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Annual report 2013

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Radiation and Nuclear Safety Authority

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Management review

In 2013, the Finnish nuclear power plants operated safely and caused no danger to the plant environment or employees. The collective radiation doses of employees were the lowest ever during the history of the plants, and radioactive releases into the environment were extremely low. The low employee radiation doses were the result of short annual outages and radiation safety improvements implemented by the plants. Radioactive waste generated in the operational processes of the nuclear power plants accumulated as anticipated. Its processing and final disposal in underground facilities took place in a controlled manner.

The number of events to be reported to STUK by the Loviisa power plant has increased over the past few years. The licensee launched a study due to the events in 2012. A report on the results of this study was submitted to the management of the power plant and to STUK in 2013. STUK will follow progress of the detailed measures specified based on the recommendations at the Loviisa power plant and assess adequacy of the measures. STUK has also monitored the development of management system processes and a procurement development project that was launched in 2013 at the Loviisa power plant. The licensee has reformed its procurement organisation and procurement procedures based on the development project.

STUK did not make any significant observations in its inspections and reviews of the operating Olkiluoto nuclear power plant units in 2013. Over the course of the year, STUK focused its regulatory oversight on the plant's management, modification and procurement processes, and the handling of non-conformances. STUK has also overseen TVO's plans linked to the commissioning of Olkiluoto 3. According to these plans, the management system and organisation of the Olkiluoto 3 project will be merged with the management system of Olkiluoto 1 and Olkiluoto 2. The licensee has several ongoing development projects related e.g. to process based management system and modification process.

At both Olkiluoto and Loviisa, modifications required for improving safety continued regarding plant systems, structures and components as well as operating procedures. Modifications to, for instance, replace the emergency diesel generators was started at Olkiluoto to improve the reliability of power supply in exceptional situations. An expansion project of the spent fuel storage facility proceeded as planned in 2013. Preparations for the commissioning of the storage facility are ongoing. According to the licensee, implementation of the second phase of the I&C renewal in Loviisa has been postponed to 2016. Based on lessons learned from the Fukushima accident, both nuclear power plants have prepared action plans to improve safety. Most of the improvements will be implemented in 2014 and 2015. In 2013, improvements on the capacity of the battery banks in redundant electricity systems were made at Loviisa, and cooling towers to secure residual heat removal from the reactor and fuel pools were being constructed.

Most of the detailed design of the Olkiluoto 3 plant unit has been approved by STUK, and the volumes of construction work and component manufacture have decreased. The focus of STUK's oversight has therefore transferred to the onsite installation and commissioning of components at Olkiluoto. The most important open point of plant design is the plant's I&C systems. In its review of the I&C architecture design documentation, STUK has paid attention to the independence of I&C systems in particular. The review will continue in early 2014. STUK has also requested an assessment of the safety impact of a potential I&C failure and taking into account the assessment results in design. In 2013, STUK ordered a study on the status of the safety culture at the Olkiluoto 3 construction site. Based on the study results, one can state that the safety culture of the Olkiluoto 3 project has improved over the past few years. The study recommended that TVO and the plant suppliers should try to reach a consensus about the concept of safety culture and continue supporting the work of the safety coordinators.

As part of the continuous improvement of safety and preparation for new nuclear power plant projects, STUK continued the revision of its own YVL Guides and also participated in the preparatory work for amending the Finnish Nuclear Energy Act. Two amendments of the Nuclear Energy Act and one amendment of the Nuclear Energy Decree were implemented in 2013. Furthermore, new Government Decrees on the safety of nuclear power plants and emergency preparedness at nuclear power plants entered into force in October 2013. A comprehensive reform of the YVL Guides that took several years was effectively completed in November 2013. The reform aimed at making the YVL Guides clearer and more user-friendly as well as updating their technical requirements. The structure of the YVL Guides as a whole and the internal structure of single YVL Guides were reformed. The reform means replacing the more than 70 old YVL Guides with 44 new YVL Guides. Forty of these were simultaneously published. There are almost complete drafts for the remaining four new YVL Guides, but most of them cannot be published until amendments have been made in the Finnish legislation. Thus, seven of the old YVL Guides are still valid. The new YVL Guides are applied as such to new nuclear power plants. In the case of plants under construction and operating plants, the YVL Guides come into force by means of a separate implementation decision.

The processing and storage of nuclear waste and spent nuclear fuel, as well as the nuclear fuel repository project, proceeded in a safe manner, and no problems were detected at the Loviisa or Olkiluoto power plants. Due to successful planning of operations, the plants accumulated clearly less nuclear waste than nuclear power plants on average. At Loviisa, STUK supervised the commissioning of a liquid waste solidification facility. The facility's systems operated as planned in connection with the solidification test runs, but some damage was detected in solidification tanks manufactured from reinforced concrete and the test runs were disconnected to study the underlying cause of the damage. STUK will assess the related reports once they are complete.

Posiva Oy (Posiva) continued its operations that aim at the final disposal of spent nuclear fuel. At the end of 2012, Posiva submitted to the Government a construction license application for the encapsulation facility and repository, and delivered to STUK the safety documentation required by the Finnish Nuclear Energy Decree. Documentation on the safety case on the long-term safety of the repository was submitted to STUK separately from the rest of the documentation. The fact that some of the application documentation was submitted to STUK late and the fact that supplements to some documents have been required have postponed the review process, but it is expected to be completed by the end of 2014. Processing of the documentation was started at STUK with a coverage review that verified the sufficiency and appropriateness of the submitted information. STUK decided to start the further processing of the documents. Supplements to some documents are still needed. In a more detailed review, STUK observed several issues for which further information is needed. STUK used a team of Finnish and international experts from a variety of technical sectors as an aid in its review. In addition to reviewing the documents, STUK conducted reviews of Posiva's management system and organisation. STUK stated after the reviews that Posiva's personnel resources are still incomplete and Posiva does not, based on the review results, have the required readiness to supervise and control detailed design and implementation of a nuclear facility. STUK will continue assessment of the personnel resources of Posiva's plant project in 2014.

Most of the construction activities of an underground research facility were completed in 2012. In 2013, Posiva excavated facilities to be used to test the final disposal method and divide the repository into smaller areas, as well as the last of the shafts and tunnels, and completed structural engineering works. STUK supervised the construction of the underground research facility, the operations of Posiva's organisation and the research carried out at Onkalo.

The implementation of nuclear safeguards functioned without problems in Finland, and no cause for remarks was found in the inspections carried out by STUK, IAEA and the European Commission. In 2013, Posiva drafted the first basic technical characteristics documents for the encapsulation facility and repository required by the Commission Regulation and submitted them to the European Commission. STUK, the Commission and IAEA verified during an inspection that Onkalo has been constructed as stated in the report. The basic technical characteristics of Olkiluoto 3 were also verified by an inspection. Development of the nuclear safeguards of spent nuclear fuel continued in cooperation with the European Commission and IAEA.

Introduction

This report constitutes the report on regulatory control in the field of nuclear energy which the Radiation and Nuclear Safety Authority (STUK) is required to submit once a year to the Ministry of Employment and the Economy pursuant to section 121 of the Nuclear Energy Decree. The report is also delivered to the Ministry of Environment, the Finnish Environment Institute and the regional environmental authorities of the localities in which a nuclear facility is located.

The regulatory control of nuclear safety in 2013 included the engineering, construction and operation of nuclear facilities, as well as nuclear waste management and nuclear materials. The control of nuclear facilities and nuclear waste management, as well as nuclear non-proliferation, concern two STUK departments: nuclear reactor regulation and nuclear waste and material regulation.

The first parts of the report explain the fundamentals of nuclear safety regulation as part of STUK's duties, as well as the objectives of the operations, and briefly introduce the objects of regulation. The chapter concerning the development and implementation of legislation and regulations describes changes in nuclear legislation, as well as the progress of STUK's YVL Guide reform work.

The section concerning the regulation of nuclear facilities contains an overall safety assessment of the nuclear facilities currently in operation or under construction. For the nuclear facilities currently in operation, the section describes plant operation, events during operation, annual maintenance and observations made during regulatory activities. Data and observations gained during regulatory activities are reviewed with a focus on ensuring the safety functions of nuclear facilities and the integrity of structures and components. The chapters describing the development of the plants and their safety also include summaries of the development targets established after the Fukushima accident. For the existing NPPs, the report describes the regulation and inspections of the interim storage of spent nuclear fuel, management of operating waste, and the provisions for the costs of nuclear waste management. The report also includes a description of the oversight of the operations and quality management of organisations, oversight of operational experience feedback activities, and the results of these oversight activities. The radiation safety of nuclear facilities is examined on the basis of employees' individual doses, collective doses, radioactive releases and the results of environmental radiation monitoring. The report also includes summaries on STUK's regulatory oversight concerning physical protection, emergency preparedness and safeguards of nuclear materials at the nuclear power plants. For the Olkiluoto 3 plant unit currently under construction, the report includes descriptions of the regulation of design, construction, manufacturing, installation, and commissioning preparations, as well as regulation of the operations of the licensee and the organisations participating in the construction project. At the end of the chapter on the regulation of nuclear facilities there is a summary of new plant projects and the regulation of the research reactor.

The chapter concerning the regulation of the final disposal project for spent nuclear fuel describes the preparations for the final disposal project and the related regulatory activities. In addition, the oversight of the design and construction of the research facilities (Onkalo) currently under construction in Olkiluoto, as well as the assessment and oversight of the research, development and design work being carried out to specify further the safety case for final disposal are included in the report.

In addition to actual safety regulation, the report describes safety research, regulatory indicators and the development of regulatory operations, as well as emergency preparedness, communication and STUK's participation in international nuclear safety cooperation.

Appendix 1 presents a detailed study of the safety performance of the nuclear power plants by means of an indicator system. Appendix 2 includes a summary of employees' doses at the nuclear power plants. Appendix 3 describes exceptional operational events at the nuclear power plants. Appendix 4 lists the licenses granted by STUK pursuant to the Nuclear Energy Act in 2013. Summaries of inspections included in the periodic inspection programme of nuclear power plants are presented in Appendix 5, and the Olkiluoto 3 construction inspection programme is in Appendix 6. Inspections included in the construction period inspection programme for Onkalo are listed in a table in Appendix 7 and the inspection programme for the processing stage of Posiva's construction licence application are listed in Appendix 8. A table in Appendix 9 lists the amount of nuclear materials in Finland. Appendix 10 lists the most important assignments funded by STUK concerning the safety of nuclear power plants and final disposal of nuclear waste in 2013. Appendix 11 contains definitions of terms and abbreviations used in the report.

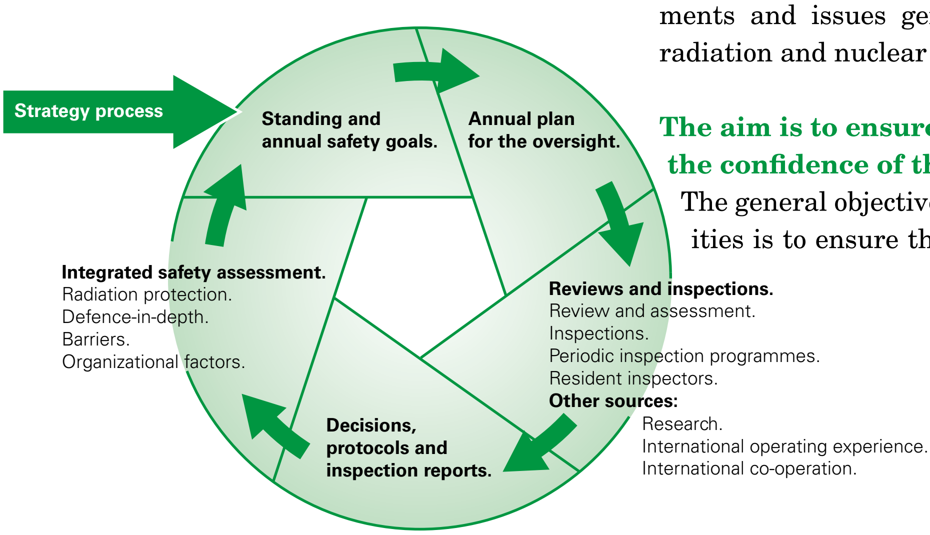
Contents

1 Fundamentals of nuclear safety regulation

Regulatory oversight by STUK is based on the Nuclear Energy Act.
The Radiation and Nuclear Safety Authority (STUK) is responsible for the regulatory oversight of nuclear safety in Finland. Its responsibilities include the control of physical protection and emergency response, as well as the safeguards for nuclear materials necessary to prevent nuclear proliferation.

STUK lays down detailed requirements concerning nuclear safety.
STUK contributes to the processing of applications for licences under the Nuclear Energy Act, controls compliance with the licence conditions, and formulates the detailed requirements. STUK also lays down qualification requirements for personnel involved in the use of nuclear energy and controls compliance with these requirements. In addition, STUK submits proposals for legislative amendments and issues general guidelines concerning radiation and nuclear safety.

The aim is to ensure safety and maintain the confidence of the general public.
The general objective of STUK's regulatory activities is to ensure the safety of nuclear facilities,



STUK functions for the oversight of nuclear power plants	
Oversight of New Plant Projects and Plant Modifications Changes at the nuclear facility **Safety Assessments and Analysis** Deterministic safety analysis Probabilistic risk analysis (PRA) Safety performance indicators; analysis and feedback **Oversight of Operations** Compliance with Technical Specifications Incidents Oversight of outage management Maintenance and ageing management Fire protection Radiation protection Emergency preparedness Physical protection	**Oversight of Management in Regulated Organizations** Safety management Management systems and QM Training and qualification of staff Use of operational experiences Event investigation Nuclear liability Inspection and testing organisations Manufacturers of nuclear pressure equipment **Oversight of Nuclear Waste Management and Nuclear Materials** Safeguards of nuclear materials Nuclear waste management Transport of nuclear material and nuclear waste Licences for the nuclear materials and nuclear waste

Figure 1. Oversight of nuclear facilities; from strategy to implementation.

Defence in depth

The safety of a nuclear power plant is ensured by preventing the harmful effects of reactor damage and radiation through successive and mutually-redundant functional and structural levels. This approach is called the "defence in depth" principle. Safety-ensuring functions may be divided into preventive, protective and mitigating levels.

The aim of the preventive level is to prevent any deviations from the plant's normal operational state. Accordingly, high quality standards apply to component design, manufacture, installation and maintenance, as well as plant operation.

The protective level refers to providing for operational transients and accidents through systems aimed at detecting disturbances and preventing their development into an accident.

If the first or second level functions fail to stop the progress of an accident, its consequences must be mitigated. In such a case, the main thing is to ensure the integrity of reactor containment and the operation of its associated systems.

In addition to the functional levels, the defence in depth approach includes the principle of multiple successive barriers to potential radioactive releases, and a number of good design and quality management principles.

Advisory Commission on Nuclear Safety

Pursuant to the Nuclear Energy Act, the preliminary preparation of matters related to the safe use of nuclear energy is vested with the Advisory Commission on Nuclear Safety. It is appointed by the Government and functions in conjunction with STUK. Its term of office is three years. The Commission was appointed on 1 October 2012 and will remain in office until 30 September 2015.

In 2013, the Chairman of the Commission was Dr. Sc. (Tech.) Seppo Vuori, and the Vice-Chairman was senior specialist Miliza Malmelin (Ministry of the Environment). Members of the Commission were professor Riitta Kyrki-Rajamäki (LTY), customer director Rauno Rintamaa (VTT), chief commercial officer Timo Okkonen (Inspecta Oy), customer manager Ilona Lindholm (VTT) and Dr. Sc. (Tech.) Antero Tamminen. Petteri Tiippana, Director General of STUK, was a permanent expert to the Commission.

The Commission has two committees, the Reactor Safety Committee and the Nuclear Waste Safety Committee. Foreign and Finnish experts have been invited to join the committees. English is the working language in the committees, and more extensive questions of principle will be brought to them for preparation. Nuclear industry experts from the UK, France, Sweden, Germany, Switzerland, Hungary and the United States have been invited to join the committees. Both of the Committees convened once in 2013. The members of the actual Commission also participate in the work of the committees.

so that plant operation does not cause radiation hazards that could endanger the safety of workers or the population in the vicinity or cause other harm to the environment or property. The most important objective is to prevent a reactor accident that would cause a release of radioactive substances, or the threat of a release. Another objective is to maintain public confidence in regulatory activities.

STUK ensures the adequacy of safety regulations and compliance with their requirements.

It is STUK's task to ensure in its regulatory activities that safety regulations contain adequate requirements for the use of nuclear energy and that nuclear energy is used in compliance with these requirements.

Regulation by STUK ensures the attainment of safety objectives.

STUK ensures, by means of inspections and controls, that the operational preconditions and operations of the licensee and its subcontractors and the systems, structures and components of nuclear facilities are in compliance with regulatory requirements. STUK's operations are guided by annual follow-up plans, presenting the key items and activities for inspection and review. STUK carries out

Nuclear liability

The Nuclear Liability Act prescribes that the users of nuclear energy must have a liability insurance policy, or other financial guarantee, for a possible accident at a nuclear facility that would harm the environment, population or property. Fortum Power and Heat Oy and Teollisuuden Voima Oy (TVO) have prepared for damage from a nuclear accident as prescribed by law by taking out an insurance policy for this purpose, mainly with the Nordic Nuclear Insurance Pool.

International negotiations concerning the renewal of the Paris/Brussels nuclear liability agreements were completed in 2004. It was agreed that the funds available for compensation were to be increased, and plant owners were to have unlimited liability. However, the entry into force of these international agreements has been repeatedly postponed. Consequently, the decision was taken in Finland to legislate nationally regarding a higher amount of insurance and impose an unlimited liability on licence holders. A temporary amendment of the Nuclear Liability Act entered into force at the beginning of 2012. The legislative amendment will be revoked once the agreements discussed above will become valid.

In case of an accident, the funds available for compensation come from three sources: the licensee, the country of location of the facility and the international liability community. In 2013, a total of 600,000,000 SDR was available for compensation from these sources. SDR refers to Special Drawing Right, an international reserve asset defined by the International Monetary Fund (IMF), whose value is based on a basket of key international currencies. In 2013, the value of the SDR was about EUR 1.12.

In Finland, the Financial Supervisory Authority is responsible for ascertaining the contents and conditions of the licensee's insurance arrangements. The Financial Supervisory Authority has approved both Fortum Power and Heat Oy's and Teollisuuden Voima Oy's liability insurance, and STUK has verified the existence of the policies as required by the Nuclear Energy Act.

The Nuclear Liability Act also covers the transport of nuclear materials. STUK ascertains that all nuclear material transport has had liability insurance either approved by the Financial Supervisory Authority or by the authorities of the sending state in accordance with the Paris Convention.

inspections of plans for nuclear facilities and other documents that the licensee is obliged to request STUK to do. The compliance of activities with the plans is verified through inspections carried out at the plant site or at subcontractors' premises. In addition to these inspections and reviews, STUK has separate inspection programmes for periodic inspections of operating plants and inspections during construction. STUK also employs resident inspectors at the plants, who supervise and witness the construction, operation and condition of the plant and the operations of the organisation on a daily basis and report their observations. An overall safety assessment is conducted annually on each nuclear facility, dealing with the attainment of radiation protection objectives, the development of defence in depth, and the operation of organisations constructing or operating nuclear facilities and providing services to them.

STUK evaluates the safety of nuclear facilities starting from the application for a decision-in-principle

The construction of a nuclear power plant, intermediate storage for spent fuel and a final disposal facility require a Government decision-in-principle that the project is in line with the overall good of society. The task of giving a statement on and preparing a preliminary safety assessment of the application for the decision-in-principle is vested with STUK. The safety assessment will state, in particular, whether any issues have been discovered that would indicate that the necessary prerequisites for the construction of a nuclear power plant in compliance with the Nuclear Energy Act do not exist. In connection with the application for the decision-in-principle, the applicant also presents a report on the environmental impact assessment. When an application for a construction or operating licence for a nuclear facility has been submitted to the Government, STUK issues a statement on it and includes its safety assessment.

STUK regulates the different nuclear facility design and construction stages

The principles of STUK's regulatory oversight activities and oversight and inspection procedures are described in the YVL Guides issued by STUK. The purpose of oversight and inspection activities regarding plant projects is to allow STUK to verify that the prerequisites for operations of a high standard exist, that the plans are acceptable before the implementation begins and that the implementation is compliant with regulations before the operating licence is granted.

Pursuant to the Nuclear Energy Act, the licensee must ensure safety. Through its oversight, STUK ensures that the licensee meets its responsibilities. STUK oversees and inspects the implementation of the plant and the organisations participating in its implementation and operation. STUK does not monitor and inspect every detail; instead, the oversight and inspections are targeted on the basis of the safety implications of each subject. To this end, the plant is divided into systems, structures and equipment, which are further classified according to their importance to plant safety. The safety classification of the plant is reviewed by STUK at the stage of applying for the construction licence. STUK inspects and monitors the design and manufacture of the equipment and structures that are most critical from the point of view of safety. Inspection organisations approved by STUK have been trusted with the inspection of equipment and structures with lesser safety implications. STUK oversees the operations of these inspection organisations.

In plant projects, STUK ensures with its oversight and inspections, the bulk of which are scheduled to take place in advance, that the power company planning to build the plant and the plant supplier responsible for its implementation, and its main sub-contractor, have the necessary capabilities for a high-quality implementation.

During the construction licence stage, the plant design work and quality assurance of implementation are evaluated in order to make sure that the plant can be implemented in compliance with high quality standards and Finnish safety requirements. During construction, inspections and oversight are deployed in order to ensure that the plant is implemented in compliance with the principles approved at the construction licence stage. The inspections are based on detailed documentation delivered to STUK and onsite inspections at the suppliers' premises. Before the manufacture of equipment and structures may commence, STUK inspects both the respective detailed plans and the capabilities of the manufacturing organisations to produce high-quality results. During manufacture and building, STUK carries out inspections in order to verify that the equipment and structures are manufactured in compliance with the plans approved by STUK. Regarding the installation of equipment and structures, STUK carries out inspections in order to verify that the installations are made in compliance with the approved plans and that the requirements set out for installations are fulfilled. Approval by STUK after inspection is a prerequisite for trial operation of the equipment. After that, STUK inspects the results of the trial operation before the actual commissioning.

Before operating the plant, STUK must be provided with documentation proving that the plant was designed and implemented in compliance with Finnish safety requirements. In addition, STUK has to be provided with evidence verifying that the prerequisites exist for safe operation of the plant. These include personnel that have been trained and verified to be competent, the instructions required for operating the plant, safety and preparedness arrangements, maintenance schedule and staff, as well as radiation protection staff. Having verified that the implementation is safe and the organisation has the required capabilities, STUK prepares the safety assessment and report required for the operating licence. Obtaining the operating licence is a prerequisite for loading the reactor with fuel.

Comprehensive safety assessment is a prerequisite for extending the operating licence

In Finland, operating licences are granted for a fixed term, typically 10 to 20 years. A comprehensive safety assessment is required to renew the operating licence. If the operating licence is granted for a period exceeding 10 years, a periodic safety review (PSR) is carried out during the licence period. The scope of the safety review is similar to that carried out in conjunction with renewing the operating licence. During the assessments, the state of the plant is investigated, paying particular attention to the effects of ageing on the plant and its equipment and structures. In addition, the capabilities of the operating personnel for continued safe operation of the plant are assessed.

Regulation of operating plants includes continuous safety assessment.

STUK's regulation of operating nuclear facilities ensures that the condition of the facilities is and will be in compliance with the requirements, the facilities function as planned and are operated in compliance with the regulations. The regulatory activities cover the operation of the facility, its systems, components and structures, as well as the operations of the organisation. In this work, STUK employs regular and topical reports submitted by the licensees, on the basis of which it assesses the operation of the facility and the plant operator's activities. In addition, STUK assesses the safety of nuclear power plants by carrying out inspections on plant sites and at component manufacturers' premises, and based on operational experience feedback and safety research. On the basis of the safety assessment during operation, both the licensee and STUK evaluate the need and potential for safety improvements.

Safety analyses provide tools for assessing the safety of nuclear facilities

Safety analyses ensure that the nuclear facility is designed to be safe and that it can be operated safely. Deterministic and probabilistic approaches complement each other.

Deterministic safety analyses

For the purpose of STUK's regulatory YVL Guides, deterministic safety analyses are analyses of transients and accidents required for justifying the technical solutions employed by nuclear power plants. The licensees update these analyses in connection with the renewal of operating licences, periodic safety reviews and any significant modifications carried out at the plant.

Probabilistic risk analyses

Probabilistic risk analysis (PRA) refers to quantitative estimates of the threats affecting the safety of a nuclear power plant and the probabilities of chains of events and any detrimental effects. PRA makes it possible to identify the plant's key risk factors, and can contribute to the design of nuclear power plants and the development of plant operation and technical solutions. The licensees employ PRA for the maintenance and continuous improvement of the technical safety of nuclear facilities.

STUK reviews the deterministic safety analyses and probabilistic risk analyses related to construction and operating licences and the operation of a nuclear power plant. When required, STUK has its own independent comparison analyses made in order to verify the reliability of results.

STUK oversees modifications from planning to implementation

Various modifications are carried out at nuclear facilities to improve safety, replace aged systems or components, facilitate plant operation or maintenance, or improve the efficiency of energy generation. STUK inspects the plans for extensive or safety-significant plant modifications and oversees the modification work by reviewing the documents submitted by the licensee and carrying out inspections on site or at manufacturers' premises.

As a consequence of modifications implemented at the plant, several documents that describe the plant's operation and structure – such as the Operating Limits and Conditions, the Final Safety Analysis Report and the operating and maintenance procedures – have changed. STUK oversees the document revisions and generally follows the updating of plant documentation after the modifications.

Operability of the plant is overseen during operation and annual maintenance

The technical operability of nuclear facilities is overseen by assessing the operation of the facility in compliance with the requirements laid down in the operational limits and conditions, and overseeing annual maintenance outages, plant maintenance and ageing management, fire safety, radiation safety, physical protection and emergency preparedness.

Operational limits and conditions

The operational limits and conditions (OLC) of nuclear facilities lay down the detailed technical and administrative requirements and restrictions concerning the plant and its various systems, equipment and structures. The licensee is responsible for keeping the operational limits and conditions up-to-date and ensuring compliance with them. STUK controls compliance with the plants' operational conditions and limits by witnessing operations on site. Special attention is paid to the testing and fault repairs of components subject to the operational limits and conditions.

When annual maintenance outages end, STUK ascertains the plant unit's state in compliance with the operational limits and conditions prior to start-up. Any changes to and planned deviations from the operational limits and conditions must be submitted to STUK for approval in advance. In addition, the licensee is responsible for reporting to STUK without delay all situations deviating from the requirements under the operational limits and conditions. In the report, the power company presents its corrective action for approval by STUK. STUK oversees the implementation of corrective action.

Oversight of operation, incidents during operation and reporting the operation to STUK

STUK oversees the safe operation of plants through regular inspections and reports submitted by the power companies. In addition, STUK's local inspectors working on plant sites oversee the operation on a daily basis. The local inspectors assess faults and oversee their repairs, as well as tests of safety-critical equipment. The inspections of the periodic inspection programme focus on major faults, incidents and progress made in corrective actions, as well as on operating procedures. The inspections are based on the regular reports submitted by power companies and inspections and walkdown inspections conducted on site.

The power companies are obliged to report any operational transients and any matters that may compromise safety. STUK assesses the safety implications of the incidents and the power company's ability to detect safety deficiencies, take action and carry out corrective actions.

The licensees submit event reports to STUK on operational events at nuclear facilities, comprising special reports, operational transient reports and scram reports. In addition to event reports, the facilities submit daily reports, quarterly reports, annual reports, outage reports, annual environmental safety reports, monthly individual radiation dose reports, annual experience operational feedback reports and safeguard reports to STUK.

Internal processing and reporting is also required for events or near-misses not subject to a special or operational transient report. Reports on such events are submitted to STUK for information if the event is or may be relevant to nuclear or radiation safety or STUK's communication activities.

The majority of radioactive substances created during the operation of a nuclear reactor *are contained in the nuclear fuel. In addition, radioactive substances are contained in the reactor cooling system, as well as in the related purification and waste systems. The liquid and atmospheric effluents from the plant are purified and delayed so that their radiation impact on the environment is very low compared with the impact of radioactive substances normally existing in nature. The emissions are carefully measured to ensure that they remain clearly below the prescribed limits.*

Radioactive emissions from a nuclear power plant *into the air and sea are verified through comprehensive radiation monitoring. Radiation monitoring in the environment of a power plant comprises radiation measurements and determination of radioactive substances, conducted to analyse the radioactive substances existing in the environment. In case of potential accident situations, continuously-operating radiation measurement stations monitoring the external radiation dose rate are installed in the vicinity of nuclear power plants at distances of a few kilometres. The measurement data from these stations are transferred to the power plant and to the national radiation-monitoring network.*

Annual maintenance

Work that cannot be done during plant operation is carried out during annual maintenance of nuclear power plants. These include refuelling, preventive equipment maintenance, periodic inspections and tests, as well as failure repairs. These actions ensure the preconditions for operating the power plant safely during the following operating cycles.

STUK is responsible for controlling and ensuring that the nuclear power plant is safe during the annual maintenance and future operating cycles, and that the annual maintenance does not cause a radiation hazard to the workers, the population or the environment. STUK ensures this by reviewing the documents required by the regulations, such as outage plans and modification documentation, and by performing on-site inspections during annual maintenance.

Plant maintenance and ageing management

In its regulatory activities concerning the ageing management of operating nuclear facilities, STUK controls the plants' ageing management strategy and its implementation ensures the maintenance of sufficient safety margins for safety-significant systems, components and structures throughout their lifetime. The organisation of the licensee's operations, the prerequisites for the organisation to carry out the necessary actions, and the condition of components and structures important to safety are subject to inspection and review. Regulatory control and inspections ensure that the power companies have the lifetime management programmes in place that enable them to detect potential problems in time. In addition, corrective action must be carried out in a way that ensures the integrity and operability of safety-significant components and structures so that safety functions can be activated at any time.

STUK monitors ageing management through the inspections of the periodic inspection programme and inspections related to modifications and annual maintenance. The key issue in operation licence renewal and periodic safety assessments is the management of plant ageing.

Every year, the power companies provide STUK with reports on the ageing of electrical and I&C equipment, mechanical structures and equipment, as well as buildings. These reports describe the most salient ageing phenomena to be monitored, observations related to the ageing process and actions required for extending the service life of equipment and structures.

The licensee must carry out periodic inspections of safety-critical equipment and structures (such as the reactor pressure vessel and reactor coolant system). STUK approves the inspection programmes prior to the inspections and monitors the inspections and their results on site. The final result reports will be submitted to STUK for approval after the annual maintenance.

Radiation safety

STUK oversees occupational radiation safety by inspecting and reviewing dosimetry, radiation measurements, radiation protection procedures, radiation conditions and radiation protection arrangements for work processes at each facility. The dosimeters used for measuring the occupational radiation doses undergo annual tests carried out by STUK. The test comprises irradiating a sample of dosimeters at STUK's measurement standard laboratory and reading the doses at the power plant. In addition, STUK oversees the meteorological dispersion measurements of radioactive substances, release measurements and environmental radiation monitoring, and also reviews the relevant result reports.

Emergency preparedness

Besides the periodic inspections of other operations, STUK controls the readiness of the organisations operating nuclear power plants to act in abnormal situations. The inspection focuses on training in emergency response organisation, arrangement of rooms, securing the connections used for the transfer of meteorological measurement data during an emergency situation and radiation monitoring of the surrounding environment, as well as the development of internal alarm procedures at the power plant. Emergency exercises test the operation of the emergency response organisation, the functionality of the emergency response guidelines and the usability of the alert areas in practice, which are developed on the basis of the feedback received for the exercises. STUK monitors the actions of power companies during these emergency drills.

Oversight of the operation of organisations is part of the process of ensuring plant safety

STUK oversees the operation of organisations by reviewing safety management, the management and quality systems, the competence and training of the staff of nuclear facilities and operational experience feedback activities. The aim is to ensure that the organisations of the power company as a whole and its key suppliers operate in a manner that ensures the safety of the plant at all levels and in connection with safety-related actions.

Training and qualifications of personnel

STUK monitors the training and qualifications of personnel through inspections included in the periodic inspection programme, by assessing the suitability and approving the appointment of certain key personnel and by assessing the ability of the power company to ensure safety in conjunction with incidents and annual maintenance operations. The key persons whose appointment must be approved by STUK are the director in charge of the construction and safe operation of the nuclear facility, the operators working in the plant control rooms and the persons in charge of materials related to preparedness, safety and nuclear technology. In addition, STUK's approval is required for personnel carrying out certain integrity checks on materials. In case events reveal flaws in the operation of the organisation, number of personnel or their competence, STUK will require the power company to take rectifying action as required.

Operational experience feedback

According to the Government Decree the advancement of science and technology and operating experience must be taken into account for the further enhancement of the safety of nuclear power plants. This principle is not limited to operational experience from Finnish nuclear power plants, but feedback from abroad must also be analysed systematically, and action must be taken to improve safety as necessary. STUK controls and ensures that the power companies' operational experience feedback activities effectively prevent the reoccurrence of problematic events. STUK pays particular attention to the power companies' ability to detect and identify the causes of the events and to remedy the underlying operational weaknesses. In addition, STUK analyses Finnish and foreign operational experience data and, as necessary, lays down requirements to enhance safety.

STUK controls the operational experience feedback activities by reviewing the event reports submitted by the licensee and the annual summary of operational feedback activities. During inspections included in the periodic inspection programme, the operational experience feedback activities of the plant and utilisation of international experience are monitored.

Event investigations

An event investigation team is appointed when the licensee's own organisation has not operated as planned during an event or when it is estimated that the event will lead to significant modifications to the plant's technical layout or procedures. A STUK investigation team is also set up if the licensee has not adequately clarified the root causes of an event.

Pressure equipment critical to nuclear safety is monitored by STUK

In addition to regulating the design and manufacturing of pressure equipment, STUK oversees the operational safety of pressure equipment included in the most important safety classes and performs periodic inspections of such equipment. Pressure equipment in other safety classes is inspected by inspection organisations authorised by STUK. STUK oversees the operation of the manufacturers and testing and inspection organisations authorised by it in connection with its own inspection activities, and by reviewing documents and making follow-up visits.

Regulatory oversight of nuclear non-proliferation is a basic requirement for using nuclear energy

Oversight of nuclear non-proliferation ensures that nuclear materials and other nuclear commodities remain in peaceful use in compliance with the relevant licences and notifications, and that nuclear facilities and the related technologies are only utilised for peaceful purposes. Another objective of the oversight of non-proliferation is to ensure that appropriate security arrangements are in place for nuclear items.

The operator is responsible for managing the nuclear items in its possession, accounting for them and reporting on plant sites and its activities relating to the nuclear fuel cycle to STUK and submitting their reports on nuclear materials to the European Commission. STUK maintains a national control system the purpose of which is to carry out the safeguards for the use of nuclear energy that are necessary for the non-proliferation of nuclear weapons. In compliance with the Safeguards Agreement and its additional protocol, STUK forwards data on activities relating to the nuclear fuel cycle in Finland to the International Atomic Energy Agency (IAEA). STUK verifies the correctness of the notifications, accounting and reporting through on-site inspections and participates in all inspections carried out by the IAEA and the European Commission. STUK also grants the approvals for IAEA and Commission inspectors to perform safeguards inspections in Finland.

Oversight of nuclear waste management extends from planning to final disposal

The aim of the regulation of nuclear waste management is to ensure that nuclear waste is processed, stored and disposed of safely. The control of nuclear waste processed at plant sites is part of the regulatory control of operating plants mentioned above. STUK oversees the nuclear waste management of nuclear power plants through document reviews and inspections within the periodic inspection programme. In addition, STUK approves the clearing of waste from control and reviews plants' nuclear waste management and decommissioning plans, on the basis of which the licensees' nuclear waste management fees are determined.

The final disposal project for spent fuel requires special attention. STUK inspects and reviews Posiva Oy's plans and research work for project implementation and is overseeing the construction of an underground research tunnel called Onkalo at Olkiluoto. Onkalo is also being used to test suitable working methods for the final disposal facility and mapping the underground premises. The plan is to later convert the research tunnel into an entrance for the repository.

2 Objects of regulation

Loviisa NPP

Plant unit	Start-up	National grid	Nominal electric power, (gross/net, MW)	Type, supplier
Loviisa 1	8.2.1977	9.5.1977	520/496	PWR, Atomenergoexport
Loviisa 2	4.11.1980	5.1.1981	520/496	PWR, Atomenergoexport

Fortum Power and Heat Oy owns the Loviisa 1 and 2 plant units located in Loviisa.

Olkiluodon voimalaitos NPP

Plant unit	Start-up	National grid	Nominal electric power, (gross/net, MW)	Type, supplier
Olkiluoto 1	2.9.1978	10.10.1979	910/880	BWR, Asea Atom
Olkiluoto 2	18.2.1980	1.7.1982	910/880	BWR, Asea Atom
Olkiluoto 3	Construction license granted 17.2.2005		n. 1600 (net)	PWR, Areva NP

Teollisuuden Voima Oyj owns the Olkiluoto 1 and 2 plant units located in Olkiluoto, Eurajoki, and the Olkiluoto 3 plant unit under construction.

Onkalo

Posiva Oy is constructing an underground research facility (Onkalo) in Olkiluoto, where bedrock volumes suitable for final disposal of spent nuclear fuel can be investigated in more detail. Bedrock research at the planned final disposal depth is a requirement for granting a construction licence for the final disposal facility. Posiva has designed Onkalo to function as one of the entrance routes to the planned final disposal facility, so STUK is applying the same regulatory procedures to the construction of Onkalo as those of a nuclear facility.

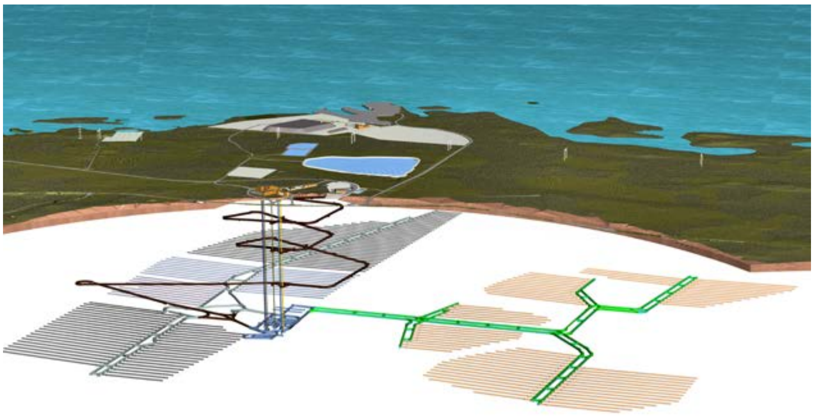


Figure 2. Diagram of the encapsulation and disposal facility in Olkiluoto (Posiva Oy).

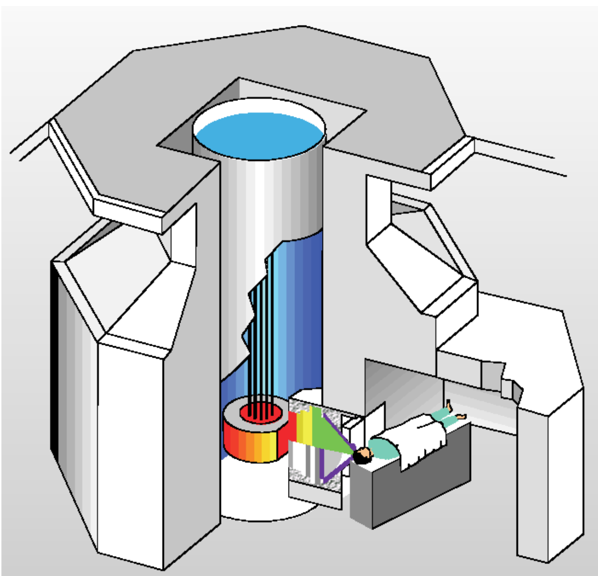
The underground research facility consists of a drive tunnel, three shafts and a research gallery quarried to a depth of 437 m. Posiva started constructing Onkalo in 2004. By the end of 2011, the excavation of the drive tunnel had reached a depth of 455 m, and the length of the tunnel was 4913 m. In addition, intake air and personnel shafts had been quarried using raise boring techniques to a depth of 290 m and exhaust air shaft to a depth of 437 m.

Research reactor

In addition to nuclear power plants, STUK regulates the FiR 1 research reactor operated by VTT Technical Research Centre of Finland. The reactor is located in Otaniemi, Espoo, and its maximum thermal power is 250 kW. It was started in March 1962, and its current operating license will expire at the end of 2023. The reactor is used to manufacture radioactive tracers, perform activation analyses and train students. The reactor was also used to treat cancer with the boron neutron capture therapy (BNCT), but this operation was stopped in January 2012.

Other uses of nuclear energy

The regulation also applies to mining and milling of ore aiming at obtaining uranium or thorium. Such operations are practiced at the production plants of Norilsk Nickel Harjavalta Oy and Freepoint Cobalt Oy. A planned uranium extraction plant at Talvivaara is also part of this regulatory group. There are small amounts of regulated materials at some laboratories. The regulation also applies to nuclear equipment, systems and data as well as nuclear sector research and development activities and the transport of nuclear materials and nuclear waste.



- **TRIGA** Mark II research reactor
  Thermal power 250 kW
- **Fuel** of the core:
  80 fuel rods with 15 kg uranium
  TRIGA reactors have a unique fuel type;
  uranium–zirconium hybrid combination
  8% uranium
  91% zirconium
  1% hydrogen

Figure 3. FiR 1 research reactor and the BNCT station.

3 Development of regulations

Two amendments to the Nuclear Energy Act (990/1987) were made in 2013. The first amendment (499/2013) enforced the Council Directive establishing a Community framework for the responsible and safe management of spent fuel and radioactive waste. A framework provision stating that the volume of waste must be kept as low as reasonably practicable was added to the Nuclear Energy Act. Furthermore, regulations of the Nuclear Energy Act on arranging self-assessments and peer reviews on nuclear safety and nuclear waste management were supplemented, and a principle on graded approach was added.

The second amendment of the Nuclear Energy Act (1148/2013) was linked to the amending of the Coercive Measures Act. It caused a minor change relating to legislation technique in the Nuclear Energy Act.

In 2013, STUK also prepared in cooperation with the Ministry of Employment and the Economy an amendment of the Nuclear Energy Act, based on the results of the international IRRS evaluation on STUK's regulatory work in 2012, that would change the monitoring of the surroundings of nuclear power plants into one of STUK's regulatory duties and also implement other changes that would emphasise STUK's independent position in the regulation of nuclear safety.

An amendment (755/2013) of the Nuclear Energy Decree (161/1988) entered into force in late October 2013. The amendment specified regulations on inspection organisations and corrected other defects observed over the course of the years in the Decree.

A reform of the Government Decree on the Safety of Nuclear Power Plants and the Government Decree on Emergency Response Arrangements at Nuclear Power Plants was also prepared simultaneously with the Nuclear Energy Decree. The new Decrees entered into force in October 2013. Several minor corrections and more precise formulations were made in the Government Decree on the Safety of Nuclear Power Plants (717/2013). Regulations were added, deemed necessary after the Fukushima accident, stating that nuclear power plants must have equipment and methods to ensure that the residual heat of the spent nuclear fuel can be removed from the reactor and the storage pools in three days in a manner independent of the plant's external supply of electricity and water in case of a rare external event or a disruption of the plant's internal electricity distribution system. Furthermore, a regulation was added, in compliance with the safety objectives of the Western European Nuclear Regulators' Association (WENRA) published in 2010, on ensuring that a radioactive release after a severe nuclear power plant accident may not cause the need to implement extensive protection measures concerning public or long-term limitations on the use of extensive land or water areas.

Most of the changes made in the Government Decree on Emergency Response Arrangements at Nuclear Power Plants (716/2013) were specifications caused by changes made in the Finnish rescue services legislation. Furthermore, the amendment of the Decree took into account the possibility of a simultaneous accident at several nuclear facilities in the same power plant area, which was a lesson learned from the Fukushima accident.

A comprehensive reform of the YVL Guides that took several years was practically completed in November 2013. The reform aimed at making the YVL Guides clearer and more user-friendly as well as updating their technical requirements. The structure of the YVL Guides as a whole and the internal structure of single YVL Guides were reformed. The reform means replacing the more than 70 old YVL Guides with 44 new YVL Guides. Forty of these were simultaneously published. There are almost complete drafts for the remaining four new YVL Guides, but most of them cannot be published until amendments have been made in the Finnish legislation. Thus, seven of the old YVL Guides are still valid.

One of the goals in terms of technical requirements was to take into account in the YVL Guides lessons learned from the Olkiluoto 3 project and the requirements of IAEA's top level documents Safety Fundamentals and Safety Requirements. Furthermore, STUK wished to take into account in the YVL Guides the Safety Reference Levels agreed in the Western European Nuclear Regulators' Association (WENRA). The Fukushima accident took place while the reform was underway. STUK wished to take into account the lessons learned from Fukushima accident in the YVL Guides as well, which is why the completion of the reform was delayed. Due to the Fukushima accident the new YVL Guides include requirements based on which the nuclear facilities have to endure more powerful natural phenomena than before and situations where the plant's power supply is lost.

Relevant STUK's personnel received systematic training on the new YVL Guides in 2013. A course in English was also arranged for stakeholders at the end of 2013.

The new YVL Guides are applied as such to new nuclear facilities. In the case of facilities under construction and operating facilities, the YVL Guides will be brought into effect by means of a separate enforcement decision by the end of 2015.

Structure of the new YVL-guides

A	Safety management of a nuclear facility	B	Plant and system design	C	Radiation safety of a nuclear facility and environment	D	Nuclear materials and waste	E	Structures and equipment of a nuclear facility
A.1	Regulatory oversight of safety in the use of nuclear energy	B.1	Safety design of a nuclear power plant	C.1	Structural radiation safety at a nuclear facility	D.1	Regulatory control of nuclear safeguards	E.1	Authorised inspection body and the licensee's in-house inspection organisation
A.2	Site for a nuclear facility	B.2	Classification of systems, structures and components of a nuclear facility	C.2	Radiation protection and exposure monitoring of nuclear facility workers	D.2	Transport of nuclear materials and nuclear waste	E.2	Procurement and operation of nuclear fuel
A.3	Management system for a nuclear facility	B.3	Deterministic safety analyses for a nuclear power plant	C.3	Limitation and monitoring of radioactive releases from a nuclear facility	D.3	Handling and storage of nuclear fuel	E.3	Pressure vessels and piping of a nuclear facility
A.4	Organisation and personnel of a nuclear facility	B.4	Nuclear fuel and reactor	C.4	Radiological monitoring of the environment of a nuclear facility	D.4	Predisposal management of low and intermediate level nuclear waste and decommissioning of a nuclear facility	E.4	Strength analyses of nuclear power plant pressure equipment
A.5	Construction and commissioning of a nuclear facility	B.5	Reactor coolant circuit of a nuclear power plant	C.5	Emergency arrangements of a nuclear power plant	D.5	Disposal of nuclear waste	E.5	In-service inspection of nuclear facility pressure equipment with non-destructive testing methods
A.6	Conduct of operations at a nuclear power plant	B.6	Containment of a nuclear power plant	C.6	Radiation monitoring at a nuclear facility	D.6	Production of uranium and thorium	E.6	Buildings and structures of a nuclear facility
A.7	Probabilistic risk assessment and risk management of a nuclear power plant	B.7	Provisions for internal and external hazards at a nuclear facility					E.7	Electrical and I&C equipment of a nuclear facility
A.8	Ageing management of a nuclear facility	B.8	Fire protection at a nuclear facility					E.8	Valves of a nuclear facility
A.9	Regular reporting on the operation of a nuclear facility							E.9	Pumps of a nuclear facility
A.10	Operating experience feedback of a nuclear facility							E.10	Emergency power supplies of a nuclear facility
A.11	Security of a nuclear facility							E.11	Hoisting and transfer equipment of a nuclear facility
A.12	Information security management of a nuclear facility							E.12	Testing organisations for mechanical components and structures of a nuclear facility

Collected definitions of YVL-guides: same data is shown both as the collection and within the guides.

Figure 4. The structure of the new YVL guides at the end of 2013.

4 Regulatory oversight of nuclear facilities and its results in 2013

4.1 Loviisa nuclear power plant

4.1.1 Overall safety assessment of Loviisa power plant

STUK oversaw the safety of the Loviisa power plant and assessed its organisation in different areas by means of reviewing materials provided by the licensee, carrying out inspections in line with the periodic inspection programme, and by overseeing operations at the plant. On the basis of this regulatory oversight, STUK can state that plant operations did not cause a radiation hazard to the employees, population or the environment. The radiation doses of the employees were the lowest in the entire history of the plant, partly because of the brief annual outages and partly because the operations were improved and modifications implemented that also affected issues influencing the radiation dose. Radioactive releases into the environment were also low; they remained below the prescribed limits. Emergency preparedness at the Loviisa power plant complies with the requirements. The processing, storage and final disposal of low and intermediate level waste (operating waste) at the power plant have been arranged in compliance with the requirements.

According to the tests and inspections carried out, the condition of the containment and the reactor coolant system, which prevents the release of radioactive materials into the environment, comply with the requirements. Based on the test results, the calculated acceptance criterion for total leakage from the outer isolation valves of Loviisa 2 was not met, which is why the isolation valves were repaired to comply with the leaktightness criteria. The inner isolation valves complied with the corresponding criterion. In December 2012, a minor fuel leak was detected in Loviisa 2. A leaking fuel assembly was removed from the reactor during the annual outage of 2013.

The plant's operation has been, for the most part, systematic and safe. In 2013, seven events warranting a special report were reported. Three of them were rated as INES Category 1 or incidents affecting safety. The number of events and the problems detected still indicate deficiencies in the power company's policies. The licensee started an investigation based on the events in 2012 to identify problem areas in the operations in more detail. The recommendations drafted based on the investigation were reported to STUK in June 2013. STUK will monitor implementation of the licensee's measures based on these recommendations and assess the impact of the measures. The events are described in more detail in Appendix 3.

No major modifications were implemented during the annual outages of the power plant units in 2013. However, a large number of maintenance measures and inspections are carried out during each annual outage to ensure the safe and reliable operation of the power plant. Implementation of the second phase of the I&C renewalin Loviisa (the LARA project) has been postponed until 2016. The systems to be upgraded at the second phase include the nuclear island's I&C systems that have the greatest safety significance, as well as the I&C systems of most important safety functions, such as the emergency power supply. In addition to this major modification project, other modification projects are currently ongoing at the power plant, such as an upgrade of the refueling machine and main crane, the solidification facility for liquid radioactive waste and the safety valves of steam generators. The deadline for several projects improving safety has been postponed and the starting points of many of the modification projects have been revised to such an extent that revising the projects has been necessary. The licensee has introduced new project management and procurement procedures, and STUK has assessed these procedures.

Table 1. Events at the Loviisa plant units subject to special reports or a root cause analysis and/or classified INES Level 1 or higher. All events subject to reporting are discussed in Appendix 1 (indicator A.II.1). Events with a special report are described in more detail in Appendix 3.

Event	Non-compliances with the OLC	Special report and/or root cause report	INES rating
Faulty connections in Loviisa 1 I&C system preventing automatic starting of the boron feed pumps	•	•	1
Some of the OLC requirements were not taken into account during the startup stage of the Loviisa 1 annual outage	•	•	0
Some of the OLC requirements were not taken into account during the repair of the fuel pool cooling system valve of Loviisa 1	•	•	0
Control rod drive mechanism failures at Loviisa 2		•	0
Forgotten wedges kept ice condenser bottom doors closed after a repair outage at Loviisa 2	•	•	1
Relay faults in emergency diesel generators at Loviisa 2		•	1
Problem with sample flow of an activity monitor during a planned release	•	•	0

Furthermore, several upgrade projects that will improve plant safety which have been designed based on assessments of the Fukushima accident are currently ongoing at the power plant. These changes include increased capacity of the battery banks for the redundant electricity systems, for example. Construction of cooling towers to secure residual heat removal from the reactor and the fuel pools has also been started. These modifications will improve the provisions for extreme external threats.

