23 December 2002
- ST 1.1 Safety of Radiation Practices, 23 May 2005
- ST 1.4 Radiation User's Organization, 16 April 2004
- ST 1.5 Exemption of the Use of Radiation from the Safety Licence and Reporting Obligation, 1 July 1999
- ST 1.8. Qualifications of Persons Working in Radiation User's Organization and Radiation Protection Training Required for Competence, 16 April 2004
- ST 5.1 Radiation Safety of Sealed Sources and Equipment Containing Them, 7 November 2007
- ST 6.2 Radioactive Wastes and Discharges, 1 July 1999
- ST 12.2 Radioactivity of Construction Materials, Fuel Peat and Peat Ash, 8 October 2003

L.6 References to official national and international reports related to safety

- The Final Disposal Facility for Spent Nuclear Fuel, Environmental Impact Assessment Report, Posiva Oy, 1999.
- Vieno, T., Nordman, H., Safety Assessment of Spent Fuel Disposal in Hästholmen, Kivetty, Olkiluoto and Romuvaara, TILA-99, POSIVA 99-07, March 1999.
- Ruokola E (ed.). Posiva's Application for a Decision in Principle Concerning a Disposal Facility for Spent Nuclear Fuel. STUK's Statement and Preliminary Safety Appraisal, STUK-B-YTO 198, March 2000.
- Nuclear Waste Management of the Olkiluoto and Loviisa Power Plants: Programme for Research, Development and Technical Design for 2007–2009, TKS-2006, Posiva Oy, November 2006.
- Statement of Position by the Finnish Radiation and Nuclear Safety Authority Regarding the Construction of the Third Unit at Olkiluoto Nuclear Power Plant, January 2005.
- Plan for Oversight of the Underground Rock Characterization Facility at Olkiluoto, STUK, May 2005.
- Regulatory Control of Nuclear Safety in Finland, Annual Report 2004, STUK-B-YTO 239, April 2005.
- STUK-B 79 Kainulainen E (ed.). Regulatory control of nuclear energy in Finland. Annual report 2006. STUK, Helsinki 2007.
- STUK-B 89 Kainulainen E (ed.). Regulatory control of nuclear energy in Finland. Annual report 2007. STUK, Helsinki 2008.

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- Finnish Report on Nuclear Safety, Finnish Second National Report as Referred to in Article 5 of the Convention on Nuclear Safety, STUK-B-YTO 210, September 2001.
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- STUK-B 80 Finnish report on nuclear safety. Finnish 4th national report as referred to in Article 5 of the Convention on Nuclear Safety. STUK, Helsinki 2007.
- Finnish Report on the Safety of Spent Fuel and Radioactive Waste Management, Finnish national Report as Referred to in Article 32 of the Joint Convention on the Safety of Spent Fuel and Radioactive Waste Management, STUK-B-YTO 223, Helsinki 2003.
- Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management. 2nd Finnish National Report as referred to in Article 32 of the Convention. STUK-B-YTO 243. STUK, Helsinki 2005.
- Compliance with the General Regulations for the Safety of Nuclear Power Plants (Government Decision 395/1991), the Loviisa plant, STUK-B-YTO 179, September 1998.
- Compliance with the General Regulations for the Safety of Nuclear Power Plants (Government Decision 395/1991), the Olkiluoto plant, STUK-B-YTO 180, September 1998.
- Statement Issued by the Radiation and Nuclear Safety Authority Concerning the Construction of the Olkiluoto Nuclear Power Plant Unit 3, Annex 1: Safety Assessment of the Olkiluoto 3 Nuclear Power Plant Unit for the Issuance of Construction License, Helsinki, January 2005.
- STUK-B 81 Safety assessment of the Loviisa nuclear power plant. Statement regarding the licence application by Fortum Power and Heat Oy concerning the operation of the Loviisa nuclear power plant. STUK, Helsinki 2007.