Fortum Power and Heat Oy and the Loviisa power plant organisation have operated in a systematic and development-oriented way to ensure the safety of the plant. Over the course of the year, STUK has focused in its regulation on the processing of non-conformances, development of the management system and procurement procedures, in particular. The power companies have initiated measures to develop the management system processes, but the development work is still ongoing. In 2013, Fortum launched a procurement procedure development project whereby the licensee will reform its procurement organisation and procurement procedure. The project has proceeded according to plan, and STUK has monitored the project results. In the autumn of 2013, STUK ordered a study on the safety culture of Fortum's nuclear operations from VTT Technical Research Centre of Finland. The purpose of this study is to assess the current status of the safety culture, its strengths and areas requiring development as well as to assess the functionality and scope of the procedures used to assess the safety culture. The study report will be completed at the beginning of 2014.

4.1.2 Plant operation, events during operation and the prerequisites of safe operation

Compliance with operational limits and conditions

The operational limits and conditions (OLC) list the values within which nuclear power plant units must remain during operation. The OLC must be kept up-to-date at all times, i.e. the licensee must assess the need to update the OLC when planning modifications, for example. The licensee must comply with the OLC. Deviations from the OLC are only allowed based on a safety analysis, provided that the deviation will not compromise plant safety

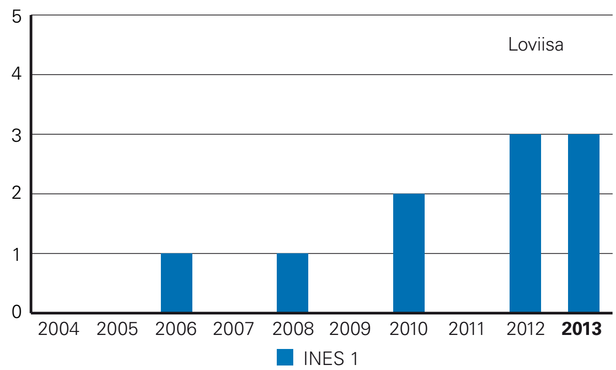


Figure 5. INES classified events at the Loviisa plant (INES Level 1 or higher).

or radiation safety and that STUK has approved the deviation. A deviation may be justified to ensure occupational safety or to implement a modification that will improve safety, for example. STUK assesses the OLC and verifies that they are up to date when inspecting modifications and reviewing analyses, as well as in connection with supervision of the plant site.

Issues to be developed in the OLC maintenance procedures were observed in 2013. The Loviisa power plant submitted three applications for approval to STUK. These applications involved changes to the OLC based on modifications that had been implemented several months or years prior to the application date. These applications prove that the OLC have not been continuously kept up to date. STUK required in its decision that Fortum draft an action plan and a schedule on studying whether the OLC are up to date and on developing the OLC maintenance procedures. Fortum drafted the action plan and further continued studying the OLC by completing a root cause analysis concerning the management of changes in the OLC. The measures specified based on these studies are currently being processed. STUK will continue monitoring their progress.

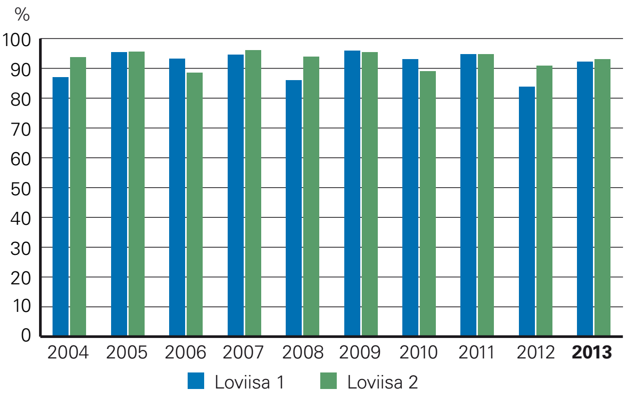


Figure 6. Load factors of the Loviisa plant unitsmet.

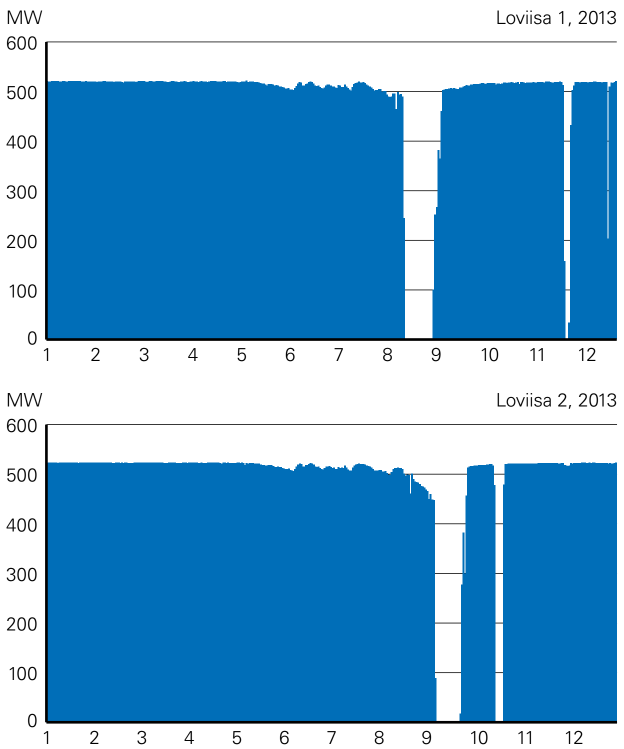


Figure 7. Daily average gross electrical power of the Loviisa plant in 2013.

In 2013, the Loviisa power plant reported five events during which the plant was non-compliant with the OLC without an advance safety analysis and STUK's permission. In one of these cases, the deviation from the OLC was caused by a human error made when planning repairing of a valve. Some of the OLC requirements applied to the repair work were not identified at the design stage, which means that they were not taken into account at the implementation stage. In one case, treated evaporator concentrate was drained into the sea as planned. However, one of the radiation measurements included in the monitoring of emissions into water was unavailable at the time of the first emission, and this fact went unnoticed. In the three other cases, the OLC deviation was related to a switching of the plant unit's operating mode during a startup after an annual outage or a repair outage; the operating mode was changed even though the conditions laid down for the new operating mode had not been met. In two of these cases, equipment whose operation had been prevented for the duration of the outage were inadvertently not restored back to the operating mode. In one of the cases, valve malfunctions were still being studied; proceeding with the startup of a plant unit with unresolved valve malfunctions is not allowed. Fortum analysed all five OLC deviations and determined corrective measures to prevent similar events from occurring in the future. Because there were several events linked to the switching of operating modes, Fortum decided to study the procedures used in more detail. The results of the study and corrective measures will be presented in a root cause analysis to be drafted by 30 April 2014.

During the year, Fortum submitted to STUK for approval 11 amendment proposals for the operational limits and conditions. Most of the amendments were due to modifications and equipment replacements carried out at the plant, as well as a systematic review of inservice testing. STUK accepted seven of the proposed amendments in whole and four of the proposed amendments in part. No justification was given for some of the proposed amendments, which is why STUK was unable to assess whether these amendments were acceptable and thus decided to accept only some parts of these amendments.

Fortum applied for permission from STUK for nine planned deviations from the operational limits and conditions (Appendix 1, indicator A.I.2). Five of these applications concerned modifications, one repairing of a valve and three an unclear item in the OLC. As the planned deviations had no significant safety implications, STUK approved the applications. Further reviews prior to approval were requested in one of the cases.

Operation and operational events

STUK oversaw the operation at the plant site on a daily basis by inspecting, regular reports on operating activities and event reports, and by conduct-

Operation and operational events

The load factor of Loviisa 1 was 92.9%, while that of Loviisa 2 was 93.1%. The annual outages have a major effect on the load factors. The outage of Loviisa 1 took 19 days, while that of Loviisa 2 took 16.5 days. Repair outages due to faults observed in the rod cluster control assembly mechanism were also implemented at both units. The losses in gross energy output due to operational transients and component malfunctions were 1.3% at Loviisa 1 and 1.6% at Loviisa 2.

In a periodic inspection of the I&C system in January, Fortum observed that ***two boron feed pumps at Loviisa 1 would not have automatically started in a case where they would have been needed.*** *Automatic starting of the pumps was prevented during a repair outage in September 2012 and the locking was accidentally not removed at the plant unit startup stage.*

Some of the requirements of the operational limits and conditions (OLC) were not taken into account *during the startup stage of the Loviisa 1 after the 2013 annual outage. During the startup stage of the plant unit, it was noted that two of the valves included in the pressure control of the reactor coolant system did not fully open. However, the startup of Loviisa 1 – or, in practice, the dilution of the boron acid concentration in the reactor coolant system – was continued even though the fault had not been fully analysed and handled..*

Operational transients were observed in a device connected to the position data of a valve included in the fuel pool cooling system of Loviisa 1. According to the OLC, repairs can be implemented during the plant unit's power operation, but the valve paired with the valve to be repaired in the same pipeline must be closed if the work will take more than 24 hours. In this case, the valve paired with the valve being repaired was closed with a delay of more than 24 hours, ***i.e. some of the OLC requirements were not taken into account when planning the work****.*

Two control rods at Loviisa 2 jammed *during testing in September and October. A repair outage was implemented to study and eliminate the cause of this control rod fault.*

The bottom doors of the ice condenser at Loviisa 2 were kept closed with wedges during said repair outage. The wedges were used to prevent unnecessary movement of the doors. ***The employees forgot to remove the wedges at the end of the outage****. The mistake was detected a couple of days later, at which time the wedges were removed.*

Two of the emergency diesel generators of Loviisa 2 did not operate as planned *during testing in December 2013. The underlying cause of both of the events was a temporary malfunction of an auxiliary relay. This fault could have prevented the starting of the diesel generator in case of an emergency. The relays in all of the diesel generators at Loviisa 1 and Loviisa 2 were replaced with new ones. The device manufacturer was aware of the increased malfunction risk of the old relays, but failed to clearly notify the users of the risk.*

One of the measurements included in the monitoring of radioactive releases did not operate as planned *when treated evaporator concentrate was released into the sea from the Loviisa power plant.*

The events are described in more detail in Appendix 3.

ing one operational inspection. The results of the inspections are described in Appendix 5 of this report.

No events leading to a reactor trip occurred at the Loviisa nuclear power plant. Four events were classified as operational transients. A control rod dropped to its lower position twice in Loviisa 1. In Loviisa 2, one of the turbine lines had to be stopped because of human errors made in the operation of the main condensate purification system. Furthermore, an isolating valve in the steam line of a steam generator was closed because of a card malfunction in the plant protection system. These operational transients are described in more detail in Appendix 1 (indicator A.II.1).

The Loviisa power plant drafted special reports for other significant events. Seven events for which a special report must be drafted were detected in 2013 (see the enclosed list). The events are described in more detail in Appendix 3.

In 2013, the risks caused by component malfunctions, preventive maintenance and other events causing unavailability of equipment were 1.4% (Loviisa 1) and 1.0% (Loviisa 2) of the expected value of the annual accident risk calculated using the plant's risk model. The results were in line with those of previous years.

Annual maintenance outages

The refueling outage in Loviisa 1 was completed between 18 August and 6 September 2013, and the refueling outage of Loviisa 2 was from 7 September to 23 September 2013.

Some of the nuclear fuel is replaced with fresh fuel during an annual outage. Other measures implemented during an annual outage include inspecting, maintaining, replacing or modifying equipment and structures important to plant safety. These measures ensure the preconditions for operating the power plant safely during the following fuel cycles.

STUK is obligated to verify that the licensee properly handles radiation and nuclear safety. STUK oversees the planning, implementation and assessment of annual outages, in practice by reviewing documents pertaining to the planning and implementation, as well as by conducting inspections onsite. The startup of a plant unit after an annual outage always requires an inspection by, and licence from, STUK. Prior to issuing the licence, STUK will verify that the reactor core has been designed in such a manner that it is safe, and check that the work on all equipment and structures important to plant safety has been completed and all malfunctions have been properly studied.

During the annual outage of 2013, STUK ob-

Annual outage of Loviisa 1

The annual outage of Loviisa 1 took 19 days. One quarter of the fuel was replaced with fresh fuel during the annual outage. Furthermore, inspections, maintenance, repairs and testing of systems, equipment and structures were carried out. For example, four emergency diesel generators were maintained and some switches in the electricity system were replaced. No extensive modifications were implemented.

The outage was around 3.5 days longer than planned. The delay was caused by the installation of measuring piping to prepare the future I&C upgrade, and the study and repair of an issue that had been overlooked when planning the work. The modification influenced leaktightness of the containment, which is why the piping had to be properly sealed. Another issue delaying the work was a non-conformance observed in the operation of two spray valves: when tested, the valves did not fully open. The fault was eliminated but its underlying cause could not be determined.

Two exceptional events took place during the annual outage: lead blankets that had been accidentally left on top of reactor coolant system pipes were detected and the startup of the plant unit was continued despite the problems with the operation of the pressurizer spray valves (see the full descriptions of these events in Appendix 3).

Repair outage of Loviisa 1

Non-conformances in the operation of one of the control rods in Loviisa 1 were detected on 24 November 2013 and 28 November 2013. Fortum studied the issue and located the cause of the fault, the motor of the control rod drive mechanism, on 29 November 2013. A decision was made to replace the control rod drive mechanism. The plant was shut down for the duration of the replacement, i.e. there was a repair outage of the plant unit from 29 November to 2 December 2013.

Annual outage of Loviisa 2

The annual outage of Loviisa 2 took 16.5 days. The annual outage was similar to that of Loviisa 1 in terms of the scope of work. One quarter of the fuel in the reactor was replaced. Furthermore, one leaking fuel assembly was removed from the reactor. The leak was detected during the fuel cycle 2012–2013. The fuel leak did not influence environmental radiation safety, because the emissions from a minor fuel leak are small.

The annual outage took a little more than 24 hours longer than planned. The delay was caused by the jamming of two control rods during the startup stage. The assemblies started moving again when they were moved with an actuator (see a full description of the event in Appendix 3).

Repair outage of Loviisa 2

Two control rods at Loviisa 2 jammed during testing in September and October. A repair outage was realised from 15 to 20 October 2013 to study and repair the fault.

The mechanisms of two control rods were replaced during the outage. All of the control rods operated normally during testing at the startup stage of the repair outage and during testing at power operation. There is more information on the control rods in Chapter 4.1.4.

served that most of the measures implemented were fine and the operation of the plant was being continuously developed. However, both the licensee and STUK noted that there is room for improvement in the compliance of the methods used in practice and the procedures, in keeping plant documentation up to date and in the management of modifications.

4.1.3 Ensuring plant safety functions

Deterministic safety analyses

An extensive evaluation of the transient and accident analyses (deterministic safety analyses) carried out to verify the safety functions of the Loviisa power plant was performed in connection with the renewal of the plant's operating license in 2007. The licensee has later supplemented the deterministic safety analyses with an extension of postulated accidents and in connection with plant modifications. The licensee did not submit any updated analyses to STUK in 2013.

Probabilistic risk analyses

The risk of a severe nuclear accident is evaluated on the basis of a probabilistic risk analysis (PRA). As a rule, PRA calculations use regularly updated information on the occurrences of initiating events and the unavailability of equipment together with a logical model of the plant's systems and their interdependencies.

The annual probability of a severe reactor accident calculated for the Loviisa plant units was around $2{,}5 \cdot 10^{-5}$/year at the end of 2013, which is around 20% lower than in 2012 ($3{,}1 \cdot 10^{-5}$/year).

The risk assessed for the Loviisa power plant in 2013 was lower than before because of the following issues, for example:

- Based on testing of the shaft seals of the reactor coolant pumps, the seals can withstand higher temperatures than previously estimated, which means that the probability of seal leaks is lower than previously estimated.
- New cable connections to the new diesel emergency power plant were added to improve availability of the electricity system during a transient.
- A specific type of heavy lifting during outages will be performed at a lower height than before. This will decrease the damage caused by any falling loads.

The accident risk at the Loviisa power plant and its changes are discussed in more detail in Section A.II.4 of Appendix 1, Accident risk of nuclear facilities.

4.1.4 Integrity of structures and equipment

STUK has verified the integrity of structures and equipment important for nuclear safety with the help of inservice inspections and by supervising and inspecting repairs and modifications. Most of the actual repairs and modifications were implemented during the annual outages in the autumn of 2013. No deviations affecting the use of the inspection objects were observed in the monitoring and inspections of the reactor coolant system or other equipment and structures important to safety.

Reactor coolant system

Fortum has applied from STUK approval for a plan on revising the scope and inspection intervals for the visual inspections of the interior of the Loviisa 1 and Loviisa 2 reactor pressure vessels. The previous procedure calls for removing the fuel, dismantling the internals and visually inspecting them every four years. Fortum proposes changing the inspection interval so that the dismantling and visual inspection of the reactor pressure vessel surface coating and barrel cylinder would be implemented every eight years. However, as the Loviisa plant units age, the reactor pressure vessel components may exhibit damage mechanisms that have not been previously identified and that may pose a risk to safety. Furthermore, the proposal on changing the reactor pressure vessel interior inspection interval to eight years accentuates the need to obtain reliable information about the condition of all the reactor pressure vessel components important to safety, and assessing their operability until the next inspection date based on this information. Thus, STUK required from Fortum a report on how these conditions would be met if the new procedures were applied. Fortum submitted supplemented procedures and STUK approved them, provided that some of the visual inspections of the internals of the reactor pressure vessels are replaced with qualified ultrasound inspections performed from the outside. If such inspections from the outside are not arranged, the internals of the reactor must be inspected in the same way as before.

Control rods

It was observed in tests implemented in connection with the startup of Loviisa 2 that two control rods of the reactor jammed. When the control rods were retested, one of them still jammed. This malfunction would have prevented the planned gravitational operation of the control rod. The other control rods were deemed operable in the retests. The malfunctioning control rod was replaced with a spare part and inspected by means of dismantling. It was noted during the inspection that a cylinder roller bearing at the top end of the control rod drive mechanism's motor occasionally jammed when it was manually rotated. The radial clearance in between the bearing's inner and outer race was too small, and the bearing rollers did not freely rotate between the races. Fortum was initially of the opinion that the problem was caused by a factory defect, but it subsequently turned out that the bearing's customised inner and outer race had been accidentally mixed up with the races of a similar bearing in another assembly. As a corrective measure, Fortum added in the maintenance procedures for the control rod drive mechanism a note that the identification numbers of a bearing's inner and outer race must be checked prior to assembly.

Reactor coolant pump seal

It was observed in studies implemented by Fortum that wearing of the mechanical shaft seals of the reactor coolant pumps, which contain antimony, and the dissolution of antimony into the reactor coolant system is a significant factor influencing the radiation level of the reactor coolant system. According to the studies, up to half of the entire radiation level of the Loviisa 1 and Loviisa 2 reactor coolant systems is caused by the isotopes of antimony. As a result of this, Fortum launched a development project aiming at replacing these seals with seals manufactured from a material that does not contain any antimony. No changes in the mechanical seal structure have been made. Commissioning of the new antimony-free graphite seals will clearly reduce the radiation level during the plant's maintenance outages and thus clearly reduce the radiation dose of the personnel during maintenance. Extensive factory acceptance tests of the rubbing-face seals verified that the structure will be safe also in the case of the postulated transients.

A study submitted to STUK in the spring of 2013 states that the operating experiences from the antimony-free seals during the first fuel cycle were good. The seal that had been in use for twelve months at the time of the 2013 maintenance outage was also inspected by means of non-destructive methods. The results showed that the condition of the antimony-free seal was as good as new. After STUK's approval, the seal was reinstalled in the reactor coolant pump and two new seals were installed in Loviisa 1 and four new seals in Loviisa 2. The remaining seals containing antimony will be replaced as soon as possible during future maintenance outages.

Lead blankets accidentally left in steam generator room

At the beginning of the annual outage, employees of Fortum noticed that plastic-covered lead blankets used for radiation protection had been accidentally left on top of pipes inside the reactor pressure vessel's thermal barrier during the previous annual outage. Such blankets were found on top of reactor coolant and safety injection system pipes and on the floor of the room. The blankets on the floor had apparently been placed on top of some pipes but had dropped onto the floor during startup.

Such lead blankets are used as the radiation protection to lower the radiation dose of the maintenance and inspection personnel. The radiation protection blankets should be removed prior to startup from all rooms that will be closed when the plant is in operation, but not all of the blankets had been removed after the annual outage of 2012.

When the blankets had been found, the outer surfaces of the affected pipes were cleaned and inspected using a variety of methods. The microstructure of the steel was also studied at several points with replica samples. No indication suggesting that the integrity of the pipes had been compromised by the lead blankets was found in these studies. In addition to the studies implemented by Fortum, an outside expert assessed the potential risks caused by the lead to the surface coating, because a comprehensive assessment of the consequences of this unexpected event was deemed necessary. STUK approved these studies and their justification prior to granting permission for for startup of the plant unit after the annual outage.

Fuel

The fuel elements closest to the reactor pressure vessel wall were replaced with protective elements manufactured from steel in both plant units of the Loviisa power plant in order to slow down the radiation embrittlement process of the wall. One protective element that could not be inspected as planned in 2012, and that was consequently not placed back into the reactor, was inspected prior to the annual outage in the autumn of 2013. A new data collection system of the pool inspection system, which will replace the old system, was used in this inspection. No significant changes from the previous inspections were found in a visual inspection, a deformation inspection or a length measurement of the protective element. During an inspection performed in connection with the annual outage of the reactor core of Loviisa 1, a new jammed spring pack was observed in one of the protective elements. It was replaced.

A minor fuel leak was observed in Loviisa 2 in December 2012. A leaking fuel assembly that had been in the reactor for a period of twelve months was removed during the 2013 annual outage. The plan is to study the assembly in more detail by the end of 2014 to find out why it started leaking.

Maintenance, management of ageing

Inservice inspections

Inservice inspections must be carried out on equipment and structures important to nuclear safety as required by the YVL Guides. The inspection objects were selected based on an annual inspection plan laid down by the power company which STUK approved prior to the inspections to be carried out during the annual outage. Non-destructive inservice inspections of piping have been carried out in Loviisa 1 since 2008 and in Loviisa 2 since 2011. The inspections are carried out in compliance with risk-informed inspection programmes, according to which inspection objects important for nuclear safety are inspected most often. In addition to piping, the inservice inspections of primary components and other pieces of pressure equipment were carried out in compliance with their inspection programmes. No significant changes from the previous inspections were observed in the inspections performed in 2013.

Management of ageing

STUK's Ageing Management Committee plans and coordinates STUK's regulatory duties pertaining to the ageing of nuclear facility systems, equipment and structures. The regulatory activities focus on any structures or equipment important to the nuclear safety of the Finnish nuclear power plants where faults or increased repair needs have been observed. The committee addresses such cases and demands corrective measures by the licensees if it deems that the condition monitoring or maintenance has been defective. The committee also assesses events at nuclear facilities outside Finland

and any links between them and the monitoring of the ageing of the Finnish nuclear power plants. Issues studied by the committee in Loviisa include emergency diesel generators, increased readings of steam generator tubes and bimetal welds in steam generator collectors because of cracks observed in similar welds at other VVER plants.

STUK assessed the condition monitoring of plant components important to safety that Fortum implements during operation of the plant either in real time or by means of periodic measurements and observations to verify that the scope and implementation method of the condition monitoring of different plant components is sufficient when taking into account their impact on safety. STUK reviewed plant rounds by the operating group, in-service testing and other condition monitoring measures during operation, such as vibration and leak monitoring. No significant defects were observed. Based on the review results, STUK requested a study of the opportunity to develop the long-term monitoring procedure of the operability of safety systems and safety devices, particularly the analyses of inservice test results by the operating group.

Based on observations made during the structural engineering review, STUK required that inspecting the roofs at the plant site must be included in the scope of the preventive maintenance system. No other significant structural engineering observations were made.

Emergency diesel generators

The functionality of a new type of bearing installed at the bottom end of the diesel engines' connecting rods was monitored at the Loviisa plant units, because only little operating experience from this bearing type is available. The monitoring was implemented by analysing lubricating oil more often than normal and performing a visual inspection of one bearing in connection with the annual outage. No deviation from normal wear was observed in the inspected bearing, nor were any abnormalities observed in the lubricating oil analyses. The next bearing inspection will take place during the 2014 annual outage.

For the annual outages of Loviisa 1 and Loviisa 2 in 2013, Fortum acquired new bearings for four emergency diesel generators. STUK chose maintenance of the diesel generator bearings as the object of the operational safety inspection to be performed during the annual outage because of the abnormal observations regarding the bearings made in the 2012 annual outage. Fortum installed new spare part bearings that were similar to the original bearings during the annual outage. Fortum performed a bearing acceptance test and the required non-destructive tests on the bearings prior to installation to verify integrity and adhesion of the bearing metal.

Pressure equipment manufacturers and inspection and testing organisations

STUK approved, pursuant to the Nuclear Energy Act, one manufacturer of nuclear pressure vessels for the Loviisa power plant on application by the Loviisa power plant of Fortum Power and Heat Oy. In addition, STUK approved, on application by the Loviisa power plant of Fortum Power and Heat Oy and pursuant to the Nuclear Energy Act, three testing organisations to carry out tests related to the manufacture of mechanical equipment and structures. Testing operators from two testing organisations were approved for carrying out periodic tests of mechanical equipment and structures in accordance with YVL Guide 3.8.

Containment

STUK noted that the containment complies with the design requirements laid down for it. In leak tests performed in 2013, four valves in Loviisa 1 and six valves in Loviisa 2 had to be repaired. When these repairs had been implemented, the goals laid down in the leak budget were met.

4.1.5 Development of the plant and its safety

I&C renewal in Loviisa power plant

The LARA I&C renewal of the Loviisa power plant was launched in 2005. The LARA project will modernise almost the entire I&C system of the plant into a digital equipment platform. The plant's control room will be simultaneously modernised. The original intention was to carry out the upgrade in four phases, but according to the current plan, all safety-classified modifications will be implemented during phase 2 of the implementation and phases 3 and 4, involving modernisation of the non-classified operational I&C, are to be combined. In

2013, STUK's regulation and inspections linked to the LARA project were focused on processing the I&C system specifications in workshops with the licensee and the equipment supplier. Development of configuration management during design and manufacture as well as development of quality management continued, and several meetings regarding these issues were arranged. In December 2013 the licensee announced that the implementation of the I&C renewal's second phase has been further postponed to the year 2016. The delay requires the licensee to take measures to ensure the adequacy of the maintenance measures and spare part management of the existing I&C systems and components that cannot be replaced with new ones as planned. The licensee will describe these measures in more detail in connection with the periodic safety review of the Loviisa power plant, at the latest in 2015.

Reactor coolant system pressure control system upgrade

Fortum plans to implement an upgrade in the pressure control system of the reactor coolant system in Loviisa 2 during the 2014 annual outage. A similar upgrade was implemented in Loviisa 1 in 2012. The goal of the upgrade is to improve the pressure control system functions and ensure that it will remain in good condition until the end of the operating license period.

Fortum has taken into account all of the problems that occurred when implementing the project in Loviisa 1 and the problems observed during the 2012 annual outages in the design, implementation and carrying out of the modification in order to develop its procedures based on the experiences obtained from the similar project in Loviisa 2. Fortum has improved its testing and inspection procedures during this project, particularly when it comes to electricity and I&C technology. Furthermore, project resources were doubled to ensure that the required competence will be available when needed and the work can be completed within the planned schedule.

Replacing float balls of the low-pressure safety injection system water tank

The conical bottoms of all of the low-pressure safety injection system water tanks at the Loviisa power plant were repaired during the 2012 annual outages. There are four tanks in both plant units. There are floating balls in the tanks. The balls settle in the conical bottom part of the tank, seal the tank and prevent the nitrogen gas used when pressurising the tank from entering the reactor. The plan was to replace the balls in all of the pressure water tanks with new ones whose sealing surface has been milled during the 2013 annual outages, but only two balls in the Loviisa 2 tanks were ultimately replaced, because of delays in selecting the material of the balls and updating the welding procedure as well as manufacturing problems. The rest of the balls will be replaced during the 2014 annual outages. The postponing of the replacement will not have any significant impact on safety, because stricter limit values for surface level and pressure monitoring of the tanks from the operational limits and conditions will be applied until the balls have been replaced. Furthermore, the operators will release the nitrogen gas from the tanks whenever necessary to prevent it from entering the reactor coolant system past the balls. The fact that the conical bottoms were repaired in 2012 has also improved the situation.

Radiation measuring system upgrade

Fortum is about to start an upgrade of a radiation measuring system that was commissioned in the 1990s. The system is used to measure the activity concentration of main steam. The radiation measuring system will detect any leaks between the reactor coolant system and the secondary circuit. Spare parts are no longer available for the old radiation measuring instruments. When upgrading the system, Fortum plans to implement structural improvements based on operating experience.

At present, the measuring point is in the turbine hall upstream the safety and isolating valves in the steam flow direction. The plan is to move the measuring point to a location where it will be easier to maintain and where the environmental conditions will be more favourable. Radiation protection that will dampen radiation from sources other than the source to be measured can be added at the new measuring point location. This will make the noble gas measuring process more sensitive, which means that a leak from the reactor coolant system to the secondary circuit will be easier to detect.

STUK has requested that Fortum supplement some parts of the conceptual design plan it has submitted to STUK. When supplementing the conceptual design plan, Fortum decided to propose new, alternative structural solutions.

Development objects based on Fukushima accident

After the Fukushima accident in 2011, STUK sent a decision to the licensees concerning provisions and plans to be made by the power companies for natural phenomena and power supply disruptions. In 2013, STUK approved cooling tower design bases submitted by Fortum to secure residual heat removal from the reactors and fuel pools in a case where heat transfer to the sea has been lost. Four cooling towers will be built at the plant, two for each plant units. One of the towers in each plant unit will take care of residual heat removal from the reactor and the other from the fuel pools.

Fortum submitted reports on improving flood protection of the Loviisa power plant to STUK. Fortum must submit a related action plan by the end of 2014. STUK approved an implementation plan submitted by Fortum on improving the fuel pool cooling system. According to the plan, a redundant system for verifying the cooling of the fuel pools in the reactor building will be built, and new connections will be added for the spent fuel storage pools to supply make-up water to the pools. STUK also approved Fortum's plan on improving the battery capacity of the uninterrupted power supply system according to which the target battery lifetime is two hours. Some of the battery banks were replaced during the 2013 annual outage and the rest will be replaced during the 2014 annual outage. The battery stands were also replaced with models designed to endure earthquakes in connection with the upgrade. Fortum has delivered a report on the availability of raw water in accident situations to STUK. The report also covers situations in which both plant units, as well as the fuel pools in the containments and in the interim storage for spent nuclear fuel, need to be simultaneously cooled down.

Loviisa weather observation system upgrade

The weather observation system at the Loviisa power plant is being modernised. The plan is to replace both the mast and the equipment. The plant's current weather observation mast dates back to the early 1970s and will soon reach the end of its service life. STUK approved a conceptual design plan for the new the Loviisa power plant weather observation system in 2013. The new mast will be around 115 metres in height. The plan is to add to the weather observation system one marine observation station around ten kilometres from the power plant. The plan is to use modern technology in weather measuring to obtain clearly better information about the spreading of air than with the currently used system. Furthermore, the system has been designed to withstand power failures lasting several days. The preliminary plan is to commission the system in 2016.

Loviisa environmental radiation measuring system upgrade

Some of the instruments included in the environmental radiation measuring system at the Loviisa power plant have been replaced. The new system includes 28 measuring stations, compared to 17 in the old one. The system offers more detailed information about the radiation status in the surroundings of the power plant during normal operation and in case of an accident. The system has been designed in such a manner that it will operate independently for several years without any external mains current. The new instruments were tested in the surroundings of the power plant in addition to the old system in 2013. The plan is to officially commission the system in 2014.

Repairs, modifications and upgrades

Each of the Loviisa power plant main steam lines include two safety valves (with staggered set pressures). These have been qualified for steam flow only. The plan is to replace all of the safety valves with a lower set pressure (twelve valves in total) with new valves that have been qualified also for potential water and water/steam flow. Fortum is planning to replace the safety valves in Loviisa 2 during the 2014 annual outage and the Loviisa 1 valves during the 2015 annual outage. However, the design and procurement phase of the upgrade regulated by STUK did not proceed in compliance with the schedule given by Fortum in 2013.

4.1.6 Spent nuclear fuel storage and NPP operational waste

The processing, storage and final disposal of low and intermediate level waste (NPP operational waste) at the Loviisa power plant were carried out as planned. The volume and activity of operational waste in relation to generated electrical power remained low compared with most other countries. The contributing factors include the high quality requirements for nuclear waste management and nuclear fuel, the planning of maintenance and repair operations, decontamination as well as component and process modifications. In addition, the power plant employs efficient procedures for reducing the volume of waste destined for final disposal. Because of waste monitoring and sorting, some of the waste with a very low radioactive substance content can be exempted from control. Waste below the set activity limits was exempted from control at the power plant with STUK's approval in 2013 to be processed elsewhere. Waste exempted from control included operational waste, scrap metal for recycling and hazardous waste to be further processed, such as waste oil and waste chemicals.

In 2013, STUK controlled operating waste management and final disposal of operating waste as well as the concrete and rock structures of the repository. STUK assessed reports and other documents submitted to it, performed control inspections and performed inspections included in the periodic inspection programme. At the beginning of 2013, the overall responsibility for the repository for operating waste during a reform of the division of labour in the Loviisa power plant organisation was transferred to the operational waste team. The reform changed the party in charge of the coordination and reporting of rock follow-up measurements, for example. Follow-up measurements are used to ensure long-term safety of the repository. No significant deficiencies or development needs were observed during the inspections carried out in 2013.

Construction and commissioning of a liquid waste solidification facility

Implementation of a modification of the systems in the liquid waste solidification facility and trial runs were continued at the Loviisa power plant in 2013. The modifications are implemented to improve the systems and equipment because of technical deficiencies that were detected during trial runs in 2010. STUK approved Fortum's application on continuing the trial runs of the solidification facility for liquid radioactive waste with solidification of evaporator bottom and resin in compliance with a plan included in the application. The Loviisa power plant also submitted updated project and commissioning plans to STUK for review. The power plant recruited the operating personnel of the solidification facility in 2013. Their training has already started and will be continued in 2014. The operating personnel have participated in the trial runs in compliance with STUK's YVL Guide requirements.

The Loviisa power plant was able to complete most of the modifications of the first solidification facility's systems and equipment as well as their test runs in 2013. STUK performed commissioning inspections of the modified systems and equipment and approved their trial run reports.

Testing of the solidification facility was continued in late 2013 by testing the solidification of evaporator bottom. The facility's systems operated as planned in connection with the solidification test runs, but some leaks were detected in containers manufactured from reinforced concrete. It was noted in inspections after the solidification that there were dark spots on the walls of the containers. These were identified as cracks in further studies. The fact that the outer surface of the concrete structure seemed wet in the area where there were such cracks suggested leaks through the container wall. The Loviisa power plant discontinued the trial runs to study why the containers had been damaged. The trial runs will not be restarted until the studies have been completed. STUK will

Quantities of spent fuel and low- and intermediate-level waste

The volume of spent nuclear fuel stored on-site at the Loviisa power plant at the end of 2013 was 4,657 assemblies (560 tU), an increase of 150 assemblies (18 tU). The volume of low- and intermediate-level waste finally disposed of was 1,886 m³. The total increase of volume from 2012 is 49 m³. Approximately 57% of the waste has been finally disposed of..

continue assessing the situation once the Loviisa power plant has submitted a report on the damage in the concrete containers, the underlying reasons and planned further measures.

Expansion of repository for low- and intermediate-level waste

An expansion of the repository for low- and intermediate-level waste (the VLJ repository) was initiated at the Loviisa power plant in 2010. The expansion will comprise operational waste facility 3 and a connecting tunnel. The new facility will be used for the sorting and temporary storage of operational waste.

According to a statement issued by the Ministry of Employment and the Economy, the expansion could be implemented subject to STUK's approval and regulation. The Loviisa power plant submitted the operating license application for operational waste Facility 3 to STUK for approval in 2012. STUK issued its decision on the application on 5 February 2013. A commissioning inspection by STUK will also be necessary before commissioning can take place.

Provisions for the costs of nuclear waste management

In compliance with section 88, subsection 2 of the Nuclear Energy Decree, Fortum provided the Ministry of Employment and the Economy with revised and supplemented waste management schemes and information on costs and prices of nuclear waste management measures. The update of the waste management scheme includes a report on nuclear waste management measures and an estimate of the remaining waste management costs at the end of 2013, 2014 and 2015.

STUK reviewed the documents submitted in compliance with the Nuclear Energy Decree and submitted a statement regarding them to the Ministry of Employment and the Economy. In its statements, STUK assessed the technical plans and cost estimates on which the financial provisions are based, considered them acceptable and stated that they can be used as the basis for the cost provisions. Fortum's extent of liability was €1,059.2 million at the end of 2013.

According to the Nuclear Energy Decree, supplemented waste management schemes for technical and financial plans, as well as related calculations, must be prepared every three years. The next revision will take place in 2016.

4.1.7 Organisational operations and quality management

Based on STUK's regulation, it can be stated that with a view to ensuring safety, the organisation of Fortum Power and Heat Oy has operated in a systematic and development-oriented way. Over the course of the year, STUK has focused in its regulation on the processing of non-conformances, development of the management system and procurement procedures, in particular.

In 2013, Fortum launched an internal procurement procedure development project based on a study conducted. The plan with the project is to develop both the procurement process and related procedures. STUK has monitored progress of the project in several follow-up meetings. The project has proceeded as planned.

Furthermore, the Loviisa power plant implemented a fairly major organisational reform that influenced investments and procurement in the spring of 2013. An investment unit was established to manage investments and strategic procurement. Responsibility for the procurement of spare parts was transferred to the maintenance unit in this organisational reform. Furthermore, work planning and the planning of annual outages were merged. The maintenance unit is in charge of these duties as well. The Loviisa power plant has drafted a safety analysis for the organisational reform and also updated its management code.

At the end of 2012, the Loviisa power plant applied for permission to deviate from the process management requirements in item 6 of YVL 1.4. STUK decided, however, that the Loviisa power plant must continue development of its management system in compliance with the requirements of the YVL Guide. In connection with the periodic inspection programme, STUK has also monitored the process description and development work.

Fortum updated its management system description for nuclear operations subject to a licence at the end of the year. Over the course of the year, an investigation committee appointed by a unit of the licensee, Nuclear Safety Oversight (NSO), independently assessed the processing of events at the Loviisa nuclear power plant. The committee's report and recommendations have been handed over to STUK and the Loviisa power plant. The observations and recommendations in the report were similar to the observations made by STUK. The committee recommended that the Loviisa power plant should:

- update plant data, documentation and starting data used in design
- develop its procedures and add all procedures in its process descriptions
- improve its work supervision measures
- develop the quality management process used in connection with modifications
- better utilise lessons learned from operating events and other events and
- introduce Human Performance tools in its operations.

STUK has requested an action plan for these corrective measures from the Lovissa power plant. Furthermore, NSO performed an independent assessment of the scope and functionality of a management system as laid down in YVL 1.4. The committee's report and recommendations have been handed over to the Loviisa power plant and STUK for information.

In its regulation pertaining to personnel resources and competence management, STUK discovered that the Loviisa power plant has been able to improve the quality management and auditing competence of its employees by means of training. The quality management and radiation protection resources are currently fairly meagre when compared to the duties. The power plant's HR planning procedures have been developed since 2011. The new deadline for completing the development project is 31 March 2014.

In the autumn of 2013, STUK ordered a study on the safety culture of Fortum's nuclear operations (Nuclear Competence Center NCC) from VTT Technical Research Centre of Finland. The purpose with this study was to assess the current status of NCC's safety culture, its strengths and areas requiring development as well as to assess the functionality and scope of the procedures used to assess the safety culture. The study report will be completed at the beginning of 2014.

STUK oversaw the oral examinations of shift personnel where the shift managers, operators and trainee operators prove that they are competent in all key issues related to plant operation and safety. In 2013, STUK granted 22 licenses to shift managers and operators on application by the power company and following a successful oral examination, six of them to new operators. All participants passed their examinations in 2013. The new operators achieved good results in the examination, which indicates that the basic training programme is effective. The operators renewing their licenses also achieved good results in the examination, which indicates that the power company's refresher courses and supplementary training are effective.

4.1.8 Fire safety

In 2013, STUK reviewed reports, carried out on-site inspections, implemented a periodic inspection programme, and sent resident inspectors on their rounds to oversee the maintenance of the fire protection systems that ensure fire safety at the Loviisa power plant.

In a fire protection inspection STUK discovered that parts of the galvanised fire water piping at the Loviisa power plant are in poor condition. Damage caused by corrosion has also been detected in the fire water lines' drip valves. Fortum will replace some valves and repair the fire water line piping as necessary. STUK requires a fire water system condition evaluation by an inspection organisation as part of the periodical safety review. STUK's inspectors also detected defects in the archiving of the annual inspection records for the fire detection system. STUK has requested that the maintenance procedures be supplemented in terms of the documentation of work done.

4.1.9 Operating experience feedback

STUK assessed the operating experience feedback activities and corrective measures on the basis of reports, inspection visits and inspections within the periodic inspection programme. Three events rated as INES Category 1 took place during the course of the year: 1) boron feed pumps failed to start because of non-acknowledged simulations in Loviisa 1, 2) doors of ice condensers were wedged during load operation in Loviisa 1 and 3) relays in the diesel generators in Loviisa 2 malfunctioned.

The Loviisa power plant submitted seven special reports on the events in 2013 to STUK. In five of these events, the plant did not comply with the OLC; three of these non-conformance events were linked to the changing of the plant's operating mode during startup after an annual outage or a repair outage. The Loviisa power plant also drafted special reports regarding the jamming of control rods in Loviisa 2, and malfunctions of auxiliary relays detected during the testing of emergency diesel generators in Loviisa 2. The special reports were prepared and delivered to STUK in accordance with the requirements, but the power company's investigation of some of the events remained superficial and incomplete. For a more detailed description of the events discussed in special reports, see Appendix 3.

Three root cause analyses were performed at the Loviisa power plant in 2013. These root cause analyses concerned the following events: 1) using voltage relays including programmable technology that have not been qualified for the required safety class, 2) verifying the operability of a pressure equalisation system that was upgraded during the 2012 annual outage, and 3) management of changes in the OLC and their non-conformance with procedures.

In the operating experience feedback review, STUK verified procedures and practices related to the feedback operations. An operating experience and safety culture team has been established at the Loviisa power plant. It is responsible for the maintenance and development of the power plant's operating experience feedback process. The operations have been continuously developed, procedures are currently being improved and some resource changes were implemented over the course of the year. The inspection included verification of the implementation of corrective measures in Loviisa and in other power plants on the basis of example cases. STUK found that there was room for improvement in the follow-up of corrective actions decided on the basis of operational events at the plant, as well as in the assessment of the effectiveness of corrective actions.

Of the latest events at the Loviisa power plant, STUK recorded in the International Reporting System for Operating Experience (IRS) maintained by the International Atomic Energy Agency (IAEA) one new report on problems that occurred during the 2012 outage with the implementation of pressure management during a reactor coolant system modernisation project in Loviisa 1. STUK also decided to submit a report to IRS on the lead mats that were accidentally left on top of the reactor coolant system pipes in the lower compartment of the reactor building in Loviisa 1 after the 2012 maintenance outage. Furthermore, STUK will draft an IRS report on the problems with the moving of the control rods during the startup after the 2013 maintenance outage in Loviisa 2.

The Loviisa power plant uses methods to assess and utilise operating experience from other plants. Event reports and events at other plants outside of Finland are systematically and comprehensively reviewed. Fortum itself conducts pre-screening of the reports coming from various sources, mainly via the World Association of Nuclear Operators (WANO) and the IRS database maintained by the IAEA. The plant is in direct contact with other VVER plants. All the information on events and malfunctions at the other plants is assessed to determine whether it applies to the Loviisa power plant.

Fortum is performing a variety of studies due to the Fukushima accident of 2011 to improve the capability of the plant units to cope with a variety of natural phenomena and power supply disruptions. A summary of the development measures determined because of the Fukushima accident is available in Chapter 4.1.5.

STUK has its own operating experience feedback methods, which it uses to study and assess the operating experience provided by the Finnish power plants and the international channels to be used as the basis of its requirements, and to be able to assess the sufficiency of the procedures and measures applied by the power companies. In addition to the operating experience feedback review included in the 2013 periodic inspection programme, STUK has studied the situation at the Finnish power plants and the measures taken by the licensees based on the events for which an IRS report has been prepared during the periodic inspections of the electricity and I&C systems, structural engineering and fire protection as well as during the periodic inspections performed in connection with the annual outages. There are summaries of the most important events in 2013 at other plants that have also influenced the Finnish plants in Chapter 11.

4.1.10 Radiation safety of the plant, personnel and the environment

Occupational radiation safety

STUK carried out a radiation protection inspection as part of the periodic inspection programme at the Loviisa power plant, focusing on occupational radiation safety in particular. The items to be inspected included radiation protection targets and the role of radiation protection when processing work permits. The dosimeters used for measuring the occupational radiation doses underwent annual tests. The tests comprised irradiating a sample of dosimeters at STUK's measurement standard laboratory and reading the doses at the power plant. The test results were acceptable.

STUK carried out targeted radiation protection inspections during the annual outages. Radiation protection activities of the plant's radiation protection personnel and employees within the controlled area were assessed during these inspections. Based on the inspection results, radiation protection at the plant is good: no major defects were observed. The power plant's radiation protection organisation has developed methods to improve the occupational radiation safety of employees doing specific jobs. Individual targets for development were also observed in the inspections concerning the arrangements of the protective equipment boundaries of the controlled area and the use of protective equipment.

Replacing the seals of reactor coolant pumps with seals that do not contain antimony was continued at the Loviisa power plant to reduce the activity level of the reactor coolant system. Two seals were replaced in Loviisa 1 and four seals in Loviisa 2. One seal was replaced during the 2012 annual outages of Loviisa 1, which means that a total of seven of the twelve reactor coolant pump seals are now antimony-free. The dose rates are expected to decrease in the next few years, particularly in the lower compartment of the reactor building,

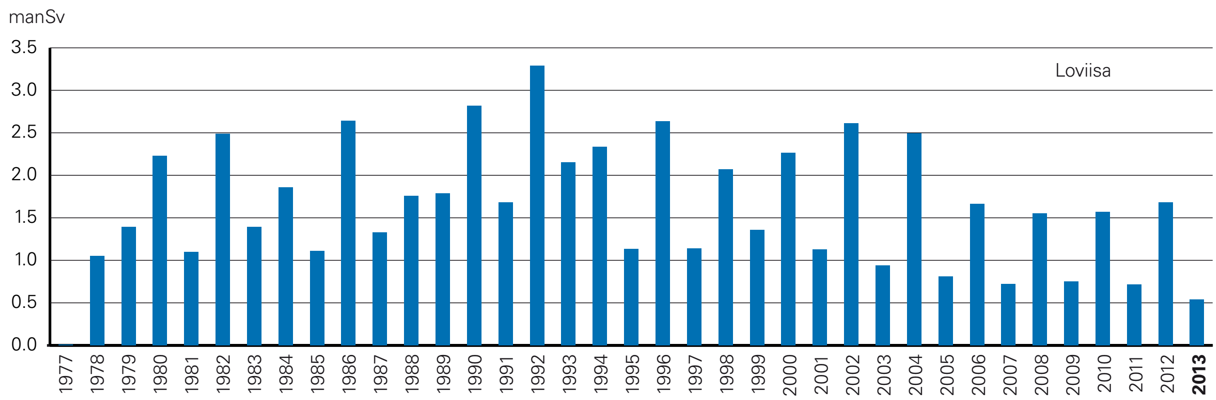


Figure 8. Collective occupational doses since the start of operation of the Loviisa nuclear power plant.

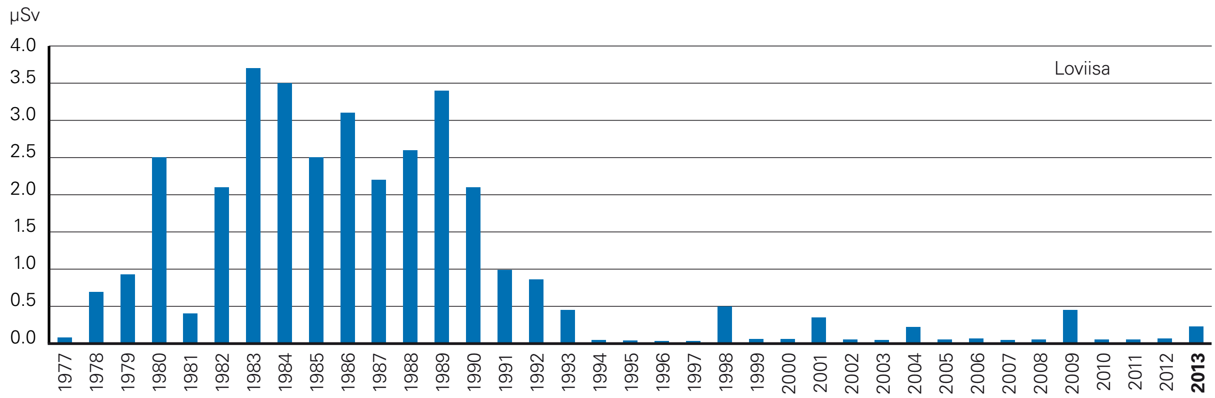


Figure 9. Annual radiation doses to the most exposed person of the public since the start of operation of the Loviisa nuclear power plant. Over the recent years, the doses calculated based on the radioactive discharges have remained below one percent of the set limit, 0.1 milliSv.

Table 2. NPP originated radioactive nuclides found in the environmental samples of the Loviisa power plant in 2013

Sample types containing detected radionuclides. Figures indicate the number of positive samples in a sample group. Several different nuclides may be found in the same sample.

Radionuclide / Type of sample	H-3	Mn-54	Co-58	Fe-59	Co-60	Ag-108	Ag-110m	Te-123m	Sb-124	Sb-125	Total
Air					1						1
Fallout		1	1		6		7				15
Aquatic plants					4		4				8
Perifyton		2	2	1	4		4	2	2	1	18
Sedimenting materials		1			6	1	5	1	1		15
Sediment					2						2
Seawater	2										2
Sludge					3						3
Total	2	4	3	1	26	1	20	3	3	1	64

since activated antimony (Sb-122 and Sb-124) has been a major cause of radiation doses at the power plant.

Radiation doses

The collective occupational radiation dose for the entire year was 0.33 manSv in Loviisa 1 and 0.21 manSv in Loviisa 2. Refueling outages were implemented at both of the Loviisa plant units. The outages were short and did not cause any major workload. Because of this and because of the improvements made in the plant's radiation protection, the collective occupational radiation dose was the lowest ever during the operation of the power plant. The collective occupational dose at the Loviisa power plant was lower than the collective doses at plants with pressurised water reactors (VVER) in OECD countries. According to the YVL Guide issued by STUK, the threshold for one plant unit's collective dose averaged over two successive years is 2.5 manSv per gigawatt of net electrical power. This means a collective dose value of 1.24 manSv per Loviisa plant unit. This threshold was not exceeded at either of the plant units.

Most of the occupational radiation dose of a nuclear power plant worker is accumulated during annual outages. The collective occupational radiation dose caused by work carried out during the annual outages was 0.30 manSv in Loviisa 1 and 0.18 manSv in Loviisa 2. The highest individual radiation dose incurred amounted to 5.0 mSv in Loviisa 1 and to 4.1 mSv in Loviisa 2. The highest individual dose incurred at either plant unit during the entire year was 8.6 mSv. This dose was caused by cleaning work.

The radiation doses for nuclear power plant workers remained below the individual dose limits. The effective dose for a worker from radiation work may not exceed the 20 manSv/year average over any period of five years, or 50 manSv during any single year.

The individual radiation dose distribution of workers at the Loviisa and Olkiluoto nuclear power plants in 2013 is given in Appendix 2.

Radioactive releases and environmental radiation monitoring

Radioactive releases into the environment from the Loviisa nuclear power plant remained well below the authorised annual limits in 2013. Releases of radioactive noble gases into the air were approximately 6.5 TBq (as Kr-87-equivalent activity), which is approximately 0.05% of the authorised limit. The releases of radioactive noble gases were dominated by argon-41, the activation product of argon-40 originating in the air space between the reactor pressure vessel and the main radiation shield. Releases of iodine into the air were approximately 25 MBq (as I-131-equivalent activity), which is approximately 0.01 % of the authorised limit. Emissions through the vent stack also included radioactive particulate matter amounting to 0.8 GBq, tritium amounting to 0.2 TBq and carbon-14 amounting to approximately 0.5 TBq.

The tritium content of liquid effluents released into the sea was 16 TBq, which is approximately 11% of the release limit. Total activity of other nuclides released into the sea was about 1.2 GBq, which is 0.1% of the plant location-specific release limit.

The calculated radiation dose of the most exposed individual in the vicinity of the plant was around 0.23 µSv per year, i.e. around 0.2% of the set limit (Appendix 1, indicator A.I.5c). The average person living in Finland receives an equivalent radiation dose from radiation sources in nature and in space in less than two hours. The dose of the most exposed individual in the vicinity of the Loviisa power plant was higher than usual in 2013 because the power plant discharged low-activity evaporator bottom into the sea as planned (Fig. 9). Larger radiation doses in 2004 and 2009 were also caused by the discharge of evaporator bottom into the sea. The monitor monitoring the radioactivity of the discharge line for liquid releases did not function as planned during the planned release of evaporator bottom in 2013. The release remained clearly below the annual release limit based on samples taken from the letdown tanks, however. There is a more specific description of the event in Appendix 3.

A total of 300 samples were collected and analysed from the land and marine environment surrounding the Loviisa power plant in 2013. External background radiation and the exposure to radioactivity of people in the vicinity of the plant were also measured regularly. Extremely small amounts of radioactive substances originating from the nuclear power plant were observed in some of the analysed environmental samples. The amounts were so small that they are insignificant in terms of the radiation exposure of the environment or people.

4.1.11 Emergency preparedness

STUK monitors the capability of the emergency preparedness organisations of nuclear power plants to act under abnormal conditions. No events requiring emergency response actions occurred at the Loviisa power plant in 2013.

Emergency preparedness at the Loviisa power plant complies with the key requirements. The emergency preparedness organisation of the Loviisa power plant consists of the organisation of the Loviisa power plant and of Fortum's technical support organisation at Keilaniemi. STUK's inspection of the emergency preparedness arrangements of the Loviisa nuclear power plant included the inspection of the emergency preparedness organisation and its training, drills, equipment and facilities, alarm arrangements, environmental radiation measurements, weather observations at the plant site, and the status of emergency preparedness procedures. STUK required from the power plants systematic monitoring on participation in emergency preparedness training and drills as well as a report on repairs and changes made during the commissioning of the emergency preparedness data transfer system. Modifications of emergency preparedness operations based on the lessons learned from the Fukushima accident have been completed or are being completed. Some of the new requirements laid down in the Government Decree on Emergency Response Arrangements at Nuclear Power Plants (716/2013) have been met and the details of other requirements are further specified in the application decision of the YVL Guide.

The emergency preparedness data transfer system was upgraded in 2012 and its commissioning continued in early 2013. The system is used to transfer key measuring parameters of the plant's processes to STUK's emergency preparedness centre and Fortum's emergency preparedness room at Keilaniemi. Minor modification needs were observed in the system after its commissioning, and these modifications were implemented and tested throughout 2013. The data transfer system was used in data connection tests and drills, for example.

An extensive cooperation drill, Loviisa 13, took place at the Loviisa power plant in March. In addition to the power plant, around sixty central, regional and location administration organisations participated in the drill. The drill was also a scenario for a drill arranged in the Nordic and Baltic countries.

4.1.12 Physical protection

A review of the physical protection at the Loviisa power plant by STUK included commissioning a new alarm centre and surveillance system, training offered to the protection organisation and a training plan for a new physical protection tool to be commissioned at a later date. The review also covered a drill arranged together with several authorities. The licensee has developed its internal training procedures and implemented internal drills based on the drill arranged together with other authorities. STUK reviewed the physical protection at the plant also during the annual outage. The inspection focused on the resources needed for the maintenance of adequate physical protection during an annual outage, development measures and their status during the outage, and surveillance of the refueling area. The power plant has improved the physical protection in accordance with the principle of continuous improvement.

An information security review by STUK focused on I&C systems of the Loviisa power plant. Other data system environments of the plant were also studied, however. Continuous improvement of information security requires further investments from the power plant. The Loviisa power plant implemented a comprehensive risk assessment based on the requirements laid down in a previous review. The risk assessment dealt with I&C system upgrades. According to STUK's estimate, the risk assessment was carried out using the best information security practices.

4.1.13 Safeguards of Nuclear Materials

A total of ten safeguard inspections were carried out at the Loviisa power plant in 2013 . This is slightly more than usual. STUK performed an inspection of the physical inventory of nuclear materials together with IAEA and the European Commission both before and after the maintenance outages. Furthermore, STUK inspected the locations of the reactor core fuel assemblies prior to closing of the reactor cover in Loviisa 1 and Loviisa 2. STUK performed one interim safeguards inspection and another together with the Commission. A surveillance camera of the international organisations was maintained in connection with the Commission inspection. IAEA performed two unannounced inspections of the spent fuel storage pool during the course of the year. STUK participated in both inspections. Due to an extra outage in the autumn, IAEA, the Commission and STUK performed two extra safeguards inspections in Loviisa 2 because the preliminary data suggested that fuel might have to be transferred with the cover open in Loviisa 2. No remarks were made in the inspections.

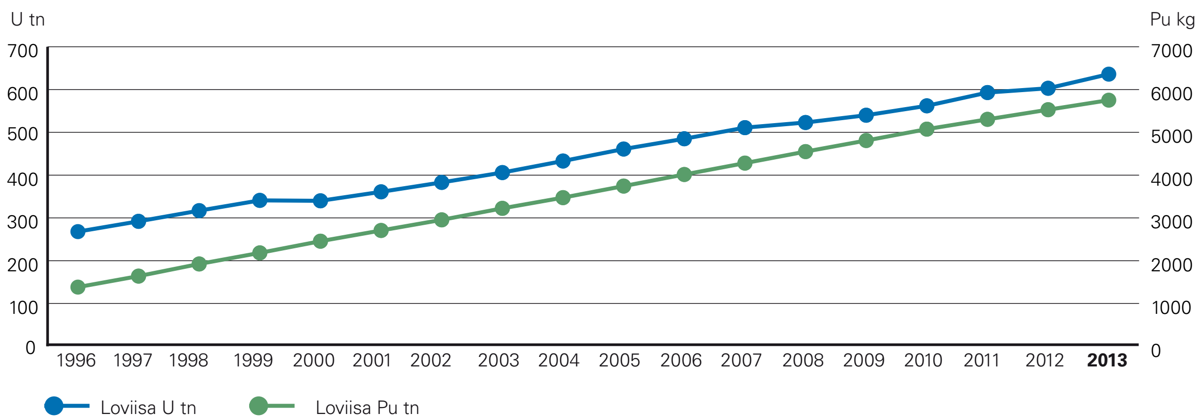


Figure 10. Amounts of uranium and plutonium at the Loviisa NPP.

4.2 Olkiluoto nuclear power plant units 1 and 2

4.2.1 Overall safety assessment of Olkiluoto 1 and Olkiluoto 2

STUK oversaw the safety of the Olkiluoto power plant and assessed its organisation in different areas by means of reviewing materials provided by the licensee, carrying out inspections in line with the periodic inspection programme, and by overseeing operations at the plant. On the basis of this regulatory oversight, STUK can state that plant operations did not cause a radiation hazard to the employees, population or the environment. The radiation doses of the employees were the lowest in the entire history of the plant, mostly because of plant modifications that reduced the humidity level of the steam drained to the turbine island. Radioactive releases into the environment were also low; they remained below the prescribed limits. Emergency preparedness at the Olkiluoto power plant complies with the requirements. The processing, storage and final disposal of low and intermediate level waste (operating waste) at the power plant have been arranged in compliance with the requirements.

According to the tests and inspections carried out, the condition of the containment and the reactor coolant system, which prevents the release of radioactive materials into the environment, comply with the requirements. One leaking fuel assembly was removed from the reactor of Olkiluoto 2 during the annual outage.

The plant's operation has been, for the most part, systematic and safe. In 2013, four events warranting a special report were reported. These events did not have any essential safety significance, however. The events are described in more detail in Appendix 3.

In the annual outages of the plant units, low voltage switchgear was replaced in Olkiluoto 2 in compliance with a plan covering a period of several years. A large number of maintenance measures and inspections are also carried out during each annual outage to ensure the safe and reliable operation of the power plant. Several upgrade projects that will improve plant safety which have been designed based on assessments of the Fukushima accident are currently ongoing at the power plant. These modifications will improve the provisions for extreme external threats. For example, the modifications will improve systems used to cool the reactor and add whole new systems for pumping water into the reactor in case of a complete loss of AC power. Other ongoing projects include an upgrade of the power plant's emergency diesel generators where the eight diesel generators will be replaced and a ninth generator will be built. Furthermore, the plant is planning to build remote shutdown stations to improve the functionality of the current remote control systems. An expansion project of the spent fuel storage pool proceeded as planned in 2013. Preparations for the commissioning of the storage pool are ongoing. TVO submitted to STUK for approval several applications regarding changes to the operational limits and conditions which are part of a reform of said document's justification chapters.

Based on STUK's oversight and the results of operating activities, it can be stated that, with a view to ensuring safety, TVO's organisation has operated in a systematic and development-oriented way. Over the course of the year, STUK focused its oversight on TVO's management procedures, modification and procurement processes, and the processing of non-conformances. STUK also monitored TVO's plans linked to the commissioning of Olkiluoto 3. According to these plans, the management system and organisation of the Olkiluoto 3 project will be merged with the management system of Olkiluoto 1 and Olkiluoto 2. TVO has several ongoing development projects on systematic development of the ERP system and management system as well as the management of modifications.

4.2.2 Operation of the plant units, events during operation and prerequisites for safe operation

Compliance with operational limits and conditions

TVO has ensured that the operational limits and conditions (OLC) of the Olkiluoto power plant are up to date. The OLC list the values within which nuclear power plant units must remain during operation. STUK has monitored compliance with the requirements and limits laid down in the OLC, the process used to ensure that the OLC remain up to

Table 3. Events at the Olkiluoto plant units subject to special reports or a root cause analysis and/or classified INES Level 1 or higher. All events subject to reporting are discussed in Appendix 1 (indicator A.II.1).

Event	Non-compliances with the OLC	Special report	INES rating
Defects in maintenance of a reactor coolant pump in Olkiluoto 2		•	0
Non-compliance in management of work pertaining to reactor cooling at Olkiluoto 2	•	•	0
Material faults detected during maintenance of emergency diesel generator at Olkiluoto 2		•	0
Non-conformance with administrative procedures when working in a cross-connection room at Olkiluoto 1	•	•	0

Operation and operational events

The load factor of Olkiluoto 1 was 97.1% and that of Olkiluoto 2 was 93.1%. The annual outages have a major effect on the load factors. The outage of Olkiluoto 1 lasted a little less than eight days, while that of Olkiluoto 2 lasted for more than 18 days. The losses in gross energy output due to operational transients and component malfunctions were 0.35% in Olkiluoto 1 and 1.95% in Olkiluoto 2.

A turbine trip occurred in Olkiluoto 2 on 9 September 2013 because of a tripped earth fault protector of a generator's stator. This caused a maintenance outage that lasted from 9 September 2013 to 15 September 2013. Safety functions operated as planned during the event, and the event did not compromise reactor safety.

A reactor coolant pump was maintained during the annual outage of Olkiluoto 2. An impeller was accidentally replaced with a sealing plug of the wrong type in one of the reactor coolant pumps. The wrong plug type was detected when more water than normal started to leak from the reactor pressure vessel into the reactor coolant leakage drain system. The power company identified several human errors as the underlying causes of this event. These human errors are linked with the plant's work procedures and communication.

During the annual outage of Olkiluoto 2, TVO observed that one of the heat exchangers used to cool spent nuclear fuel was dirty. Dirt will reduce the performance of a heat exchanger, which is why TVO decommissioned the heat exchanger for cleaning. TVO inadvertently started this maintenance action at the wrong time. Other annual outage works on the cooling system were being simultaneously carried out, and thus some of the requirements on operability of the systems and equipment in the operational limits and conditions (OLC) were no longer met.

Material faults were detected during the maintenance of an emergency diesel generator in Olkiluoto 2. The wound core of a rotor manufactured from flat bar copper had been extended with silver solder at some points when the rotor was being repaired in the autumn. In a visual inspection, the subcontractor repairing the generator detected two major indications in one of the solder joints. Furthermore, small indications were detected in two solder joints. In addition to the indications found in the solder joints, two of the eight stator weld joints in the generator exciter were cracked. Because of this fault, the weld joints of all of the plant's exciters were studied with an endoscope. Another similarly cracked joint was found. The detected material faults have not rendered the emergency diesel generators of the nuclear power plants inoperable. There are four diesel generators at both of Olkiluoto's operating plants. Their operability is tested monthly.

During preparations for an upgrade of the fire extinguishing system in the cable rooms below the relay rooms, employees needed to enter a cross-connection room to install a new cable. The employees were allowed to enter the control room's cross-connection room alone without supervising operating personnel. The event did not comply with a requirement included in the operational limits and conditions (OLC) which states that the door of the cross-connection room must always be opened by permanent operating personnel.

The events are described in more detail in Appendix 3.

date when modifications, tests and safety analyses are reviewed, and supervised the licensee's actions onsite. When annual outages ended, STUK verified that the OLC were up to date and the plant unit complied with the OLC prior to issuing a permit to startup of the plant unit. TVO continued development of the OLC to improve their justification and clarify the requirements.

In 2013, TVO reported two events during which the plant was non-compliant with the OLC without an advance safety analysis and STUK's permission. All of these non-conformances were unintentional. In one of the cases, the non-conformance with the OLC was caused by an administrative error in work pertaining to reactor cooling during the annual outage. The second case was a non-conformance with the administrative procedures when working in a cross-connection room in Olkiluoto 1. The individual events did not put the plant or its surroundings at risk. TVO analysed all events and defined corrective measures to prevent similar events from recurring. STUK oversees the licensee's operations at the plant site and carries out random inspections to ensure compliance with the requirements and limits of the OLC. No non-conformances were observed in the 2013 inspections.

Over the course of the year, TVO submitted to STUK for approval 18 amendment proposals for the operational limits and conditions. Most of the amendments were due to modifications and equipment replacements carried out at the plant, as well as an OLC development project. One of the amendments was due to a requirement by STUK regarding minimum manning in the plant area during power operation. STUK paid attention to the fact that the OLC can be interpreted as stating that the entire operating shift need not be onsite at all times and that the presence of two persons with a shift supervisor license and two of the shift personnel would suffice. STUK wished to eliminate the possibility of the OLC being interpreted in this way because it is important in case of a transient, for instance, that the reactor operator and the turbine operator are present in addition to the leading shift supervisor. STUK approved 16 of the amendments as such or with minor modifications. Two amendment proposals were approved partly or with additional requirements.

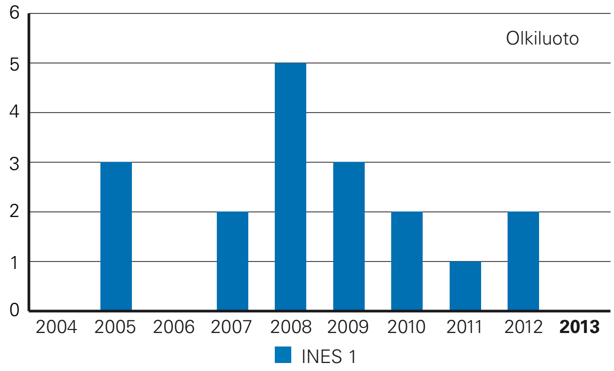


Figure 11. INES classified events at the Olkiluoto plant (INES Level 1 or higher).

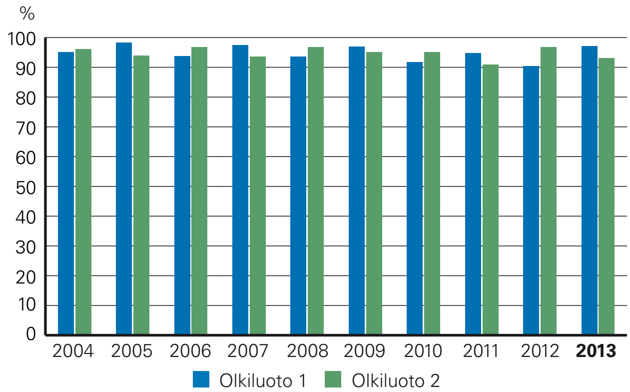


Figure 12. Load factors of the Olkiluoto plant units.

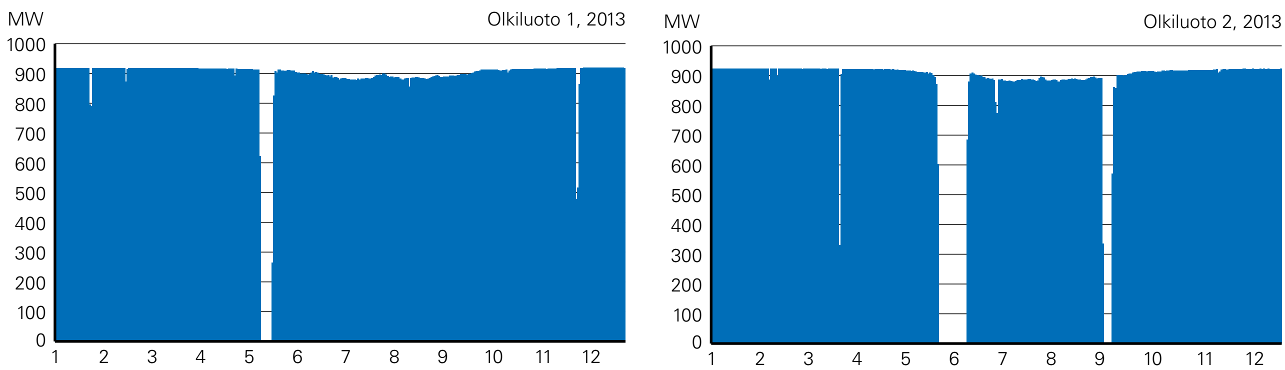


Figure 13. Daily average gross power of the Olkiluoto plant in 2012.

TVO applied for permission from STUK for four planned deviations from the operational limits and conditions (Appendix 1, indicator A.I.2). All of these applications were linked to modifications. One of the applications was linked to an upgrade of a radiation measuring channel in Olkiluoto 2 and three of them were linked to an expansion of the spent fuel storage pool. As the planned deviations had no significant safety implications, STUK approved the applications.

Operation and operational events

STUK oversaw the operation on a daily basis at the plant site, reviewed regular reports on operating activities and event reports and performed three inspections of operations that focused on the responsibilities and duties of the operating unit during modifications, actions during an annual outage and operating experience feedback. The results of the inspections are described in Appendix 5 of this report.

No events leading to a reactor trip occurred at the Olkiluoto nuclear power plant during the course of the year. Seven events classified as operational transients occurred. Most of the operational transients were caused when .one of the reactor coolant pumps slowed down as planned due to a disturbance in the external power supply. One turbine trip took place in Olkiluoto 2 because of a tripped earth fault protector. A generator breaker tripped in Olkiluoto 1 because of a fault in the generator exciter surge arrester. One of the operational transients was caused by the erroneous closing of an HP turbine control valve in Olkiluoto 1.

Events warranting a special report included defects in the maintenance of a reactor coolant pump and the management of work linked to the cooling

Annual outage of Olkiluoto 1

The refueling outage of Olkiluoto 1 lasted for a little less than eight days, which was slightly less than 24 hours longer than expected. The delay was caused by a fault in the surface level measuring system of a floor drain in the containment prior to startup and problems with the synchronisation of a generator breaker in connection with the startup.

During the annual outage, one fifth of the nuclear fuel was replaced. No major modifications are carried out during a refueling outage; instead, the work mainly consists of inspections, maintenance, repairs and tests of systems, equipment and structures, such as fuel inspections and leak tests of containment isolation valves.

Annual outage of Olkiluoto 2

The maintenance outage of Olkiluoto 2 lasted for a little more than 18 days, which was more than 24 hours longer than expected. The delays were caused by the replacement of a pulse sensor of a control rod y and problems with creating a vacuum in the condenser.

Around one fifth of the nuclear fuel was replaced during the annual outage. The most major modifications implemented included replacing low voltage switchgears of two trains. In addition to the modifications, a considerable number of inspections, maintenance work, repairs and tests were carried out on systems, equipment and structures.

A fuel leak was detected in the plant unit at the end of the fuel cycle in May 2013. The leaking fuel assembly was located and removed from the reactor during the annual outage. The fuel leak had no significance in terms of the radiation safety of the environment, as the released radioactivity was contained within the plant.

Wall thicknesses falling below the nominal thickness (87.5% of the nominal thickness) were observed at several points in erosion corrosion measurements of the piping of Olkiluoto 2 during the annual outage. TVO proved by means of strength calculations that the wall thickness at the thinner points is still sufficient. These observations are described in more detail in Chapter 4.2.4.

Two events warranting a special report took place during the annual outages. An impeller was accidentally replaced with a sealing plug of the wrong type in one of the reactor coolant pumps during the annual outage. The wrong plug type was detected when more water than normal started to leak from the reactor pressure vessel into the reactor coolant leakage drain system. The second event occurred when TVO decommissioned one of the heat exchangers in order to clean it, which caused a non-conformance with some of the requirements in the operational limits and conditions on operability of systems and equipment.

of the reactor, material faults detected when maintaining an emergency diesel generator, and a nonconformance with the key handover procedure of a cross-connection room below the control room. The events are described in more detail in Appendix 3.

In 2013, risks caused by component malfunctions, preventive maintenance and other events causing unavailability of equipment were 2.8% and 11.0% of the expected value of the annual accident risk calculated using the plant's risk model for Olkiluoto 1 and Olkiluoto 2, respectively. The results were in line with those of previous years.

Annual maintenance outages

The Olkiluoto 1 refueling outage was from 12 May to 20 May 2013 and the maintenance outage of Olkiluoto 2 from 26 May to 14 June 2013 . During an annual outage, equipment and structures important to plant safety are inspected, serviced, replaced or modified. These measures ensure the preconditions for operating the power plant safely during the following fuel cycles. In addition, some of the nuclear fuel is replaced with fresh fuel during the annual outages. STUK oversees that the licensee ensures the safe completion of the annual maintenance work and prevents radiation hazards to the plant employees and the environment. STUK performed an annual outage inspection in compliance with the inspection programme during the annual outage.

4.2.3 Ensuring plant safety functions

Deterministic safety analyses

An extensive evaluation of the transient and accident analyses (deterministic safety analyses) carried out to verify the safety functions of the plant has been performed in connection with the periodic safety review of 2009. Since then, TVO has further supplemented the sections of the transient and accident analyses that concern an extension of postulated accidents and loss of coolant accidents. In 2013, no updated deterministic safety analyses were delivered to STUK.

Probabilistic risk analyses

The risk of a severe nuclear accident is evaluated on the basis of a probabilistic risk analysis (PRA). As a rule, PRA calculations use regularly updated information on the occurrences of initiating events and the unavailability of equipment together with a logical model of the plant's systems and their interdependencies.

The annual probability of a severe reactor accident calculated for the Olkiluoto plant was around $1.21 \cdot 10^{-5}$/year at the end of 2013, which is around 10% lower than in 2012 ($1.35 \cdot 10^{-5}$/year).

The key reason why the core damage frequency was lower than in 2012 is that a system was commissioned that will automatically submit any report of an oil spill at sea submitted to the Satakunta rescue services to the Olkiluoto power plant as well. This means that the power plant will be more likely to initiate measures to prevent unavailability of the service water system due to the oil spill because it will be informed of the accident in due time.

TVO has introduced separate risk models for Olkiluoto 1 and Olkiluoto 2. At present, the differences in core damage frequency are only fractions of a percent. The differences between the units will increase in the next few years because significant plant modifications will be implemented in stages.

The accident risk at the Olkiluoto power plant and its changes are discussed in more detail in Section A.II.4 of Appendix 1, Accident risk of nuclear facilities.

4.2.4 Integrity of structures and equipment

STUK assessed the integrity of equipment and structures important to safety in Olkiluoto 1 and Olkiluoto 2 with inservice inspections and by monitoring and inspecting repairs and modifications of systems, equipment and structures. Most of these repairs and modifications were implemented in connection with the annual outages in the spring of 2013. No observations that would limit the safe operation of pressure equipment, piping or other equipment and structures were made in these inspections.

Reactor coolant system

STUK has asked TVO to study the significance of chloride deposits in the reactor control rod actuators when securing the integrity of the reactor coolant system. In 2011, some values exceeding the allowed chloride content were detected when parts were replaced in compliance with a maintenance plan. Further studies revealed that the allowed values had been exceeded before as well. The significance of chlorides to corrosion resistance of parts manufactured from non-corrosive materials was studied in the case of specific sleeves manufactured from acid-proof steel, for example. The tightly sealing contact surface of these sleeves could become susceptible to corrosion when paired with a graphite seal. It was determined, however, that the chlorides in the seals do not influence the plant's water chemistry because the chloride content is very low when compared to the water volume in the reactor.

In 2013, TVO submitted a non-conformance report regarding the excessive chloride content and the other required reports for approval. STUK approved these reports with remarks. In its decision, STUK required that the power company compare the results of trip tests with the results from the previous years to ensure that any non-conformances are detected prior to submitting the startup permit application for Olkiluoto 2. Furthermore, STUK required that TVO specify the chloride contents of the new graphite seals to be installed during the annual outage of Olkiluoto 2, study the need to replace the graphite seals based on studies of the parts to be removed and draft an operational policy based on this data to be submitted to STUK for approval by 31 December 2013.

During the 2013 annual outage, TVO started inspecting the supporting feet of moderator tanks in the reactors in Olkiluoto 1 and Olkiluoto 2. A decision to inspect the supporting feet was made because two cracks were found in almost identical supporting structures in Sweden in 2011. The inspections were started at the reactor of Olkiluoto 2 with a camera. Six of the eighteen supporting feet were inspected before the camera got stuck close to the bottom of the reactor. The interrupted inspection was complemented by verifying by means of ultrasonic testing the integrity of the seal weld connected to the reactor sheath in all of the supporting feet. A wider area of the reactor pressure vessel sheath close to the supporting feet was also inspected with the ultrasound device. These inspections verified that there are no cracks extending up to the reactor pressure vessel's interior surface coating in the supporting feet, and that the wall of the reactor pressure vessel is intact in the studied areas. The plan is to continue the inspections during the 2014 annual outage.

An indication at one of the welded joints of the reactor feedwater system has been monitored by means of ultrasound and eddy current examinations during inservice inspections since the indication was detected in 2003. The indication's depth (around 10 mm) has not changed in any significant manner. The same qualified inspection methods have been consistently used. The nozzle has also been inspected with a new ultrasound technique since 2011. The inspection was carried out underwater. It was a combination of the eddy current method to detect indications close to the surface and multi-channel phased ultrasound technology to detect indicators deeper down. The depth of the indication when measured with this method was 15.3 mm in 2011, 2012 and 2013. The weld was also inspected from the outside using the phased method in 2013. The depth of the indication when measured in this manner was 23 mm, which suggests that the weld only has 10–11 mm of intact neck left. A separate eddy current inspection was also carried out to verify that the fault has not penetrated the wall. According to strength calculations made with the new fault size, the indication still complies with the size criteria laid down in the standard (ASME XI), and it is not possible, based on the measuring data, that the indication could increase to close to the acceptance limit determined based on the fracture mechanism within the next few years. TVO has proposed to STUK that the fault be annually inspected and assessed during the following three years. STUK approved TVO's proposal.

Fuel and control rods

No abnormal observations were made during the fuel inspections in connection with the Olkiluoto 1 annual outage. The assemblies and channels behaved normally when taking into account their burnup. Two irradiated fuel assemblies were repaired in Olkiluoto 2 in late 2013. A leak was detected in one of the assemblies during the annual outage. When inspecting the assembly, it was also noted that the supporting structures of the assembly had been dislocated. A similar bundle that was inspected during the 2011 annual outage was also inspected after the annual outage to study the underlying cause for the damage and non-conformances. It is likely that the supports moved after the previous inspections when an old guide thimble was used to place the fuel assembly into the channel. The plan is to place the assemblies back into the reactor once repaired.

The planned visual inspections and dimension measurements of the fuel assemblies and channels were implemented during the fuel cycle 2012–2013. All of the planned inspections were performed, except for the channel dimension measurements: fewer dimension measurements than planned were performed in Olkiluoto 2.

Maintenance and management of ageing

Inservice inspections

TVO submitted the inservice inspection plans regarding the 2013 inspection programmes to STUK, and STUK approved the plans before the inspections to be implemented during the annual outages were started. The plans concerned volumetric and visual inspections of the reactor pressure vessels in the plant units and inservice inspections of equipment. Risk-informed methods are used in the non-destructive testing of piping. The risk-informed methods involve inspecting points important to safety more often than other points. No significant changes from the previous inspections were observed in the inspections performed in 2013.

Wall thicknesses falling below the nominal thickness were observed in erosion corrosion measuring of the turbine island's main condensate piping system during the annual outage of Olkiluoto 2. TVO repaired these areas by means of deposition welding. STUK required that follow-up measurements of the thinner areas be taken during the 2014 annual outage. The wall thickness of some pipes was also deemed thinner than normal in erosion measurements in Olkiluoto 1. TVO proved by means of strength calculations, however, that the wall thickness at the thinner points is still sufficient.

According to the erosion inspection report, TVO plans to replace the above-mentioned deposition welded elbow pipe section in Olkiluoto 1 and determine by means of ultrasound studies whether there is need to replace the other lines. TVO will either repair any points where the wall thickness has fallen to the calculated minimum by means of deposition welding or replace these pipes. STUK will assess the deposition welding of the piping and follow-up measures of the erosion inspections in connection with its inspections. The nuclear safety class of the piping to be subjected to erosion inspections is not high, although these pipes are significant in terms of pressure equipment safety.

Management of ageing

STUK's Ageing Management Committee plans and coordinates STUK's regulatory duties pertaining to the ageing of nuclear facility systems, equipment and structures. The regulatory activities focus on any structures or equipment important to the nuclear safety of the Finnish nuclear power plants where faults or increased repair needs have been observed. The committee addresses such cases and demands corrective measures by the licensees if it deems that the condition monitoring or maintenance has been defective. The committee also assesses events at nuclear facilities outside Finland and any links between them and the monitoring of the ageing of the Finnish nuclear power plants. In Olkiluoto, the committee has focused on the prolonged operating times of relief valves, the condition of concrete structures in the service water systems, emergency diesel generators and the supporting feet of the moderator tank because of the cracks observed at a Swedish sister plant (see above).

STUK assessed the condition monitoring of plant components important to safety that TVO implements during operation of the plant either in real time or by means of periodic measurements and observations to verify that the scope and implementation method of the condition monitoring of different plant components is sufficient when taking into account their impact on safety. STUK inspected plant rounds by the operating group, inservice testing and other condition monitoring measures during operation, such as vibration and leak monitoring. Based on the inservice testing results reviewed during the inspection, it seemed that the functional capacity of the heat exchangers in the residual heat removal chain had gradually decreased to such an extent that one of them only barely met the heat transfer criterion. This is why STUK required that TVO study the underlying reasons for the permanent decrease of the heat transfer capacity of these heat exchangers and assess whether similar decreases have occurred in any other heat exchangers important to safety. No significant defects were observed in the inspection, however.

The condition of a channel on the inlet side of the Olkiluoto 2 turbine island is being monitored because minor washing off of the bonding agent of the concrete structure's board form surfaces has been detected. The status of the channel was last inspected during the 2013 annual outage and no significant changes were observed.

Emergency diesel generators

The risk of the bottom bearings of the connecting rods in the emergency diesel generators at the Olkiluoto plant being damaged is being studied based on international operating experience. Damage has been observed at other plants in bearings manufactured by the manufacturer of the bearings used in the engines. STUK required that TVO study how reliable operation of the diesels can be verified. According to a report submitted by TVO, the bearings susceptible to damage have been used in engines that are not of the same type as the engines in Olkiluoto. According to the report, the dimensions of the bearing strips in the Olkiluoto diesel engines are not the same as those of the susceptible bearing type, which means that the bearings will be subjected to lower pressure, lower circumferential speed and lower risk of premature wear. STUK approved the report on 17 June 2013.

A crack was observed in a solder joint of a core winding during an overhaul of an emergency diesel generator in Olkiluoto 1. The rotor's wound core, which is manufactured from flat bar copper, had been extended with silver solder at some points. An indication was observed in a visual inspection of one of these solder joints. TVO ordered a damage study which proved that there were cracks in the solder joints already when they were made in the 1970s. It was verified by means of electron microscopy that ageing phenomena during operation (such as sparking or fatigue) had not occurred. The windings that had been cut in order to perform the damage study were repaired with a qualified soldering method.

Cracks were also found in two stator weld joints of the generator's exciter during the same overhaul. An event report and a weld repair plan were drafted. The weld joints of the exciters that were in operation at the power plants were also inspected because of this observation. One broken weld was detected. It will be repaired during maintenance once the overhaul of the current generator is complete. The detected faults have not rendered the emergency diesel generators of the nuclear power plants inoperable. There are four diesel generators at both of the operable Olkiluoto plants. Their operability is tested monthly.

Containment

STUK noted that the containment complies with the design requirements laid down for it. No significant observations were made in the latest leak tests performed in 2012.

4.2.5 Development of the plant and its safety

Construction of an remote shutdown station in Olkiluoto

Pursuant to a government decree, a nuclear power plant must have a remote shutdown station independent of the control room, and the necessary local control systems for shutting down and cooling the nuclear reactor, and for removing residual heat from the nuclear reactor and spent fuel stored at the plant in a situation where operations in the main control room are not possible.

TVO is in the process of constructing remote shutdown stations for the Olkiluoto units currently in operation in compliance with the requirements set out in STUK's implementation decision regarding YVL Guide 5.5 and in the periodic safety assessment of Olkiluoto. STUK reviewed and approved a conceptual design plan for the remote shutdown stations in 2012. Final design documentation is expected to be completed in early 2014. The plan is to commission the remote shutdown stations in Olkiluoto 2 in 2015 and in Olkiluoto 1 in 2016.

Replacing diesel generators

In 2012, STUK approved a conceptual design plan submitted by TVO on replacing all of the emergency diesel generators in Olkiluoto 1 and Olkiluoto 2. There are four emergency diesel generators in both of the currently operating Olkiluoto plants. Furthermore, a ninth emergency diesel generator will be shared by the plant units. It will be used during upgrades, for instance, to replace the plant unit's own diesel generator that is being upgraded. In addition to the diesel generator upgrade, the

Pressure equipment manufacturers and inspection and testing organisations

A total of 24 nuclear pressure equipment manufacturers were approved for the Olkiluoto plant (plant units Olkiluoto 1, 2 and 3). STUK approved 17 testing organisations to carry out tests related to the manufacture of mechanical equipment and structures. Testing operators from three testing organisations were approved to carry out periodic tests of mechanical equipment and structures pursuant to YVL 3.8.

plan is to improve the cooling of the diesel engines by building an air cooling system independent of the service water cooling system.

STUK approved the updated conceptual design plan for the diesel generator upgrade in early 2013. According to a preliminary estimate, the emergency diesel generator to be shared by the plant units will be installed and commissioned in the spring of 2016. It has been estimated that the installation and commissioning of all the new diesel generators will be completed by the spring of 2020. TVO has selected Wärtsilä Finland as the new emergency diesel generator supplier.

Auxiliary feed water system recirculation line modification

TVO submitted pre-inspection documents for a modification of a recirculation line in the auxiliary feed water system to STUK for approval. The modification consists of draining the recirculation lines to the demineralised water storage pools that are also used as the water source by the auxiliary feed water system. In addition to the pipe, the necessary drain valves and strainers to prevent foreign objects from entering the storage pools will be installed in the lines. The modification will not influence the auxiliary feed water system in any other operating mode apart from the recirculation mode. At present, the water that has flowed through the pump in recirculation mode is cooled using a separate cooler from where the heat is transferred via an intermediate circuit to the service water system. If the service water cooling is lost, the temperature of the recirculated water will quickly increase, which will eventually lead to a loss of the auxiliary feed water system pumps. The plan is to implement the modification in Olkiluoto 1 in 2014 and in Olkiluoto 2 in 2015.

Changed schedule of design of reactor surface level measuring

The reactor surface level is measured in Olkiluoto 1 and Olkiluoto 2 only with one method. STUK has requested that TVO study the opportunity to measure the surface level in the reactor pressure vessel with an alternative method, but TVO has so far failed to propose a viable alternative. The plan is to commission the alternative measuring method in 2016 and 2017.

Low-voltage switchgear upgrade project

TVO has initiated a low voltage switchgear upgrade project in Olkiluoto 1 and Olkiluoto 2. The key reasons for replacing the switchgears are an increase in maintenance costs due to the ageing of the original equipment, and the need to modernise the switchgear to correspond to the current requirements regarding plant and personnel safety. The upgrade mainly concerns the switchgears and associated transformers of electricity systems important to safety. TVO already replaced the medium voltage switchgears (6.6 kV) in 2005 and 2006. The voltage in the plant units' low voltage networks varies from 24 VDC to 660 VAC. The switchgears are used to supply the required electrical power to the plant units' I&C systems and components that are important to safety.

According to the current plan, the low voltage switchgears will be replaced during the plant units' annual outages between 2010 and 2016. TVO continued the work during the 2013 annual outage of Olkiluoto 2 by replacing the switchgear two trains. STUK reviewed the documents for the switchgear project and oversaw the execution of the work onsite. TVO intends to continue the project in Olkiluoto 1 during the 2014 annual outage by replacing the switchgear of two subsystems.

Development of operational limits and conditions

The OLC development plan states that TVO improves the justification for requirements and clarifies the requirements when necessary. In 2011, TVO conducted internal discussions regarding the need to amend the OLC and produced amendment proposals. TVO submitted the first four amendment proposals to STUK for approval in 2012. In 2013 TVO submitted six amendment proposals to STUK for approval. The development project will be continued in 2014 and possibly also later.

Abnormal and emergency operating procedures

TVO continued an upgrade project of the abnormal and emergency operating procedures that was started based on the results of the periodic safety review. The goal of the project is to improve the procedures by describing the measures in more detail. Furthermore, flowcharts included in the emergency operating procedure have been redrawn and background materials for the procedures have been updated to comply with the updated procedures.

TVO submitted updated versions of the emergency operating procedure and the abnormal operating procedures concerning outages to STUK at the beginning of 2013. TVO will update the abnormal operating procedures not pertaining to outages by 2015. The modifications implemented because of Fukushima will also cause changes in the procedures.

STUK assessed TVO's procedures and their validation, and verified that the updated procedures are proper in terms of content and structure. TVO uses three methods to validate procedures: reviewing them by reading, comparing them with the plant and performing simulator runs. The review by reading and comparison with the plant were applied to all of the procedures submitted to STUK in early 2013. Simulator validation was applied only to procedures where TVO felt that it offered additional benefits when compared to the other validation methods. Minor revisions and additions were made to some of the procedures as a result of the validation. STUK found that the procedure validation methods need some improvement, particularly as it comes to the simulator run.

Development objects based on Fukushima accident

After the Fukushima accident in 2011, STUK sent a decision to the licensees concerning provisions and plans to be made by the power companies for natural phenomena and power supply disruptions. In 2013, TVO submitted to STUK reports on the opportunity to use a water supply system independent of existing plant systems to cool the reactors of Olkiluoto 1 and Olkiluoto 2. The proposed solution consists of supplying make-up water from the fire water system to the reactor after depressurisation. System design based on the proposed solution is currently underway.

STUK approved TVO's plant modification plans to improve independence of the auxiliary feed water system from the service water cooling system. TVO also delivered to STUK a report on adequate volume and availability of water for the simultaneous cooling of all reactors, fuel pools and spent fuel storage during long-lasting accidents which involve loss of the normal heat sink. Furthermore, TVO has drafted a study on acquiring portable electric generators and pumps. Portable generators are to be used for purposes such as recharging the uninterruptible power supply batteries during long-lasting accidents. The portable fire water pumps can be used to fill up the containment in case of a severe accident and supply make-up water to the fuel pools in the reactor building and the spent fuel storage facility. According to TVO's assessment, the earthquake resistance of the Olkiluoto 1 and Olkiluoto 2 fuel pools and fire extinguishing systems is high. Based on the assessment results, improvements to the fire extinguishing system are being planned. They will be implemented in 2014.

Radiation monitor upgrade

TVO has upgraded the fixed radiation measuring systems in Olkiluoto 1 and Olkiluoto 2. The latest upgrades were improvements of the release and activity measuring systems in case of an accident in the vent stack and room radiation measuring systems. During the 2013 annual outage, two upgraded and one new measuring channel were commissioned in Olkiluoto 2. All of the new monitors used for measuring during an accident were commissioned by the end of 2013.

The measuring instrument modernisation project will improve and standardise the plant's operating equipment base. The latest items to be upgraded are the radiation measuring instruments used to monitor releases during normal operation of the plant.

4.2.6 Spent nuclear fuel storage and NPP operational waste

The processing, storage and final disposal of low and intermediate level waste (NPP operational waste) at the Olkiluoto power plant were carried out as planned. The volume and activity of operational waste in relation to generated electrical power remained low compared with most other countries. The contributing factors include the high quality requirements for nuclear waste management and nuclear fuel, the planning of maintenance and repair operations, decontamination as well as component and process modifications. In addition, the power plant employs efficient procedures for reducing the volume of waste destined for final disposal. Because of waste monitoring and sorting, some of the waste with a very low radioactive substance content can be exempted from control. Waste below the set activity limits was exempted from control at the power plant with STUK's approval in 2013 to be processed elsewhere. Waste exempted from control included operational waste, scrap metal for recycling and hazardous waste to be further processed, such as waste oil and pickling solutions.

In 2013, STUK regulated operating waste management and final disposal of operational waste as well as the concrete and rock structures of the repository. STUK assessed reports and other documents submitted to it, performed control visits and performed inspections included in the periodic inspection programme. STUK accepted the new limit values for the operational waste released from control at the Olkiluoto plant units on 20 August 2013. The approval decision also includes limit values for the operational waste of Olkiluoto 3. These limit values will apply once the permit for achieving criticality of the plant unit has been granted. No significant deficiencies or development needs were observed during the inspections carried out in 2013.

Expansion of spent fuel storage facility

TVO will add three new pools to the spent fuel storage facility (KPA storage) in Olkiluoto. At the same time, the structures of the storage facility will be modified to comply with the current safety requirements. The original KPA storage capacity in Olkiluoto would have been sufficient until 2014, and the expansion will increase the capacity for the spent fuel coming from the Olkiluoto plant units 1, 2 and 3.

TVO submitted the documentation regarding expansion of the storage facility to STUK for approval at the end of 2009. The extension of the storage facility is designed to meet the current safety requirements, the most significant of which are its earthquake resistance and its ability to withstand the crash of a large aircraft. The structures of the existing part of the storage facility will be simultaneously renovated to comply with the current requirements.

In 2013, work on the expansion of the storage facility continued with indoor work, such as lining the pool and installations of the expanded systems. Work on the airplane crash structures outside the facility has also started. Expanded systems have been tested as they are completed. TVO reviewed the operational limits and conditions for the storage facility and submitted the necessary changes to STUK for approval.

The storage facility expansion was changed into a controlled area in 2013 to complete the merger of the already existing facility with the expansion. Prior to changing the expansion into a controlled area, STUK performed an inspection to verify that the requirements laid down for controlled areas are met.

An inspection of the storage facility expansion was performed in 2013. In the inspection, STUK assessed the licensee's procedures in commissioning of the expanded storage facility. The requirements laid down in this inspection involved the procedures used when inspecting the welds in the pool lining.

Quantities of spent fuel and low- and intermediate-level waste in Olkiluoto

The volume of spent nuclear fuel on-site at the Olkiluoto plant at the end of 2013 was 8,096 assemblies (1,292 tU, tonnes of original uranium) with an increase of 212 assemblies (37 tU). The volume of low- and intermediate-level waste finally disposed of was 5,681 m³ at the end of 2013. The total increase of volume from 2012 is 42 m³. Approximately 93% of the waste has been finally disposed of..*

Provisions for the costs of nuclear waste management

In compliance with section 88, subsection 2 of the Nuclear Energy Decree, TVO provided the Ministry of Employment and the Economy with the revised and supplemented waste management schemes and information on the costs and prices of nuclear waste management measures by the end of June. The update of the waste management scheme includes a report on nuclear waste management measures and an estimate of the remaining waste management costs at the end of 2013, 2014 and 2015.

STUK reviewed the documents submitted in compliance with the Nuclear Energy Decree and submitted a statement regarding them to the Ministry of Employment and the Economy. In its statements, STUK assessed the technical plans and cost estimates on which the financial provisions are based, considered them acceptable and stated that they can be used as the basis for the cost provisions. TVO's extent of liability was €1,317.8 million at the end of 2013.

According to the Nuclear Energy Decree, supplemented waste management schemes for technical and financial plans, as well as related calculations, must be prepared every three years. The next revision will take place in 2016.

4.2.7 Organisational operations and quality management

Based on STUK's oversight and the results of operating activities, it can be stated that, with a view to ensuring safety, TVO's organisation has operated in a systematic and development-oriented way. During the year, STUK has focused its oversight activities on TVO's human resources planning, development of the modification work process, and the quality management competence of the procurement personnel. One of the particular focus areas has been TVO's preparations for the commissioning of Olkiluoto 3, including the integration of the project organisation and management system to the organisation and management system of the existing plant units.

At present, TVO strongly invests in the development of its operations. The goal with the management process development is to standardise the company's management methods and leadership. Furthermore, TVO has started a group-level ERP development project that aims to ensure the use of the proper systems to support the processes. The modification work process will also be developed as part of the ERP development project. The process description will be complete by the end of 2013 and the related procedures will be completed by the 2014 annual outage. Training and implementation of the renewed process will start after the annual outage. Key changes from the current modification work process will include focusing on a proactive approach and dividing the process into clear-cut stages. STUK is of the opinion that the current development work has proceeded well.

TVO has used verbal descriptions in the ERP system, procedures and operating principles as the basis when describing the processes. The processes will be described in a standardised manner complying with the instructions and indicators will be determined for them. STUK has also requested that TVO describe the duties and responsibilities of the process owner and how these duties and responsibilities are different from the duties and responsibilities of the line organisation supervisors. An independent assessment of the functionality of TVO's management system has been performed and discussed by the management group.

The volume of training offered by TVO has evened out and increased training will probably not be necessary in the future. The number of people working at the personnel development office, which is in charge of general training, has decreased. Development of the procedures and methods pertaining to TVO's HR planning and allocation of resources has not proceeded in line with the schedule laid down by STUK. TVO must submit a plan and schedule for the resource management development project to STUK by the end of Q1/2014. The number of people working at the quality and environment office has increased from last year, and additional resources have been allocated to the development of the quality assurance of procurement, for example. Development plan goals also include increasing the number of lead auditors and standardising supplier approval practices. TVO did not submit the name of a deputy for the person who is responsible for emergency preparedness and physical protection to STUK for approval in 2013.

STUK oversaw the oral examinations of shift personnel where the shift managers, operators and trainee operators prove that they are competent in all key issues related to plant operation and safety. In 2013, STUK granted 22 licenses to shift managers and operators on application by the power company and following a successful oral examination, six of them to new operators. All participants passed their examinations in 2013. The new operators had good results in the examination, which is an indirect indication that the basic training programme is effective. The operators renewing their licenses also had good results in the examination, which, for its part, indicates that the power company's refresher and supplementary training is effective.

4.2.8 Fire safety

In 2013, STUK reviewed reports, carried out onsite inspections, implemented a periodic inspection programme, and sent resident inspectors on their rounds to oversee the maintenance of the fire protection systems and arrangements that ensure fire safety at the Olkiluoto power plant.

In a fire protection inspection carried out by STUK at Olkiluoto, the processing of previous issues was continued, TVO's plans pertaining to the condition of fire extinguishing piping were assessed and functionality of TVO's fire protection organisation was assessed. Based on the inspection results, STUK required that TVO verify the sufficiency of the fire brigade personnel by also taking into account the additional personnel required by Olkiluoto 3 and the Posiva repository. TVO will submit a report regarding the issue to STUK.

TVO has renovated some cable penetrations in the intermediate floor between the relay rooms and the cabling rooms. Modifications of control room facilities and fire compartments in Olkiluoto 1 and Olkiluoto 2 were completed. TVO is currently improving the earthquake resistance of fire water systems.

The fire safety organisation will also be responsible for preparation for an oil spill. In case of an accident, oil containment booms of 400 and 600 metres can be placed between islands in the area. However, drawing the wire needed to put the booms in place with the current machinery is slow. An order has been placed for an anchoring system to keep the booms in place. The system includes buoys and warning lights. The booms are stored onsite. Booms for the water intake channel are stored in a container from where they can be quickly installed.

4.2.9 Operating experience feedback

STUK assessed the operating experience feedback activities and corrective measures on the basis of reports, inspection visits and inspections within the periodic inspection programme. There are development actions in progress in both the internal and external operating experience activities at the Olkiluoto power plant.

No INES Category 1 events occurred at Olkiluoto over the course of the year nor were any root cause analyses made.

TVO drafted eleven event reports and seven operational transient reports on unexpected operational incidents during 2013. Ten of these were submitted to STUK for information. TVO drafted four special reports over the course of the year. These are described in more detail in Appendix 3.

In the operating experience feedback inspection, STUK verified methods, procedures and new practices related to the feedback operations. Despite personnel changes, operations were found to be well organised and directed, and had adequate resources. The operating experience feedback team meets every two weeks. The team discusses experience feedback from Finland and from abroad, as well as the utilisation of the feedback in the improvement of operations. Expertise has been added to the team by including a simulator trainer from Olkiluoto 3 and the project's safety engineer.

Of all the events that occurred in 2013 in Olkiluoto, STUK decided to draft one new report on problems with the cracks in the stator welds of the emergency diesel generators' exciters in Olkiluoto 1 and Olkiluoto 2 for the International Reporting System for Operating Experience (IRS) maintained by the International Atomic Energy Agency (IAEA).

The Olkiluoto power plant uses methods to assess and utilise operating experience from other plants. TVO has utilised Nordic cooperation in the preselection of reports from the World Association of Nuclear Operators (WANO), the IRS database maintained by the IAEA and reports from the plants in the United States. TVO develops methods and procedures for operating experience feedback activities during construction and commissioning. A new procedure on utilising events that occur at Olkiluoto 3 in Olkiluoto 1 and Olkiluoto 2, as well as in the planned Olkiluoto 4, was published in late 2013.

TVO is performing a variety of studies due to the Fukushima accident of 2011 to improve the capability of the plant units to cope with natural phenomena and power supply disruptions. A summary of the development measures determined because of the Fukushima accident at the Olkiluoto plant unit is available in Chapter 4.2.5.

4.2.10 Radiation safety of the plant, personnel and the environment

Occupational radiation safety

STUK carried out a radiation protection inspection as part of the periodic inspection programme at the Olkiluoto power plant, focusing on occupational radiation safety in particular. The items to be inspected included radiation protection targets and the role of radiation protection when processing work permits. The dosimeters used for measuring the occupational radiation doses underwent annual tests. The tests comprised irradiating a sample of dosimeters at STUK's measurement standard laboratory and reading the doses at the power plant. The test results were acceptable.

STUK carried out targeted radiation protection inspections during the annual outage at the Olkiluoto plant units. Radiation protection activities of the plant's radiation protection personnel and employees within the controlled area were assessed during these inspections. Based on the inspection results, radiation protection at the plant is good: no major defects were observed. Individual development areas were revealed in the inspections concerning the use of personal protective equipment in the controlled area and the employees unnecessarily spending time in a radiation work environment.