L.7 References to reports of international review missions performed at the request of the Contracting Party

- Technical Notes of the International Regulatory Review Team (IRRT) Mission to Finland, 12–13 March 2000, IAEA, Vienna, 2000.
- Regulatory Review Team (IRRT), Follow-Up Mission to Finland, 31 August – 9 September 2003, IAEA/NSNI/IRRT/03/03, IAEA, Vienna, 2003.
- Evaluation of the Finnish Nuclear Waste Management Programme, Report of the WATRP Review Team / International Atomic Energy Agency, Waste Management Assessment and Review Programme, Ministry of Employment and the Economy, Helsinki, 1994.
- Operational Safety of Nuclear Installations, Finland (Olkiluoto), OSART Mission (Operational Safety Review Team), IAEA-NENS-86/2, IAEA, Vienna, September 1986.
- Operational Safety of Nuclear Installations, Finland (Loviisa), OSART Mission (Operational Safety Review Team) 5–23 November 1990.
- Integrated Safety Assessment of Research Reactors (INSARR), Report to the Government of Finland, NSNI/INSARR/1999-2, IAEA, Vienna, August 1999.
- Operational Safety of Nuclear Power Plant, Finland (Loviisa), OSART Mission (Operational Safety Review Team), IAEA-NSNI/OSART/07/139, 5–21 March 2007.

L.8 Spent fuel and radioactive waste management policy

Responsibilities

Nuclear Energy Act (Section 9) prescribes that generators of nuclear waste are responsible for all nuclear waste management measures and their appropriate preparation, and are also responsible for the expenses arisen. The state has the secondary responsibility in case that any producer of nuclear waste is incapable of fulfilling its nuclear waste management obligation (Nuclear Energy Act, Sections 31 and 32). When the licensee's waste management obligation has ceased because the final disposal of nuclear waste has been carried out in an approved manner, the ownership right to the nuclear waste is transferred to the State, which shall be responsible thereafter for the nuclear waste (Nuclear Energy Act, Sections 32–34).

Radiation Act (Section 50) provides that the organization engaged in radiation practice is required to take any measures to render harmless radioactive wastes arising from its operation. Rendering radioactive waste harmless means any measure needed to treat, isolate or dispose of the waste, or to restrict its use so that it does not endanger human health or the environment. Also, the responsible party utilizing natural resources containing radioactive substances shall ensure that radioactive waste poses no hazard to health or to the environment, both during the operations and on their conclusion. The state has the secondary responsibility in case that a producer of radioactive waste is incapable of fulfilling its management obligation (Radiation Act, Section 51).

Political decision-making and public consultation

According to the Nuclear Energy Act (Section 11), construction of a nuclear facility of considerable general significance shall require a Government Decision-in-Principle (DiP) on that the construction project is in line with the overall good of society. Such facilities include major nuclear waste management facilities. Before making the DiP referred to in Section 11, the Government shall ascertain that the municipality where the nuclear facility is planned to be located, is in favour of the facility (Section 14 of the Nuclear Energy Act). The Government DiP shall be forwarded, without delay, to Parliament for perusal. Parliament may reverse the DiP as such or may decide that it remains in force as such (Section 15 of the Nuclear Energy Act).

Nuclear Energy Decree (Section 24) provides that an application for a DiP shall be appended by an assessment report drawn up according to the Act on the Environmental Impact Assessment Procedure as well as a description on the design criteria that will be observed by the licence-applicant to avoid environmental damage and to restrict the burden on the environment. The environmental impact assessment procedure is a consultative process facilitating public involvement and information transfer to the affected people. It considers a wide scope of potential impacts, such as human health and comfort, natural environment and biodiversity, municipal structures and the use of natural resources

Spent fuel and nuclear waste management principles

According to the Nuclear Energy Act (Section 6a) nuclear waste generated in Finland shall be handled, stored and permanently disposed of in Finland. Respectively, nuclear waste generated elsewhere than in Finland, shall not be handled, stored or permanently disposed of in Finland. There are only minor exemptions to these principles, notably the spent nuclear fuel arising from the research reactor. As stipulated in Section 7 of the Nuclear Energy Decree, that fuel can be handled, stored and disposed of outside Finland, if justified on grounds of safety or due to a significant economic or other weighty reason.