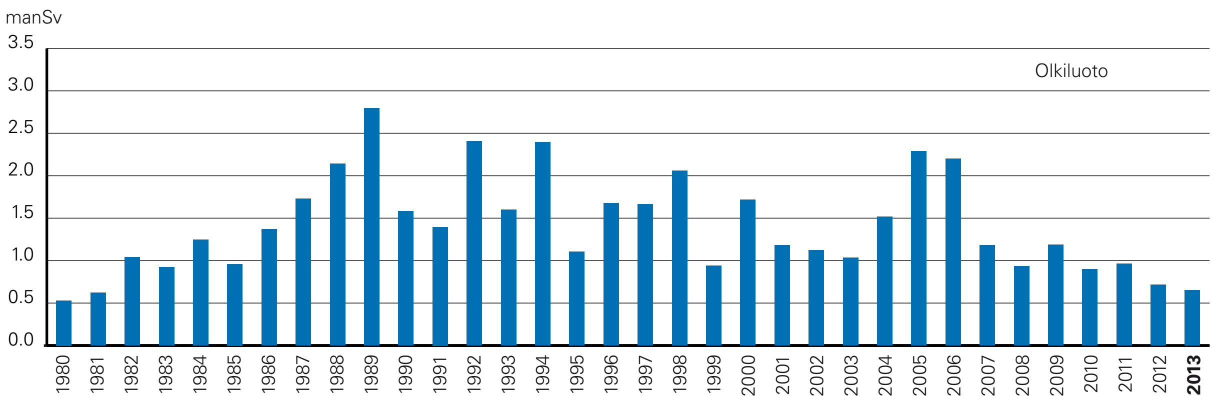


Figure 14. Collective occupational doses since the start of operation of the Olkiluoto units 1 and 2.

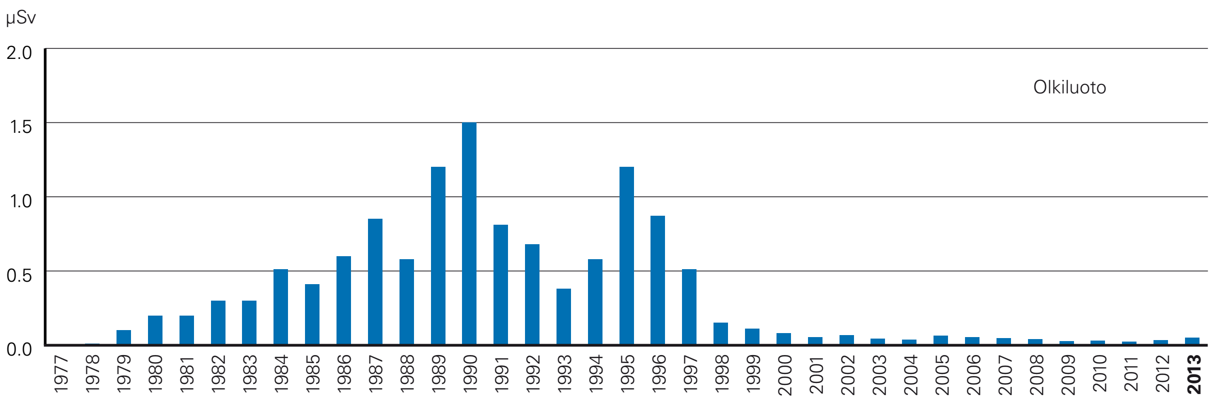


Figure 15. Annual radiation doses to the most exposed person of the public since the start of operation of the Olkiluoto units 1 and 2. Over the recent years, the doses calculated based on the radioactive discharges has remained below one percent of the set limit, 0.1 milliSv.

Table 4. NPP originated radioactive nuclides found in the environmental samples of the Olkiluoto power plant in 2013.

Sample types containing detected radionuclides. Figures indicate the number of positive samples in a sample group. Several different nuclides may be found in the same sample.

Radionuclide / Type of sample	H-3	Mn-54	Fe-59	Co-60	Sb-124	Total
Air		1	1	2	1	5
Aquatic plants		1		7		8
Perifyton		1		5		6
Sedimenting materials				10		10
Sediment				3		3
Rainwater	1					1
Kaatopaikan valumavesi				1		1
Total	1	3	1	28	1	34

Radiation doses

The collective occupational dose of employees for the entire year was 0.14 manSv in Olkiluoto 1 and 0.51 manSv in Olkiluoto 2. The collective occupational radiation dose of Olkiluoto employees was the lowest ever recorded during the operation of the power plant. The collective occupational radiation doses of employees in Olkiluoto were smaller than the average doses of employees working in boiling water reactors in OECD countries.

According to the YVL Guide issued by STUK, the threshold for one plant unit's collective dose averaged over two successive years is 2.5 manSv per gigawatt of net electrical power. This means an average annual dose value of 2.20 manSv per Olkiluoto plant unit. This threshold was not exceeded at either of the plant units.

Most of the occupational radiation doses of nuclear power plant workers are accumulated during annual outages. The collective radiation dose of employees due to operations during the outage in Olkiluoto 1 was 0.09 manSv, and the collective radiation dose due to operations during the outage in Olkiluoto 2 was 0.47 manSv. The radiation levels at the turbine plants continued to decrease thanks to the new steam dryers that were installed in 2005 and 2006.

The highest individual radiation dose accumulated was 3.8 mSv in Olkiluoto 1 and 7.4 mSv in Olkiluoto 2. The highest individual dose incurred at either plant unit during the entire year was 8.1 mSv. This dose was caused by inspection work. The highest individual radiation doses have been less than 10 mSv during the last seven years. The radiation doses for nuclear power plant workers remained below the individual dose limits. The effective dose for a worker from radiation work may not exceed the 20 manSv/year average over any period of five years, or 50 manSv during any single year.

The radiation dose distribution of workers at the Olkiluoto and Loviisa nuclear power plants in 2013 is given in Appendix 2.

Radioactive releases and environmental radiation monitoring

Radioactive releases into the environment from the Olkiluoto nuclear power plant remained well below authorised annual limits in 2013. Releases of noble gases into the air were approximately 0.2 TBq (as Kr-87-equivalent activity), which is approximately 0.002% of the authorised limit. Releases of iodine into the air were approximately 91 MBq (as I-131-equivalent activity), which is approximately 0.09% of the authorised limit. Releases through the vent stack also included radioactive particulate matter amounting to 20 MBq, tritium amounting to 0.6 TBq and carbon-14 amounting to approximately 0.8 TBq. The tritium content of liquid effluents released into the sea, around 1.5 TBq, was around 8% of the annual release limit. The total activity of other radionuclides released into the sea was 91 MBq, which is approximately 0.03% of the plant location-specific release limit.

The calculated radiation dose of the most exposed individual in the vicinity of the plant was around 0.05 µSv, i.e. less than 0.05% of the set limit (Appendix 1, indicator A.I.5c). An average person living in Finland receives the equivalent radiation dose from radiation sources in nature and in space in about 20 minutes.

A total of 300 samples were collected and analysed from the land and marine environment surrounding the Olkiluoto power plant in 2013. External background radiation and the exposure to radioactivity of people in the vicinity of the plant were also measured regularly. Extremely small amounts of radioactive substances originating from the nuclear power plant were observed in some of the analysed environmental samples. The amounts were so small that they are insignificant in terms of people's radiation exposure.

4.2.11 Emergency preparedness

STUK monitors the capability of the emergency preparedness organisations of nuclear power plants to act under abnormal conditions. No events requiring emergency response actions occurred at the Olkiluoto power plant in 2013.

Emergency preparedness at the Olkiluoto power plant complies with the main requirements. STUK's inspection of the emergency preparedness arrangements of the Olkiluoto nuclear power plant included the inspection of the emergency preparedness organisation and its training, drills, equipment and facilities, alarm arrangements, environmental radiation measurements and weather observations at the plant site. Modifications of emergency preparedness operations based on the lessons learned from the Fukushima accident have been completed or are being completed. Some of the new requirements laid down in the Government Decree on Emergency Response Arrangements at Nuclear Power Plants (716/2013) have been met and the details of other requirements are further specified in the application decision of the YVL Guide.

An emergency preparedness drill to test the forming of the preparedness organisation, launch of operations, and assessment of situations was organised at the Olkiluoto power plant in November 2013. STUK oversaw the drill onsite.

4.2.12 Physical protection

The inspection performed during the annual outage focused on the resources needed for the maintenance of adequate physical protection during an annual outage, development measures and their status during an outage, and surveillance of the refueling area. During the 2013 annual outage, physical protection was implemented according to plan and no non-conformances were observed.

Focus areas in the physical protection inspection included training and drills on maintaining physical protection, status with the requirements posed in previous inspections, development measures and the status of the physical protection at Olkiluoto 3 during construction. TVO presented its plan on naming a deputy for the person in charge of physical protection. The training programme for 2013 was completed according to plan. All of the reviewed non-conformance reports were properly processed and none of the non-conformances had been caused by any illegal activities. TVO has planned an improvement of the surveillance systems and also started the improvement of some of the system components.

In an information security inspection of the Olkiluoto power plant, STUK assessed technical information security solutions for the reactor units and information security of the Olkiluoto 3 construction site. STUK inspected the implementation of physical protection for the spent fuel storage facility expansion.

Based on the assessment results, STUK estimated how the processes related to physical protection are described in the ERP system, how physical protection is taken into account in the risk management process, and how the management can verify the functionality of physical protection. Furthermore, discussions on how physical protection has been taken into account when assessing and developing the organisation culture were conducted. Based on the inspection results, STUK required that the descriptions included in the ERP system must be updated to comply with the activities in practice.

4.2.13 Safeguards of Nuclear Materials

A total of fourteen inspections of TVO's operating plants and the spent fuel storage facility were performed. STUK performed, together with IAEA and the European Commission, inspections on the physical inventory of nuclear materials at both plant units and the spent nuclear fuel storage facility both before and after the annual outages. The amount of nuclear material in the spent nuclear fuel storage facility was verified separately because the verification could not be implemented simultaneously with the reactor units due to the construction of the expansion . Furthermore, STUK inspected the locations of the reactor core fuel assemblies prior to the closing of the reactor cover in Olkiluoto 1 and Olkiluoto 2. STUK also performed two interim safeguards inspections of all three sites and one review of the accounting of uranium batches abroad that are currently being managed by the TVO uranium procurement office.

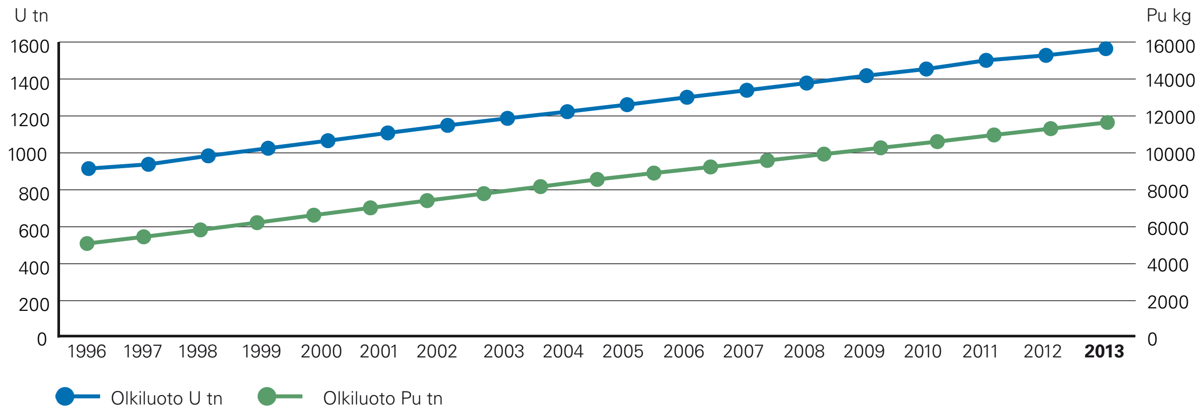


Figure 16. Amounts of uranium and plutonium at the Olkiluoto NPP.

4.3 Regulatory oversight of the construction of Olkiluoto 3

4.3.1 Overall safety assessment of Olkiluoto 3

The overall safety assessment of Olkiluoto 3 discusses the observations made by STUK on the basis of a review of plans, the oversight of manufacturing, construction, installation and commissioning operations, results of the construction inspection programme during construction, oversight of the plant supplier and its subcontractors, and experience acquired as a result of interactions between STUK, TVO and the plant supplier.

Detailed design of the plant systems continued in 2013. The licensee submitted to STUK for approval some nuclear island process and electricity system plans, which needed reapproval by STUK because they had been modified. Some of the revisions have been made as a result of the requirements STUK has imposed on systems design, but the majority of revisions have arisen from the licensee's and the plant supplier's own requirements. Several updates and additions have also been submitted for the equipment plans. Most of the plans have been of a good quality after STUK remarked about the quality of plans in connection with reviews performed in compliance with the construction inspection programme a couple of years ago. The licensee also develops its own safety assessment policies to ensure that the safety requirements are met and compliance with the safety requirements can be verified more easily.

The most important part of plant design that has not been fully processed yet are the plant's I&C systems. STUK has required that TVO submit unambiguous requirements for the design of the overall architecture of the I&C systems, and that the I&C architecture created on the basis of the requirements is described. In terms of safety, it is important to specify unambiguous requirements for the independence of the various I&C systems involved in the architecture, because the I&C systems will back each other up. TVO submitted the general architecture design documents to STUK in the spring of 2013. At the end of the year, the documents were still being processed.

Furthermore, STUK has requested TVO take into account the possibility of faults in the I&C system software and possible consequences of such faults when assessing the implementation of the plant's general design bases. Several meetings on the analysis methods to be used were conducted with TVO and the plant supplier in the autumn of 2013, and STUK expects TVO to submit a proposal on the analyses to be drafted for the consequences of potential software faults.

Except for some final touches, construction work on the Olkiluoto 3 buildings is completed. STUK oversaw and inspected grouting, anchoring and injecting related to component installations as well as the installation of steel platforms. In 2013, STUK started commissioning inspections of the buildings by inspecting the containment's concrete slab, the interior concrete structures and the concrete part of the containment walls. The procedures applied by the licensee and the plant supplier in verifying readiness for commissioning inspections have proven functional.

Manufacture of equipment and piping continued in 2013. STUK's construction inspections, intended to ensure that the manufacture of components complies with requirements, still revealed issues preventing the inspections from being carried out as planned. The most severe of these issues concerned the equipment's readiness for inspection and open issues related to construction plans. STUK required that the licensee and plant supplier revise their procedures to enable inspections.

Testing of equipment and systems in the turbine island continued. The absence of operational I&C at the nuclear island prevented test operation except for the commissioning of individual equipment independent of the plant I&C. Also the fact that installation of some of the equipment and piping of the nuclear island is also incomplete prevents the commissioning of process systems. Test runs of electrical systems, on the other hand, continued with the help of temporary control automation. STUK monitored the progress of commissioning in connection with its onsite inspection visits and assessed sufficiency of the licensee's actions in construction inspection programme inspections. STUK reminded the licensee that result reports for commissioning tests were not completed immediately after completion of the tests. They should be completed immediately after the tests to ensure that all the persons who participated in the test are still present and remember the tests clearly. No other significant non-conformances or defects were observed.

Besides technical trial runs, commissioning also includes verification of the organisational capabilities to operate the plant in a safe manner. Safe operation requires, for example, the availability of a sufficient number of licensed operators and maintenance personnel familiar with the plant. The required operating procedures must also be available for the plant. The unfinished state of system design has prevented the training simulator at the plant from being finalised and the simulator training of operators from being started. The production and validation of operating procedures has also been delayed due to the unfinished state of system design.

At TVO's request, STUK began a pre-review of the operating license application documents before the submittal of the actual application. The documents submitted for pre-review must form a logical entity, and represent the final plant design. The pre-review will balance the workload of the various parties to the process as completed thematic sections are reviewed in advance. All the documents that are delivered to STUK in connection with an operating license application will be reviewed by STUK at the operating license stage as a whole, and STUK will approve their key parts before delivering a safety assessment and a statement on the operating license application to the Ministry of Employment and the Economy. In 2013, STUK pre-reviewed a chapter of the final safety analysis report concerning processing of radioactive waste and submitted its observations regarding the text to TVO. Furthermore, STUK processed a chapter of the safety analysis report on the accident analysis methodology and performed comparative analyses to verify correctness of the accident analyses made by the plant supplier. No major discrepancies were observed in the results of the analyses made. More comparison analyses will be made in 2014.

Based on the construction inspection programme and other oversight activities by STUK, the methods, operations and adequacy of TVO's organisation have mainly been found to be at a good level, for example as far as the commissioning of the plant is concerned. STUK encouraged the licensee to further improve the processing and closing of open items in the project to avoid them from being transferred to the commissioning and operating license stages. Furthermore, STUK required from TVO a report on how the procedures included in the management system of TVO, and of the Olkiluoto 3 project and the instructions in the project manuals will be reconciled prior to the loading of nuclear fuel, so that no confusion about which instructions are to be followed will occur.

In 2013, STUK ordered a study on the status of the safety culture at the Olkiluoto 3 construction site. According to the study results, the safety culture of the Olkiluoto 3 project has improved over the past few years and also communication between the involved parties has improved. The study recommended that TVO and the plant suppliers should try to reach a consensus about the safety culture and continue supporting the work of the safety coordinators.

During construction, TVO and the plant supplier have taken into account modification needs that have emerged as design of the various areas of technology has become more detailed. Defects detected in manufacturing and installation have either been corrected so that the original quality requirements are met, or it has been demonstrated by means of additional inspections or analyses that the requirements are met. The flaws in the work of various parties and in product quality have resulted in additional work to assess and rectify the problems. This has had an impact on the progress of the project but not on the compliance with quality requirements. In summary, based on the results of regulatory oversight, STUK is able to state that the original safety targets of the plant can be achieved.

4.3.2 Design

Plant and system design

STUK continued to review the detailed design of process systems, support systems and electricity systems. Almost all of the system descriptions corresponding to the final system design of the process and ventilation systems were processed in 2012. Only a few remaining descriptions were submitted in 2013. STUK has approved most of the process, support system and electricity system designs, but some of them will still have to be revised prior to the operating license stage to take into account requirements laid down in STUK's decisions. Furthermore, TVO announced that the plant supplier will make some additional plant system modifications that will require STUK's approval.

The most important part of plant design that has not been fully processed yet are the plant's I&C systems. In 2013, STUK approved the I&C system design processes, and STUK has reviewed most of the I&C architecture design processes. STUK has also approved the I&C system platforms in so far as the approval can be given prior to a test run. In relation to the design of the I&C systems, STUK has required that TVO and the plant supplier specify unambiguous design requirements for the overall architecture of I&C systems, and that the I&C architecture created on the basis of the requirements is described. In terms of safety, it is important to specify unambiguous requirements for the independence of the various I&C systems involved in the architecture, because the I&C systems will back each other up. TVO submitted the general architecture design documents to STUK in the spring of 2013. At the end of the year, the documents were still being reviewed. TVO also submitted the first plans regarding individual I&C systems to STUK at the end of the year.

Fault analyses of the plant and system design

An unfinished issue in relation to fault analyses important to safety has been determining the approval criteria for software faults in I&C systems. In 2011, STUK required TVO to investigate further and account for the impacts of faults and malfunctions in I&C systems of lower safety classes on the electrical systems and other functions of higher safety classes. In the spring of 2013, TVO requested from STUK more detailed instructions on how faults in I&C software should be taken into account in plant design, and how the possible consequences of software faults should be assessed. In its decision on the issue made in 2013, STUK required that TVO take into account the possibility of faults in the I&C system software, and the possible consequences of such faults, when assessing the implementation of the plant's general design bases. Several meetings with TVO and the plant supplier on the analysis methods to be used were arranged during the autumn. STUK is still waiting for TVO's response on the analyses to be drafted on the consequences of possible software faults.

In 2013, STUK reviewed the failure mode and effects analysis method description for I&C systems and I&C devices (the non-programmable part) and issued a clarification request stating that the description must be revised to comply with the requirements by the end of February 2014. STUK also simultaneously offered its view on the I&C fault analyses as a whole, the goals of single analyses and potential problems.

No common-cause failure or failure mode and effects analyses pertaining to the process and electricity systems or devices were submitted to STUK for processing during the year under review. STUK has observed some defects in the previous analyses, which is why the analyses must be revised.

Transient and accident analyses

The review of the methodology reports of the transient and accident analyses for the Olkiluoto 3 final safety analysis report began in the autumn of 2012 and preliminary review observations were processed with TVO and the plant supplier in work meetings. The observations were submitted in a letter in early 2013. The letter required that TVO take into account the questions and comments when drafting its operating license application.

Transient and accident analyses drafted in compliance with the methodology reports have been unofficially submitted to STUK to be used as an aid when reviewing the methodology reports. TVO has announced that errors detected in three computation codes will cause minor changes in the results of a couple of the analyses. Code error

To verify the correctness of the plant supplier's transient and accident analyses, STUK has ordered comparison analyses with the same initial data. The methods and codes used in the comparison analyses are not the same as those used by the plant supplier.

Of the transient and accident analyses ordered by STUK, the calculations of the reactor coolant pump trip during the first fuel cycle and steam line break analyses were completed in 2013. The comparison analyses of radiation doses to the population due to accident releases were also completed in 2013, and the results were acceptable. Based on these comparison analyses made by an independent party, the plant supplier's analysis results can be considered acceptable.

More comparison analyses will be made in 2014.

reports describing the impact of the errors will be submitted to STUK in connection with the next official analysis report update.

In 2013, STUK also reviewed analyses on the cooling of the spent fuel pool by means of evaporation in case of a potential loss of the pool cooling system, and radiation doses caused by a potential large passenger airplane crash in the immediate surroundings of the plant. No significant deficiencies were found in the reviews.

Probabilistic risk assessment

The review of the probabilistic risk assessment (PRA) of Olkiluoto 3 focused in 2013 on ensuring the realisation of the fundamental design principles in the detailed design documents of systems and structures (including I&C architecture, system descriptions, topical reports and fault analyses). In addition, the goal has been to ensure that adequate provisions sufficient precautions are in place regarding area events (internal fires and flooding), as well as external events, with the help of e.g. the latest update of Olkiluoto's PRA model. Revisions of the materials delivered for information are expected since the detailed design, particularly that of I&C systems, is still in progress.

Radiation safety

In connection with the suitability assessment of electrical and I&C equipment, STUK also reviewed compliance with requirements regarding the radiation resistance of equipment in normal operation and during accidents. STUK also took part in the factory acceptance testing of the components of the Olkiluoto 3 radiation measurement systems in 2013. At the licensee's request, the deadlines for updating several radiation measurement system design documents were postponed in 2013.

Plant fire safety

In 2013, STUK completed a review of the updated fire hazard analyses (FHA) regarding the sufficiency of fire compartmentalisation structures and the protection of penetrations. In addition to the structural fire hazard analyses, the review of fire hazard functional analyses (FHFA) was completed. STUK required that the FHA and FHFA analyses be verified to ensure that they are up to date in terms of actual plant design. STUK will also verify the sufficiency of the results of fire safety studies on fire-retardant power and I&C cables performed by VTT Technical Research Centre of Finland in 2011 in terms of actual plant design.

Design of components and structures

STUK continued reviewing the detailed plans of safety class 2 equipment and structures in 2013. The key plans include the construction and implementation plans of steel structures, the construction plans of mechanical equipment, and updated construction plans. STUK has also reviewed and approved containment testing plans related to the commissioning of the nuclear power plant unit.

STUK has reviewed and approved nearly all construction plans of safety-classified concrete structures. In 2013, STUK approved non-conformance reports regarding the containment liner after an extensive verification process by means of tests and analyses. Revised plans to specify the structural descriptions of the fuel pool steel lining were also approved.

Furthermore, in 2013 STUK reviewed most of the design documents for the steel platforms that were originally intended to be used only as maintenance platforms. The safety significance of the steel platforms has increased because process piping and equipment important to safety will be supported on them, unlike in the original plans. This applies to around 200 steel platforms. The steel platforms have been used for component installation purposes after construction inspections done in stages. Compliance with the requirements set by plant operation will be confirmed before the final commissioning of the steel platforms. STUK has done inspection visits to the site and verified that TVO's inspections have progressed in line with the approved procedure. STUK will review the final design documentation of steel platforms before starting its own commissioning inspections where compliance with the requirements will be ultimately verified.

In 2013, STUK continued reviewing final strength analyses of the main components of the reactor coolant system. STUK was provided with supplementary and modification documentation on the strength analyses, where the modifications made during manufacture had been taken into account. The basic inspection plans of inservice inspections, periodic inspection programmes and qualification documentation concerning inspection systems compliant with YVL Guide 3.8 regarding pressure vessels, heat exchangers, pumps, valves and pipelines continued in 2013.

Design of the nuclear island piping also continued in 2013. Calculations of piping support structures and piping stress analyses, as well as construction plans and construction plan updates concerning safety class 1 and 2 components were submitted to STUK for review. The review workload of STUK remained high in 2013 due to the large volume of design modification documents.

Review of the design of the I&C of fuel handling systems and safety class 3 cranes continued in 2013. The design documentation of electrical and I&C systems of safety class 3 equipment must be approved and the equipment tested before use, but some of the cranes have been used for installation work at the Olkiluoto 3 construction site before these measures. However, approval of the design and tests is a prerequisite for the final commissioning of lifting and transfer equipment before fuel is transferred into the reactor.

4.3.3 Construction

Except for some final touches, construction work on the Olkiluoto 3 buildings is completed. In 2013 STUK oversaw and inspected grouting, anchoring and injecting related to component installations, as well as the installation of steel platforms.

In November 2013, STUK started commissioning inspections of the buildings by inspecting the containment's concrete slab, the interior concrete structures and the concrete part of the containment wall. Commissioning inspections of the monitoring systems related to the containment structures started in December 2013.

The procedures to determine readiness to start commissioning inspections have proven functional. These procedures have served to ensure that the plant supplier and TVO have reviewed and approved the structures and their testing plans before STUK is invited to complete its inspections.

4.3.4 Manufacture of components and piping

The manufacture of Olkiluoto 3 components and piping continued in 2013. STUK oversaw and inspected the manufacture of safety class 1 and 2 piping, tanks, heat exchangers, pumps, valves and steel structures. STUK also oversaw and inspected the manufacture of fuel handling equipment as well as the emergency diesel generators and their auxiliary equipment.

STUK's construction inspections, intended to ensure that the manufacture of components complies with requirements, still revealed issues preventing the inspections from being carried out as planned. The most severe of these issues concerned the equipment's readiness for inspection and open issues related to construction plans. As early as in 2008, STUK required TVO and the plant supplier to ensure before the inspections that the prerequisites for construction inspection exist. TVO and the plant supplier have changed their supervision and inspection procedures with the aim of ensuring readiness for inspection prior to STUK's inspections.

The manufacture of auxiliary equipment for the emergency diesel generators continued in 2013. Changes to the pipe system design delayed the manufacture and installation of prefabricated pipes in the diesel generator facility. Prefabrication of the emergency diesel generators' auxiliary system piping continued in France. A large number of faulty welded joints were detected in a radiographic inspection of the prefabricated piping. The plant supplier required re-welding of these prefabricated elements. The licensee required comprehensive radiographic inspections prior to installation of the piping to verify that the piping complies with the requirements. Most of the inspections will be performed in 2014. Repairs and inspections delayed signifigantly the progress of the installation work in the diesel building in 2013.

4.3.5 Installation

Installation of the internals of the reactor pressure vessel, installation of the rod control rod drive mechanisms and accessories of the reactor pressure vessel head were completed in 2013.

The plant supplier did not comply with the appropriate quality requirements when abrading the welds of the reactor coolant system piping, which means that the roughness of the surface profile will make, among other things, future inservice inspections more difficult. inservice inspection ability of the joints will be verified in 2014 after the qualification of an appropriate inspection method.

Lining of the reactor building and the fuel building pools and installation of filters were completed in 2013.

The plant supplier continued piping and support installation in the reactor building in 2013. Formed parts of small-diameter piping had to be repaired/replaced because of detected superficial faults. Part of the piping in the nuclear island was high-pressure washed to remove impurities from the interior surface of the pipes. STUK has followed the progress of pipe installations and the activities by the licensee, plant supplier and the plant supplier's subcontractors. In 2013, STUK paid attention to the personnel resources of the plant supplier and the licensee in welding work supervision. STUK required that the previously issued supervision plan be followed. The licensee's resources were deemed sufficient, but defects were observed in the plant supplier's resources.

Problems with the design and manufacture of auxiliary equipment continued to delay the installation work in the diesel buildings in 2013.

Most of the electrical equipment and cabling in the nuclear island and most of the containment cable penetrations were completed in 2013. However, nuclear island I&C systems were not installed because the systems are still unfinished. In 2013, STUK oversaw the installation of electrical equipment and cabling and preliminary electricity system commissioning activities onsite.

Some of the low voltage cable trays on the plant's main cable routes are too full, which is why cables have been and will be rerouted. Furthermore, some cable trays have been made wider and several parallel trays have been installed in some places. Some cables have also been installed on top of each other on the trays. In 2013, STUK reviewed a report on acceptability of the multi-layer cable installation method. The report supplemented a cable dimensioning report already approved by STUK. STUK approved the proposed multi-layer installation principles. In connection with an electrical engineering inspection, STUK requested from TVO a report on how compliance with the requirements of the electric shielding and power distribution of 'parallel cabling' can be proven. The term 'parallel cabling' refers to power being supplied to one electric consumer with more than one cable.

STUK inspected TVO's installation supervision in several inspections carried out in accordance with the inspection programme for the construction stage and in connection with regulatory activities onsite to verify the sufficiency of TVO's supervision methods. During the daily inspection rounds compliance with approved procedures was monitored, among other things. STUK also participated in quality audits of subcontractors carried out by the plant supplier and TVO onsite. No significant deviations were observed.

4.3.6 Commissioning

Equipment and system test runs

Testing of equipment and systems in the turbine island actively continued in 2013. In the nuclear island, the absence of operational I&C still prevents any large-scale testing. Furthermore, some of the equipment and piping installation work in the nuclear island are still incomplete.

The next important milestone in the testing of the nuclear island will be the pressure and leak tightness tests of the containment. The plan is to complete these tests in early 2014. In 2013, the plant supplier focused, in terms of the commissioning of the reactor island, mainly on preparing the testing of the containment: leak tightness testing of the containment isolation and testing of the doors leading to the containment (personnel airlock, emergency airlock and material hatch) started in early 2013. The previously started testing of electricity systems continued. A temporary control I&C system is used in the testing because the final operational I&C has not been installed yet. Testing of the building technology systems (such as telephone systems, fire detection systems and lighting systems) has also continued at the reactor island.

STUK has supervised the commissioning tests (such as the personnel airlock, material hatch and leak tightness tests of isolation valves) onsite. STUK regularly oversees the commissioning of electricity systems. The licensee's actions have been pertinent in connection to any problems in the commissioning of the electricity systems. TVO's own supervision of commissioning activities were reviewed in the spring as part of the construction inspection programme. The inspection focused on the performance of test runs and the processing of documents including test results. TVO's own supervision was deemed comprehensive in the inspection. However, STUK voiced its concern regarding the fact that it takes a long time to draft result reports after testing, even though the actual results are written down during the test.

Inspecting of commissioning test programs is an important element of STUK's regulatory work. STUK has approved all the turbine island commissioning testing programs plans that require STUK's approval. In 2013, a couple of dozen test programmes were submitted to STUK for approval. STUK posed some requirements concerning the test programmes but no major defects were observed. Relatively few test programmes were submitted to STUK because most of the reactor island system test programmes will not be updated until the I&C design has been completed. Furthermore, TVO announced that several of the already approved test programmes will be revised, which means that they have to be submitted for approval again.

Preparations for future operation of the plant unit

Besides technical test runs, commissioning also includes verification of the organisation's capability to operate the plant in a safe manner. The prerequisites of safe operation include for example an adequate number of licensed operators and the necessary plant documentation, such as procedures and the operational limits and conditions.

The plant supplier has not been able to provide operator trainees with the required simulator training yet because the simulator does not yet correspond to the final plant design. This is caused by the fact that the I&C design is incomplete. In an inspection as part of the construction inspection programme in March 2012, STUK required that TVO produce a plan on how TVO will approve the simulator for training while the current situation prevails. TVO submitted the plan to STUK in the spring of 2013 and STUK approved it as such. The simulator will be updated once the I&C design is complete. When this has been done, several test cases will be run on the simulator. The test runs will be performed to assess whether the simulator describes the plant accurately enough for it to be used in training.

The preparation of plant procedures and the operational limits and conditions, as well as the validation of procedures and control room and operating interfaces, have been delayed due to the delays in the I&C design.

4.3.7 Reviewing documents related to operating license application

STUK has agreed with TVO that STUK may review parts of the operating license application documents before the delivery of the actual operating license application. This will balance the workload of the various parties as completed thematic sections are reviewed in advance. The documents submitted for advance processing must form a unified whole, and represent the final plant design. As a result of the pre-review, STUK presents a decision including potential observations and requests for further clarifications. The pre-review also functions as practice for the review procedures planned for the operating licensing stage. All the documents that are delivered to STUK in connection with an operating license application will be reviewed by STUK at the operating license stage as a whole, and STUK will approve their essential parts before delivering a safety assessment and a statement on the operating license application to the Ministry of Employment and the Economy.

The pre-review of the operating license application documents began in 2012 with the review of the methodology reports and radiological analyses presented in Chapter 15 of the final safety analysis report. Chapter 11, Processing of radioactive waste, was also submitted for pre-review in 2013. STUK's review comments were sent to TVO as an appendix to the decision.

4.3.8 Organisational operations and quality management

Organisation and performance of management system

The total number of personnel working at the Olkiluoto 3 project site towards the end of 2013 was around 2,160, of which around 1,815 people were from the plant supplier's site organisation and around 345 people from TVO's project organisation. TVO's project organisation consists of project personnel (around 65), TVO's line organisation personnel (around 80) and consultants (around 200). The number of people in the plant supplier's construction site organisation has decreased from last year.

In 2011, TVO performed an assessment of the performance and scope of the Olkiluoto 3 project management system. Many improvement areas were observed in this assessment. These areas were developed in 2012 and 2013. Areas requiring improvement included standardisation of work planning between the Olkiluoto 3 project and the operating plants and standardisation of indicators used for the project and during the operational stage.

The management system of the Olkiluoto 3 project is part of TVO's management system. In compliance with the project contract, the plant supplier's instructions are followed. In addition to the plant supplier's instructions, there is a separate quality system for the Olkiluoto 3 project of TVO. It complements TVO's management system. The procedures have been developed over the course of the project, and an acceptable level in terms of commissioning has been reached, but managing the project's procedures as a whole requires special competence – the commissioning responsibilities and procedures are specified in agreements between TVO and the plant supplier, the commissioning handbook, the commissioning plan and the commissioning concept as well as other separate TVO procedures on commissioning. STUK required that TVO find out how the procedures of the Olkiluoto 3 project and the procedures included in TVO's management system are to be applied after the loading of fuel so that there will be no uncertainties as to which procedures apply.

Quality management and supplier monitoring

TVO's independent quality assurance unit monitors the quality of the Olkiluoto 3 project and its management by processing any critical non-conformances observed in the operations of the plant supplier and its subcontractors, product non-conformances and audit results, as well as by recording statistics and analysing information pertaining to the underlying causes for the non-conformances. Another concern in the OL3 project is the large volume of open items, and their postponement until the commissioning and operating license phases.

STUK has previously required that TVO develop its supplier supervision and control procedures. Comprehensive supervision of the key subcontractors working at the construction site was improved in 2013. For example, TVO selected six of the largest companies working at the construction site and appointed a TVO delivery controller for them. Most of these companies do installation work at the plant site. The delivery controllers submit biannual reports to the heads of their units at TVO. Any issues needing more studies will be discussed together with the companies being supervised and the plant supplier. Commissioning and related organisations have not yet been assessed in terms of the need for delivery control. A separate survey on the need to apply delivery control to the I&C system will also be made.

STUK noted, in connection with the inspections included in the scope of the construction inspection programme, that experienced auditors of TVO have been lost. Thus, TVO must ensure that the auditing activities will remain proper by determining requirements for auditor qualifications and experience.

TVO's design data review

During the Olkiluoto 3 project, STUK has paid attention to the fact that there have been defects in many of the licensing documents submitted to STUK for reviwing. Furthermore, documents which have not been approved by TVO have been submitted to STUK for reviewing. STUK has required that TVO revise its document management process so that no unfinished issues will be submitted to STUK for reviewing and the assessment on compliance with safety requirements made in connection with TVO's own review will be clearly traceable. In connection with the inspections made in 2013, TVO presented to STUK its development measures which aim to ensure that compliance with safety requirements is verified more thoroughly. STUK will monitor sufficiency of the licensee's measures in connection with the inspections included in the scope of the construction inspection programme.

Safety culture

In 2013, STUK ordered a study on the status of the safety culture at the Olkiluoto 3 construction site. Based on the study results, one can state that the safety culture of the Olkiluoto 3 project has improved over the past few years. The study results also show that communication between the organisations working at the plant site in issues pertaining to the safety culture and other issues pertaining to safety has improved as well. Formal meeting practices between the parties have also been established to improve communication. According to the study, the fact that the plant supplier's project organisation is located at the construction site has improved the management's understanding of the conditions under which the project is implemented.

Compliance with rules, regulations and procedures is of utmost importance at the Olkiluoto 3 construction site. Processing practices at the construction site have been very hierarchical, which has sometimes prolonged the processing times. The attitude towards human errors made by individual employees is either neutral or punitive. People in general understand the significance of safety issues at the construction site, but their understanding may be limited to a narrow field.

TVO employs two safety culture coordinators who promote and assess the safety culture. The plant supplier has also invested in promotion of the safety culture by hiring its own safety culture coordinator. Since sufficient resources have been allocated, the safety culture coordinators are able to work daily at the construction site.

The safety culture principles of TVO and the plant supplier are divergent. TVO's principles applied to the construction site comply with those applied to the operating plants. The plant supplier applies its own safety culture principles also to other projects, which is why they are of a more general nature. The divergent safety culture principles of TVO and the plant supplier may confuse the subcontractors who need to follow these principles. The study recommended that TVO and the plant suppliers should try to reach a consensus about the safety culture and continue supporting the work of the safety coordinators. The study also noted that financial issues and schedules are major risks of the project and the fact that the construction site is a multicultural working environment requires more investments in communication about the safety culture.

4.3.9 Safeguards of Nuclear Materials

STUK performed a safeguards inspection o the Olkiluoto 3 design data (technical basic data) with IAEA and the European Commission. The inspection focused on locating the key issues in terms of nuclear non-proliferation control, such as fuel storage locations and transfer routes. In the same occasion, a meeting on practical implementation of the systems related to nuclear non-proliferation control (such as CCTV cameras) was arranged.

4.4 New nuclear power plant projects

STUK arranged several meetings with TVO and Fennovoima on a variety of issues such as the safety culture, safeguards of nuclear materials, civil engineering, planning of licensing, management systems, seismology, radiation control, plant technology and interpretation of the requirements in STUK's draft procedure YVL B.1. STUK's experts participated in supplier assessment of TVO and Fennovoima as observers.

In project meetings and the meetings focusing on a particular issue, STUK stressed the significance of the planning of licensing and monitored development of the license applicant's management and quality control systems, operations of the power companies and the preparation of their organisations for the new nuclear power plant project. In these discussions, STUK aimed at improving the power companies' competence, as the construction licence stage will start soon.

Contrary to expectations, TVO and Fennovoima did not submit any significant volume of documentation to STUK for approval in advance. An amendment of section 55 of the Nuclear Energy Act came into force in the autumn of 2012. According to the amendment, STUK can approve equipment and structures prior to the construction licence decision and also review in advance plant and system level documentation. In the autumn of 2013, STUK started assessment of the AES-2006 plant based on a request of Fennovoima. Preparation for a potential supplement to the Fennovoima decision-in-principle also in terms of the assessment of organisations and plant siting was simultaneously started.

As part of the preparation for new plant projects, STUK kept in contact with the Ministry of Employment and the Economy, the municipality of Pyhäjoki and other authorities in the region who are involved in the Pyhäjoki cooperation committee. In June, STUK arranged a national licensing seminar. In addition to the license applicants, representatives of nuclear power plant suppliers were invited to the seminar. The discussion theme was the importance of the licensing stage and the status of plant design at the construction licence stage.

STUK continued development of its own requirement management procedures. STUK hired an expert in requirement management and started the expert's orientation. As the completion of the YVL Guides was postponed, the setting of more specific goals for the plant and system design to be reviewed at the construction licence stage was also postponed.

STUK reviewed Fennovoima Oy's nuclear security procedures and related documentation.

Including the safeguard requirements in the design and construction of new plants as early on as possible is important both in terms of the operator's own supervision activities and the safeguards of nuclear materials arranged by STUK and international parties. TVO submitted preliminary design data for Olkiluoto 4 in November 2012 and Fennovoima submitted preliminary design data for Hanhikivi 1 in July 2013. The European Commission issued Material Balance Area codes for the plants and submitted the data to IAEA. Thus, international safeguards of nuclear materials organisations have been able to start the planning of their regulatory actions and regulation of the projects.

4.5 Research reactor

VTT's FiR 1 research reactor was commissioned in 1962. The reactor was built for research and educational purposes and for producing isotopes. The reactor underwent considerable modifications in the 1990s, and in 1999, the use of the reactor for the boron neutron capture therapy (BNCT) of cancers in the head and neck area began. BNCT treatment and the related research became the reactor's most important use in the 2000s. In 2013, FiR 1 mainly focused on isotope irradiation and arranging basic training in reactor physics.

The operating license for FiR 1 is valid until the end of 2023. However, VTT Technical Research Centre of Finland has decided to shut down and decommission the reactor earlier due to financial reasons. VTT submitted an up-to-date plan on nuclear waste management at FiR 1 to the Ministry of Employment and the Economy in June 2013. The document includes a preliminary reactor decommissioning plan. The plan is to continue operating the reactor while the decommissioning plans are being specified. VTT started an environmental impact assessment (EIA) procedure for the reactor's decommissioning by submitting an EIA programme to the Ministry of Employment and the Economy on 6 November 2013. According to a preliminary schedule included in the programme, the reactor will be shut down in late 2015 and demolished over the course of around two years. Based on a request by the Ministry of Employment and the Economy, STUK submitted a statement on the nuclear waste management plan and prepared a statement on the EIA programme for the Ministry. In these statements, STUK paid special attention to the safe operation of the reactor, more specific planning of the demolition, development of physical protection and more specific planning of the nuclear waste management during the decommissioning stage.

There are safety requirements for decommissioning in the Nuclear Energy Act, acts and decrees on the use of radiation and the YVL Guides. A new YVL Guide, YVL D.4, deals with the decommissioning of nuclear facilities. It entered into force on 1 December 2013 for new nuclear facilities. The plan is to extend the Guide to cover FiR 1 based on a decision by STUK in 2015. The Guide states that the licensee must, for example, submit a final decommissioning plan to STUK for approval.

STUK completed inspections of FiR 1 in compliance with the regulatory plan. The inspections involved operational safety, physical protection, emergency preparedness, nuclear non-proliferation control, nuclear waste management and radiation protection. STUK assessed the updated physical protection procedures of the research reactor, taking into account the decommissioning plans. Over the course of the year, STUK performed three reviews of nuclear material records, one of them in cooperation with the European Commission and one of them an inventory review together with the Commission and IAEA. The plant was studied in detail in connection with the inventory review because IAEA and the Commission have also started preparations for the decommissioning of FiR 1.

In 2013, STUK approved the person in charge of the nuclear non-proliferation control of FiR 1 and deputies in charge of physical protection and emergency preparedness. STUK approved one supervisor and two operators for a period of four years. Furthermore, VTT submitted to STUK for approval proposals on one supervisor, two operators and one operator candidate at the end of the year.

4.6 Encapsulation facility and repository for spent nuclear fuel

4.6.1 Processing of construction licence application

At the end of 2012, Posiva submitted to the Government a construction licence application for an encapsulation facility and repository for spent nuclear fuel and submitted to STUK the construction licence application documentation laid down in the Nuclear Energy Decree and Government Decree no. 736/2008. In addition to submitting the documents, a representative of Posiva personally presented the documents to STUK.

Completeness review(s)

Processing of the construction licence application for an encapsulation facility and repository for spent nuclear fuel was started at STUK by a completeness review that verified sufficiency and appropriateness of the submitted documentation. STUK decided to start further processing of the documents. The completeness review was implemented in two stages because the documentation submitted by Posiva at the turn of the year did not include safety case documentation pertaining to long-term safety.

The first part of the completeness review, i.e. the review of the documentation excluding the safety case, was completed in April 2013. The decision stated that Posiva's construction licence application documentation is mostly comprehensive. However, some of the documents need to be supplemented and STUK decided to start the processing of these documents once Posiva has supplemented them. Such documents included Chapters Y2 (Plant description), Y9 (Behaviour of the encapsulation facility and repository in case of a transient and accident), Y11 (Organisation and functions), a classification document proposal, a report on the management of ageing and a licensing plan. Furthermore, system descriptions submitted in connection with the preliminary safety analysis report were not processed because of deficiencies in the classification. The completeness review also stated that a project plan and its appendices, a safety management report, a safety culture report and environmental condition classification of the encapsulation facility's rooms were not included among the submitted documents.

The safety case pertaining to long-term safety was submitted to STUK in several stages during 2013. The last key documents were submitted to STUK in October 2013. The scope of these documents was reviewed in the same way as the scope of the other documents, and a decision on the completeness was issued in November 2013. Minor deficiencies were observed, but the documents were approved for further processing.

Plant design, plant construction and safety classification

STUK arranged several meetings focusing on specific technical issues based on the observations made during the completeness review. The safety classification and system documentation were discussed in these meetings. Thus, the licensee has been able to take into account the observations made so far when updating the application documentation. A review of the system descriptions were not started until the licensee submitted the revised documents at the end of the year.

In terms of the underground facilities, the review focused on the division of the underground facilities for different systems and their safety classification: the systems and the classification must unambiguously take into account the long-term safety viewpoint. Special attention was paid to the consistency of the safety case with the safety classification.

When processing the descriptions of the repository location, final disposal and long-term safety in the safety analysis report, STUK paid attention particularly to Posiva committing to a sufficient extent to the requirements posed by the regulations with its comments.

Operational safety

Chapters Y7, Radioactive materials, Y8, Radiation protection and Y9 Behaviour of the encapsulation facility and repository in case of a transient and accident, of the preliminary safety analysis report deal with operational safety. When reviewing them, STUK will verify that the safety of employees and the environment have been taken into account in the design of the encapsulation facility and repository.

STUK submitted a request for supplementary information to Posiva on Chapter Y7 in October

2013. Chapter Y7 includes the radioactive material contents in the spent fuel, but there is no assessment on the volume of radioactive materials that will be accumulated in the facility and its systems, such as filters. In the request, STUK required that Posiva add the missing information in Chapter Y7. Review of the other chapters pertaining to operational safety in the safety analysis report was started in 2013 and will be continued in 2014.

Posiva submitted, in connection with the construction licence application, a probabilistic risk analysis for the design stage. STUK started the review of the risk analysis in 2013 and will continue it in 2014. So far, no deficiencies that warrant a request for supplementary information have been found.

Long-term safety

The actual review of the documents started once the coverage review of the safety case was complete. In terms of the repository site and the facility, STUK has so far processed geological descriptions of the site, the bedrock classification system, design bases of the final disposal system, initial state of the system, a performance assessment and background data on hydrogeology, rock mechanics and hydrogeochemistry. A review of engineered barriers was started with their design bases, initial state and its feasibility, as well as performance assessment and its justification.

A review related to the safety assessment focused on, for instance, methodology used to create the scenarios describing possible lines of evolution of the final disposal system and their coverage, compliance of the performance analysis of the barriers with the base scenario, preparation for lines of evolution not in line with the expected evolution of the final disposal system (base scenario) in case an variant scenario or disturbance scenario is realised, compliance of the safety analysis calculations with the scenarios and justification of long-term safety.

STUK is using a group of international experts as a supportin the review. STUK has used a lot of time in launching its own review procedures as well as in planning, launching and managing the review work of these experts. This was necessary for STUK to benefit as much as possible from the review work of the external experts when reviewing all the documents.

As the review proceeded, STUK submitted to Posiva requests for additional information in following areas, site investigations, technical barriers and long-term safety analyses. STUK required that Posiva submit to STUK the background reports STUK deemed the most important for the safety case. A total of 52 documents must be submitted by 30 April 2014. In addition to compiled requests for additional information, STUK submitted more detailed requests for additional information to Posiva. Based on the review of site investigation reports, requests for additional information on the brittle deformation structural models modelled by Posiva, the model of the facility to be excavated, a hydrogeochemical database, missing site related reports and uncertainties in the hydrogeological discrete fracture network model were submitted to Posiva. In terms of the safety analysis, STUK submitted a request for additional information in October where it required that Posiva 1) specify in more detail the safety functions of the barriers in compliance with section 2 of the Government Decree no. 736/2008 or provide justification as to how the safety functions defined by Posiva comply with the above-mentioned requirement and 2) further define the performance targets specified for the safety functions by presenting for each performance target a criterion describing the charactheristics of the barrier that ensures the performance of a safety function.

STUK arranged three workshops when reviewing the safety case. Participants of these workshops included the international experts who support STUK's review work. The first workshop was also the kick-off meeting of the safety case review, and it took place in March 2013. In this workshop, the consultants participating in the review were familiarised with the background of the Finnish spent nuclear fuel repository project, the licensing procedures and the planned review process. Furthermore, Posiva presented the licence application's safety case documentation.

A second, smaller meeting was arranged in June. The focus of this meeting was on possible critical issues based on the first reviews of the safety case. A total of fourteen issues were discussed. A couple of them were selected for the next larger workshop that took place in September 2013. Four to five themes were laid down based on the workshop in September to be processed in a separate workshop in addition to the document review.

The first subject-specific workshop was arranged on 10–13 December 2013. This workshop focused on reviewing the rock classification system used by Posiva, rock mechanics at Olkiluoto and sufficiency of the thermal characterisation of the bedrock.

In addition to its own review work, STUK followed the progress of a similar licence review process in Sweden. STUK agreed with the Swedish authority SSM that invitations to representatives of STUK/SSM will be sent to all of the workshops arranged when processing these licence applications. In 2013, STUK participated in workshops arranged by SSM on seismology and biosphere analyses.

Quality management

As part of the repository's construction licence application, Posiva submitted a report on construction project quality management to STUK for approval. In this report, Posiva describes the procedures to be used to verify the quality of operations and products. The quality assurance procedures to be applied to the design and construction of the Posiva repository are described in Posiva's management system and several of the documents related to the project. When reviewing the report, STUK noted that Posiva's procedures have been developed to such an extent after the drafting of the report that some of the descriptions in the report are no longer up to date. In its decision on the report, STUK required that Posiva update the report, taking into account the development of the activities and the procedures guiding it. STUK will continue processing the report in 2014 once Posiva has submitted the updated documents.

Detailed quality management procedures to be applied in practice during construction and the quality management organisation will be described in separate project and quality plans to be drafted at a later date. Posiva submitted the plans to STUK for review in 2013. The project plan describes the construction project's goals, scope and division. The plan also illustrates key policies to be applied to project management and the completion of the project, plans, duties of the units that will participate in the project, interfaces with other projects and key processes. In the quality plan, Posiva describes the project's goals and the procedures to be applied to reach the goals. The plan also illustrates the quality management duties laid down in the project plan and determines the parties responsible for them. STUK is of the opinion that the project and quality plan are key documents pertaining to the implementation, control and quality management of Posiva's construction project. Since the plans are important, STUK has requested an assessment by an outside expert to support its own review. The expert compared the plans to STUK's requirements and international proven standards. The assessment reports included all non-conformances found in the plans and observations that STUK deemed especially important. Thus, STUK required that Posiva assess the feedback from the reports and take it into account to the extent necessary when updating the project plan and quality plan. STUK also required that Posiva submit updated versions of the plans to STUK in early 2014.

STUK's regulatory activities and assessments also cover the licensee's suppliers. In 2013, STUK participated as an observer in four audits performed by Posiva on its equipment suppliers. The purpose with these audits was to verify that the supplies are capable of supplying products that comply with the requirements. By participating in the audits, STUK was able to assess Posiva's auditing activities and their functionality as well. STUK is of the opinion that Posiva's auditing is advanced and complies with the requirements.

According to the Nuclear Energy Act, Posiva must arrange for STUK appropriate and sufficient opportunities to conduct its regulatory activities in Finland and abroad. As part of the construction licence application, Posiva submitted to STUK a report as laid down in the Nuclear Energy Decree on providing the preconditions for the regulatory activities. In this report, Posiva describes the procedures it has planned to use to ensure that STUK will have the opportunity to inspect equipment and structures, monitor their manufacture, assess the design and manufacturing organisations and conduct investigations as necessary. STUK required that Posiva supplement some parts of the report. For instance, STUK wanted Posiva to provide STUK with an opportunity to assess and monitor type testing and testing of systems, equipment or structures that are conducted to find out whether the design requirements are met. Furthermore, STUK wanted the objects to be monitored also to include demonstration tests at the repository, the test programme and testing procedures. STUK also required from Posiva a summary describing the practical measures to be implemented to ensure that STUK can conduct its regulatory activities, including training on the procedures to be provided to personnel. STUK will verify these practical arrangements in 2014 when processing the construction licence application.

Emergency preparedness and physical protection

Posiva submitted to STUK a preliminary emergency response plan as laid down in section 35 of the Nuclear Energy Decree when submitting the construction licence application on 31 December 2012. After having reviewed the document, STUK sent a letter to Posiva on 9 October 2013 where it requested that Posiva update the preliminary emergency response plan and specify the cooperation procedures with the Olkiluoto power plant to be applied during the construction stage in terms of Posiva's emergency preparedness and the accident analyses. The results of the accident analyses will be used when determining the scope of protection measures required during a potential accident, for example. Posiva submitted its preliminary emergency response plan to STUK on 20 November 2013.

STUK processed the construction licence application documents on physical protection submitted by Posiva to STUK on 31 December 2012 and issued a safety classified decision on them, stating that the processing of the documents was discontinued because of deficiencies found in the documents. STUK submitted its decision to Posiva and a memorandum clarifying the observations made so that Posiva could update the documents and submit them to STUK. Most of the updated documents were submitted to STUK for approval in December 2013.

Safeguards of Nuclear Materials

Posiva submitted to STUK a description of arrangements required to non-proliferation of nuclear weapons as laid down in section 35 of the Nuclear Energy Decree when submitting the construction licence application on 31 December 2012. STUK performed a coverage review and noted that Posiva had identified the duties laid down in the Nuclear Energy Act, regulations and international treaties, but the plan did not describe how Posiva plans to ensure compliance with them. Posiva submitted to the European Commission and STUK the design information laid down in the Commission Regulation in 2013. STUK used the design information as part of the construction licence application review. Since safeguards of nuclear materials is international, several technical meetings with the European Commission and IAEA have been arranged on safeguards of nuclear materials at the Posiva plant.

4.6.2 Posiva's organisational operations and quality management

In 2013, Posiva continued the systematic improvement of its management system and policies. The improvements involve Posiva's management system as a whole. The management system comprises a management handbook, an organisation handbook, processes used to control the activities and procedures in the form of handbooks. To support the development, Posiva requested an external assessment of its management system. The improvements based on the results of the assessment will be continued in 2014. After a review of the updated management system and its processes, STUK further required that Posiva develop the processes, particularly the organisation's operations processes, to comply with the requirements laid down in STUK's YVL Guides. Posiva will submit new process charts and process descriptions on safety control and quality management to STUK for review in early 2014.

The procedures guiding Posiva's organisation have been compiled into several handbooks covering a variety of areas, such as the R&D handbook, the procurement handbook, the design handbook, the manufacturing handbook and the construction handbook. Most of these handbooks and the procedures to be included in them are still being drafted. Since the handbooks are key documents that will control the future construction project, STUK is of the opinion that they must be approved and taken into use by Posiva before construction of the repository starts.

Posiva developed its organisational structure in 2013 to better correspond to the needs of the preparation and construction stage after delivery of the construction licence application. A key organisational change was a transfer to a line management model from the process management model that had been in use since 2011. The units and departments were also revised, and the job descriptions of some employees were changed. Posiva merged its previous technology unit and R&D unit into a development unit and changed its construction unit into a project unit. Posiva implemented a safety assessment required by STUK for the organisational changes prior to implementing them. According to Posiva's assessment, the changes do not have any safety implications. Furthermore, Posiva must assess the implemented change by the end of 2014 to verify that the safety goals set for the change were met.

The organisation to be used during the construction stage of the repository will, according to Posiva's report, consist of Posiva's line organisation and a project organisation to be established for the construction stage. The line organisation will be in charge of the development of the final disposal concept and supporting functions at the company level for the implementation project. According to Posiva, the repository project's resources will be allocated from among the employees of Posiva and the owners, whenever possible. In late 2013, Posiva launched a project on improving its resources by hiring several experts in project management, implementation and control. The organisation will be complemented as necessary based on the construction requirements. STUK will continue evaluation of the Posiva organisation, personnel resources and competence as part of the construction licence application process in 2014.

STUK evaluated Posiva's management system and its functionality in 2013 by means of several inspections of Posiva's operations. The purpose of these reviews was to assess readiness of the Posiva organisation to carry out the construction project. STUK stated in its summary of the reviews that Posiva must further develop its operations and processes before implementing the construction stage. STUK stated in the reviews that Posiva's personnel resources are still incomplete and Posiva does not, based on the review results, have the required readiness to supervise and control detailed design and implementation of a nuclear facility. STUK will continue assessment of the personnel resources of Posiva's plant project in 2014. The reviews and their results are described in more detail in Appendix 8. The management system and the functions described in it do not yet fully comply with STUK's requirements.

4.6.3 Construction of research facility Onkalo

General

The excavation of the Onkalo access tunnel was mostly completed in 2012. The combined length of the access tunnel and other tunnels is 4,987 metres, and the deepest part is 455 metres in depth (Fig. 17). In 2013, Demonstration Tunnels 3 and 4 as well as Vehicle Access Tunnel 13 were excavated at level –420 in Onkalo. The casting of building

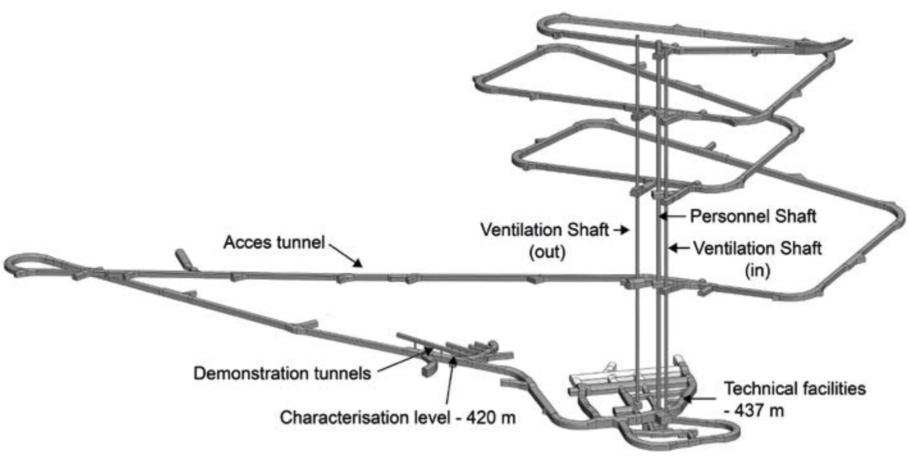


Figure 17. Status of the excavation of Onkalo in January 2014 (Posiva Oy).

elements and HVAC and electricity system installations were completed in the access tunnel, at the bottoms of the shafts, in connecting tunnels, in pump rooms and at the precipitation tank.

Further reinforcing of the first part of the Onkalo access tunnel (between piles 60 and 220) with bolts was completed. The further reinforcements were necessary because of the excavation of a hoisting device building of the repository that will be constructed at ground level. When the foundation of the hoisting device building was being excavated, the top parts of the exhaust air shaft and personnel shaft were injection grouted by injecting the bedrock around them. Rocks and loose stone matter were removed from the Onkalo access tunnel and other rock facilities by scaling. Condition of the surfaces reinforced with shotcrete was simultaneously inspected.

A test hall above ground level was almost completed. It will be used to test the functionality and use of equipment for tests and demonstrations to take place in Onkalo. An expansion of the Onkalo project office was completed, except for the acceptance inspection, by the end of 2013.

Posiva started preparation for the ‘large-scale projects’, i.e. construction of the repository and encapsulation facility, by starting modification of the area. The modification measures include new roads and moving the access gate and related access control system elements.

In 2013, missfired explosives were found in several parts of Onkalo when the stone material was removed for a geological survey and the bedrock was cleaned with a pressure washer. Posiva isolated the dangerous areas, notified the people working in Onkalo and submitted reports on the unexpected conditions to STUK. All of the detected missfired explosives were removed from Onkalo.

In 2013, Posiva added to its database a total of 42 new non-conformances regarding the construction of Onkalo or regarding environmental damage caused by foreign materials. These were caused by casting during the civil engineering construction project, vibration measuring at the ventilation and hoisting device building, unauthorised materials being taken to Onkalo and exceeding of the excavation tolerances for demonstration Tunnels 3 and 4.

RSC demonstration

Posiva has excavated in Onkalo four demonstration tunnels at level –420 m. Between September and November 2013, Posiva excavated demonstration tunnel 4 (20.8 m) and demonstration tunnel 3 (25.3 m). A geological survey was completed in both tunnels. Prior to starting excavation, water pressure tests were carried out through probing holes at the location of demonstration tunnel 3. A very large volume of water, 221 l/min, was poured into one of the holes. Some of the water also flowed into an experimental deposition hole in nearby demonstration tunnel 1. Posiva did not inject this point, however. The decision was not in line with the procedures, but Posiva justified it by stating that a plug test requires a volume of rock with as few holes as possible.

The main purpose of the demonstration tunnels is to yield information for the development of the rock suitability classification (RSC), as well as information for the needs of characterisation and modelling of the Onkalo bedrock. The full-scale plug test (Poplu) of Posiva will probably take place in demonstration tunnel 4. The plan is to use demonstration tunnel 3 to store the equipment needed during testing. Various testing of technical barriers, installation and operation procedures and simultaneous application of several technical barriers will also be carried out in the other demonstration tunnels. Modifications of the concrete slabs of the experimental deposition holes took place in demonstration tunnel 1 as a preparation of the above-mentioned tests. The bottom of demonstration tunnel 2 was levelled out by rough-grinding. The excavation damage zone (EDZ) was studied with a ground-penetrating radar prior to the rough-grinding and after the grinding.

Posiva drafted the ninth revision of the detailed model description of the demonstration area in late 2013. Of the seven planned experimental deposition hole locations in demonstration tunnel 2, one has been deemed unsuitable in a preliminary estimate and one will not be used because the area may be needed for the plug structure. Drilling of the holes and an assessment on the rock classification method will be completed by the end of 2014. Posiva completed the first suitability analysis of demonstration tunnel 4 when it was completed in October 2013. STUK will closely monitor Posiva’s RSC development work.

Rock falls

In 2013, STUK was informed of several rocks of varying sizes having peeled off the vault of demonstration tunnel 2 (at around PL 55). The falling rocks had been caught by the tunnel vault reinforcing mesh. Even though the falling rocks did not actually pose any danger to occupational safety, they are an indication of stresses in the bedrock being released, which means that they are an indication of the properties of the bedrock at Olkiluoto. The communication and reporting practices between Posiva and STUK were updated to ensure that STUK will be notified of such events in real time and can assess their safety significance.

Grouting of Onkalo shafts to manage seepage water

So far, only the ventilation shaft at Onkalo is open from the ground level to the level –437. In 2013, Posiva used colloidal silica to seal leaking points in the bedrock inside the supply air shaft and the personnel shaft at level –290 m.

In October 2013, Posiva announced that it will start vertical drilling of the supply air shaft, even though the volume of seepage water from the control hole still exceeded the injection limit value determined by Posiva. In early November 2013, STUK posed to Posiva during a seepage water and injecting inspection a requirement that Posiva must submit to STUK for information a report on representativeness, reliability and coverage of the background data used to reach the decision to start the vertical drilling of the supply air shaft prior to starting the drilling. STUK will monitor progress of shaft injecting during its construction site inspections, in the Onkalo construction follow-up meetings and during its other inspections.

Studies

In 2013, Posiva conducted studies on the long-term safety of nuclear waste disposal at Onkalo:

- In research niche 1 (PL 1475), the properties of bentonite under the conditions of the final repository was studied. In December 2013, the second hole of the test site was emptied and the bentonite samples were taken to a laboratory to be studied. The test continues in the first hole of the research facility.
- No R&D activities took place in research niche 2 (PL 2440) in 2013.
- In research niche 3 (PL 3620), thermal and rock mechanics properties of the bedrock and the direction of tension stress in the bedrock are being studied. Heating elements were installed in a test hole to increase the temperature for a period of three months. After this period of time, cooling of the test site was monitored for a period of two months. In November, Posiva drilled more research holes around the above-mentioned hole for geological modelling and taking rock mechanics samples. A separate research area was used to conduct hydrogeological studies and mise à la masse method measurements in between excavation damage zones and hydrogeological areas to study their interconnection.
- In research niche 4, hydrogeological studies were conducted in between two holes. These studies focused on the interaction between the holes, water consumption and links between cracks in the bedrock that conduct water.
- In research niche 5, tests on drift of radioactive tracers (H-3, Cl-36, Na-22, Sr-85 and Ba-33) were continued. These tests aim at obtaining more information on how radionuclides are retained by the bedrock of Olkiluoto.

In November 2013, Posiva announced to STUK that the sulphide, sulphate and TDS (total dissolved solids) content in several of the groundwater chemistry monitoring tests had exceeded the action limits. This may have been caused by the impact of the construction of Onkalo on the hydrogeological and hydrogeochemical properties of the bedrock at Olkiluoto. It is also possible that the action limits were exceeded because different types of groundwater have been mixed up by cracks that conduct water in the drilled holes or the multi-plug equipment used to isolate structures. Posiva will monitor the situation by taking samples more often than before.

Posiva has continued its survey of the groundwater's sulphate/sulphide balance and oxidation-reduction reactions through groundwater chemistry and geo-microbiological sampling and laboratory tests.

Surveys of Onkalo also include a survey of incoming seepage water and measuring the total volume of seepage water. According to results of measurements that Posiva has deemed successful, the total volume of seepage water in Onkalo varied from 30.0 to 37.5 l/min in 2013. These total volumes include in average around 2.4–4.0 l/min of seepage from the exhaust air shaft. In 2013, the measured total volumes of seepage water in Onkalo remained clearly below the limit value of 80 l/min set by Posiva.

Seismic measurements were conducted in the Onkalo demonstration area and the surroundings of the access tunnel to obtain more information for demonstrating the bedrock classification method.

Regulatory inspections in Onkalo and at the Onkalo construction site

In 2013, STUK performed seven regulatory site inspection in Onkalo and at the Onkalo construction site above ground level. During these inspections, STUK focused on the planning and implementation of ongoing works and Posiva's own quality assurance and quality control. Discussions with Posiva on the results of the inspections were conducted and the observations were also used to better target future inspections. During a regulatory inspections in October, Posiva received a remark about delays in the weekly reporting of foreign materials used by an excavation contractor in its work; because of the delays, the volume monitoring system of the foreign materials which may be used onsite was no longer up to date. Deficiencies in Posiva's system of monitoring the quantities of foreign materials were also observed in a foreign material inspection in December.

Inspections of the Onkalo construction inspection programme

The construction inspection programme for Onkalo included four inspections in 2014. Of these, an inspection on drilling and modelling was postponed, to be arranged in connection with the construction licence application inspection programme in 2014. The three completed inspections on Onkalo dealt with the inspection and monitoring procedures at the Onkalo construction site, management of seepage water in Onkalo and management of foreign materials. STUK set requirements for Posiva and paid special attention in the following issues:

- In the Onkalo construction site inspection and monitoring procedures, Posiva must verify that the procedures on storage of products take into account the prevention of unintentional misuse. For example, products that have not been approved for use in Onkalo must be physically separated from products that have been approved for use in Onkalo in the warehouse.
- In terms of the control of seepage water in Onkalo, STUK requested a report on how Posiva has verified coverage, representativeness and reliability of the single control hole that had been used as the basis of the supply air shaft sealing results when reaching a decision to start the vertical drilling of the supply air shaft. STUK required that Posiva must submit a report on this issue before starting the vertical drilling of the supply air shaft.
- STUK found clear deficiencies in the management of foreign materials at Onkalo. Posiva must develop its monitoring of the volume of at least the class A materials that have been deemed the most harmful in terms of long-term safety to ensure that the volume of foreign materials delivered to the Onkalo construction site and used at the construction site does not exceed the allowed volume. Furthermore, Posiva must study the long-term safety significance of traces from explosives (nitrogen compounds).

Construction document reviews

In 2013, STUK processed 84 documents regarding the construction of Onkalo that were submitted to STUK for information or for approval. The most significant included changed implementation scope of Onkalo (to excavate demonstration tunnels 3 and 4); a report on construction of the hoisting equipment building and an expansion of the ventilation building; updates of the Onkalo construction design documents and Onkalo's construction communication plan; a report on loose rocks in demonstration tunnel 2; a report on further reinforcement plans of phase TU1 of the Onkalo project; a report on geological values; and a report on drilling records.

Inspection of the readiness to start construction work

In May 2013, Posiva arranged three internal inspections on the readiness to start construction of demonstration tunnels 3 and 4. In November, Posiva arranged two similar inspections on the vertical drilling of the supply air shaft. STUK participated in these inspections as an observer and considered the internal readiness for both construction projects comprehensive enough to make a decision on not to arrange a separate readiness inspections of its own.

In 2013, STUK carried out one inspection on the readiness to start construction work by shotcreting. During the inspections, the rock surfaces of the Onkalo area in question were compared with the survey documentation; the results of laser scan measurements and the structures reaching across Onkalo were also considered. The inspection also included a visit to the tunnel to verify that the documentation and the laser scan measurements comply with the actual tunnel. STUK verified that the documentation and the laser scan measurements comply with the observations made in the tunnel and granted the permit to start shotcreting without posing any requirements.

Commissioning inspections

In October 2013, Posiva started an internal inspection, Commissioning inspection in stages of the underground facilities, on the quality of the documentation of tunnel phases TU1–TU4. STUK will have oversight of the work by Posiva and its suppliers that will, according to Posiva's plans, culminate in commissioning inspections of the underground Onkalo facilities in 2014.

Follow-up meetings on the construction of Onkalo

STUK conducted a total of eight follow-up meetings on the construction work at Onkalo in 2013. They included reviews of topical issues pertaining to the construction of Onkalo, such as reviews of the construction status, design, construction site, studies, rock classification procedure demonstration, quality management (supplier approval procedures and orientation, audits, non-conformances, environmental damage, etc.), inspection programmes, monitoring of barriers and correspondence between STUK and Posiva. In 2013, STUK started to give a summary of the key observations made during the latest regulatory visit in each follow-up meeting.

4.6.4 Safeguard of Nuclear Materials

STUK has carried out safeguards of nuclear materials at the Onkalo that is currently under construction and that will become part of the repository. STUK's regulatory activities have been implemented in line with the national safeguards plan. Finland is the first country in the world to implement safeguards for a final disposal facility, which is why STUK holds a key position in the development and implementation of international safeguards regarding geolocial repositories. In 2013, Posiva drafted the first reports of the technical basic declarations included in the construction licence application design documentation to the European Commission and IAEA. In December 2013 STUK, the Commission and IAEA reviewed technical basic declaration of the repository at Onkalo to verify that Onkalo has been built in compliance with the declaration.

5 Other uses of nuclear energy

5.1 Talvivaara

Talvivaara Mining Company Plc practices mining operations at Talvivaara in Sotkamo. The mine's key products are nickel and zinc, and the ore also includes smaller concentrations of other elements that can be utilised. The metal is separated from the ore at the mine by means of bioheapleaching. In this process, uranium is dissolved from the ore in addition to other heavy metals. The uranium concentration of the Talvivaara metals is low (in average 17 ppm), but Talvivaara considers the recovery of uranium to be profitable because of the large volumes. That is why Talvivaara submitted an application to the Finnish Government on the recovery of uranium in 2010. If not recovered, the uranium will end up in the gypsum waste pond and part of it will end up in the mine's nickel product. Talvivaara was granted a conditional licence to start recovery by the Government on 1 March 2012. The licence states that the recovery of uranium may be started once STUK has approved several documents pertaining to the recovery process.

Talvivaara started construction of a uranium recovery plant after granting of the licence. STUK monitored progress of the construction project and prepared to start regulation of the uranium recovery process. In 2013, STUK carried out an inspection at Talvivaara on the readiness to start the utilisation of nuclear energy. The review focused on nuclear security of the uranium recovery plant. The poor financial status of Talvivaara postponed the completion of the recovery plant, and Talvivaara failed to submit the documents pertaining to the start of the recovery of uranium to STUK for official processing. In the autumn of 2013, the Supreme Administrative Court returned, with its decision 3825/2013, the uranium recovery licence of Talvivaara to the Government for new round of processing.

In the winter of 2012–2013, several leaks occurred at the Talvivaara mine where water stored in the gypsum waste ponds was discharged into the safety dams of the mine and further into the environment. Uranium and other heavy metals were discharged. Based on the Radiation Act, STUK participated in environmental impact monitoring of the leaks in 2013. Uranium contents in watercourses close to the mine were monitored with care.

5.2 Others

Uranium is being extracted in the production processes of Freeport Cobalt Oy in Kokkola and Norilsk Nickel Harjavalta Oy in Harjavalta. STUK has reviewed their inventory reports on the production of uranium. Other inspected nuclear material inventories include those of the Helsinki University Laboratory of Radiochemistry, Suomen Nukliditekniikka and the Radiation and Nuclear Safety Authority. The nuclear non-proliferation control system of the Aalto University has been reviewed as well. No remarks were made in the reviews.

6 Safety research

The purpose of publicly funded safety research is to ascertain that the authorities have adequate expertise available, including a concern for unforeseeable issues affecting the safety of nuclear facilities. Since the beginning of the 1990s, Finnish safety research has typically taken the form of four-year research programmes. Safety research is divided into two research programmes, of which SAFIR2014 focuses on nuclear power plant safety and KYT2014 on the comparison of the practices and methods of nuclear waste management. The projects under the research programmes are selected annually on the basis of a public call for projects. The projects selected for the programmes must be of a high scientific standard, and their results must be available for publication. The results must have a broader scope of applicability than the nuclear facility of a particular licensee. Funding will not be granted for any research which is directly connected with projects that licensees, or parties representing them, carry out for their own needs, or for research which is directly provided by nuclear energy regulatory oversight.

STUK controls this research by contributing to the work of the programmes' steering and reference groups. Every year, the Ministry of Employment and the Economy ascertains that the proposed set of projects meets the statutory requirements and STUK's nuclear safety research needs. STUK issued statements on the SAFIR2014 and KYT2014

Nuclear safety research in Finland

In general terms, nuclear safety research comprises two distinct areas of research: nuclear power plant safety and nuclear waste management safety. In Finland, nuclear safety research is conducted by research institutions, universities and power companies operating nuclear power plants. In addition to the above-mentioned parties, research on the safety of nuclear waste management is conducted by Posiva Oy. Posiva's research programme is the most extensive of all the research programmes.

Research programmes SAFIR2014 and KYT2014 were launched in 2011. The purpose of these programmes is not only to provide scientific and technical results, but also to ensure the maintenance and development of Finnish competence. Further information on the projects is available on the websites of the research programmes at
http://virtual.vtt.fi/virtual/safir2014/,
http://www.ydinjatetutkimus.fi and
http://kyt2014.vtt.fi/.

Pursuant to Finnish legislation, the parties with nuclear waste management obligations are unambiguously responsible for the design, implementation and costs of managing the waste they have produced, including the associated research and development work. The research and development work regarding final disposal is carried out by Posiva Oy. Posiva also conducts research in different sectors linked to the final disposal of nuclear fuel in cooperation with international parties.

The Finnish actors contribute extensively to international nuclear safety research within the framework of the following programmes and organisations: the European Union's framework research programmes (both fission and fusion research), the Nordic NKS safety research programme, the Nuclear Energy Agency (NEA) of the OECD, and the International Atomic Energy Agency (IAEA) within the UN family.

programmes in February 2013.

The current four-year safety research programme, SAFIR2014, was initiated as a continuation of the previous SAFIR2010 programme. The new programme is more extensive than the previous one due to decisions-in-principle issued in the summer 2010 regarding new plant units. Following the decisions, funds for the research programme were also collected according to the maximum outputs defined in the license conditions for the new plant units (funding from the National Nuclear Waste Management Fund). The annual volume of the SAFIR2014 programme was EUR 10.4 million in 2013, of which the National Nuclear Waste Management Fund covered EUR 5.7 million. The project programme initiated at the beginning of the year 2013 provided funding for 45 projects. The organisation providing the largest amount of funding was VTT Technical Research Centre of Finland, whose share was EUR 2.8 million.

The SAFIR2014 research programme is divided into nine competence areas, which mainly correspond to the support group areas of the previous research programme. The new support group introduced at the beginning of 2011 is Support Group 9, Infrastructure, since the construction of significant arrays of test equipment is funded and guided at, for example, VTT and the Lappeenranta University of Technology. The areas of research under SAFIR2014 and their shares of the total funding are illustrated in Figure 17.

In autumn 2012, the call for projects for the 2013 project programme was updated with the additions to the SAFIR2014 framework plan considered necessary as a result of the Fukushima Dai-ichi nuclear accident that took place in March 2011. The call for projects resulted in new accident management proposals and expansion of earlier projects that dealt with the management of severe accidents and the provisions made for external threats. The call for projects for the 2014 project programme was updated with the additions of topical research needs on the regulatory oversight of nuclear safety, such as analyses used to prove compliance of new regulations with the requirements and nuclear power plant quality management in a networked operating environment.

The research programme involved extensive development of Finnish expertise for defining the design basis of nuclear power plants and for producing safety analyses, as well as for managing expert work and organisations with a high standard of safety culture. A project on studying the coverage of the Finnish nuclear safety regulations by applying methods from the field of sociology was launched in 2013. An issue that is still topical is the research on external threats where the potential impacts of climate change on the extreme weather conditions and seawater levels occurring in Finland were studied, along with the seismic requirements for nuclear facilities. Another topical issue is the definition of the source term for an accident, and provisions for accidents of a long duration.

The four-year KYT2014 programme was also launched in 2011, and the programme will be implemented between 2011 and 2014. The programme framework consists of research targets important to national competence. A special feature of KYT2014 is the aim of implementing

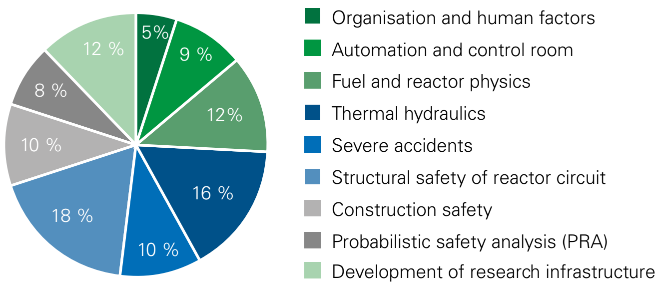


Figure 18. Research areas of SAFIR2014 programme and their shares of the total funding in 2013.

extensive coordinated research projects. In 2013, such projects included ones on safety cases, the performance of buffer and backfilling materials, and the long-term durability of final disposal canisters.

The KYT steering group gave its funding recommendations to the Ministry of Employment and the Economy, relying on the evaluations of support groups. In 2013, the total funding of the programme was around EUR 2.8 million, of which funding from the National Nuclear Waste Management Fund amounted to around EUR 1.8 million. In 2013, the research programme provided funding for 32 research projects representing new and alternative technologies for nuclear waste management (three projects), safety research on nuclear waste management (28 projects of which 16 were combined into three coordinated projects) and social nuclear waste management research (one project). The total scope of the research programme is 25.2 man-years. Figure 18 illustrates the relative shares of these areas of the total funding.

In 2012, the Ministry of Employment and the Economy ordered an international evaluation of the KYT-programme. It was completed in 2013. According to the evaluation, the programme meets its key objectives, the recommendations given in the previous international evaluation have been well taken into account, the programme is comprehensive and new research areas have been taken into account to a sufficient extent. In addition, the organisation of the programme has been developed based on information obtained from coordinated projects and mentoring, for example. The national nuclear waste management course that has been arranged four times so far was mentioned as an especially good part of the KYT programme. According to the evaluation, the results are commensurate with the programme funding: the programme has clearly influenced training and its results can be applied in practice. As its recommendations on development areas, the evaluation workgroup mentioned increasing visibility, continuing the development of training, working in cooperation with the SAFIR programme, establishing competence centres, funding arrangements, monitoring of results, organising support groups and giving the management group a more active role.

A total of 33 proposals for research projects were submitted for the KYT2014 programme for 2014. These were evaluated using the same criteria as in the previous year, such as the project's significance and utilisation value, networking, impact on training and profitability. The research programme according to the management group's funding recommendation includes 28 research projects.

At the end of the year, the Ministry of Employment and the Economy started planning the future of the research programme. The plan is to launch KYT2018 at the beginning of 2015, and the programme period will end in 2018. There are representatives of Fennovoima, Fortum Power and Heat, Posiva, the Ministry of Social Affairs and Health, TVO, the Ministry of Employment and the Economy, the Ministry of the Environment and STUK in the planning workgroup. STUK chairs the group.

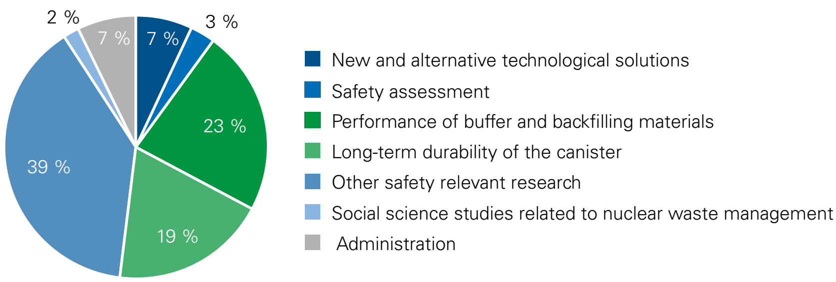


Figure 19. Research areas of KYT2014 programme and their shares of the total funding in 2013.

7 Oversight of nuclear facilities in figures

7.1 Processing of documents

A total of 3,135 documents were submitted to STUK for processing in 2013. Of these, 767 concerned the nuclear power plant unit under construction and 355 the repository for spent nuclear fuel. The reviewing process of a total of 3,442 documents was completed, including documents submitted in 2013 or earlier as well as licenses granted by STUK by virtue of the Nuclear Energy Act, which are listed in Appendix 4. The average document review time

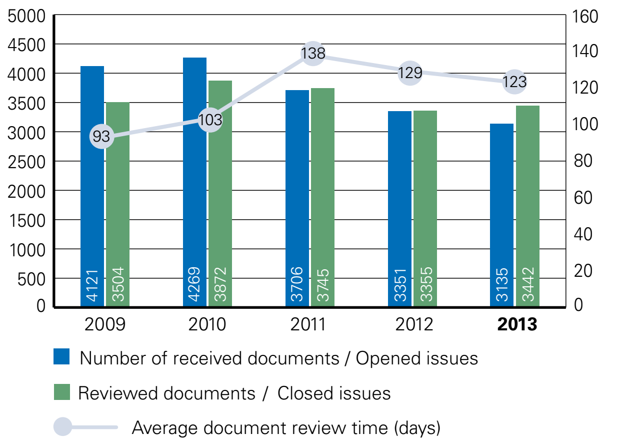


Figure 20. Number of documents received and reviewed as well as average document review time.

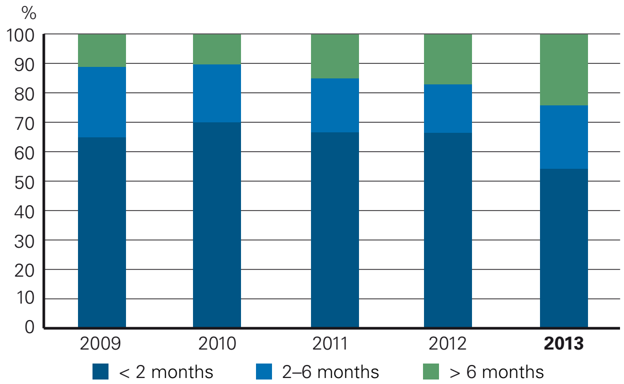


Figure 21. Distribution of time spent on preparing decisions on the Loviisa plant.

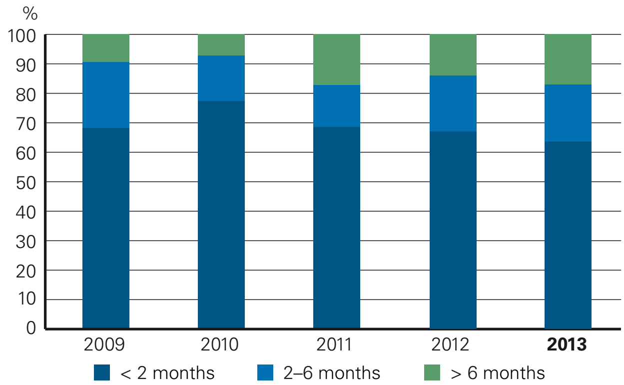


Figure 22. Distribution of time spent on preparing decisions on the operating plant units of Olkiluoto.

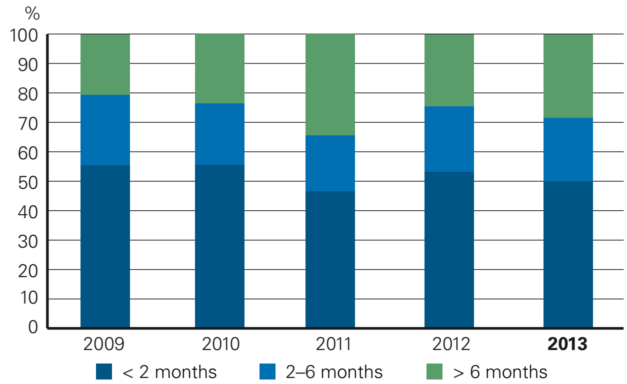


Figure 23. Distribution of time spent on preparing decisions on Olkiluoto plant unit 3.

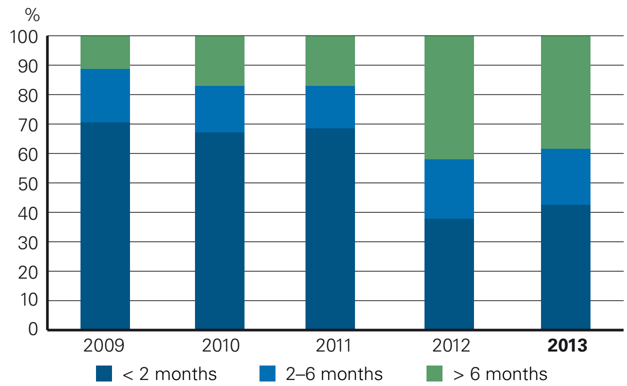


Figure 24. Distribution of time spent on preparing decisions on Posiva.

was 123 days. The number of documents and their average review times in 2009–2013 are illustrated in Figure 20. Figures 21–24 illustrate the review time distribution among documents from the various plant units and documents from Posiva.

7.2 Inspections at nuclear power plant sites and suppliers' premises

Periodic inspection programmes

A total of 25 inspections at the Loviisa plant and 23 at the Olkiluoto plant were carried out under the 2013 periodic inspection programme (Appendix 5). STUK carried out nine inspections within the Olkiluoto 3 construction inspection programme (Appendix 6) and three inspections within the Onkalo construction inspection programme (Appendix 7). The key findings of the inspections are presented in the appendices and the chapters on regulatory oversight.

Other inspections at plant sites

A total of 1,131 inspections on site or at suppliers' premises were carried out in 2013 (other than inspections of the periodic or construction inspection programmes, of the safeguards of nuclear materials and of the construction inspection programme of the underground research facility at Olkiluoto, which are discussed separately). An inspection comprises one or more sub-inspections, such as a review of results, an inspection of a component or a structure, a pressure or leak test, a functional test or a commissioning inspection. Of the inspections, 254 were related to the regulatory oversight of the plant under construction and 876 to that of the plants in operation.

The number of inspection days on site and at component manufacturers' premises totalled 3,203. This number includes not only inspections pertaining to the safety of nuclear power plants but also those associated with nuclear waste management, safeguards of nuclear materials, audits and inspection of the underground research facility at Olkiluoto. Six resident inspectors worked at the Olkiluoto power plant and two resident inspectors at the Loviisa power plant. The numbers of onsite inspection days in 2009–2013 are illustrated in Figure 25.

7.3 Finances and resources

The duty area of nuclear safety regulation included basic operations subject to a charge, as well as operations not subject to a charge. Basic operations subject to a charge mostly consisted of the regulatory oversight of nuclear facilities, with their costs charged to those subject to oversight. Those basic operations not subject to a charge included international and domestic cooperation, as well as emergency response operations and communications. Basic operations not subject to a charge are publicly funded. Overheads from the preparation of regulations and support functions (administration, development projects in support of regulatory activities, training, maintenance and development of expertise, and reporting, as well as participation in nuclear safety research) were carried forward into the costs of both types of basic operation and of contracted services in relation to the number of working hours spent on each function.

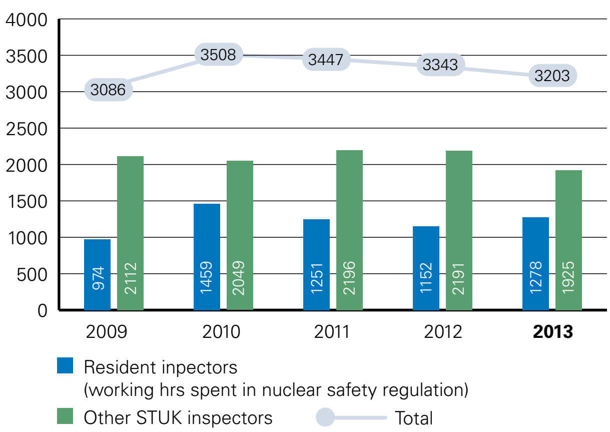


Figure 25. Number of inspection days onsite and at component manufacturers' premises.

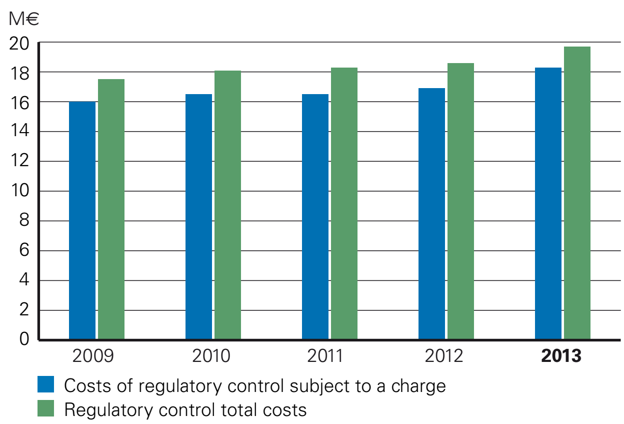


Figure 26. Income and costs of nuclear safety regulation.

In 2013, the costs of the regulatory control of nuclear safety subject to a charge were EUR 18.3 million. The total costs of nuclear safety regulation were EUR 19.7 million. Thus, the share of activities subject to a charge was 92.7%.

The income from nuclear safety regulation in 2013 was EUR 18.3 million. Of this, EUR 4.0 million and EUR 10.1 million came from the inspection and review of the Loviisa and Olkiluoto nuclear power plants, respectively. In addition to the operating plant units, the income from the Olkiluoto plant includes that derived from the regulatory oversight of the Olkiluoto 3 construction project. The income from the regulatory oversight also includes costs of the safety assessments of the new nuclear power plant projects of TVO and Fennovoima. The regulation of Posiva Oy's operations yielded EUR 3.3 million. Figure 26 shows the annual income and costs from nuclear safety regulation in 2009–2013.

The time spent on the inspection and review of Loviisa nuclear power plant was 16.0 man-years or 10.8% of the total working time of the regulatory personnel. The time spent on the Olkiluoto nuclear power plant's operating units was 12.9 man-years or 8.4% of the total working time. In addition to the monitoring of the operation of nuclear power plants, the figure includes nuclear material control. The time spent on the inspection and review of Olkiluoto 3 was 26.2 man-years or 17.8% of the total working time. Work related to new power plant projects amounted to 2.3 man-years or 0.9% of the total working time. A total of 11.7 man-years or 8.0% of the total working time was spent on inspection and review of Posiva's operations, and that spent on the FiR 1 research reactor was 0.3 man-years. The working time spent on small-scale users of nuclear materials was 0.1 man-years. Figure 27 shows the division of working hours of the personnel engaged in nuclear safety oversight (in man-years) by subject of oversight during 2003–2013.

Where necessary, STUK commissions independent safety analyses and research in support of regulatory decision-making. Figures 28 and 29 illustrate the costs of such assignments in 2009–2013. The costs in 2013 were mainly related to comparative analysis, independent assessments and third-party consultants' inspection work concerning the plant unit under construction, as well as to assessment work concerning the safety documentation for final disposal of nuclear waste. Appendix 8 lists assignments on the safety of nuclear power plants and the final disposal of nuclear fuel funded by STUK in 2013. The reviews of the safety documentation for the final disposal of nuclear energy are discussed in Chapter 4.6.1.

The distribution of the annual working time of the nuclear safety regulation personnel to the various duty areas is shown in Table 5.

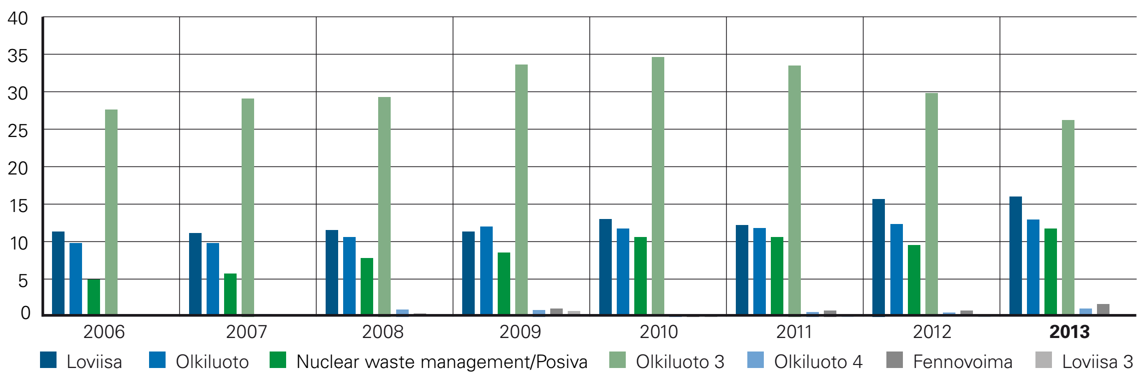


Figure 27. Distribution of working hours (person-years) of the regulatory personnel by subject of oversight in 2005–2013. Until 2011 the nuclear waste management includes both the oversight of the operating nuclear power plants' nuclear waste management as well as the oversight of Posiva, since 2012 only the oversight of Posiva. The oversight of the operating nuclear power plants' nuclear waste management is combined with the oversight of the power plants.

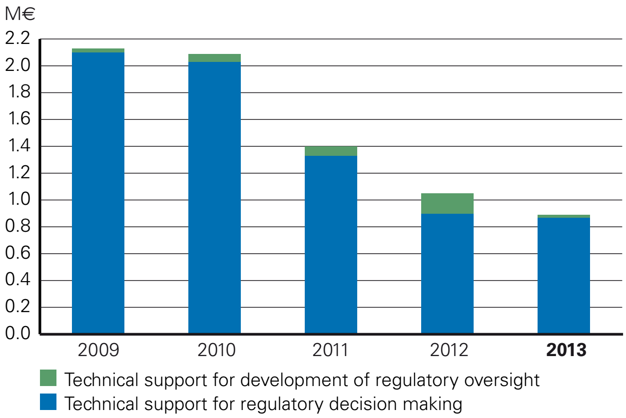


Figure 28. The costs of research and commissioned work pertaining to the safety of nuclear power plants.

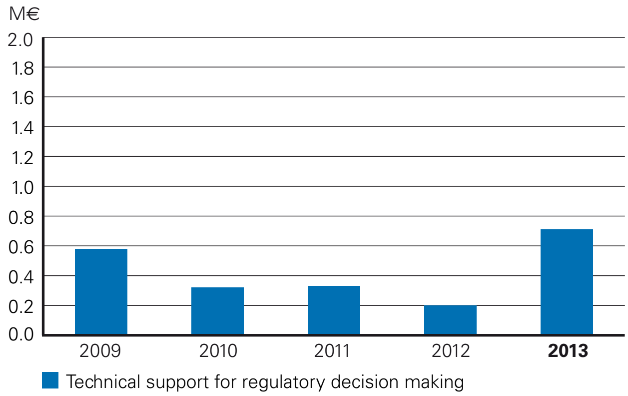


Figure 29. The costs of research and commissioned work pertaining to nuclear waste management and nuclear non-proliferation.

Table 6. Distribution of working hours (person-years) of the regulatory personnel in each duty area.

Duty area	2009	2010	2011	2012	2013
Basic operations subject to a charge	68.0	70.5	70.2	68.9	69.7
Basic operations not subject to a charge	6.6	7.8	8.8	5.6	5.0
Contracted services	1.7	1.9	1.7	2.2	1.6
Rule-making and support functions	33.6	38.2	43.0	46.3	45.3
Holidays and absences	23.5	24.3	24.7	24.7	25.1
Total	133.5	142.9	148.4	147.7	146.7

8 Development of regulatory oversight

8.1 STUK's own development projects

Changes in practices and the organisation updated into the quality manual

A total of 18 guides were updated in the quality manual for nuclear safety regulation, and 24 appendices to the guides were updated. The guides were updated following changes in procedures as well as changes in the personnel of the nuclear reactor regulation department and the nuclear waste and materials regulation department.

International assessment of STUK's regulatory oversight

STUK's regulatory oversight activities were comprehensively assessed in the autumn of 2012. STUK prepared an action plan based on the assessment report and has started implementation of the measures listed in the action plan.

Development of records management system

The records management system that was launched in the autumn of 2009 was updated. The new version is shared by several governmental agencies, and it better supports the processing of electronic documents. Development of workflows planned to be added into the system was postponed to 2014.

Electronic inspection protocols expanded to new areas

The electronic inspection protocol system (TARKKA) that was launched in 2011 was further expanded. At present, TARKKA covers all of the records needed in regulatory inspections with the exception of inspections of nuclear materials. Features and availability of TARKKA were further developed based on user feedback.

Progress in development of requirement management

As the preparation of the new YVL Guides proceeds, STUK launched a development project of its requirement management procedures. The goal is to specify requirement management procedures as part of STUK's current operating processes to create clear-cut requirements that can be managed throughout the lifecycle of plants.

Lessons learned

Due to changes made in STUK's personnel structure, the importance of sharing competence and knowledge has increased. As experts who have been with STUK for a long time are about to retire, there is a risk that the tacit knowledge will be lost. STUK has launched a project where the experts who will soon retire are interviewed and methods are developed to share the lessons they have learned with experts who are at the beginning of their careers.

8.2 Renewing and working capacity

Training on issues such as nuclear power plant systems, safety culture, document management and regulatory activities was arranged for inspectors. Furthermore, the inspectors received training in compliance with a separate training plan on STUK's new YVL Guides.

New STUK inspectors participated in a national training programme in the field of nuclear safety (the YK course), which STUK organises together with other actors in the field. The total duration of the tenth YK course was 20 days in six periods. Three of the periods took place in the spring of 2013. Eight STUK employees participated in the YK10 course. The YK11 course was launched in the autumn of 2013. Ten STUK employees participated in the course. There were a total of 77 participants in the YK11 course.

STUK was actively involved in the planning and execution of national nuclear waste management training, now organised for the fourth time. The course took six days and had nineteen participants. Lecturers included experts from the Ministry of Employment and the Economy, STUK, Posiva, VTT Technical Research Centre of Finland, Fortum, Fennovoima, TVO, the Aalto University, the University of Helsinki Laboratory of Radiochemistry and Saanio & Riekkola. The course focused on the main themes of nuclear waste management, covering the entire nuclear fuel cycle.

STUK's inspectors also participated in training provided by external enterprises, such as lead auditor training, project operations training and auditing training. Furthermore, STUK's inspectors participated in various Finnish and international training events of the sector, both as participants and lecturers. In addition, supervisors in the field of nuclear safety participated in management and leadership skills training programmes.

Based on a recommendation of a peer evaluation of regulatory activities, a project aiming at generating standardised nuclear sector approval procedures for the STUK inspectors was launched. The project will be continued in 2014.

In 2013, three Master's theses were completed in the nuclear reactor regulation department: Uncertainty Evaluation in Deterministic Safety Analyses, Operational Safety during Outage and The Link between Qualification and Risk Informed In-service Inspection. Furthermore, two Master's theses were being prepared at the nuclear reactor regulation department and one Master's theses at the nuclear waste and materials department. These theses will be completed in 2014.

On average, 12.2 days per inspector in the field of nuclear waste and materials regulation, and 10.6 days per inspector in the field of nuclear reactor regulation, were spent on developing the expertise of STUK's nuclear safety experts in 2013.

Five new employees were hired for nuclear reactor regulation in 2013. Their positions are in the regulatory oversight of nuclear power plant I&C, manufacturing technology and operation. Two new inspectors were hired for nuclear waste management. Their positions are in the regulatory oversight of rock engineering design and rock construction as well as mining and milling of ore, preparation of regulatory guides and assessment of nuclear waste management plans. Furthermore, one person from another position within the STUK was transferred to a development position in the nuclear waste and materials regulation department.

9 Emergency preparedness

STUK actively participated in the work of the emergency response cooperation groups in both Eastern Uusimaa and Satakunta. Both groups include the most important operators of the early stages of an emergency: in addition to STUK, representatives from the power companies, the rescue services and the police. The Satakunta group also includes the Finnish Border Guard; the Eastern Uusimaa group also involves the emergency care organisation. Meetings of the cooperation teams discussed issues such as emergency response training, experiences gained from drills, the update status of external rescue plans, organisations' development projects, and changes to legislation.

STUK arranged in cooperation with the Helsinki Police, the Helsinki Rescue Services, the Satakunta Police, the Satakunta Rescue Services and TVO an emergency preparedness training event where cooperation between the authorities and operators in case of a threat caused by illegal activities involving nuclear power plants or radiation was discussed. Employees of the above-mentioned organisations and other governmental organisations participated in the event.

The Helsinki Police, STUK and the Helsinki Rescue Services arranged a joint emergency preparedness drill to practice operations in case of a threat caused by illegal activities involving radioactive materials. The drill focused on management operations. The management operations were actually practiced, but the field operations were simulated. In case of an emergency, STUK will adopt the role of an expert organisation within the joint organisation of the authorities, headed by the police in situations where illegal operations are involved.

STUK's emergency preparedness (contingency) procedures for scenarios involving illegal operations were updated in connection with the training event and drill. STUK will continue the development of integrated operations for various situations together with other authorities, utilising the results of the drills.

10 Communications

STUK's nuclear safety communications are based on active, immediate, open and honest communication and media services.

In 2013, STUK published fifteen pieces of news on nuclear safety. Furthermore, nuclear safety experts were interviewed by Finnish and foreign media.

In addition to its own website, STUK communicates with citizens via the social media, such as Facebook and Twitter. STUK also answers questions that the public presents by telephone or e-mail, participates in public meetings and receives guest groups.

At the end of May and the beginning of June, STUK's directors and experts told the public in Loviisa and Eurajoki about the results of the oversight operations at the nuclear power plants and their environment, and about topical issues related to nuclear safety. The public events were organised in cooperation with the municipalities.

STUK organised, together with the Ministry of Employment and the Economy, a briefing on the new YVL Guides and the nuclear safety legislation reform in November.

STUK provided information as quickly as possible on all deficiencies observed at the Finnish nuclear power plants that require a special report from the licensee, or that are otherwise considered matters of public interest.

In 2013, STUK gave information on its website about observations made in the inspections and oversight of the Olkiluoto 3 plant unit, currently under construction, on six separate occasions. Even though the events did not put the safety of the plant or the environment at risk, STUK reported them without delay in accordance with its communications policy.

STUK reports the operation, events and oversight of the operating power plant units as well as the oversight of Olkiluoto 3 and nuclear waste management, on a quarterly basis. In its annual report published in April 2013, STUK reported the regulatory oversight of nuclear safety and the related observations in 2012. The annual report included, among other things, the overall safety assessments of nuclear power plants, produced on the basis of the observations made during oversight operations. The reports were published in printed form and as electronic versions on the STUK website.