The principles of the nuclear waste management were originally set in the Finnish Government's policy decision of 1983 and later in the decisions by the Ministry of Employment and the Economy (MEE). These decisions set also a long-term schedule for the implementation of nuclear waste management including the site selection and start of the operation of the spent fuel disposal facility.

Principles for decommissioning of nuclear facilities

Nuclear Energy Act (Section 7g) requires that provisions for decommissioning of a nuclear facility shall be taken into account in its design. The decommissioning plan shall be updated as prescribed in the Act (Section 28). After permanent shut-down of the facility, it shall be decommissioned in accordance with a plan approved by STUK. The dismantling of the facility and other actions related to decommissioning shall not be unjustifiably postponed.

Management principles for other radioactive waste

According to the Radiation Act (Section 31b), when requesting a safety licence for the use of a high-activity sealed source, accounts of rendering harmless of any disused sources, including the arrangements for their return to the manufacturer or supplier, or their surrender to a recognised installation. Radiation Decree (Section 24b) specifies that the Radiation and Nuclear Safety Authority (STUK) shall discharge the function of rendering radioactive waste harmless where there is no recognised facility of the kind referred in the Radiation Act. STUK may agree with the custodian of the waste that custody of the waste will be permanently assigned to the government in return for a non-recurrent compensation charge.

Safety principles and control

Nuclear Energy Act (Section 7a) prescribes that the safety of the use of nuclear energy (including waste management activities) shall be as high as reasonable achievable. To further enhance safety, all actions justified by operational experiences, safety research and the progress in science and technology shall be taken. Additionally, nuclear waste shall be managed so that no radiation exposure will occur after disposal that would exceed the levels considered acceptable during the implementation of disposal. Disposal of nuclear waste in a permanent manner shall be planned with due regard to safety and that ensuring long-term safety does not depend on the surveillance of the disposal site (Section 7h of the Nuclear Energy Act).

Nuclear Energy Act (Section 55) designates STUK as the regulatory body for the control of the safe use of nuclear energy. STUK's regulatory tasks include judgement of safety in authorization processes, issuance of detailed safety requirements and control of compliance with the safety requirements and licence conditions. Respectively, the Radiation Act (Section 6) states that compliance with the Act and with the provisions and regulations issued pursuant thereto shall be supervised by STUK. The Act (Section 16) states that safety licences shall be granted by STUK upon application.

Costs and funding

Nuclear Energy Act (Chapter 7) addresses financial provision for nuclear waste management. The basic goals of the financing system for radioactive waste management and decommissioning are to ensure that funds for future waste management are collected to ensure that assets are available even in case of insolvency of the waste generator. The NPP operators include the costs of waste management, including those arising from decommissioning of the NPPs, in the price of nuclear electricity. Initially, the nuclear power companies had internal funds for that purpose, but by virtue of entry into force of the Nuclear Energy Act, the State Nuclear Waste Management Fund was established under the MEE in 1988. To ensure that the financial liability is covered, the nuclear power companies and the operator of the research reactor are each year obliged to present cost estimates for the future management of nuclear wastes and take care that the required amount of money is set aside to the State Nuclear Waste Management Fund. In order to provide for the insolvency of the nuclear utilities, they shall provide securities to the State for the part of financial liability which is not covered by the Fund. In case of the research reactor, the operator is also responsible for the planning and implementation for spent nuclear fuel and waste management. In the case of the research reactor the State provided initially the necessary provision to the State Fund.

The Radiation Act (Section 19), provides for furnishing the financial security of radioactive waste management for non-nuclear practices as follows: to ensure that the licensee meets the costs incurred in rendering radioactive waste harmless and in carrying out any decontamination measures that may be needed in the environment, it shall furnish security if the operations produce or are liable to produce radioactive waste that cannot be rendered harmless without substantial cost.

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