11 International cooperation

International conventions

CNS

The Convention on Nuclear Safety requires the submission of a report on how its obligations have been met every three years. STUK was responsible for the preparation of Finland's report, and it was submitted to the IAEA, the secretariat of the Convention, according to the agreed schedule in August 2013. The report describes changes that have occurred in the regulation of nuclear power plants in Finland in the past three years, such as a reform of the nuclear safety regulations, upgrades implemented at Loviisa and Olkiluoto due to the Fukushima accident, the Finnish IRRS evaluation and status of the Olkiluoto 3 construction project. The report will be reviewed at a large international meeting of the parties to the Convention in Vienna in spring 2014. The Convention also includes an opportunity to pose questions about the reports submitted by other countries. STUK preliminarily reviewed the reports of Finland's neighbouring countries and countries with which STUK has been involved in the scope of its international cooperation. STUK posed around 160 questions about the contents of the reports of other countries.

In 2013, STUK also participated in a committee on the Convention on Nuclear Safety that studied proposed changes to the current practices to promote the assessment process. Proposals on fourteen issues were made by the committee. Most of the proposals involve instructions provided for the assessment process, because making amendments to the actual Convention on Nuclear Safety would be very cumbersome. The proposed changes will be discussed in the sixth review meeting of the Convention on Nuclear Safety in spring 2014.

STUK participated in an extraordinary meeting of the Nuclear Waste Convention's review meetings in April 2013. The meeting participants discussed the themes that were raised in the review meeting and prepared new issues for the next competent meeting. Most of the prepared themes involved development of the country report assessment process and related arrangements.

Cooperation within international organisations and with other countries

MDEP

The Multinational Design Evaluation Programme (MDEP) was established upon the initiative of the United States nuclear safety authority (Nuclear Regulatory Commission, NRC). It involves thirteen countries with the objective of improving cooperation in the field of the assessment of new nuclear power plants and developing convergent regulatory practices. In addition to the United States of America, the following countries participate in the programme: South Africa, India, Japan, Canada, China, Korea, France, Finland, the United Kingdom, Russia and the United Arab Emirates. Sweden joined the programme in 2013. Participants in the programme include only those countries with new nuclear power plants at some stage of assessment by the regulatory authorities. The OECD Nuclear Energy Agency functions as the secretariat for the programme.

The MDEP's work is organised in design-specific and issue-specific working groups. In addition, the MDEP has a management group and a steering group. There are five Design-Specific Working Groups: EPR Working Group, AP1000 Working Group, APR1400 Working Group, VVER Working Group and ABWR Working Group; the two latter were established in 2013. STUK has representatives in all of the above-mentioned working groups, except for the AP100 Working Group, because an EPR plant is under construction at Olkiluoto (the Olkiluoto 3 project), APR1400 and ABWR are considered as alternatives in the Olkiluoto 4 project and Fennovoima is planning the construction of a VVER plant.

The EPR Working Group's work was originally a continuation of cooperation between the Finnish and French authorities concerning safety assessment of EPR power plants. The other countries in the EPR Working Group are France, the United States, the United Kingdom, Canada, China, India and Sweden. The EPR Working Group is chaired by the Finnish representative; the working group has four subgroups dealing with plant automation, accidents and transients, severe accidents and probabilistic risk analyses (PRAs). STUK's representative chairs the PRA subgroup.

The MDEP Working Groups independent of plant design dealt with the following three subjects: plant and plant supplier inspections and reviews, pressure equipment standards and programmable I&C. STUK participated in the activities of all three Issue-Specific Working Groups. The objective of the Working Group dealing with plant and equipment supplier inspections and reviews is to establish the procedures and requirements applied to inspections and reviews by the participating countries and to create the procedures and goals for joint inspections and reviews. The objective of the Working Group dealing with pressure equipment is the harmonisation of requirements in different standards. The Working Group on programmable I&C aims to promote the coordinated development of the IEC and IEEE standards, among others. Some individual issues have also been selected, on which common positions have been drafted.

Co-operation within the IAEA

The IAEA continued to revise its regulatory guides on nuclear safety. STUK had a representative on the Commission on Safety Standards (CSS) managing the preparation of the regulatory guides as well as in the committees dealing with the content of the regulatory guides, i.e. the Nuclear Safety Standards Committee (NUSSC), the Waste Safety Standards Committee (WASSC), the Radiation Safety Standards Committee (RASSC) and the Transport Safety Standards Committee (TRANSSC). STUK issued statements on the IAEA regulatory guides under preparation. STUK also participated in the composition of regulatory guide drafts in small expert groups.

STUK's representatives participated in expert groups summoned by the IAEA; the groups reviewed the regulatory authorities' operations in Bulgaria, the United Kingdom, the Czech Republic and Belgium.

STUK is the Finnish contact organisation for the following nuclear energy information exchange systems maintained by the IAEA:

- Incident Reporting System (IRS)
- Incident Reporting System for Research Reactors (IRSRR)
- International Nuclear Event Scale (INES)
- Power Reactor Information System (PRIS)
- Nuclear Fuel Cycle Information System (NFCIS)
- Net Enabled Waste Management Database (NEWMDB)
- Directory for Radioactively Contaminated Sites (DRCS)
- Illicit Trafficking Database (ITDB)
- Database on Events that have arisen during Transport of Radioactive Material (EVTRAM)

Cooperation within the EU

WENRA

STUK participated in the nuclear safety, nuclear waste and decommissioning work carried out by WENRA (Western European Regulators' Association) and its working groups. The working groups have developed common safety reference levels on the basis of the IAEA standards, and an agreement regarding their implementation in all member countries has been concluded between the members of WENRA. The Nuclear Safety Working Group updated the nuclear safety reference levels, based on lessons learned from the Fukushima accident, and published them for stakeholders to comment on, on the WENRA website in December 2013. Furthermore, the Nuclear Safety Working Group published specific safety goals for new nuclear power plants in spring 2013.

ENSREG

STUK participated in the activities of the EU member states' nuclear safety regulators' co-operation group (ENSREG, European Nuclear Safety Regulators Group) and in two of its subgroups (on nuclear safety and nuclear waste management). The Director General of STUK chaired ENSREG until June.

As a result of the Fukushima accident, the EU launched stress tests for existing nuclear power plants and for those under construction. The purpose of these tests was to establish how the plants would cope with exceptional external events and other situations associated with the simultaneous loss of operability of several safety systems. ENSREG organised an evaluation of the national plans to be executed on the basis of the stress tests in April 2013 in Brussels. STUK was the deputy chair of the review meeting and presented Finland's national action plan.

Cooperation within the OECD/NEA

The Nuclear Energy Agency of the OECD (NEA) coordinates international cooperation in the field of safety research in particular. The organisation also provides an opportunity for co-operation between regulatory authorities. STUK was represented in all main committees of the organisation dealing with radiation and nuclear safety issues. The main committees' fields of activity are:

- Nuclear safety regulation (CNRA, Committee on Nuclear Regulatory Activities)
- Safety research (CSNI, Committee on the Safety of Nuclear Installations)
- Radiation safety (CRPPH, Committee on Radiation Protection and Public Health)
- Nuclear waste management (RWMC, Radioactive Waste Management Committee).

Other international cooperation

STUK participated in the cooperation between the regulatory authorities of countries with VVER power plants (such as the Loviisa power plant) via the VVER Forum. A representative of STUK chaired the Probabilistic Risk Analyses Working Group (PRA Working Group) whose final report was presented at the VVER Forum's annual meeting. The Working Group will continue its work, chaired by the Armenian representative for the next three years.

STUK's representative was a member of the supporting committee to the Swedish nuclear safety authority, and a reactor safety expert group called by the Swiss nuclear safety authority.

STUK participated in the work of the European Safeguards Research and Development Association (ESARDA). The purpose of ESARDA is to promote and harmonise the European research and development work on nuclear non-proliferation control.

International operating experience feedback

STUK's activities

STUK has a working group for reviewing and assessing international operating experience events and reports from nuclear power plants. The working group includes STUK experts from various fields of technology. In 2013 in its monthly meetings, the working group assessed a total of approximately a hundred reports received from the IAEA's operating experience database. Of the 74 assessed reports, 58 required no measures at Finnish nuclear power plants. With regard to five events, the practices and arrangements in place at Finnish nuclear power plants were found to be adequate to prevent similar events. In the cases of eight event reports, it was decided that the situation at Finnish nuclear power plants should be subjected to closer assessment in connection with the periodic inspection programme or the inspections carried out during the annual outage. Three of the reports assessed in 2013, one on incorrect micro fuses detected at plants in Germany in safety significant instrumentation and control modules assemblies, and one on a loss of power supply during the annual outage of Forsmark 3, were deemed to give rise to measures at the Finnish plants or in future projects. The third event, on control rod problems in Oskarshamn 3 and Forsmark 2 in 2008, was an event specific to boiling water reactors, which means that it was only studied in terms of Olkiluoto 1 and 2, but similar cracking has not occurred there due to the different conditions. Measures implemented because of the two other events a year earlier were reviewed in connection with the periodic inspection programme. These

Major events

Manufacturing faults in reactor pressure vessel

Inspections carried out in Doel 3 in Belgium in July 2012 revealed indications in the pressure vessel material, believed to have been created during manufacture due to deficient hydrogen removal heat treatment. Doel 3 is a pressurised water reactor that was first commissioned in the early 1980s, with a pressure vessel manufactured at a Dutch shipyard. The shipyard manufactured pressure vessels during the same period also for several plants in Europe and the U.S. There are no pressure vessels from this manufacturer in Finland. In March 2013, STUK sent clarification requests to the operating plants at Loviisa and Olkiluoto as well as Olkiluoto 3 regarding verification of the integrity of the plant units' pressure vessels, as well as in the case of the pressurised water reactors also the pressurizers and the steam generators.

According to a report submitted by TVO, the manufacturing technology of the Olkiluoto 1 and Olkiluoto 2 reactor pressure vessels is so different than that used in the Belgian reactors that the risk of deficient hydrogen removal heat treatment can, for a justified reason, be considered minor. Furthermore, such faults would have been detected in the non-destructive testing conducted after manufacture. The reactor, steam generators and pressurizer in Olkiluoto 3 were manufactured in 2003 and 2004. At that time, the manufacturing requirements for hydrogen content were clearly stricter than those used when the reactors of the Belgian plant units were manufactured in the 1970s. The same applies to the requirements on non-destructive testing. STUK deemed this report acceptable. According to a report by Fortum, manufacturing methods that limit the hydrogen content were used also in the manufacture of Loviisa 1 and Loviisa 2, and the non-destructive testing method has been assessed as accurate enough to detect any hydrogen flaking indications. However, there were some defects in the manufacturing documentation, which is why STUK demanded that the licensee try to obtain supplementary data and assess the integrity of the reactor's supporting structures and pipe nozzles in more detail to detect any hydrogen flaking indications. Fortum also announced that it will conduct supplementary non-destructive tests on said pressure equipment in connection with their inservice inspections. STUK deemed the proposed methods and further measures sufficient and will oversee their implementation.

Holes to prevent siphon effect

In testing in compliance with recommendations made by the World Association of Nuclear Operators (WANO) in its report after the Fukushima accident at the end of 2011 in Cattenom in France, it was noted that there are no holes in the fuel pool cooling/filling pipes to prevent the pools from being drained by the siphon effect. The French Nuclear Safety Authority (ASN) and the French Institute for Radiological Protection and Nuclear Safety (IRSN) started to conduct inspections of the French plants in 2013 to emphasise the significance of this issue.

TVO submitted its reply to WANO in 2012. There are no siphon breakers in the fuel pools at the operating Olkiluoto plant units, but the pipes do not extend to such a level that the siphon effect could lead to the fuel being exposed. There are siphon breakers in the pool cooling system pipes at Olkiluoto 3 and their proper installation will be verified prior to issuing an operating licence.

Due to this event, the Loviisa operating experience team decided to study whether there are siphon breakers in the plant's fuel pool filling pipes. The description in the FSAR states that there are siphon breakers in the pipes. A decision was made to conduct a visual inspection of them during the inservice inspections of the fuel pool steel lining. These inspections do not include an inspection of the insides of the siphon breaker pipes, however. To detect any blockages, the Loviisa organisation decided to inspect the pipes from the inside with an endoscope. The inspections were conducted in Loviisa 2 during the 2013 maintenance outage, and the siphon breakers were found to be fine. The inspection in Loviisa 1 was postponed to 2014 because the 2014 outage is better suited for such an inspection.

The status of the storage pools at the spent nuclear storage facility of neither of the plant units has been studied yet.

events were indications observed in the pressure vessel material in Doel 3 of Belgium during an inspection in 2012 and the lack of siphon breakers in the fuel pool cooling/filling pipes that was observed in Cattenom 2 of France in testing after Fukushima in late 2011.

One new report, one addition to an earlier report and one follow-up report of events at Finnish nuclear power plants were added to IAEA's International Reporting System for Operating Experience (IRS). The new report was about problems that occurred during the 2012 outage in connection with the implementation of a modernisation of the primary circuitpressururizing system in Loviisa 1. STUK also decided to submit a report to IRS on lead blankets that were accidentally left on top of the reactor coolant system pipes in the steam generator room in Loviisa 1 after the 2012 maintenance outage. The blankets were detected during the 2013 maintenance outage. STUK will also draft an IRS report on the problems with moving the control rods of Loviisa 2 during the startup after the 2013 maintenance outage. Of all the events that occurred in 2013 at Olkiluoto, STUK decided to draft an IRS report on problems with the cracks in the stator welds of the emergency diesel generators' exciters in Olkiluoto 1. The experts are still considering whether to submit an international report on the cracks found in the brazed joints of rotor winding that were detected in connection with maintenance.

APPENDIX 1 STUK's safety performance indicators for NPP s in 2013

Summary of the safety performance indicators for nuclear power plants

Background and objectives of the indicator system

Safety is a primary prerequisite for the operation of nuclear power plants. The power companies and STUK evaluate and oversee the safety and operation of the plants in many ways. Along with inspections and safety reviews, indicators are a method of acquiring information on the safety level of the plant and on any changes to the safety level. The STUK indicator system consists of two main groups: 1) plant safety indicators, and 2) indicators describing the efficiency of the authorities. This summary covers the indicators describing plant safety.

The objective of the indicator system is to recognise changes in plant safety as early as possible. If the indicators weaken, the underlying factors influencing the development must be determined and changes to plant operation and STUK's oversight of the area must be considered. Indicators can also be used to monitor the efficiency and effectiveness of corrective measures. The information yielded by the indicators is also used when communicating nuclear safety.

In the indicator system, nuclear safety is divided into three sectors: 1) safety and quality culture, 2) operational events, and 3) structural integrity. STUK began the development of its own indicator system in 1995. Since 2006, indicator information has been managed in STUK's INDI (INdicator DIsplay) information system. Nominated STUK representatives are responsible for the maintenance and analysis of the indicators. Individual indicators, their maintenance procedures and the interpretation of results are presented at the end of this summary. A brief summary of the safety status of each plant in 2012 is presented below, followed by the detailed results by indicator.

Nuclear safety		
A.I Safety and quality culture	**A.II Operational events**	**A.III Structural integrity**
1. Failures and their repairs	1. Number of events	1. Fuel integrity
2. Exemptions and deviations from the Operational Limits and Conditions	3. Risk-significance of events	2. Primary and secondary circuits integrity
3. Unavailability of safety systems	4. Accident risk of nuclear facilities	3. Containment integrity
4. Occupational radiation doses	5. Number of fire alarms	
5. Radioactive releases		
6. Investments in facilities		

Safety and quality culture is assessed on the basis of information concerning the radiation protection and the operation and maintenance of the plant. The operation and maintenance of the plant is monitored using the failure and maintenance data for the components with an effect on the safe operation of the plant, as well as by monitoring compliance with the operational limits and conditions (OLC). The success of radiation protection is monitored on the basis of the employees' radiation doses and radioactive releases into the environment. When assessing the safety and quality culture, attention is also paid to investments to improve the plant and to the up-to-dateness of the plant documentation.

*The indicators concerning **operational events** are used to monitor special situations and significant disturbances at the plant. Special situations include events with an effect on the safety of the plant, the personnel or the environment. A special report is required for any special situations. Correspondingly, a disturbance report must be prepared for any significant disturbances occurring at a plant unit. Such disturbances include reactor and turbine trips, and other operational transients leading to a forced reduction of more than 5% in the reactor power or average gross power. Risk indicators are used to monitor the safety effect of the equipment's unavailability periods and the development of the plant's risk level. The results provide insight into the operational activities at the plant and the efficiency of the operating experience feedback system.*

***Structural integrity** is assessed on the basis of the leak-tightness of the multiple radioactivity confinement barriers – the fuel, primary and secondary circuits, and the containment. The integrity must meet the set objectives while the indicators must show no significant deterioration. Fuel integrity is monitored on the basis of the radioactivity of the primary coolant and the number of leaking fuel bundles. The water chemistry indicators are used to monitor and control primary and secondary circuit integrity. The monitoring is done by indices depicting water chemistry control and by following selected corrosive impurities and corrosion products. The integrity of the containment is monitored by testing the leak tightness of isolation valves, penetrations and air locks.*

Results of the safety performance indicators for the nuclear power plants in 2013

Summary of indicator results for the Loviisa power plant

Structural integrity

In 2013, the reactor of Loviisa 1 did not contain any leaking fuel assemblies. In December 2012, a minor fuel leak was detected in Loviisa 2. A leaking fuel assembly was removed from the reactor during the annual outage of 2013.

The indicators on water chemistry illustrate that the reactor coolant system integrity of both plant units was at an acceptable level in 2013.

The overall as-found leakage of the outer isolation valves in Loviisa 1 increased, but remained clearly below the limit set. In Loviisa 2, the overall as-found leakage continued to increase, and based on the first tests exceeded the limit set for overall leakage. Three outer isolation valves with plenty of leakage accounted for 84% of the overall as-found leakage. Both lines also have inner isolation valves. After the repair of the valves, the overall as-found leakage fell back to below the set limit.

The indicator describing the overall as-found leakage of the personnel airlock, material airlock, emergency personnel airlock, reactor pit, inward relief valves, cable penetrations and bellows seals (RA, RL, TL23), is good at both plant units.

Radiation doses and releases

The radiation doses received by employees and the releases into the environment remained small and clearly below the limits set in official regulations.

The occupational radiation dose was the lowest in the power plant's operational history because of short annual outages for both plant units that only included a little work with significance for radiation protection. Furthermore, improvements aimed at reducing the employees' radiation doses have also been made at the plant.

Operational events at the plant

No reactor trips occurred at the Loviisa power plant in 2013. Significant operational events included faults in the control rod drive mechanism after the annual outages (two mechanisms in

Loviisa 2 and one in Loviisa 1) as well as the repair outages implemented to repair these faults. The repair outages also account for most of the production losses caused by faults.

The number of events warranting a special report and the number of events violating the operational limits and conditions, which are also events warranting a special report, have increased in the past few years. STUK discussed the issue of the increased number of events with the management of Fortum Power and Heat Oy in the autumn of 2012. The licensee studied the underlying causes of the changed trend and specified corrective measures. Fortum Power and Heat Oy submitted to STUK for information a related action plan at the end of 2013.

For the Loviisa power plant, the most significant factors affecting the overall accident risk include internal plant events during outages (such as falling heavy loads in the reactor hall or a power surge caused by sudden dilution of the boron used to control the core reactivity), fires, high sea water level during power operation and oil spills during a refueling outage. Loviisa power plant's accident risk has continued to decrease over the last ten years, and new risk factors, discovered as the scope of the risk analysis has been extended, have been efficiently eliminated. The annual probability of a severe reactor accident calculated for the Loviisa plant units has decreased by approximately 23% from the previous year. Several minor plant modifications, improvements of computational modelling and verification of reliability data have contributed to the reduction of the risk.

The functionality of safety systems is monitored on the basis of the unavailability of the high-pressure safety injection system, the emergency feedwater system and the emergency diesel generators. The condition and availability of the former two were good. The availability of the emergency diesel generators was acceptable.

The indicators describing the condition of equipment falling under the scope of the operational limits and conditions (OLC) show that the maintenance of equipment important to safety and the repairing of faults occurring in them are appropriate.

The fire safety of the Loviisa plant units has remained at the same level as in the past few years. Four events classified as fires have occurred in the Loviisa plant area in the past ten years. The most recent of these events occurred in 2013 when a plastic protective cover of a fluorescent tube light fixture in the ceiling of an instrument room in the reactor building caught fire. The fire was minor and could be put out with a handheld fire extinguisher. There were around the same number of faults in the fire detection system as in the previous years. There were less actual alarms initiated by fire detectors than in 2012.

Summary of indicator results for the Olkiluoto power plant

Structural integrity

Based on water chemistry indicators, the integrity of the reactor coolant circuits of the Olkiluoto plant units was good in 2013. Fuel integrity of Olkiluoto 1 was good during the 2012–2013 fuel cycle, and no leaks were detected. One leaking fuel assembly was removed from the reactor of Olkiluoto 2 during the annual outage. Several fuel leaks have occurred in the 2000s in the Olkiluoto plant units, particularly in Olkiluoto 2. The main reason for the leaks has been small foreign objects entering the reactor during maintenance operations. These objects can get caught in the fuel assembly structures. The coolant flow may cause the loose objects to vibrate and break the fuel cladding. To prevent this, fuel assemblies with new sieve structures for foreign objects have been loaded into the reactor of Olkiluoto 2 in 2012. The sieve profiles were changed to make the grid denser.

The overall as-found leakage of the outer isolation valves of Olkiluoto 1's containment decreased when compared to the previous year and remained clearly below the limit set in the operating limits and conditions (OLC). The overall as-found leakage of the outer isolation valves of Olkiluoto 2's containment increased when compared to the previous year, but remained clearly below the limit set in the operating limits and conditions (OLC). The percentage of isolation valves that passed the leak test at first attempt has remained high for both plant units. The total as-found leakage rate of containment penetrations, in which TVO includes leakages in the upper and lower personnel airlocks, the maintenance dome and the containment dome, has remained small for both plant units.

Radiation doses and releases

The radiation doses received by employees and the releases into the environment remained small and clearly below the limits set in official regulations. In 2013, the collective occupational radiation dose of Olkiluoto employees was the lowest ever recorded during the operation of the power plant because of short annual outages for both plant units that only included a little work with significance for radiation protection. The radiation doses have clearly decreased after the installation of new moisture separators in 2005–2007. Due to the new moisture separators, the radiation level in the turbine building has continued to decrease. Furthermore, improvements aiming at reducing the employees' radiation doses have also been made at the plant.

The releases of substances with gamma activity into the sea from the Olkiluoto power plant have been decreasing in recent years. In 2013, the atmospheric releases of radioactive substances were of the same magnitude as in previous years. The releases into the environment were small, well below the set limits.

Operational events at the plant

For the Olkiluoto power plant, the most important factors affecting the overall accident risk include internal events during power operation (component failures and pipe ruptures leading to an operational transient). In 2013, the risk caused by operational activities remained at around the same level as in the past ten years. The annual probability of a severe reactor accident calculated for the Olkiluoto power plant (9%) remained at around the same level as in 2012.

No reactor trips occurred at the Olkiluoto power plant in 2013. The number of events warranting a special report (four in total) was around the average for the past ten years while the number of events warranting a transient report (seven in total) was slightly above the average.

Production losses due to faults in 2013 were not much different from the production losses in the previous years. Most (87%) of the production losses of Olkiluoto 2 were caused by a turbine trip that occurred in September. It was triggered by an earth fault protector in the generator's stator. This led to a maintenance outage to repair the generator. Most (78%) of the production losses in Olkiluoto 1 were also due to a generator fault. In December, a fault in a surge arrester of a generator exciter caused a generator breaker to open, which caused a turbine trip. As a result of the trip, the plant unit was placed into the hot shutdown state to locate and repair the fault.

No events classified as fires occurred in the Olkiluoto power plant area in 2013. One event classified as a fire occurred outside the plant area. The fire was minor and could be put out with handheld fire extinguishers. No fire detection system faults were observed at the Olkiluoto power plant in 2013.

In 2013, five safety-significant common-cause failures were identified at the Olkiluoto power plant. The number of common-cause failures has increased in recent years. In the three previous years, there have been a total of fifteen common-cause failures. Most of these have occurred in the emergency diesel generators (six failures) and the relief system (three failures). TVO has launched a project on replacing the emergency diesel generators. The new emergency diesel generators will be installed in 2016–2020.

Safety performance indicators

A.I Safety and quality culture

A.I.1 Faults and repairing them

A.I.1a Faults in components subject to the operational limits and conditions

Definition

The number of faults causing the unavailability of components during load operation defined in the operational limits and conditions (OLC) is monitored as an indicator. The faults are divided by plant unit into two groups: faults causing an immediate operation restriction, and faults causing an operation restriction in connection with repair work.

Source of data

The data is obtained from the work order systems and the operational documents of the power plants.

Purpose of the indicator

The indicator is used to assess the plant lifecycle management and the development of the condition of components.

Responsible units/persons

Resident inspectors

Pauli Kopiloff (Loviisa nuclear power plant)

Jukka Kallionpää (Olkiluoto nuclear power plant)

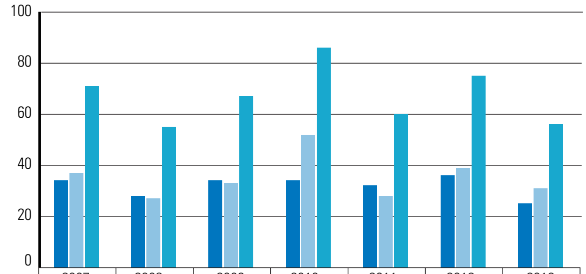
Interpretation of the indicator

Loviisa

The total number of faults causing an operation restriction of components subject to the OLC in 2013 was 178. The average number of faults during the four previous years was 180, which means that there was no significant change in the number of faults in 2013 or in the fault trend.

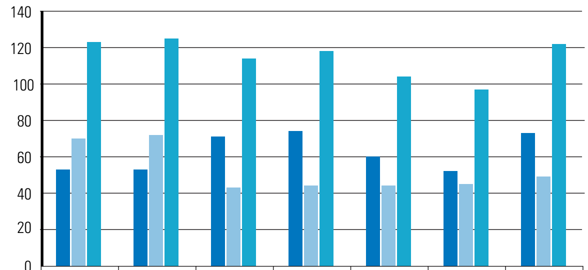
The number of faults per year has remained stable. Any variation therein has been caused by the random occurrences of faults that occur in any large number of components. Fault detection and anticipation have been continuously improved in plant maintenance operations at Loviisa, and components have been replaced. Due to these meas-

Number of failures of OLC components causing immediate operation restriction, Loviisa NPP



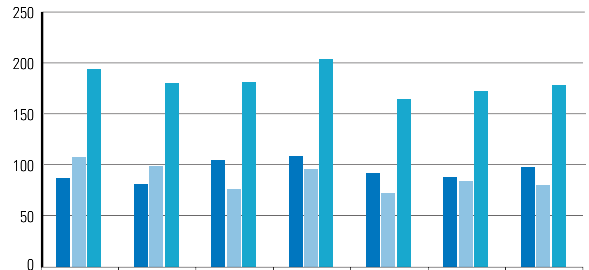
	2007	2008	2009	2010	2011	2012	2013
LO1	34	28	34	34	32	36	25
LO2	37	27	33	52	28	39	31
LO1,2	71	55	67	86	60	75	56

Number of failures of OLC components causing operation restriction from start of a repair work, Loviisa NPP



	2007	2008	2009	2010	2011	2012	2013
LO1	53	53	71	74	60	52	73
LO2	70	72	43	44	44	45	49
LO1,2	123	125	114	118	104	97	122

Number of failures of OLC components causing unavailability during power operation, Loviisa NPP



	2007	2008	2009	2010	2011	2012	2013
LO1	87	81	105	108	92	88	98
LO2	107	99	76	96	72	84	80
LO1,2	194	180	181	204	164	172	178

ures, there have been no faults with a significant impact on plant safety, and the management of component availability has been successful.

Based on the above, it can be stated that the indicator or the underlying fault data do not show any significant negative effects associated with the ageing of the facilities, which is an indication of well-functioning component lifecycle management and component maintenance.

Interpretation of the indicator

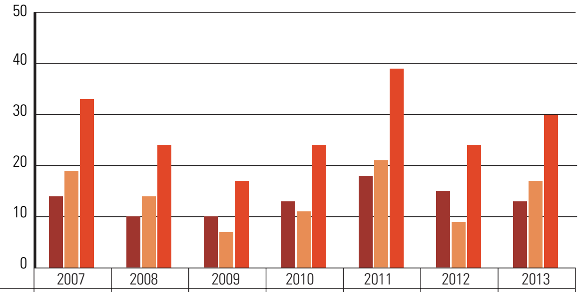
Olkiluoto

The number of faults occurring during load operation and causing the unavailability of components subject to the OLC has been increasing since 2009. In 2011, the number of faults was nearly double the number of faults in 2009. In 2012, the number of faults decreased back to the level of 2010, and the number of faults did not change in 2013. The number of faults indicates that maintenance work has been successful.

The unavailability times of OLC components in OL1 during all four quarters of 2013 were brief.

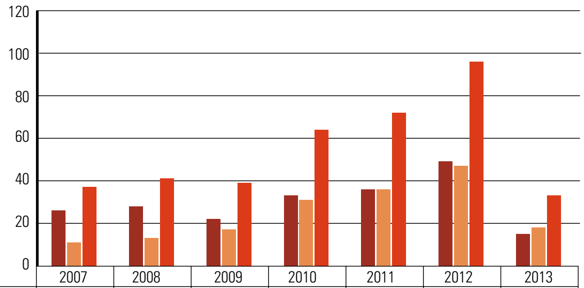
In OL2, most of the unavailability times of OLC components were brief in 2013. The number of operation restrictions decreased because of fewer cleanings of the cooling system.

Number of failures of OLC components causing immediate operation restriction, Olkiluoto NPP



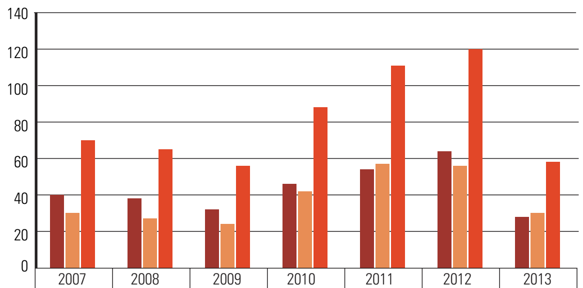
	2007	2008	2009	2010	2011	2012	2013
OL1	14	10	10	13	18	15	13
OL2	19	14	7	11	21	9	17
OL1,2	33	24	17	24	39	24	30

Number of failures of OLC components causing operation restriction from start of a repair work, Olkiluoto NPP



	2007	2008	2009	2010	2011	2012	2013
OL1	26	28	22	33	36	49	15
OL2	11	13	17	31	36	47	18
OL1,2	37	41	39	64	72	96	33

Number of failures of OLC components causing unavailability during power operation, Olkiluoto NPP



	2007	2008	2009	2010	2011	2012	2013
OL1	40	38	32	46	54	64	28
OL2	30	27	24	42	57	56	30
OL1,2	70	65	56	88	111	120	58

A.I.1b Maintenance of components subject to the operational limits and conditions

Definition
The indicator is used to follow the number of fault repairs and preventive maintenance work orders for components subject to the operational limits and conditions (OLC) by plant unit.

Source of data
The data is obtained from the plant work order systems, from which all preventive maintenance operations and fault repairs are retrieved.

Purpose of the indicator
The indicator describes the volumes of fault repairs and preventive maintenance, and illustrates the condition of the plant and its maintenance strategy. The indicator is used to assess the maintenance strategy implemented at the plant.

Responsible units/persons
Resident inspectors
Pauli Kopiloff (Loviisa nuclear power plant)
Jukka Kallionpää (Olkiluoto nuclear power plant)

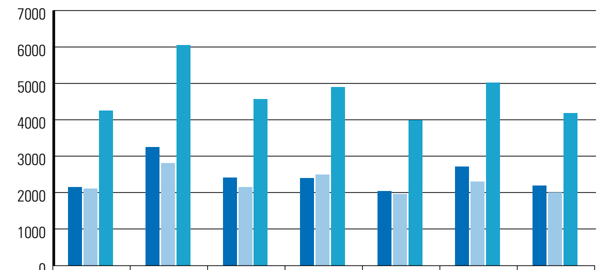
Interpretation of the indicator

Loviisa
When considering the annual variation in the volume of fault repairs and particularly in the number of preventive maintenance jobs, the scheduling of various annual outages (refueling outage, short annual outage, four-year annual outage, eight-year annual outage) included in the maintenance strategy of the Loviisa power plant during a four-year cycle should be considered, since it can have a significant impact on the annual figures. The Loviisa plant units had short refueling outages in 2013.

Based on the data on which the indicator is based, the year 2013 showed no major deviation from the average numbers of fault repairs and preventive maintenance volumes of the four previous years. In 2013, the number of maintenance tasks on components subject to the OLC was 9% lower than the average. Similarly, the number of preventive maintenance tasks was 7% and the number of fault repairs 23% lower than the average.

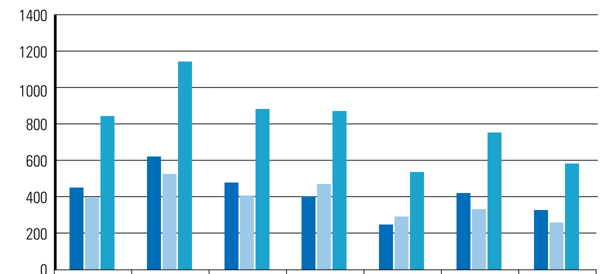
The ratio of preventive maintenance and fault repairs was 6.2. The ratio is 18% higher than

Volume of annual maintenance works of OLC components, Loviisa NPP



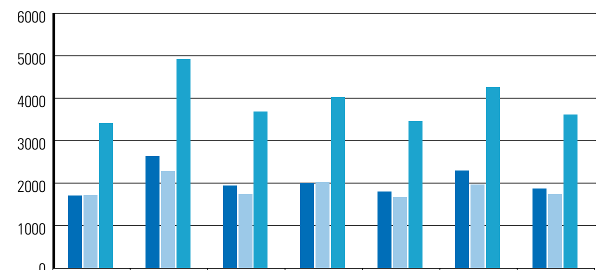
	2007	2008	2009	2010	2011	2012	2013
LO1	2148	3250	2416	2403	2040	2717	2192
LO2	2105	2807	2148	2495	1952	2299	1997
LO1,2	4253	6057	4564	4898	3992	5016	4189

Number of annual failure repair works of OLC components, Loviisa NPP



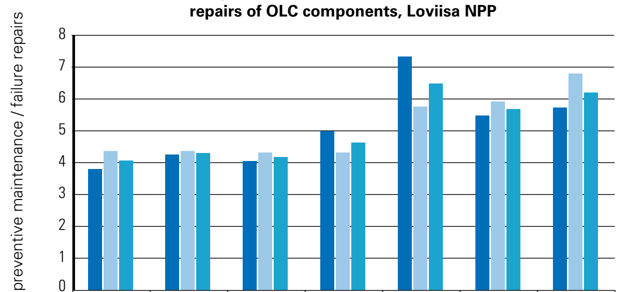
	2007	2008	2009	2010	2011	2012	2013
LO1	448	619	478	401	245	419	326
LO2	393	524	404	469	289	332	256
LO1,2	841	1143	882	870	534	751	582

Number of annual preventive maintenance works of OLC components, Loviisa NPP



	2007	2008	2009	2010	2011	2012	2013
LO1	1700	2631	1938	2002	1795	2298	1866
LO2	1712	2283	1744	2026	1663	1967	1741
LO1,2	3412	4914	3682	4028	3458	4265	3607

Ratio of preventive maintenance works to failure repairs of OLC components, Loviisa NPP



	2007	2008	2009	2010	2011	2012	2013
LO1	3.79	4.25	4.05	4.99	7.33	5.48	5.72
LO2	4.36	4.36	4.32	4.32	5.75	5.92	6.80
LO1,2	4.06	4.30	4.17	4.63	6.48	5.68	6.20

the 5.2 average of the four previous years, which means that the share of preventive maintenance of all maintenance work has remained high.

The large share of preventive maintenance operations reflects the selected maintenance strategy, the purpose of which is to keep the number of faults and the effects of faults at a tolerable level.

Interpretation of the indicator

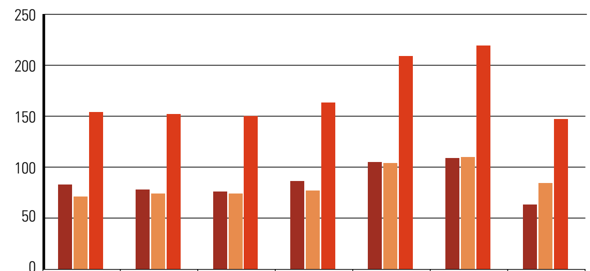
Olkiluoto

The number of maintenance works causing inoperability of components, included in the indicator, decreased during 2006–2009 due to the lower number of fault repairs. In 2010, the number of faults repaired increased while the number of preventive maintenance operations decreased.

In 2013, the number of fault repairs that caused inoperability of components remained at same level as in 2011 and 2012. The number of preventive maintenance tasks increased slightly, improving the ratio of preventive maintenance and fault repairs from 2011.

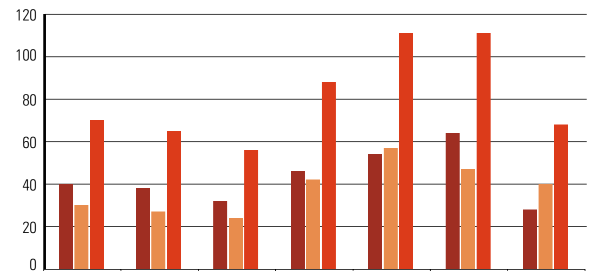
Based on the development of the ratio of preventive maintenance work to fault repairs and an assessment of the work on which the figures are based, the maintenance strategy can be considered successful.

Volume of annual maintenance works of OLC components, Olkiluoto NPP



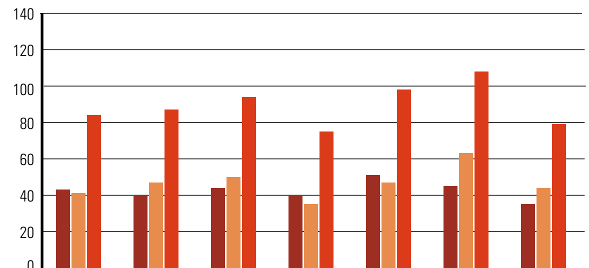
	2007	2008	2009	2010	2011	2012	2013
OL1	83	78	76	86	105	109	63
OL2	71	74	74	77	104	110	84
OL1,2	154	152	150	163	209	219	147

Number of annual failure repair works of OLC components, Olkiluoto NPP



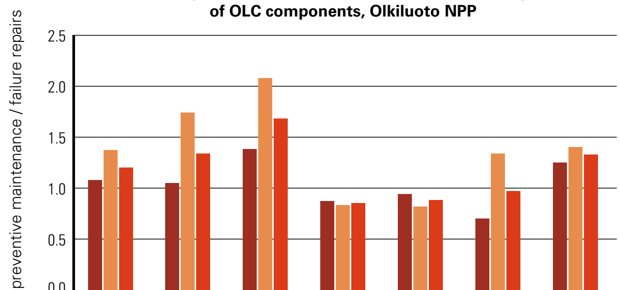
	2007	2008	2009	2010	2011	2012	2013
OL1	40	38	32	46	54	64	28
OL2	30	27	24	42	57	47	40
OL1,2	70	65	56	88	111	111	68

Number of annual preventive maintenance works of OLC components, Olkiluoto NPP



	2007	2008	2009	2010	2011	2012	2013
OL1	43	40	44	40	51	45	35
OL2	41	47	50	35	47	63	44
OL1,2	84	87	94	75	98	108	79

Ratio of preventive maintenance works to failure repairs of OLC components, Olkiluoto NPP



	2007	2008	2009	2010	2011	2012	2013
OL1	1.08	1.05	1.38	0.87	0.94	0.70	1.25
OL2	1.37	1.74	2.08	0.83	0.82	1.34	1.40
OL1,2	1.20	1.34	1.68	0.85	0.88	0.97	1.33

A.I.1c Repair times of components subject to the operational limits and conditions

Definition

As an indicator, the average repair time of faults causing the unavailability of components defined in the operational limits and conditions (OLC) is monitored. With each repair, the time recorded is the time of inoperability. In the case of a fault that causes an immediate operation restriction, it is calculated from the detection of the fault to the end of the repair work. If the component is operable until the beginning of repairs, only the time it takes to complete the repairs is taken into account.

Source of data

The data is obtained from the power plant's work order systems and maintenance and operation documentation.

Purpose of the indicator

The indicator shows how quickly failed components subject to the OLC are repaired when compared to the repair time allowed in the OLC. The indicator is used to assess the strategy, resources and effectiveness of plant maintenance.

Responsible units/persons

Resident inspectors
Pauli Kopiloff (Loviisa nuclear power plant)
Jukka Kallionpää (Olkiluoto nuclear power plant)

Interpretation of the indicator

Loviisa

The OLC define the maximum allowed repair times for components based on the components' safety significance. The times vary between four hours and 21 days. Faults in OLC components are to be repaired within the allotted time without undue delay.

Due to the small amount of work requiring operation restrictions and the varying allowed repair times, an individual operation may have a significant effect on the indicator value, even if it is completed within the allotted time. This aspect of the indicator is taken into account in the interpretation of the indicator by evaluating the significance of individual long-term fault repairs in terms of maintenance strategy, resources and efficiency of operations.

The average repair times of faults causing unavailability of components have remained stable at the Loviisa plant for several years. In 2013, the average repair time for the plant units was 21.6 h, compared to the average of 29.4 h for the four previous years. In 2013, the average repair time of OLC component faults that had an allowed repair time of 72 hours or less was 9.7 hours in Loviisa 1 and 12.0 hours in Loviisa 2.

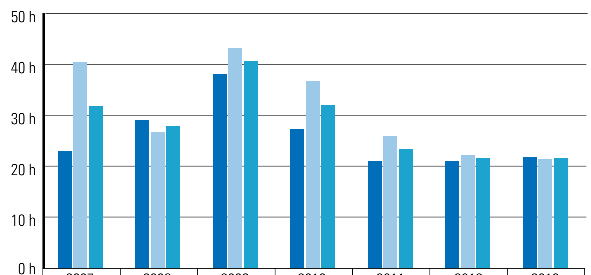
Based on the 2013 indicators and the underlying data, the plant's maintenance operations can be considered appropriate. Despite the positive development in repair times, attention still needs to be paid to the power plant's maintenance on having the necessary resources available for fault repairs, and for carrying out the repairs without unnecessary delays.

Interpretation of the indicator

Olkiluoto

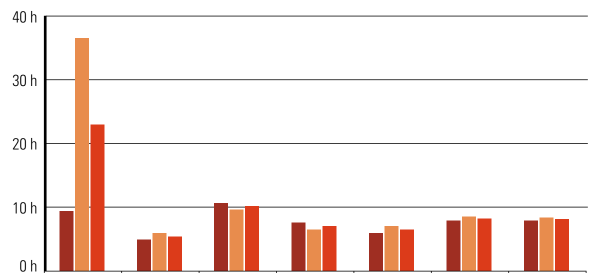
The repair time allowed in the OLC for the Olkiluoto nuclear power plant is usually 30 days for faults concerning one train and three days for faults concerning two trains. Depending on the system and the component, other allowed repair times may be defined in the OLC.

Average of real repair times of OLC component failures, Loviisa NPP



	2007	2008	2009	2010	2011	2012	2013
LO1	22.9	29.1	38.0	27.3	20.9	20.9	21.7
LO2	40.4	26.6	43.1	36.6	25.9	22.1	21.4
LO1,2	31.7	27.9	40.6	32.0	23.4	21.5	21.6

Average of real repair times of OLC component failures, Olkiluoto NPP



	2007	2008	2009	2010	2011	2012	2013
OL1	9.4	4.9	10.7	7.5	5.9	7.9	7.9
OL2	36.5	6.0	9.7	6.5	7.0	8.5	8.4
OL1,2	23.0	5.4	10.2	7.0	6.5	8.2	8.2

In the long term, the average repair time has varied between six to ten hours, with the exception of the year 2007. In 2007, repair times greatly increased for both plant units, to around 1.5 times the previous figure in the case of Olkiluoto 1 and to more than six times the previous figure in the case of Olkiluoto 2. In the case of both plant units, the increase was due to a fault in a single device. In 2013, the average repair time of faults causing inoperability of components in Olkiluoto 1 was around 8 h and in Olkiluoto 2 around 8.5 h. In the case of both plant units, the average repair time of faults causing inoperability of components subject to the OLC was at around the same level as in 2010 and 2011.

On the basis of the 2013 indicators and the underlying data, the plant's maintenance operations were appropriate.

A.I.1d Common-cause failure

Definition

As the indicator, the number of common-cause failures of components or systems defined in the operational limits and conditions (OLC) is followed.

Source of data

Data for the indicators is collected from the reports by the power companies of works causing an operation restriction.

Purpose of the indicator

The indicator is used to follow the quality of maintenance.

Responsible unit/person

Operational safety (KÄY)
Suvi Ristonmaa (Loviisa)
Niko Mononen (Olkiluoto)

Interpretation of the indicator

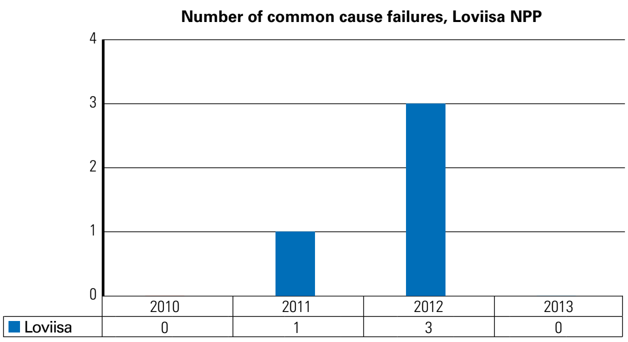
Loviisa

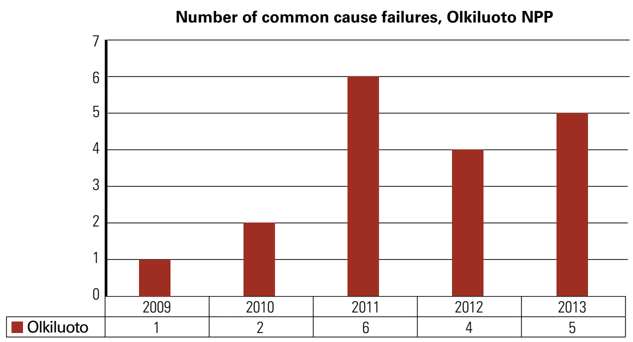
When a fault is observed in a safety-critical system, component or structure in connection with maintenance, inservice testing or other monitoring operations, the corrective measures include an investigation of whether the fault is a single fault, or whether there might be other similar faults in the system. No common-cause failures were identified at the Loviisa power plant in 2013. An increased common-cause failure risk of auxiliary relays in the emergency diesel generators was observed. The Loviisa power plant prepared a special report on the event.

Olkiluoto

In 2013, five safety-significant common-cause failures were identified at the Olkiluoto power plant. These included problems with the surface coating of pistons in the auxiliary feed water system, corrosion of galvanised flanges in the condenser's circulating water chambers, alarms pertaining to cards in the neutron flux measuring system and fluctuation of the measuring results, air leaks from the compressed air motors of the emergency diesel generators, and corroded flanges in shutdown cooling system.

The number of common-cause failures has increased in recent years. In the three previous years, there have been a total of fifteen common-cause failures. Most of these have occurred in the emergency diesel generators (six failures) and the relief train (three failures). TVO has launched a project to replace the emergency diesel generators. The new emergency diesel generators will be installed in 2016–2020.





A.I.1g Production losses due to faults

Definition

As the indicator, the loss of production caused by faults in relation to rated power (gross) is monitored.

Source of data

Data for the indicator is obtained from the annual and quarterly reports submitted by power companies.

Purpose of the indicator

The indicator is used to follow the significance of faults from the point of view of production.

Responsible unit/person

Operational safety (KÄY)
Suvi Ristonmaa (Loviisa)
Niko Mononen (Olkiluoto)

Interpretation of the indicator

Production losses due to faults have been small at both Loviisa and Olkiluoto, which is also indicated by the plants' high load factors.

Loviisa

In 2013, Loviisa 1 experienced a higher number of faults resulting in production losses than in the previous years. Furthermore, Loviisa 2 experienced more production losses due to faults in 2012 and 2013 than in the previous years.

Most (92%) of the production losses due to faults in Loviisa 2 were caused by a repair outage in October, and most (81%) of the production losses in Loviisa 1 were due to a repair outage at the turn of November and December. Both repair outages were implemented to study and repair faults observed in control rod mechanisms (one fault in Loviisa 1 and two faults in Loviisa 2). The next largest share of faults (14%) was caused by a leak in a seal in the Loviisa 1 safety injection system and its repairs.

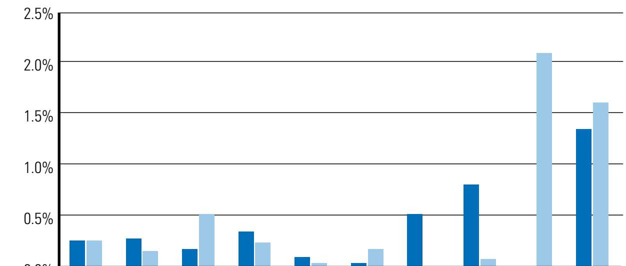
Olkiluoto

The production losses due to faults were not clearly different from the production losses in the previous years.

Most (87%) of the production losses of Olkiluoto 2 in 2013 were caused by a turbine trip that occurred in September. It was triggered by an earth fault protector in the generator's stator. This led to a maintenance outage to repair the generator. Other issues that caused production losses included repairing a steam leak in an HP reheater (an on-power maintenance measure) and inspecting and replacing flexible connection pieces in between the generator and an exciter. Reactor power was decreased when these faults were being repaired.

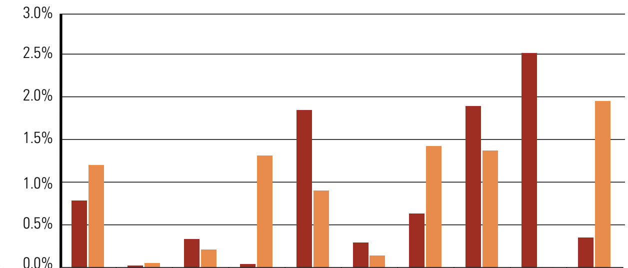
Most (78%) of the production losses in Olkiluoto 1 were due to a generator fault. In December, a fault in a surge arrester of a generator exciter caused a generator breaker to open, which caused a turbine trip. As a result of the trip, the plant unit was placed into the hot shutdown state to locate and repair the fault. Most of the other production losses were caused by the identification and repair of faults during power operation. Such repair work included the repair of an HP turbine control valve and the repair of a contactor in a valve of the relief train.

Loss of power production due to failures, Loviisa NPP



	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
LO1	0.25	0.27	0.17	0.34	0.09	0.03	0.51	0.80	0.00	1.34
LO2	0.25	0.15	0.51	0.23	0.03	0.17	0.00	0.07	2.08	1.60

Loss of power production due to failures, Olkiluoto NPP



	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
OL1	0.78	0.02	0.33	0.04	1.84	0.29	0.63	1.89	2.51	0.35
OL2	1.20	0.05	0.21	1.31	0.90	0.14	1.42	1.37	0.00	1.95

A.I.2 Exemptions from the operational limits and conditions and non-conformances

Definition

As indicators, the number of non-conformances with the operational limits and conditions (OLC), as well as the number of exemptions granted by STUK, are monitored.

Source of data

Data for the indicators is collected from applications for exemption orders and from event reports.

Purpose of the indicator

The indicator is used to follow the power companies' activities in accordance with the OLC: compliance with the OLC and identified situations during which it is necessary to deviate from them; conclusions as regards to the appropriateness of the OLC can also be made based on this data.

Responsible unit/person

Operational safety (KÄY)
Suvi Ristonmaa (Loviisa)
Niko Mononen (Olkiluoto)

Interpretation of the indicator

The main purpose of the OLC exemption procedure is to enable alterations and maintenance that will improve safety and plant availability.

Non-conformance with the OLC refers to a situation where the plant or a system or component of the plant is not in a safe state as required by the operational limits and conditions. The objective is to have zero non-conformance events at the plants. The licensee always prepares a special report on each non-conformance and any corrective measures, and submits it to STUK for approval.

Loviisa

Exemptions

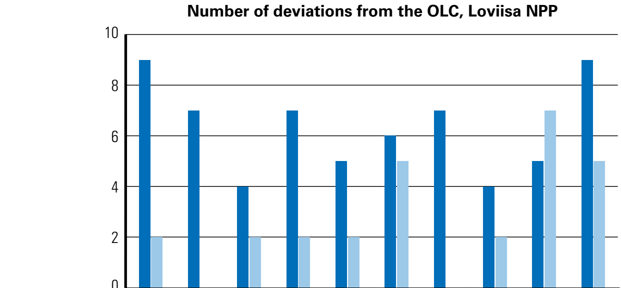
Based on the last ten years (2003–2012), the Loviisa nuclear power plant applies for STUK's approval for exemptions from the OLC eight times per year on average. Hence, the number of applications in 2013 (nine applications) was in line with the average. Five of these applications concerned modifications, one the repair of a valve and three an unclear item in the OLC. As the planned deviations had no significant safety implications, STUK accepted the applications. One of the applications was not accepted until after further reviews, however.

Non-conformance with the OLC

In 2013, five events during which the plant did not comply with the OLC without an advance safety analysis and STUK's permission were detected at the Loviisa power plant. There have been more such events in the past few years than in the previous years. Such events have occurred twice a year on average during the past ten years (2003–2012). STUK discussed the issue of the increased number of events with the management of Fortum Power and Heat Oy in the autumn of 2012. The licensee studied the underlying causes of the changed trend and specified corrective measures. Fortum Power and Heat Oy submitted to STUK for information a related action plan at the end of 2013.

One of these non-conformances with the OLC was caused by a human error made when planning the repair of a valve. Some of the OLC requirements applied to the repair work were not identified at the design stage, which means that they were not taken into account at the implementation stage. In one of the cases, one of the measurements included in the monitoring of radioactive releases did not operate as planned when treated evaporator concentrate was released into the sea from the Loviisa power plant. In the three other cases, the non-conformance with the OLC was related to a switching of the plant unit's operating mode during a startup after an annual outage or a repair outage; the operating mode was changed even though the conditions laid down for the new operating mode had not been met. In two of these cases, equipment whose operation had been prevented for the duration of the outage were inadvertently not restored

Number of deviations from the OLC, Loviisa NPP



	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Exemptions	9	7	4	7	5	6	7	4	5	9
Deviations	2	0	2	2	2	5	0	2	7	5

back to the operating mode. In one of the cases, valve malfunctions were still being studied; proceeding with the startup of a plant unit with unresolved valve malfunctions is not allowed. Fortum Power and Heat Oy analysed all five OLC non-conformances and determined corrective measures to prevent similar events from occurring in the future. There were, however, several events linked to the switching of operating modes, which is why ensuring that there are no deficiencies in the knowledge of the OLC or the procedures to ensure compliance with the OLC that would lead to unintentional non-conformance is of utmost importance. Fortum Power and Heat Oy decided to study the procedures pertaining to the switching of operating modes in more detail. The results of the study and corrective measures will be presented in a root cause analysis to be drafted by 30 April 2014.

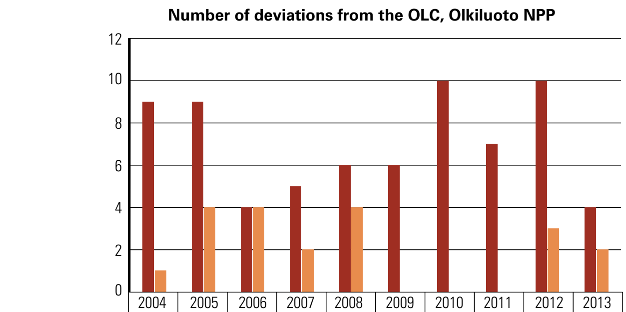
Olkiluoto

Based on data from the last ten years (2003–2012), the Olkiluoto power plant applies for STUK's approval for exemptions from the OLC seven times per year on average. Hence, the number of applications in 2013 (four) was slightly lower than the average. All of these applications were linked to modifications. One of the applications was linked to an upgrade of a radiation measuring channel in Olkiluoto 2 and three of them were linked to an expansion of the spent fuel storage facility. As the planned deviations had no significant safety implications, STUK accepted the applications. In 2004 and 2005, the number of deviations was increased by work and installations related to the modernisation of OL1 and OL2 and the construction of OL3. Similarly, major modifications were carried out during 2010 and 2011.

Non-conformance with the OLC

In 2013, TVO reported two events during which the plant did not comply with the OLC without an advance safety analysis and STUK's permission. This is slightly more events than during the past ten years on average (three).

All of these non-conformances were unintentional. In one of the cases, the non-conformance with the OLC was caused by an administrative error in work pertaining to reactor cooling during the annual outage. The other case was a non-conformance with the key handover procedure of a cross-connection room below the control room. The individual events did not put the plant or its surrounding environment at risk. TVO analysed all events and defined corrective measures to prevent similar events from reoccurring.



	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Exemptions	9	9	4	5	6	6	10	7	10	4
Deviations	1	4	4	2	4	0	0	0	3	2

A.I.3 Unavailability of safety systems

Definition

As the indicators, the unavailability of safety systems is monitored separately for each plant unit. The systems monitored at the Olkiluoto nuclear power plant are the containment spray system (322), the auxiliary feed water system (327) and the emergency diesel generators (651–656). Those followed at the Loviisa nuclear power plant are the high-pressure safety injection system (TJ), auxiliary feed water system (RL92/93, RL94/97) and the emergency diesel generators (EY).

Essentially, the ratio of a system's unavailability hours and its required availability hours is used as the indicator. Unavailability hours are the combined unavailability of redundant trains divided by the number of trains.

Annual plant criticality hours are the availability requirement for the 322, 327, TJ and RL systems. For diesel generators, the requirement is continuous, i.e. equal to annual operating hours.

The unavailability hours of a train include the time required for the planned maintenance of components and unavailability due to faults. The latter includes, in addition to the time spent on repairs, the estimated unavailability time prior to fault detection. If a fault is estimated to have occurred in a previous successful test but to have escaped detection, the time between inservice tests is added to the unavailability time. If a fault has occurred between tests but its date of occurrence is unknown, half of the time period lapsed between tests will be added to the unavailability time. If the fault clearly occurred during an operational, maintenance, testing or other event, the time between the event and the defection of the fault is added to the unavailability time.

Source of data

Data for the indicators is collected from the power companies. The licensee's representatives submit the necessary data to the relevant person in charge at STUK.

Purpose of the indicator

The indicator indicates the unavailability of safety systems. The indicator is used to track the condition of safety systems and any identifiable trends.

Responsible units/persons

Resident inspectors
Pauli Kopiloff (Loviisa nuclear power plant)
Jukka Kallionpää (Olkiluoto nuclear power plant)

Interpretation of the indicator

Loviisa

TJ system

Analysis of the unavailability figures of the high pressure safety injection systems (TJ) of the plant units and their background information shows that one fault, the repairs for which caused the system to be unavailable for 36.4 hours, occurred in Loviisa 1. One fault that caused the system to be unavailable for 10.7 hours occurred in Loviisa 2.

The unavailability of the high pressure safety injection systems was low in 2013, i.e. their condition and availability were good.

RL system

In Loviisa 1, the total unavailability time of the emergency feedwater systems was 162.1 hours, of which a total of four faults were being repaired for a total of 57.5 during load operation. The rest of the unavailability of Loviisa 1, a total of 104.6 hours for the RL94 emergency feedwater system, was caused by maintenance of an emergency diesel generator that is implemented every 16 years.

In Loviisa 2, the total unavailability time was 226.1 hours, of which the unavailability caused by a single fault during load operation accounted to a total of 4.4 hours. The maintenance of an emergency diesel generator that is implemented every 16 years in the RL94 emergency feedwater system accounted for unavailability of 221.8 hours.

The unavailability of the emergency feedwater systems was low in 2013, i.e. their condition and availability were good.

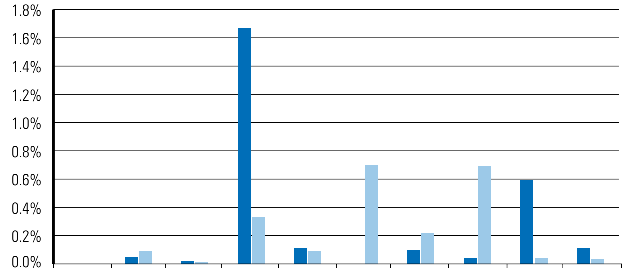
EY system

In 2013, the total unavailability time for all eight emergency diesel generators was 526.2 hours. Maintenance of the emergency diesel generator 11EY02 that is implemented every 17 years accounted for 169.4 hours of the unavailability. The maintenance of 11EY02 began as planned before the shutdown of Loviisa 1 for the annual outage. At that time, 11EY02 was replaced with a connection to the Ahvenkoski hydropower plant for the period of time the OLC set an operability requirement for 11EY02.

In 2013, there were a total of 30 diesel generator faults causing unavailability of the generators. Six of these caused immediate operation restrictions while 24 caused operation restrictions from the beginning of the repair work. Most of the faults were caused by the normal ageing of components and did not have any serious implications.

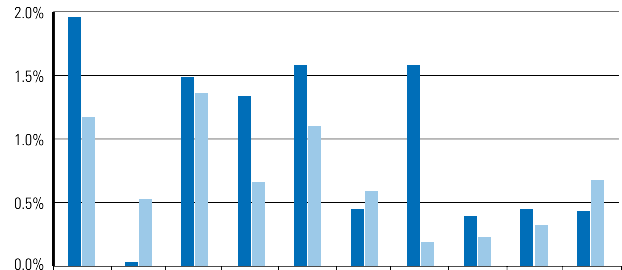
Unavailability of the emergency diesel generators, 0.93%, was close to the average for the past four years, 0.96%. Taking into account the impact of the planned periodic maintenance of 11EY02 on the unavailability, one can state that the unavailability of the diesel generators remained low, i.e. their availability was satisfactory.

Unavailability of high pressure safety injection system (TJ), Loviisa NPP



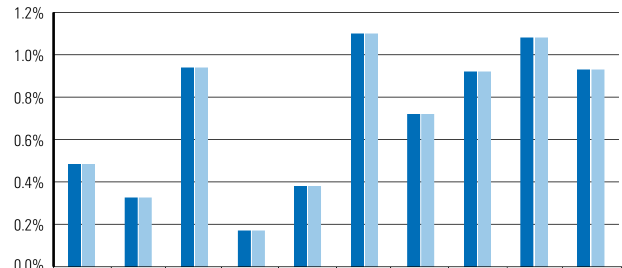
	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
LO1	0.00	0.05	0.02	1.67	0.11	0.00	0.10	0.04	0.59	0.11
LO2	0.00	0.09	0.01	0.33	0.09	0.70	0.22	0.69	0.04	0.03

Unavailability of auxiliary feed water system (RL92/93, RL94/97), Loviisa NPP



	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
LO1	1.96	0.03	1.49	1.34	1.58	0.45	1.58	0.39	0.45	0.43
LO2	1.17	0.53	1.36	0.66	1.10	0.59	0.19	0.23	0.32	0.68

Unavailability of emergency diesel generators (EY), Loviisa NPP



	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
LO1	0.49	0.33	0.94	0.17	0.38	1.10	0.72	0.92	1.08	0.93
LO2	0.49	0.33	0.94	0.17	0.38	1.10	0.72	0.92	1.08	0.93

Interpretation of the indicator

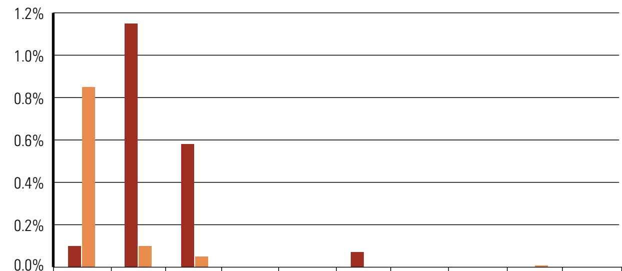
Olkiluoto

The unavailability times of the containment spray system have been decreasing since 2005. In 2007, 2008, 2010, 2011 and 2013, the unavailability was zero for both plant units, and almost zero in 2009 and 2012.

The unavailability of the auxiliary feed water system increased significantly after 2004, when the unavailability was practically zero. The increased unavailability of Olkiluoto 1 in 2006 was due to faults in the recirculation and safety valves in system 327. There were no significant faults in 2007, 2008 or 2009, and the unavailability of the auxiliary feed water system decreased to nearly zero in 2009 at both plant units. In 2010, unavailability of Olkiluoto 1 was still zero but the unavailability of Olkiluoto 2 slightly increased from the previous year, mainly as a result of several new faults discovered during the outage. In 2011, the figure for OL1 was multiplied many times over as the result of a latent fault in one auxiliary feed water system valve that remained inoperable for 504 hours (cf. Section A.II.3). In 2013, the unavailability of the auxiliary feed water system was restored to the level prior to 2011.

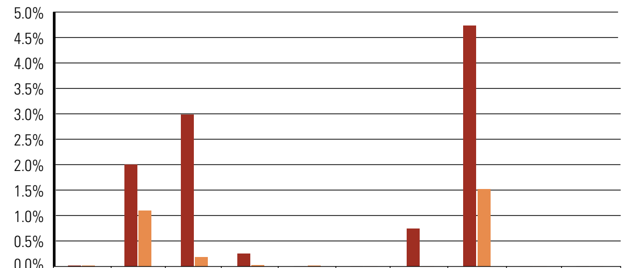
The unavailability of the diesel generators has decreased since 2004, and was very low in 2006 and 2007. In 2008, the value increased by nearly 95% compared to the previous year. The increase was due to latent faults in the compressed air motors of the diesels in both plant units. In 2009, the unavailability of the diesel generators decreased considerably from the 2008 figures. In 2010, unavailability increased somewhat from the previous year as a result of faults occurring in connection with inservice testing. At OL1, the stator winding of a diesel generator failed in connection with a periodic test in August 2010, and the generator was replaced with an overhauled unit. In 2011, the unavailability of the emergency diesel generators was more than four times higher than in 2010, the highest figure ever recorded while the parameter has been monitored. The reason for the increase was the generator fault discussed above, which may have lasted as long as from August 2010 to May 2011. In addition, there were faults in exhaust manifolds and exhaust pipes. In 2012, unavailability of emergency diesel generators was zero. The unavailability of the diesel generators slightly increased in 2013 but still remained very low.

Unavailability of containment spray system (322), Olkiluoto NPP



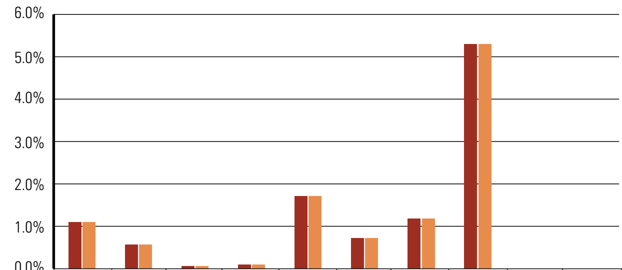
	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
OL1	0.10	1.15	0.58	0.00	0.00	0.07	0.00	0.00	0.00	0.00
OL2	0.85	0.10	0.05	0.00	0.00	0.00	0.00	0.00	0.01	0.00

Unavailability of auxiliary feed water system (327), Olkiluoto NPP



	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
OL1	0.01	2.00	2.98	0.25	0.00	0.00	0.74	4.73	0.00	0.00
OL2	0.01	1.10	0.18	0.02	0.01	0.00	0.00	1.52	0.00	0.00

Unavailability of emergency diesel generators (651…656), Olkiluoto NPP



	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
OL1	1.10	0.57	0.06	0.09	1.71	0.72	1.18	5.30	0.00	0.00
OL2	1.10	0.57	0.06	0.09	1.71	0.72	1.18	5.30	0.00	0.00

A.I.4 Radiation exposure

Definition

As the indicators, collective radiation exposure of nuclear power plant employees by plant site and plant unit is monitored, together with the annual average of the ten highest occupational doses.

Source of data

The data on the collective dose is received from the quarterly and annual reports of the power plants as well as the national dose register. The data on individual radiation doses is obtained from the national dose register.

Purpose of the indicator

The indicators are used to control the radiation exposure of employees. In addition, compliance with the YVL Guide's calculated threshold for one plant unit's collective dose averaged over two successive years is followed. The threshold value, 2.5 manSv per one gigawatt of net electrical power, means a radiation dose of 1.24 manSv for one Loviisa plant unit and 2.20 manSv for one Olkiluoto plant unit. The collective radiation doses describe the success of the plant's ALARA programme. The average of the ten highest doses indicates how close to the 20 manSv dose limit the individual occupational doses at the plants remain. It also indicates the effectiveness of the plant's radiation protection unit.

Responsible unit/person

Radiation protection (SÄT)
Antti Tynkkynen

Interpretation of the indicator

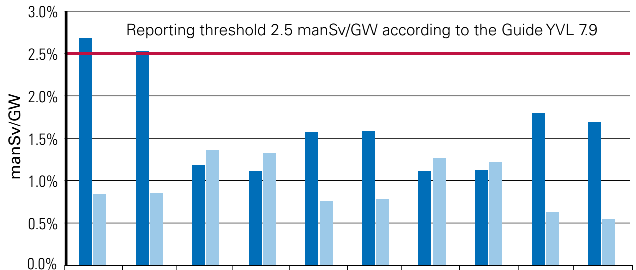
Loviisa

Most doses are incurred through work done during outages. Thus outage duration and the amount of work having significance on radiation protection affect the annual radiation doses. Both Loviisa plant units have more extensive annual outages every four and eight years (the four-year annual outage and the eight-year annual outage) so that both plant units never have a major annual outage during the same year. The four-year and eight-year outages have been held in even years and normal annual outages in odd years. The effect of annual outages on collective doses can be seen in the *Collective radiation dose, Loviisa* graph. In 2013, there was a refueling outage in both plant units. The time used for annual outages was short, and there were few operations of significance for radiation protection, which resulted in the total collective dose of the Loviisa power plant being the lowest ever in the history of the Loviisa power plant.

The radiation doses for nuclear power plant workers at Loviisa remained below the individual dose limits. The average of the ten largest doses was the lowest ever recorded during the operation of the power plant. This was mainly due to the short refueling outages of the power plant units. Furthermore, improvements aiming at reducing the employees' radiation doses have also been made at the plant. The Radiation Decree (1512/1991) stipulates that the effective dose for a worker from radiation work may not exceed the 20 manSv/year average over any period of five years, or 50 manSv in any one year.

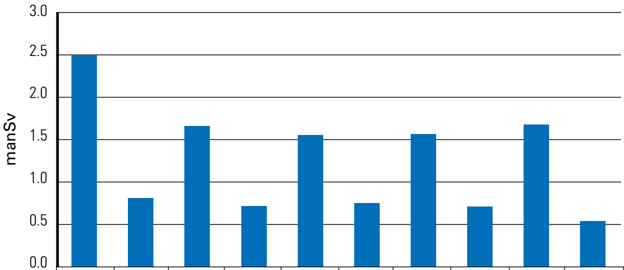
The threshold set for the collective occupational dose was not exceeded either in 2013. If, at one plant unit, the collective occupational radiation dose average over two successive years exceeds 2.5 manSv per one GW of net electrical power, the utility is to report the causes of this to STUK, and any measures required to improve radiation safety (Guide YVL 7.9).

Collective dose per 1 GW of net electrical capacity averaged over two succesive years, Loviisa NPP



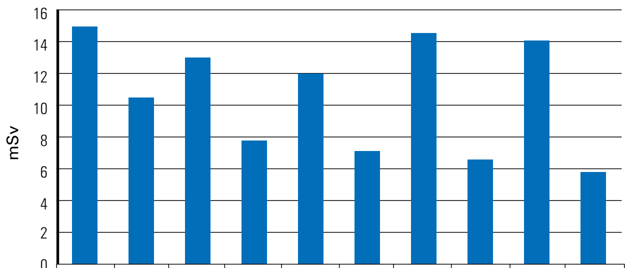
	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
LO1	2.68	2.53	1.18	1.12	1.57	1.58	1.11	0.12	1.80	1.69
LO2	0.84	0.85	1.36	1.33	0.76	0.78	1.27	1.22	0.63	0.55

Collective occupational radiation dose (manSv), Loviisa NPP



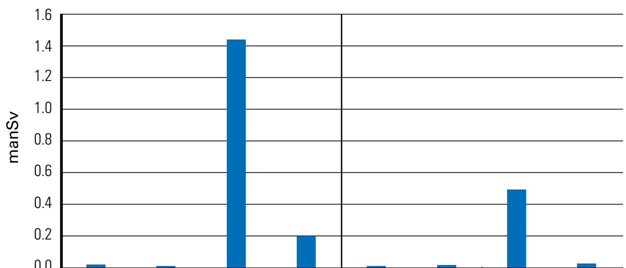
	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
LO	2.49	0.81	1.66	0.72	1.55	0.75	1.57	0.71	1.68	0.54

Average of the ten highest doses (mSv), Loviisa NPP



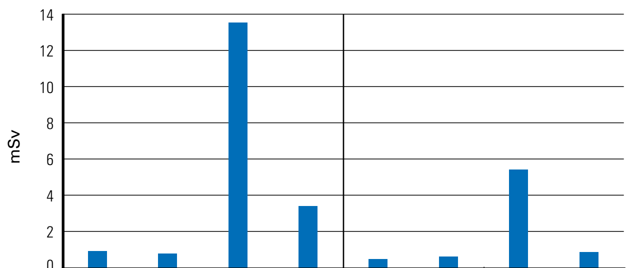
	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
LO	14.93	10.48	13.00	7.76	11.99	7.11	14.55	6.56	14.06	5.78

Collective occupational radiation dose (manSv) quarterly, Loviisa NPP



	I/12	II/12	III/12	IV/12	I/13	II/13	III/13	IV/13
LO	0.02	0.01	1.44	0.20	0.01	0.02	0.49	0.02

Average of the ten highest doses (mSv) quarterly, Loviisa NPP



	I/12	II/12	III/12	IV/12	I/13	II/13	III/13	IV/13
LO	0.91	0.76	13.53	3.39	0.46	0.60	5.40	0.84

Interpretation of the indicator

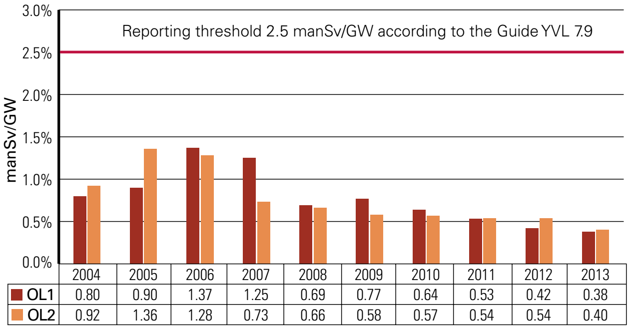
Olkiluoto

Most doses are incurred through work done during outages. Thus outage duration and the amount of work having significance on radiation protection affect the annual radiation doses. The annual outages for the Olkiluoto power plant units are divided into two groups: refueling outages and maintenance outages. The refueling outage is shorter in duration (approximately 7 days). The length of the maintenance outage depends on the amount of work (2–3 weeks). Annual outages are scheduled so that in the same year, one plant unit has a maintenance outage and the other a refueling outage. Olkiluoto 1 was subject to a refueling outage and Olkiluoto 2 to a maintenance outage in 2013.

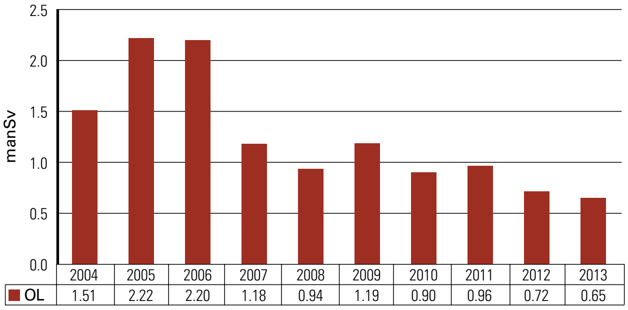
In 2013, the collective occupational radiation dose of Olkiluoto employees was the lowest ever recorded during the operation of the power plant. The radiation doses have clearly decreased after the installation of new moisture separators in 2005–2007. The radiation level in the turbine buildings has continued to decrease after the installation of the moisture separators, and this had also decreased the collective dose. Furthermore, improvements aiming at reducing the employees' radiation doses have also been made at the plant.

In 2013, the average of the ten largest doses was the lowest ever recorded during the operation of the power plant. The ten largest doses have continued to decrease during the past ten years. The prescribed dose limits (Radiation Decree 1512/1991) were not exceeded.

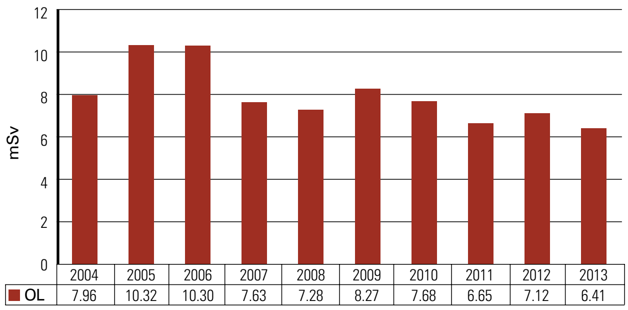
Collective dose per 1 GW of net electrical capacity averaged over two succesive years, Olkiluoto NPP



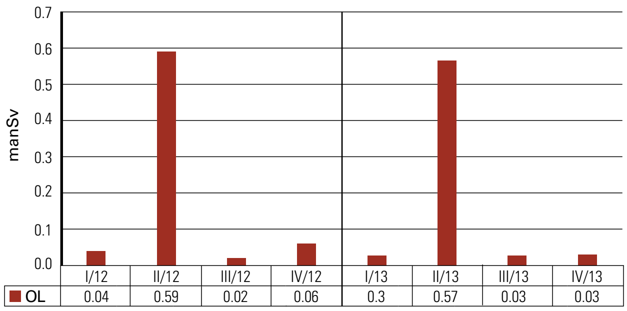
Collective occupational radiation dose (manSv), Olkiluoto NPP



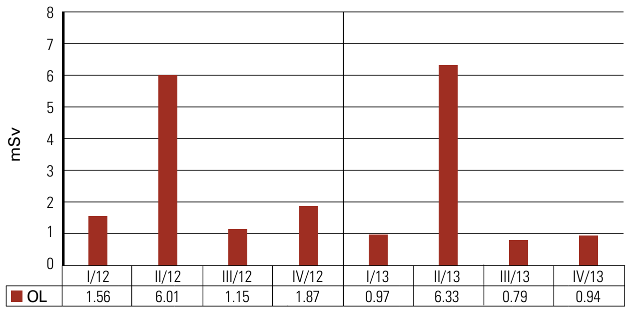
Average of the ten highest doses (mSv), Olkiluoto NPP



Collective occupational radiation dose (manSv) quarterly, Olkiluoto NPP



Average of the ten highest doses (mSv) quarterly, Olkiluoto NPP



A.I.5 Releases

Definition
As the indicators, radioactive releases into the sea and the air from the plants are monitored, together with the calculated dose due to releases to the most exposed individual in the vicinity of the plant.

Source of data
Data for the indicators is collected from the power companies' quarterly and annual reports. From this data, the calculated radiation dose for the most exposed individual in the vicinity of the plant is defined.

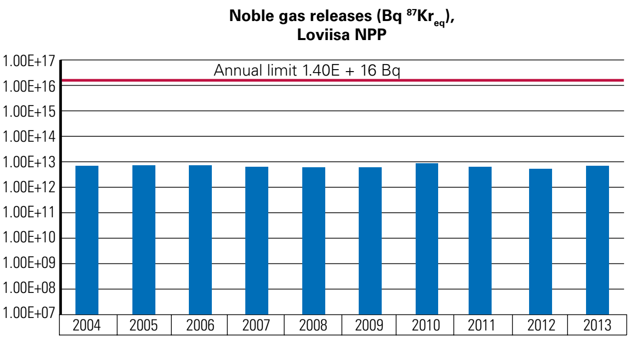
Purpose of the indicator
The indicator is used to monitor the amount and trend of radioactive releases and assess factors having a bearing on any changes in them.

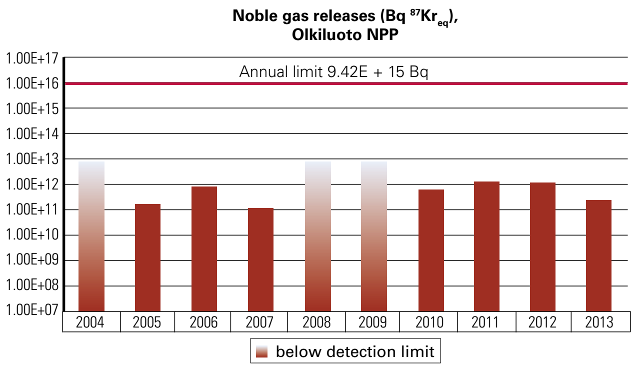
Responsible unit/person
Radiation protection (SÄT), Antti Tynkkynen

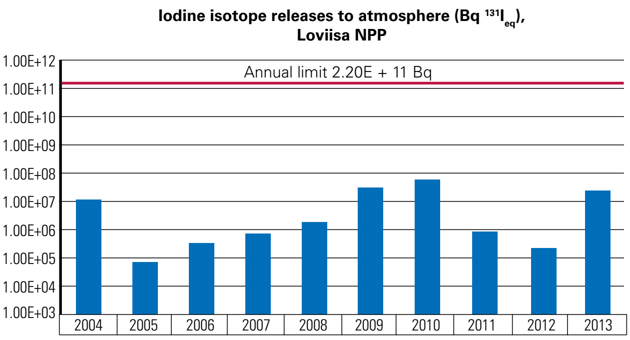
A.I.5a Releases into the air

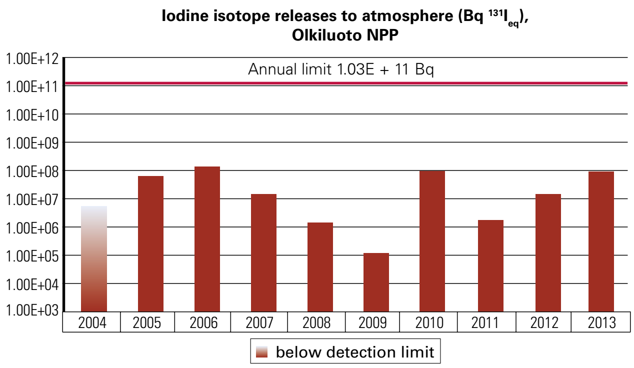
Interpretation of the indicator
In 2013, the radioactive releases into the air from the Loviisa and Olkiluoto nuclear power plants were of the same magnitude as in previous years. Releases into the environment were small, well below the set limits.

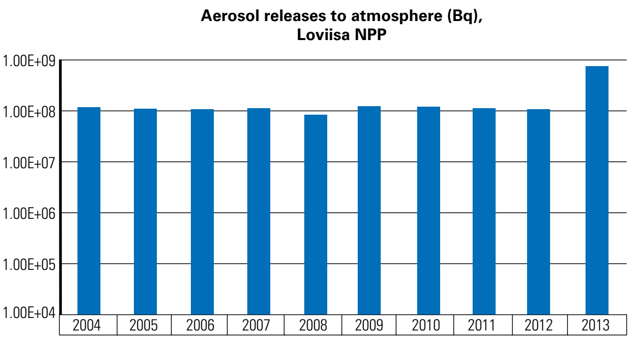
Releases of noble gases and particulate aerosols were of the same magnitude as in previous years. The releases of particulate aerosols increased almost tenfold from the previous years due to the rapidly decaying As-76 (arsenic) that was released from both plant units during the extra outages at the end of the year. The releases of iodine isotopes increased because a fuel leak from Loviisa 2 in-

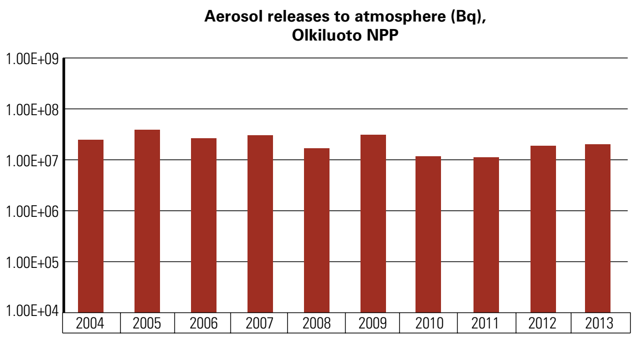












creased the total amount of iodine releases.

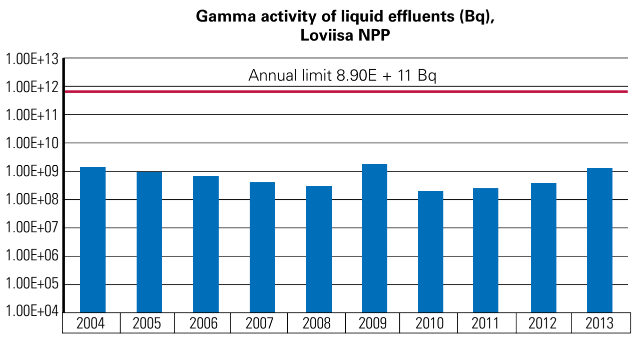
More noble gases than in the previous years were released into the air from the Olkiluoto power plant. The releases of iodine isotopes increased compared to 2011–2012 due to a minor fuel leak in Olkiluoto 2. The fuel leak did not influence the noble gas releases, however. The releases of particulate aerosols were around the same magnitude as in the previous years.

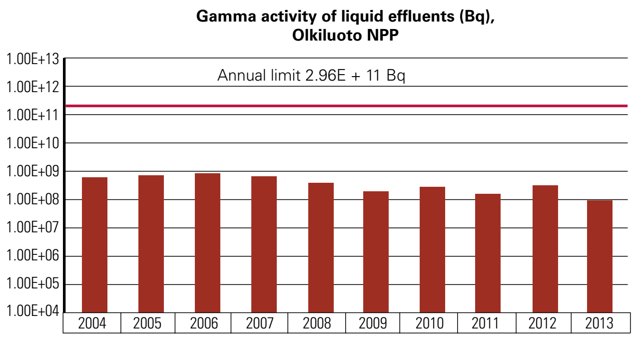
Gaseous fission products, noble gases and iodine isotopes originate from leaking fuel rods, from the minute amounts of uranium left on the outer surfaces of fuel cladding during fuel fabrication, and from reactor surface contamination from earlier fuel leaks. At both Loviisa and Olkiluoto, there have been very few leaking fuel rods and the leaks have been small. Leaking fuel assemblies were replaced during the annual outages of Loviisa 2 and Olkiluoto 2. The indicator A.III.1 describes fuel integrity. The releases of radioactive noble gases from Loviisa power plant are dominated by argon-41, the activation product of argon-40 originating in the air space between the reactor pressure vessel and the main radiation shield. Aerosol nuclides (including activated corrosion products) are released during maintenance work.

A.I.5b Releases into the sea

Interpretation of the indicator

Releases of radioactive substances emitting gamma radiation into the environment from the Loviisa and Olkiluoto nuclear power plants remained clearly below the set limits. In 2004, 2009 and 2013, the Loviisa power plant released low-activity evaporation bottom into the sea as planned. Consequently, the releases of substances with gamma activity were larger than the average in those years. The releases of substances with gamma activity into the sea from Olkiluoto have decreased in recent years.



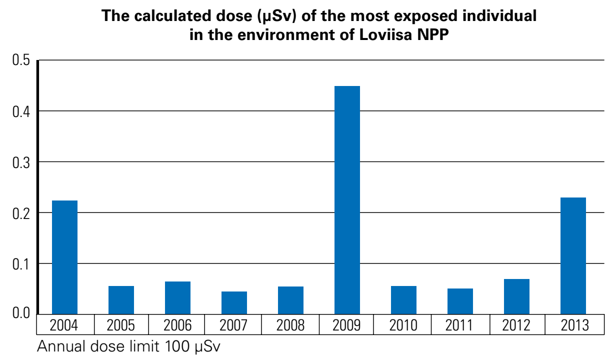


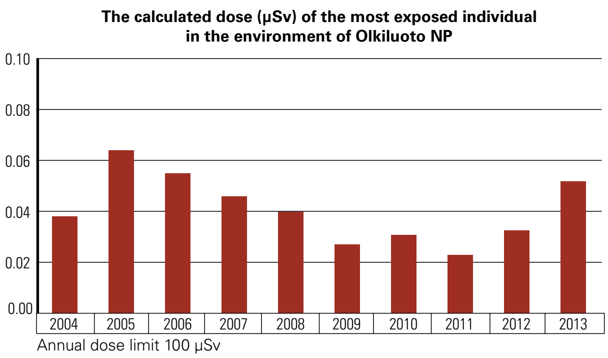
A.I.5c Population exposure

Interpretation of the indicator

The doses of the most exposed individual in the vicinity, calculated on the basis of releases from the plant, remained below the set limit in Loviisa and Olkiluoto. The calculated dose of the most exposed individual in the vicinity of the Loviisa power plant was higher than usual in 2013 because the power plant discharged low-activity evaporation waste into the sea as planned. Larger radiation doses in 2004 and 2009 were also caused by the discharge of evaporationwaste into the sea. The calculated dose of the most exposed individual in the vicinity of the Olkiluoto power plant was slightly higher than normal.

For both plants, the radiation doses were less than 0.3% of the 100-microsievert limit established in the Government Decree (717/2013).





A.I.6 Investments in facilities

Definition

Investments in plant maintenance and modifications in the current value of money adjusted by the building cost index.

Source of data

The licensee submits the necessary data directly to the person responsible for the indicator.

The indicator demonstrates the relative fluctuation of investments. The amounts given in euro are the confidential information of the power companies involved, and not to be published here. Furthermore, the scales of the Loviisa and Olkiluoto power plants' investment and modernisation diagrams are not mutually comparable.

Purpose of the indicator

The indicator is used to follow the amount of investments in plant maintenance and their fluctuations.

Responsible unit/person

Operational safety (KÄY)
Suvi Ristonmaa (Loviisa)
Niko Mononen (Olkiluoto)

Interpretation of the indicator

The variation in the indicator distinctly shows the investments related to the power upgrades and modernisation projects of the plants. Both plants have paid great attention to lifecycle management, which also shows as continuous long-term investment plans. The renewal of the operating license of the Loviisa plant in 2007 and the periodic safety review carried out at Olkiluoto in 2008 have also had an effect on the investment plans.

Loviisa

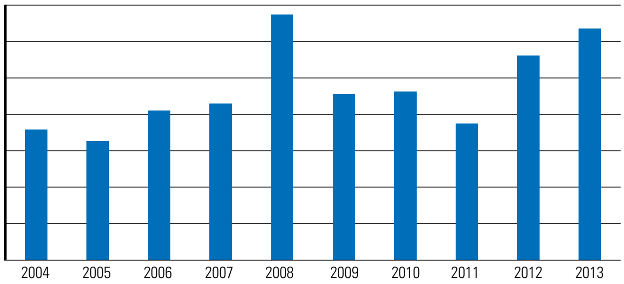
Many modification projects and other projects span over many years, which means that their total costs are also divided between several years. For example, investments in the Loviisa I&C upgrade started in 2007. Other major investments in 2013 included an upgrade of the 110 kV and 20 kV switchgear, a reheater upgrade, a turbine modernisation project, an upgrade of a maintenance data system, construction of new buildings in the accommodation area and renovation of a guest house.

Olkiluoto

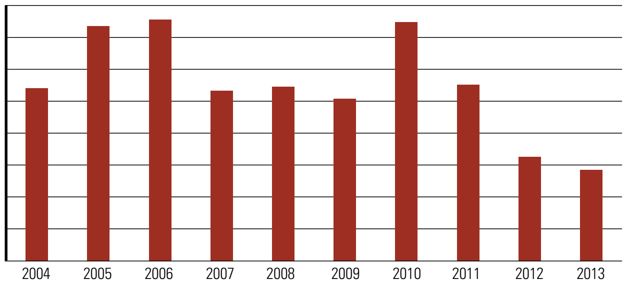
Fewer investments took place in 2013 than in the previous years.

TVO has at times carried out extensive modifications, which becomes evident in the trends. For example, major modifications mainly implemented during the 2010 annual outage of Olkiluoto 1 and the 2011 annual outage of Olkiluoto 2 show in the investment figures for 2010 and 2011. These modifications included the replacement of inner isolating valves of the main steam lines, the replacement of LP turbines and the replacement of main sea water pumps. Some of the work included in the project continued in 2013 and showed in the investment figures for the year. These included, for example, an upgrade of the low voltage switchgear. Other major investments in 2013 included a new upgrade project on the emergency diesel generators, a continued project on the diversification of the reactor surface level measuring system and a new project on the calibration system of the neutron flux measuring system.

Maintenance investments and renovations, Loviisa NPP



Maintenance investments and renovations, Olkiluoto NPP



A.II Operational events

A.II.1 Number of events

Definition

As the indicators, the numbers of events reported in accordance with Guide YVL 1.5 are monitored; these include events warranting a special report, reactor trips and reports on operational events.

Source of data

Data for the indicators is obtained from STUK's document administration system (SAHA).

Purpose of the indicator

The indicator is used to follow the number of safety-significant events.

Responsible unit/person

Operational safety (KÄY)
Suvi Ristonmaa (Loviisa)
Niko Mononen (Olkiluoto)

Interpretation of the indicator

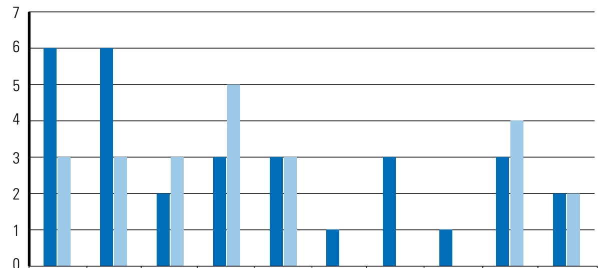
Loviisa

No reactor trips occurred at the Loviisa power plant in 2013.

Based on data from the last ten years (2003–2012), the average number of annual events warranting a special report is three to four per year, while the average number of events warranting a transient report is five per year. The number of events warranting a special report was higher than average in 2013 (seven in total) and the number of events warranting a transient report (four in total) was slightly below the average. STUK discussed the issue of the increased number of events warranting a special report with the management of Fortum Power and Heat Oy in the autumn of 2012. The licensee studied the underlying causes of the changed trend and specified corrective measures. Fortum Power and Heat Oy submitted to STUK for information a related action plan at the end of 2013.

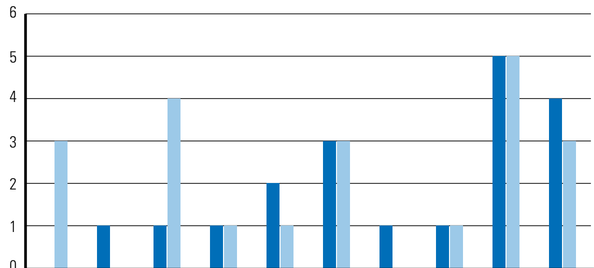
Five of the events warranting a special report in 2013 were connected to non-conformances with the operational limits and conditions (OLC). One special report was drafted on the jamming of two control rods in Loviisa 2 and another on malfunc-

Number of operational transient reports, Loviisa NPP



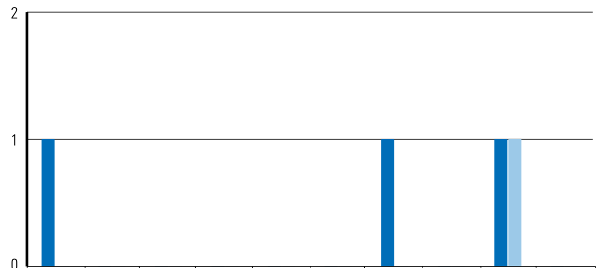
	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
LO1	6	6	2	3	3	1	3	1	3	2
LO2	3	3	3	5	3	0	0	0	4	2

Number of Special Reports, Loviisa NPP



	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
LO1	0	1	1	1	2	3	1	1	5	4
LO2	3	0	4	1	1	3	0	1	5	3

Number of reactor scrams, Loviisa NPP



	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
LO1	1	0	0	0	0	0	1	0	1	0
LO2	0	0	0	0	0	0	0	0	1	0

tions in auxiliary relays of the diesel generators. For more detailed descriptions of all the events warranting a special report, please see Appendix 3.

Four events were classified as operational transients. A control rod dropped to its lower position twice in Loviisa 1. In Loviisa 2, one of the turbine lines had to be stopped because of human errors made in the operation of the main condensate purification system. Furthermore, an isolating valve in the steam line of a steam generator was closed because of a card malfunction in the plant protection system.

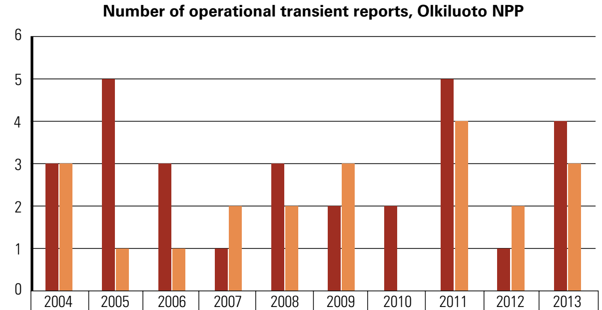
When considering the indicators concerning special and transient reports, it must be noted that the number of reports does not give a correct idea of the division of events by plant unit since, for technical reasons, the reports that concern both plant units have been entered for Loviisa 1. In 2013, one event warranting a special report concerned both plant units.

Olkiluoto

No reactor trips occurred at the Olkiluoto power plant in 2013. Based on data from the last ten years (2003–2012), the average annual number of events warranting a special report or a transient report is five. In 2013, the number of events warranting a special report (four in total) was nearly at the average, while the number of events warranting a transient report (seven in total) was slightly above the average. Events warranting a special report included defects in the maintenance of a reactor coolant pump and the management of work linked to the cooling of the reactor, material faults detected when maintaining an emergency diesel generator, and a non-conformance with the key handover procedure of a cross-connectionroom below the control room. For more detailed descriptions of all the events, please see Appendix 3. Most of the transient reports (four in total) were caused when one of the reactor coolant pumps slowed down as planned due to a disturbance in the external power supply. Two of the transient reports involved generator malfunctions at both plant units. One of the transient reports involved a malfunction of an HP turbine control valve.

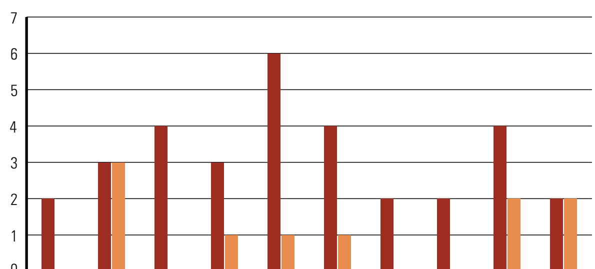
When considering the indicators concerning special and transient reports, it must be noted that the number of reports does not give the correct idea of the division of events by plant unit since, for technical reasons, the reports that concern both plant units have been entered for Olkiluoto 1. In 2013, one event warranting a special report concerned both plant units.

Number of operational transient reports, Olkiluoto NPP



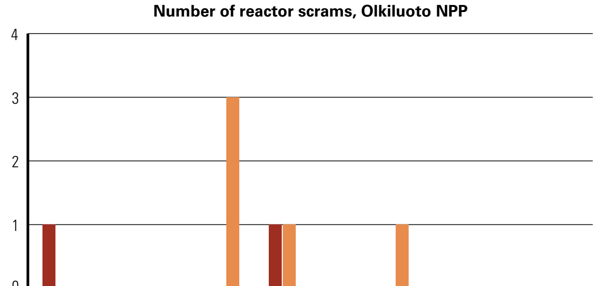
	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
OL1	3	5	3	1	3	2	2	5	1	4
OL2	3	1	1	2	2	3	0	4	2	3

Number of Special Reports, Olkiluoto NPP



	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
OL1	2	3	4	3	6	4	2	2	4	2
OL2	0	3	0	1	1	1	0	0	2	2

Number of reactor scrams, Olkiluoto NPP



	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
OL1	1	0	0	0	1	0	0	0	0	0
OL2	0	0	0	3	1	0	1	0	0	0

A.II.3 Risk-significance of events

Definition

As the indicator, the risk-significance of events caused by component unavailability is monitored. An increase in the conditional core damage probability (CCDP) associated with each event is used as the measure of a risk. CCDP takes the duration of each event into consideration. Events are divided into three categories: 1) unavailability due to component faults, 2) planned unavailability, and 3) initiating events. In addition, events are grouped into three categories according to their risk-significance (CCDP): the most risk-significant events (CCDP>1E-7), other significant events (1E-8≤CCDP<1E-7) and other events (CCDP<1E-8). The indicator is the number of events in each category.

Unavailability caused by work for which STUK has granted an exemption are included in category 2. Any non-conformances with the OLC are included in category 1 if they can be applied for this indicator. Non-conformances with the OLC are also dealt with under indicator A.I.2.

Calculations concerning the Olkiluoto plant were made with FinPSA software and those concerning the Loviisa plant with RiskSpectrum software. For the Loviisa power plant, calculations of a simultaneous fault in several components are solely based on the load operation model, meaning that the results are not as exact as for single faults which have been calculated for all operating modes. The modelling of simultaneous faults across all operating modes (17 of them) would be possible, but the calculation time would be too long when compared to the benefits gained. This year, no simultaneous faults of several components with the highest risk-significance occurred.

Source of data

Data for the calculation of the indicators is collected from the power companies' reports and applications for exemptions.

Purpose of the indicator

The indicator is used to follow the risk-significance of component unavailability and to assess risk-significant initiating events and planned unavailability. Special attention is paid to recurring events, common cause faults, simultaneously occurring faults and human errors. Another objective of the event analysis is to systematically search for any signs of a deteriorating organisational and safety culture.

Responsible unit/person

Risk assessment (RIS), Jorma Rantakivi (PRA computation)
Operational safety (KÄY) (fault data)

Interpretation of the indicator

Loviisa

A brief description of the most significant events regarding risks is provided below.

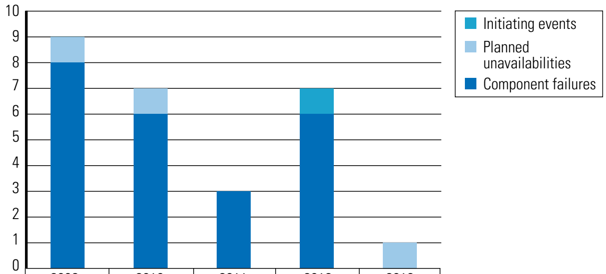
Loviisa 1:

1. Maintenance of the auxiliary emergency feedwater system at LO2 took a long time. This influenced the risk for LO1 because the LO2 emergency feedwater system can be used to replace the LO1 emergency feedwater system RL94. Unavailable for 222 hours. CCDP: 2.8E-07.

Loviisa 2:

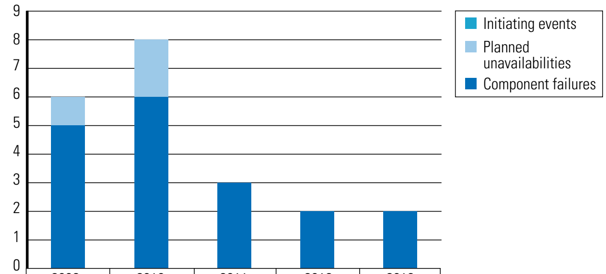
1. There was a hidden fault in the power control potentiometer of diesel generator EY02. A fault in the generator exciter. Unavailable for 123.3 hours. CCDP: 1.11E-07.
2. Diesel generator tried to race when switching to individual operation. It was a hidden relay fault. Defective relays from the same manufacturing batch may have been installed at several positions in various diesel generators, which means that this may be a common-cause failure. Fortum and STUK are still processing

Most risk-significant events
CCDP ≥ 1E-7
Loviisa 1 (total number of events)



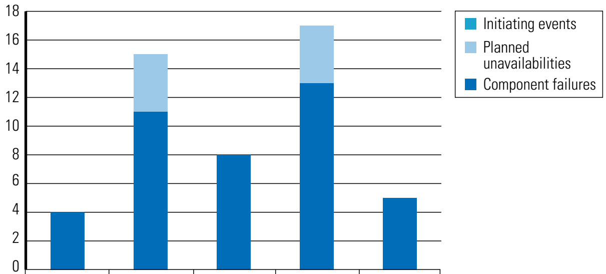
2009	2010	2011	2012	2013
0	0	0	1	0
1	1	0	0	1
8	6	3	6	0

Most risk-significant events
CCDP ≥ 1E-7
Loviisa 2 (total number of events)



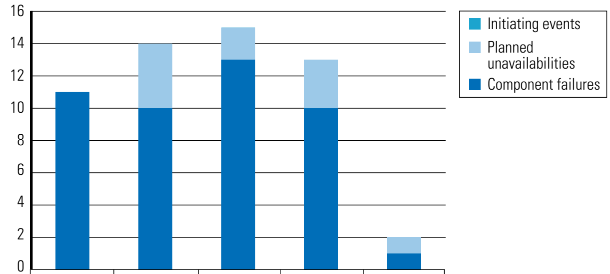
2009	2010	2011	2012	2013
0	0	0	0	0
1	2	0	0	0
5	6	3	2	2

Other significant events
1E-8 ≤ CCDP < 1E-7
Loviisa 1 (total number of events)



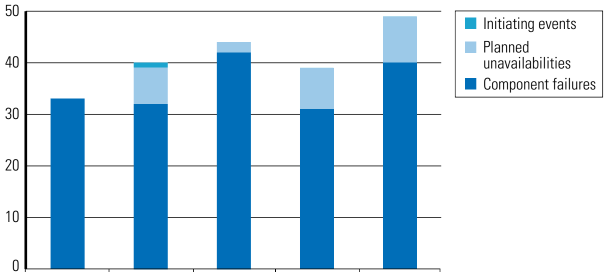
2009	2010	2011	2012	2013
0	0	0	0	0
0	4	0	4	0
4	11	8	13	5

Other significant events
1E-8 ≤ CCDP < 1E-7
Loviisa 2 (total number of events)



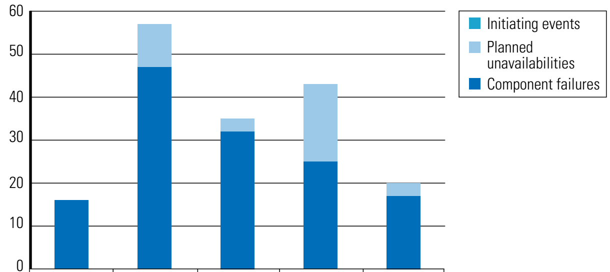
2009	2010	2011	2012	2013
0	0	0	0	0
0	4	2	3	1
11	10	13	10	1

Other events CCDP < 1E-8
Loviisa 1 (total number of events)



2009	2010	2011	2012	2013
0	1	0	0	0
0	7	2	8	9
33	32	42	31	40

Other events CCDP < 1E-8
Loviisa 2 (total number of events)



2009	2010	2011	2012	2013
0	0	0	0	0
0	10	3	18	3
16	47	32	25	17

the event. If the significance is deemed high, a report may also be issued in connection with the results for next year. Unavailable for 274 hours. CCDP: 2.6E-07.

3. Heavy hoisting of reactor components during the outage caused the highest single risk component for the Loviisa plants. It was noted during an inspection performed during the outage of LO2 that the hoisting was not being performed in compliance with the procedure assumed in the PRA risk assessment. The hoisting routes and the hoisting heights were not the same as those assumed in the PRA. The event is still being processed, and Fortum will reassess risks posed by hoisting. It is difficult to calculate the specific CCDP, but the event has been rated in the highest category due to the high risk significance of hoisting.

Olkiluoto

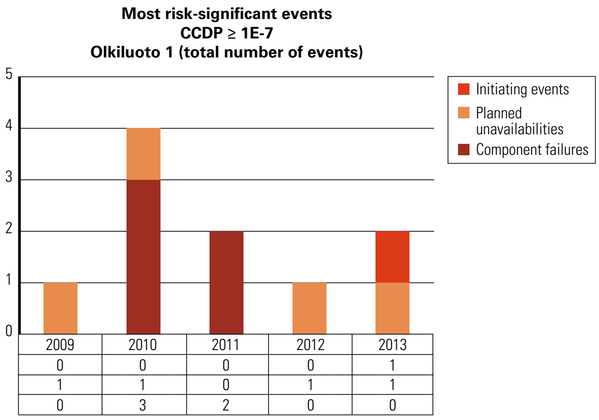
A brief description of the significant events is given below.

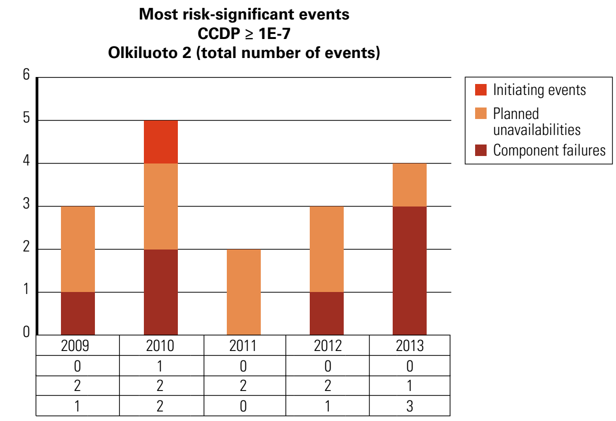
Olkiluoto 1:

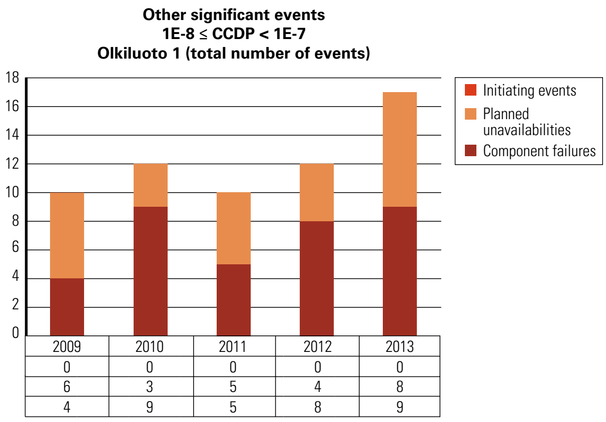
1. Preventive maintenance of a diesel generator in the D train took 110 h. CCDP: 1.11E-07.
2. A thyristor fault caused the tripping of a generator breaker. Turbine bypass started as planned. The plant was brought to a shutdown in order to repair the thyristor fault. The planned shutdown and startup caused an added risk of CCDP = 1.0E-6.

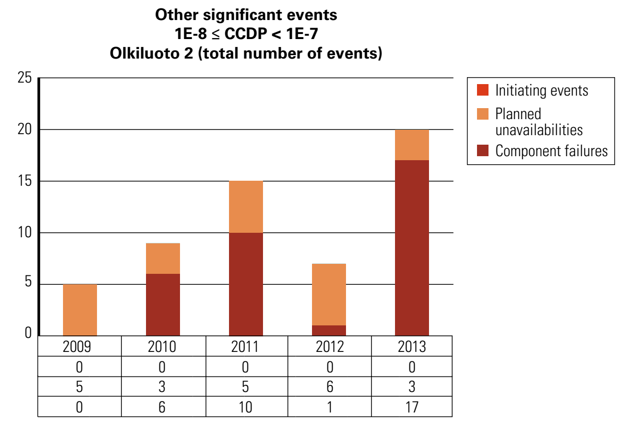
Olkiluoto 2:

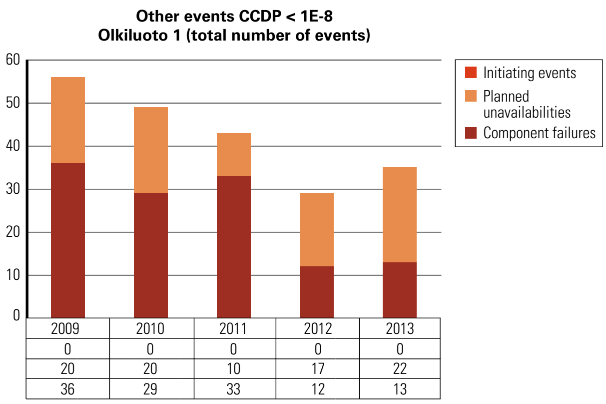
1. There had been a hidden fault in valve 323V207 in redundancy 2 of the core spray system for 324 hours. There had also been a partly overlapping fault in pump 323P004 in redundancy 4. There had simultaneously been faults in the second and fourth redundancy for 77 hours. The fault in the second redundancy persisted for 324 hours and the calculated CCDP was 7.2E-7.
2. There had been a hidden fault in pump 323P004 in redundancy 4 of the core spray system for 359 hours. A total of 77 hours of this fault were already calculated in fault no. 1 above (there

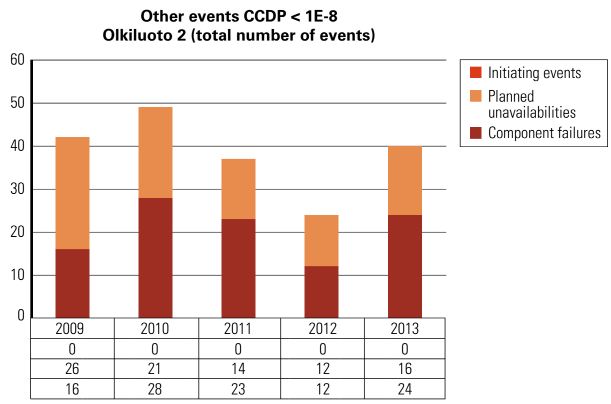












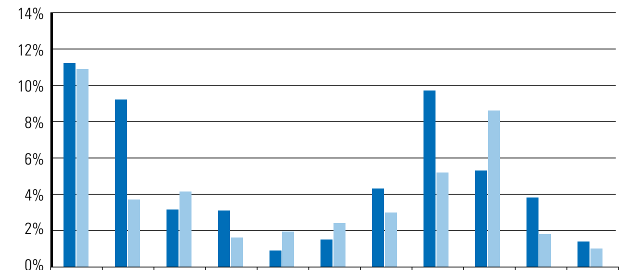
had been simultaneous faults in the second and fourth redundancy for 77 hours), which means that the fault in the pump of the fourth redundancy alone persisted for 282 hours. The fault persisted for 282 hours and the calculated CCDP was 1.6E-7.

3. The washing of a seawater heat exchanger in redundancy 3 of intermediate circuit 721 took a long time. The isolation lasted for 36 hours. CCDP: 1.4E-7.
4. Preventive maintenance of a diesel generator in the D train took 103 h. CCDP: 1.0E-07.

The combined total CCDP of all three categories divided by the probability of a severe accident gives an overview of the risk-significance of operational events. To facilitate analysis, risk calculation is based on conservative assumptions and simplifications, which materially weakens the applicability of the results for trend monitoring. If the risk-significance remains at the same average level year after year, the annual fluctuation does not warrant particular attention.

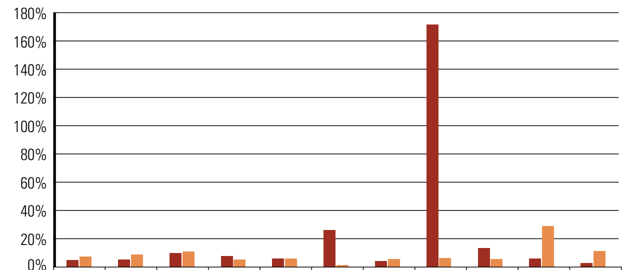
In 2013, the risk arising from operational activities decreased slightly at the Loviisa power plant when compared to previous years. At Olkiluoto, the risk remained at around the same level as normally during the past ten years.

Risk contribution of the safety system unavailability at Loviisa NPP
Persentage of the average annual core damage risk



	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
LO1	11.21	9.20	3.15	3.10	0.90	1.50	4.30	9.70	5.30	3.80	1.40
LO2	10.90	3.70	4.14	1.60	1.95	2.40	3.00	5.20	8.60	1.80	1.00

Risk contribution of the safety system unavailability at Olkiluoto NPP
Persentage of the average annual core damage risk



	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
OL1	4.68	5.10	9.64	7.60	6.00	26.10	4.00	171.40	13.10	5.90	2.80
OL2	7.39	8.60	10.95	5.00	6.00	1.30	5.40	6.30	5.40	29.00	11.00

A.II.4 Accident risk at nuclear facilities

Definition

As the indicator, the annual probability of an accident leading to severe damage to nuclear fuel (core damage frequency) is followed. The accident risk is presented per nuclear power plant unit.

Source of data

The data is obtained as the result of probabilistic risk analyses (PRA) of the nuclear power plants. The risk analysis is based on detailed calculation models, continuously developed and complemented. A total of 200 man-years have been used at Finnish nuclear power plants to develop the models. The basic data of the risk analyses includes the globally collected reliability information of components and operator activities, as well as operating experience from Finnish power plants.

Purpose of the indicator

The indicator is used to follow the development of the nuclear power plant's accident risk. The objective is to operate and maintain the nuclear power plant so that the accident risk decreases or remains stable. Risk analyses can help in detecting a need to make modifications to the plant or revise operating methods.

Responsible unit/person

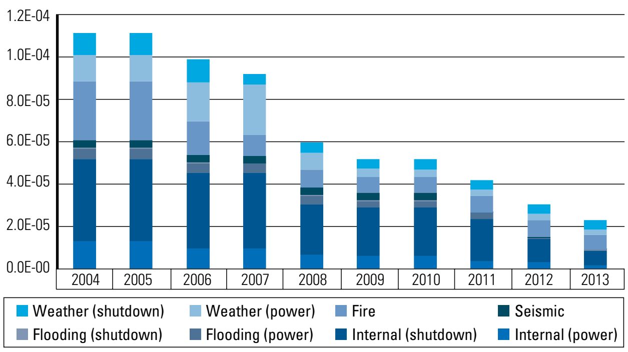
Risk assessment (RIS), Jorma Rantakivi (PRA computation)
Operational safety (KÄY) (fault data)

Interpretation of the indicator

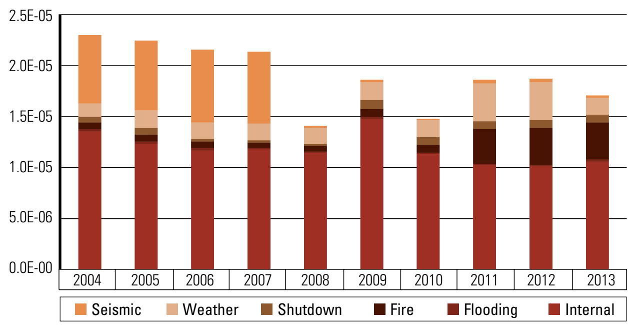
When assessing the indicator, one must keep in mind that it is affected by both the development of the power plant and the development of the calculation model. Plant modifications and changes in methods, carried out to remove risk factors, will decrease the indicator value. An increase of the indicator value may be due to the model being extended to new event groups, or the identification of new risk factors. Furthermore, developing more detailed models or obtaining more detailed basic data may change the risk estimates in either direction. For example, an increase in the Loviisa indicator in 2003 was due to the analysis being extended to cover exceptionally harsh weather conditions and oil accidents at sea during a refueling outage. In the following year, the indicator value decreased, partly as a result of a more detailed analysis of these factors.

Loviisa power plant's accident risk has continued to decrease over the last ten years, and new risk factors, discovered as the scope of the risk analysis has been extended, have been efficiently removed. The indicator decreased in 2007 due to the new sea water line completed during the period. The new line allows for the alternative intake of seawater from the outlet channel to cool the plant when it is at a shutdown. The change decreases the risks in situations where algae, frazil ice or an oil spill endanger the availability of seawater via the conventional route. The decrease of the indicator in 2008 and in the following years result from more detailed analyses performed in conjunction with the renewal of the operating license, as well as changes at the plant planned to be carried out earlier or in connection with the license renewal. Such changes include: the I&C upgrade LARA; the decrease in the probability of a criticality accident using, for example, boron analysers; modernisation of the refueling machine and a decrease in the probability of an external leak.

Fluctuation of the calculated annual core damage frequency for Loviisa plant units during 2004–2013



Fluctuation of the calculated annual core damage frequency for Olkiluoto plant units during 2004–2013



For the Loviisa power plant, the most important factors affecting the overall accident risk include internal plant events during outages (such as the falling of heavy loads or a power surge caused by the sudden dilution of the boron used to adjust reactor operation), fire, a high level of seawater during load operation and oil releases during a refueling outage.

The annual probability of a severe reactor accident calculated for the Loviisa plant units is low (approximately 2.3 x 10^{-5} in 2012). The value decreased around 23% year-on-year. The decrease of the risk was a result of several small plant changes, changes in the model and the revision of reliability data.

The indicator for the Olkiluoto plant decreased approximately 30% in 2008 compared to previous years' relatively stable value. The decrease was mainly due to the more detailed modelling of earthquake events and changes carried out at the plant to improve seismic qualification. The increase in 2009 was due to the fact that a heat exchanger in the screening system cannot be used for residual heat removal after all, contrary to earlier assessments. The decrease of the risk in 2010 was due to changes in the modelling of DC systems 672 and 679 (inclusion of battery diversity), while the increase in 2011 resulted from reassessment of fire frequencies. For the Olkiluoto power plant, internal events during load operation (component faults and pipe ruptures leading to an operational transient) are the most important factors affecting the overall accident risk.

The annual probability of a severe reactor accident calculated for the Olkiluoto nuclear power plant was approximately 1.22 × 10^{-5} in 2013. The value slightly decreased year-on-year (by 9%).

A.II.5 Number of fire alarms

Definition

As indicators, the number of fire alarms and actual fires are followed.

Source of data

Data for the indicators is collected from the power companies. The licensees submit the data needed for the indicator to the person responsible for the indicator at STUK.

Purpose of the indicator

The indicator is used to follow the effectiveness of fire protection at the nuclear power plants.

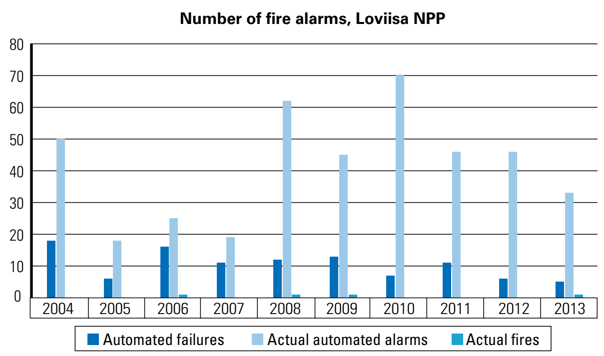
Responsible unit/person

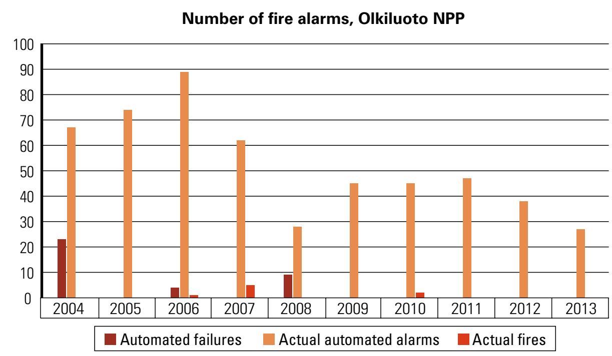
Civil engineering and fire protection (RAK)
Pekka Välikangas

Interpretation of the indicator

At the Loviisa power plant, one event classified as a fire occurred in 2013: a plastic protective cover of a fluorescent tube light fixture in the ceiling of an instrument room on level +5.80 of the reactor building caught fire on 29 August 2013. The plant's fire brigade was alerted and came to extinguish the fire. The fire was minor and could be put out with a handheld fire extinguisher. There were no events classified as fires outside the plant area in 2013. In 2013, the number of faults in the Loviisa power plant's fire detection system remained at the same level as in the previous years. There were less actual alarms initiated by fire detectors than in 2012.

No events classified as fires occurred in the Olkiluoto power plant area in 2013. One event classified as a fire occurred outside the plant area:





sparks from an angle grinder used inside the containment at the Olkiluoto 3 construction site caused a fire in a welding gas extractor. The fire in the extractor caused smoke to build up inside the building. Employees were evacuated and the plant fire brigade ventilated the premises. The fire was minor and could be put out with handheld fire extinguishers. No fire detection system faults were observed at the Olkiluoto power plant in 2013; no faults occurred during the four years preceding 2013, either. There were slightly fewer correct fire detection system alarms in 2013 than in 2012.

The fire safety at the Loviisa and Olkiluoto power plants remained at around the same level as before. There have been four events classified as fires in the Loviisa power plant area in the past ten years. The trend is slightly decreasing at the Olkiluoto power plant: the last event classified as a fire occurred three years ago. Alarms from fire detection systems have also been at a relatively low level. Most of the alarms were caused by dust, smoke or humidity. Fire detection systems are not always disconnected in a area wide enough for maintenance work. The number of alarms from the fire detection system is also affected by the amount of maintenance and repair work performed at the plants.

A.III Structural integrity

A.III.1 Fuel integrity

Definition

As indicators, the plant unit-specific maximum level and the highest maximum activity value of the iodine-131 activity concentration (I-131 activity concentration) in the primary coolant in steady-state operation (startup operation or load operation for Loviisa and load operation for Olkiluoto) are followed. The change in activity concentration of I-131 in primary coolant due to depressurisation in conjunction with shutdowns or reactor trips, as well as the number of leaking fuel assemblies removed from the reactor, are also followed as indicators.

Source of data

The licensees submit the indicator values directly to the person in charge of the indicator at STUK. The maximum activity levels are also available in the quarterly reports submitted by the power companies.

Purpose of the indicator

The indicators describe fuel integrity and the fuel leakage volume during the fuel cycle. The indicators for the shutdown situations also describe the success of the shutdown concerning radiation protection.

Responsible unit/person

Reactor and Safety Systems (REA),
Kari Mäkelä

A.III.1a Reactor coolant system activity

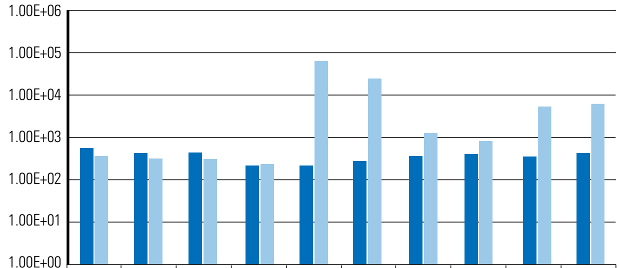
Interpretation of indicators (Loviisa)

There were no leaking fuel assemblies in the reactor of Loviisa 1 in 2013. A fuel assembly that had been observed to be leaking before was removed from the Loviisa 1 reactor in 2010. Once this was done, the maximum activity (I-131) of the primary coolant has remained low. After removal of the leaking fuel assemblies, the maximum activity values associated with shutdowns returned to the level before the leaks. Increased iodine concentration in the primary coolant of Loviisa 2 was detected in a routine laboratory test. Noble gas measurements of the primary coolant confirmed that there was a fuel leak. The leak was, however, minor and the fuel assembly was removed during the annual outage. The number of minor fuel leaks has increased at the Loviisa power plant in recent years, particularly in Loviisa 2. The actual reason for this is unknown, as examination of the damaged fuel assemblies has not been possible due to problems with the pool inspection equipment. Fortum's current goal is to repair the inspection equipment by the end of 2014. When the inspection equipment is available, the damage mechanism can be identified. All in all, the fuel integrity at both Loviisa plant units was good in 2013.

Interpretation of indicators (Olkiluoto)

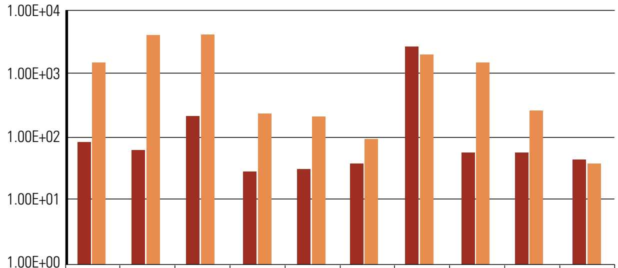
There were no leaking fuel assemblies in the reactor of Olkiluoto 1 in 2013. Thus, the primary coolant activity caused by iodine-131 in Olkiluoto 1 has continued to decrease since 2010. There was a fuel leak in the Olkiluoto 2 reactor. It started in May 2013, right at the end of the fuel cycle. The leaking bundle was removed from the reactor in the 2013 annual outage. The impact of the leak showed in the maximum activity (I-131) of

Fuel integrity:
Iodine (I-131) maximum activity concentration level of primary coolant (kBq/m³) in power operation, Loviisa NPP



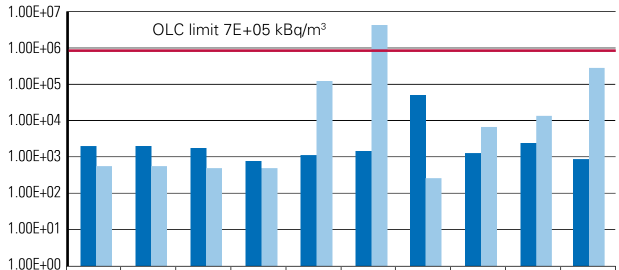
	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
LO1	5.01E+02	3.89E+02	3.91E+02	1.90E+02	2.00E+02	2.60E+02	3.80+02	3.90E+02	3.70E+02	4.00E+02
LO2	3.39E+02	2.91E+02	2.72E+02	2.10E+02	4.90E+04	2.40E+04	1.20+03	8.50E+02	4.71E+03	5.40E+03

Fuel integrity:
Iodine (I-131) maximum activity concentration level of primary coolant (kBq/m³) in power operation, Olkiluoto NPP



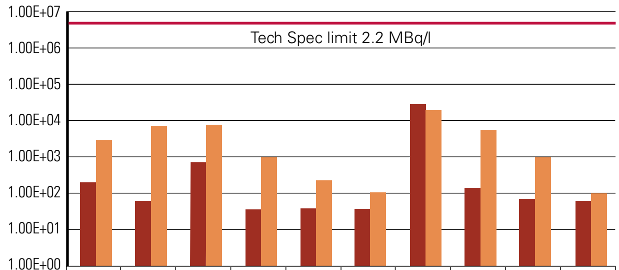
	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
OL1	8.20E+01	5.80E+01	2.00E+02	2.70E+01	3.00E+01	3.50E+01	2.45E+03	5.50E+01	5.58E+01	3.92E+01
OL2	1.49E+03	4.00E+03	4.00E+03	2.30E+02	2.10E+02	9.10E+01	1.87E+03	1.46E+03	3.03E+02	3.43E+01

Fuel integrity:
Iodine (I-131) maximum activity concentration of primary coolant (kBq/m³) in power operation, Loviisa NPP



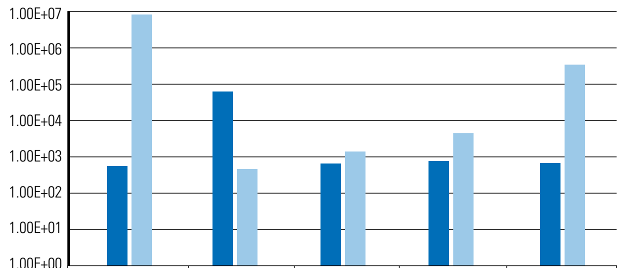
	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
LO1	2.10E+03	2.20E+03	1.90E+03	8.10E+02	1.20E+03	1.54E+03	4.97E+04	1.49E+03	2.80E+03	8.50E+02
LO2	5.80E+02	5.90E+02	5.20E+02	5.00E+02	1.30E+05	3.85E+06	3.20E+03	6.64E+03	1.27E+04	3.41E+05

Fuel integrity:
Iodine (I-131) maximum activity concentration of primary coolant (kBq/m³), Olkiluoto NPP



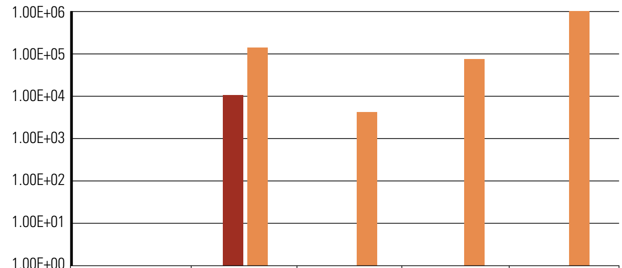
	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
OL1	1.90E+02	5.90E+01	6.90E+02	3.50E+01	3.70E+01	3.60E+01	3.12E+04	1.40E+02	6.76E+01	5.90E+01
OL2	3.12E+03	6.52E+03	7.03E+03	9.99E+02	2.30E+02	1.00E+02	2.01+04	4.84E+03	9.45E+02	9.51E+01

Fuel integrity:
Iodine (I-131) maximum activity concentration of primary coolant (kBq/m³) related to shutdowns, Loviisa NPP



	2009	2010	2011	2012	2013
LO1	4.80E+02	5.60E+04	6.70E+02	7.06E+02	6.30E+02
LO2	6.40E+06	4.10E+02	1.40E+03	4.10E+03	3.41E+05

Fuel integrity:
Iodine (I-131) maximum activity concentration of primary coolant (kBq/m³) related to shutdowns, Olkiluoto NPP



	2009	2010	2011	2012	2013
OL1	0.00E+00	1.03E+04	0.00E+00	0.00E+00	0.00E+00
OL2	0.00E+00	1.61E+05	3.93E+03	6.19E+04	1.00E+06

Olkiluoto 2 primary coolant associated with shutdown. No primary damage was observed in the removed assembly when it was inspected during the annual outage. On the basis of other inspections carried out during the annual outage, the fuel types at both plant units have mostly behaved normally. Several fuel leaks have occurred in the 2000s in Olkiluoto 2. The main reason for the leaks has been small loose objects entering the reactor during maintenance operations. The coolant flow may cause the loose objects to vibrate and break the fuel cladding. To minimise the problem, new foreign object sieves were adopted for the fuel in Olkiluoto 2 in 2012. The sieve profiles were changed to make the grid denser. The leaking assembly in 2013 was not of this type.

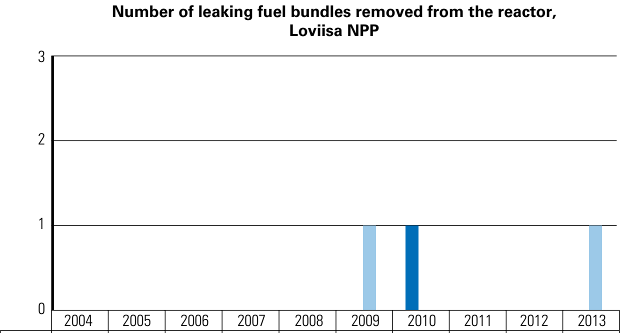
A.III.1b Number of leaking fuel assemblies

Interpretation of indicators (Loviisa)

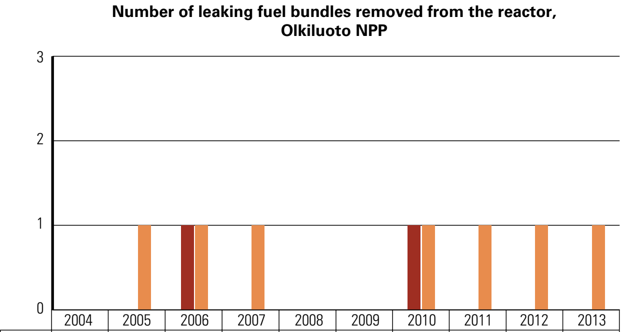
There were no leaking fuel assemblies in the Loviisa 1 reactor during the period under review. A minor fuel leak was observed in Loviisa 2 in December 2012. The leaking fuel assembly was removed during the 2013 annual outage. A method that has been found functional at Olkiluoto was used to identify a leaking fuel assembly for the first time in Loviisa. A subcontractor handled the actual equipment and provided the operators, but the plant's own radiochemistry laboratory analysed the water samples from the reactor. The leaking fuel assembly was identified based on the analysis results.

Interpretation of indicators (Olkiluoto)

The Olkiluoto 1 reactor did not have any leaking fuel assemblies in 2013. A fuel assembly that had been leaking since May 2013 was removed from the Olkiluoto 2 reactor during the annual outage.



	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
LO1	0	0	0	0	0	0	1	0	0	0
LO2	0	0	0	0	0	1	0	0	0	1



	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
OL1	0	0	1	0	0	0	1	0	0	0
OL2	0	1	1	1	0	0	1	1	1	1

A.III.2 Reactor coolant system integrity

A.III.2a Water chemistry conditions

Definition

As indicators, the water chemistry conditions for each plant unit are followed.

The water chemistry indicators are:

- Chemistry performance indices used by the licensees, depicting the effectiveness of water chemistry control in the secondary circuits of PWRs and in the reactor circuits of BWRs. The chemical conditions in the secondary circuit of a pressurized water reactor affect the integrity of the interface between the reactor coolant system and the secondary circuit. The indicator for Loviisa is a new index developed at the plant to be used together with the international index. The new index describes the water chemistry conditions in the secondary circuit at Loviisa with a higher degree of sensitivity than the corresponding international index for VVER plants. The indicator for Olkiluoto is the international index used by the plant. This index observes corrosive factors and the concentrations of corrosion products in the steam generator blowdown and the feedwater. For steam generator blowdown, the calculation includes the chloride, sulphate and sodium concentrations and acid conductivity. For feedwater, it includes the iron, copper and oxygen concentrations. The chemistry index of the Olkiluoto plant consists of the chloride and sulphate concentrations of the reactor water and the iron concentration in the feedwater. The indices for both plants only cover the aforementioned parameter values during load operation.
- The maximum chloride concentration of the steam generator blowdown at the Loviisa plant units and the reactor water at the Olkiluoto plant units during operation compared with the OLC limit in the monitoring period. At the Olkiluoto plant, the maximum sulphate content of reactor water during steady-state operation is also followed.
- Corrosion products released from the surfaces of the reactor coolant system and the secondary circuit into the coolant. For the Loviisa plant, the iron concentration of the reactor coolant and the secondary circuit feedwater (maximum values for the monitoring period) are followed. For the Olkiluoto plant, the iron concentration of feedwater (maximum value for the monitoring period) is followed. In addition, the maximum Co-60 activity concentration in the reactor coolant while bringing the plant to a cold shutdown or after a reactor trip is followed for both plants.

Source of data

The licensees submit indicators describing water chemistry control to the respective responsible person at STUK. The approximate concentration levels of corrosive substances and corrosion products can also be obtained from quarterly reports submitted by the licensees.

Purpose of the indicator

The water chemistry indicators are used to monitor and control the integrity of the reactor coolant system and the secondary circuit. The monitoring is done by indices depicting water chemistry control and by following selected corrosive impurities and corrosion products. The water chemistry indices combine a number of water chemistry parameters and thus give a good overview of the water chemistry conditions. STUK's indicators are also used to monitor the fluctuation of certain parameters in more detail. The corrosive substances monitored include chloride and sulphate. The corrosive products followed are iron and radioactive Co-60. The activity concentration of Co-60 isotope while bringing the plant to cold shutdown is used to describe the access of cobalt-containing structural materials into the reactor circuit and the success of the water chemistry control and the shutdown procedures. In addition to the parameters described here, the licensees use several other parameters to monitor the plant units' water chemistry conditions.

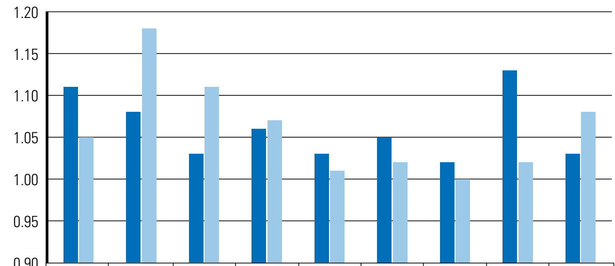
Responsible units/persons

Reactor and safety systems (REA),
Kari Mäkelä

Interpretation of indicators (Loviisa)

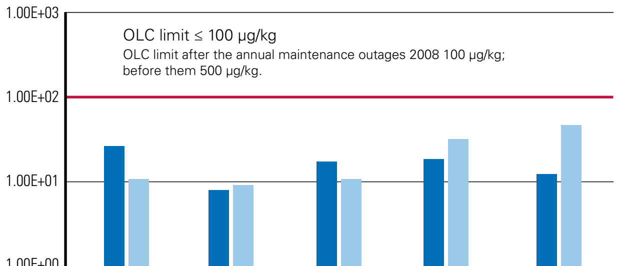
In 2013, the impurity and corrosion product levels in the reactor coolant system and the secondary circuit, followed in STUK's indicator scheme, were in keeping with the OLC limits. In the past few years, the chemistry index has remained at a good level in the Loviisa plant units. The Loviisa 1 index for 2013 was lower than in 2012 because of improved startup procedures introduced during the 2013 annual outage and more specific adherence to related procedures that aim to optimise the chemical parameters. The blowdown water chloride content and iron content of the secondary circuit feedwater were normal in 2013. No clear changes have occurred in the past few years in the iron content of the primary coolant, either. All of the water chemistry parameters for the secondary side of Loviisa 2 have slightly increased. The figures show that the most clearly discernible change from the previous years is the high iron concentration in the secondary side feedwater. This high concentration was caused by failed surface coating of filters used to treat the concentrate, which allowed some resin to enter the secondary circuit. This was a brief transient and thus it does not have a major impact on the corrosion behaviour of the steam generator pipes or the integrity of the reactor coolant system. The maximum Co-60 activity levels associated with shutdowns were measured during shutdowns for annual outages. In 2013, the concentrations were around the same as in the previous years, which indicates successful compliance with the ALARA principle. The indicator shows that the integrity of the reactor coolant systems of the Loviisa plant units was good in 2013.

Integrity of the secondary circuit: Chemistry index, Loviisa NPP



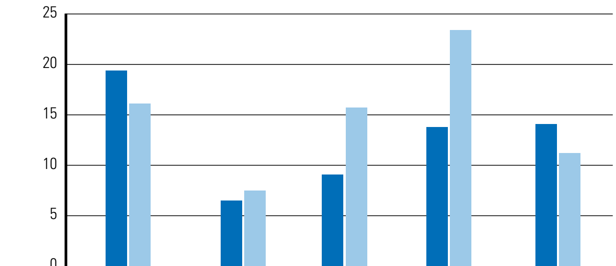
	2005	2006	2007	2008	2009	2010	2011	2012	2013
LO1	1.11	1.08	1.03	1.06	1.03	1.05	1.02	1.13	1.03
LO2	1.05	1.18	1.11	1.07	1.01	1.02	1.00	1.02	1.08

Integrity of primary circuit: Corrosive impurities; Maximum chloride concentration of a steam generator blow-down (µg/kg) in power operation, Loviisa NPP



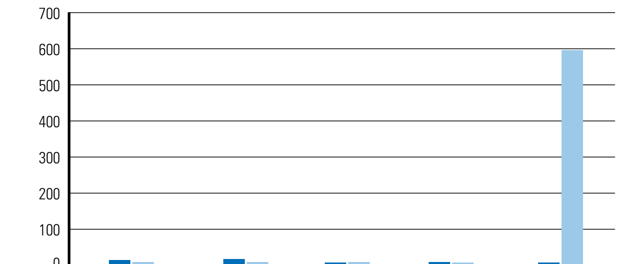
	2009	2010	2011	2012	2013
LO1	2.90E+01	7.80E+00	1.93E+01	1.98E+01	1.36E+01
LO2	1.14E+01	9.10E+00	1.10E+01	3.19E+01	4.30E+01

Integrity of primary circuit: Corrosion products; Maximum iron concentration in primary coolant (Fe-tot µg/l) in power operation, Loviisa NPP



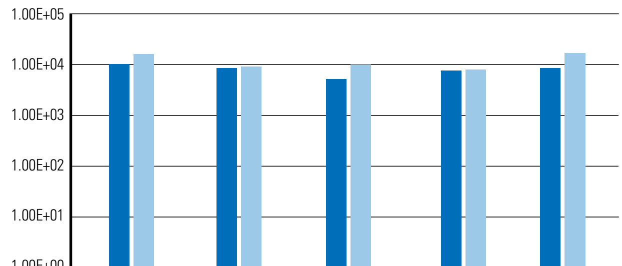
	2009	2010	2011	2012	2013
LO1	19.4	6.5	9.1	13.8	14.1
LO2	16.1	7.5	15.7	23.4	11.2

Integrity of primary circuit: Corrosion products; Maximum iron concentration in the feed water (µg/l) (RL30 / RL70) in power operation, Loviisa NPP



	2009	2010	2011	2012	2013
LO1	15.1	17.0	8.1	8.4	7.4
LO2	8.7	8.7	8.4	7.7	596.0

Integrity of primary circuit: Maximum cobalt-60 activity concentration (kBq/m³) in primary coolant related to shutdowns, Loviisa NPP

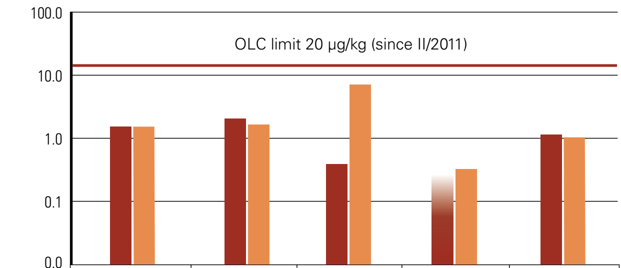


	2009	2010	2011	2012	2013
LO1	1.03E+04	8.21E+03	5.26E+03	7.48E+03	8.10E+03
LO2	1.71E+04	8.60E+03	9.88E+03	7.90E+03	1.40E+04

Interpretation of indicators (Olkiluoto)

The impurity and corrosion product levels in reactor water and feedwater, followed in STUK's indicator scheme, remained below the OLC limits at both plant units. The chemistry index of both plant units was the best possible, 1, in 2013. Iron, sulphate and chloride concentrations of the reactor coolant did not deviate from their regular values, which is also shown by the achieved chemistry index value. The monitoring and optimisation of Olkiluoto 2 water chemistry was successful in 2013. All the results for 2013 are at a normal good level. The iron concentration in feedwater has continued to increase steadily since 2010, but it still remains below all the action limits. At both plant units, the shutdown-related maximum value of Co-60 activity content occurred during shutdowns for annual outages. There were no essential changes in the Co-60 activity content compared to previous years, which indicates successful compliance with the ALARA principle. The indicator shows that reactor coolant system integrity has been good at the Olkiluoto plant units in 2013.

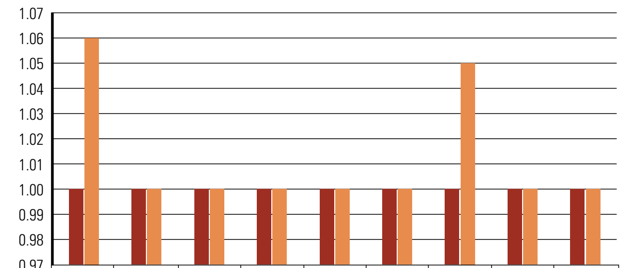
Integrity of primary circuit: Corrosive impurities; Maximum chloride concentration in primary coolant (µg/kg) in power operation. Olkiluoto NPP



	2009	2010	2011	2012	2013
OL1	2.1	3.0	0.7	0.5	1.1
OL2	2.0	2.1	7.8	0.6	1.0

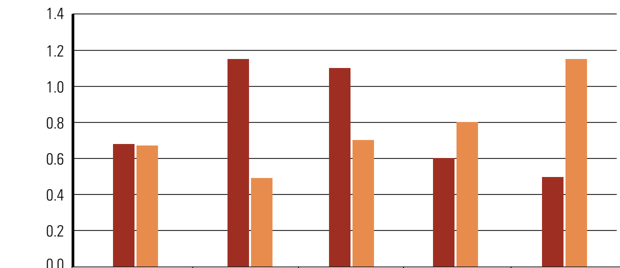
below detection limit

Integrity of primary circuit: Chemistry index, Olkiluoto NPP



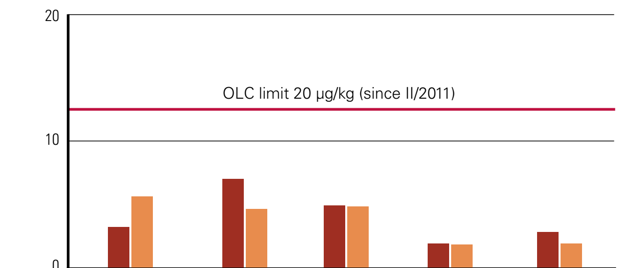
	2005	2006	2007	2008	2009	2010	2011	2012	2013
OL1	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
OL2	1.06	1.00	1.00	1.00	1.00	1.00	1.05	1.00	1.00

Integrity of primary circuit: Corrosion products; Maximum iron concentration in reactor feed water (µg/l) in power operation, Olkiluoto NPP



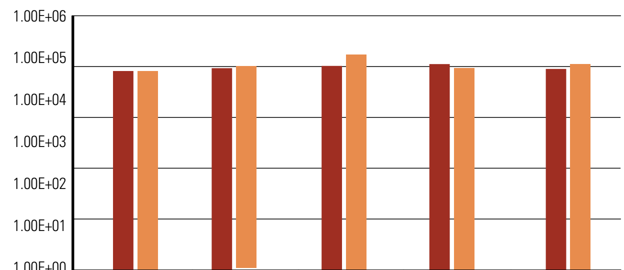
	2009	2010	2011	2012	2013
OL1	0.68	1.15	1.10	0.60	0.50
OL2	0.67	0.49	0.70	0.80	1.15

Integrity of primary circuit: Corrosion products; Maximum sulphate concentration in primary coolant (µg/l) in power operation, Olkiluoto NPP



	2009	2010	2011	2012	2013
OL1	3.2	7.0	4.9	1.9	2.8
OL2	5.6	4.6	4.8	1.8	1.9

Integrity of primary circuit: Corrosion products; Maximum cobalt-60 activity concentration (kBq/m³) in primary coolant related to shutdowns, Olkiluoto NPP



	2009	2010	2011	2012	2013
OL1	7.83E+04	8.59E+04	1.10E+05	1.19E+05	8.65E+04
OL2	7.54E+04	1.01E+05	2.66E+05	9.05E+04	1.19E+05

A.III.2b Reactor coolant system leakages (Olkiluoto)

Definition

The indicators below are used to follow identified and unidentified reactor coolant system leakages at the Olkiluoto plant units:

- Total volume (m3) of identified (from containment to collection tank 352 T1 of the controlled leakage drain system) and unidentified (total volume of leakages into the sump of the controlled floor drainage system, 345 T33) internal leakages in the containment during the fuel cycle.
- Highest daily internal leakage volume in the containment during the fuel cycle in relation to the leakage volume allowed in the OLC (outflow water volume of water condensing in the air coolers of the containment cooling system 725/ OLC limit).

Source of data

The licensee submits data on reactor coolant system leakages at the Olkiluoto power plant to the person responsible at STUK.

Purpose of the indicator

The indicators describing reactor coolant system leakages are used to follow and monitor the leak rate of the reactor coolant system within the containment.

Responsible units/persons

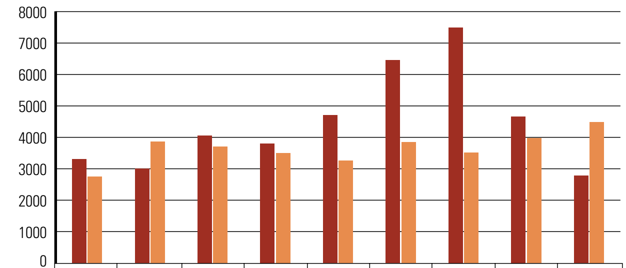
Projects (PRO), Jukka Kallionpää

Interpretation of the indicator, fuel cycle 2012–2013

One of the purposes of controlled leakage is to collect leakages from valves, pumps and other such components. The drains from the seal boxes of the valves within the containment are equipped with temperature sensors to locate any leaks. Temperature sensors installed in the drains above the main lines will detect any leakage in the line. Other methods must then be used to locate the actual leaking object. Identified leakages in the reactor coolant system increased to some extent in Olkiluoto 1 during the fuel cycles of 2009, 2010 and 2011. They decreased in 2012 and continued to decrease in 2013. Identified leakages in Olkiluoto 2 have remained almost constant. The leakage volumes do not include the drainage of process systems during annual outages and other outages. The identified leakages include sampling flows of approximately 100–1,500 m^3 from the reactor building.

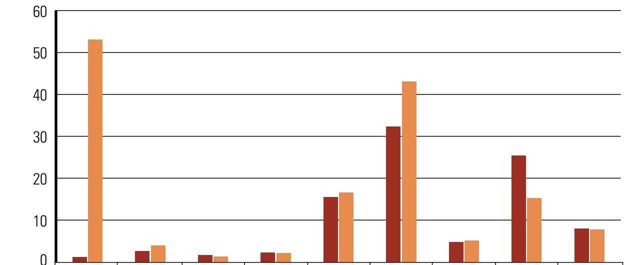
At the lowest point of the containment drywell, there is the drain water pit T33, which collects the drain water from the containment drywell floor drains and any leakage from the control rod actuator seals. The volumes of unidentified reactor coolant system leakages during the fuel cycle 2010–2011 decreased in both plant units. In 2012, they went slightly up from the 2011 level at both plant units, only to fall back to the previous level in 2013.

Identified leakages of primary circuit (352T1, m³), Olkiluoto NPP



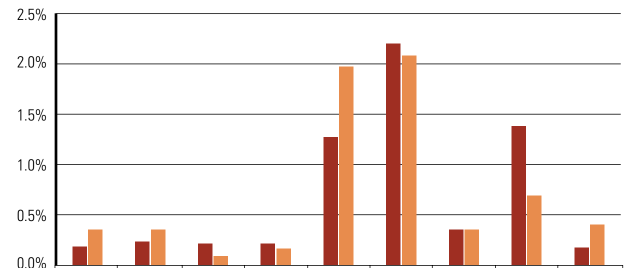
	2005	2006	2007	2008	2009	2010	2011	2012	2013
OL1	3300	3004	4058	3805	4697	6448	7496	4664	2773
OL2	2741	3862	3696	3502	3252	3847	3505	3973	4489

Unidentified leakages of primary circuit (345T33, m³), Olkiluoto NPP



	2005	2006	2007	2008	2009	2010	2011	2012	2013
OL1	1.14	2.52	1.56	2.16	15.48	32.28	4.74	25.3	7.9
OL2	53.00	3.84	1.26	2.04	16.5	43.08	5.10	15.2	7.7

The maximum unidentified leakage in ratio to the OLC limit, Olkiluoto NPP



	2005	2006	2007	2008	2009	2010	2011	2012	2013
OL1	0.18	0.23	0.21	0.21	1.27	2.20	0.35	1.38	0.17
OL2	0.35	0.35	0.09	0.16	1.97	2.08	0.35	0.69	0.40

One of the purposes of containment gas cooling system 725 is to remove moisture from the containment atmosphere. Moisture may originate from steam leaking from the reactor coolant system. During the fuel cycle of 2012–2013, the containment's largest internal daily leak volume's ratio to the maximum allowable volume, as specified in the operational limits and conditions, was low for both plant units.

The reactor coolant system was relatively leak-proof during the 2012–2013 fuel cycle.

A.III.3 Containment integrity

Definition

As indicators, the parameters below are followed:

- Total as-found leakage of outer isolation valves following the first integrity tests compared with the highest allowed total leakage from the outer isolation valves.
- Percentage of isolation valves tested during the year in question at each plant unit that passed the leak test at the first attempt (i.e. as-found leakage smaller than the acceptance criteria of the valve and no consecutive exceeding of the so-called attention criteria of a valve without repair).
- Combined as-found leakage rate of containment penetrations and airlocks in relation to their highest allowed total leakage. The combined leakage rate at Olkiluoto includes leakages from personnel airlocks, the maintenance dome and the containment dome. At Loviisa, the combined leakage rate is comprised of the leak test results from personnel airlocks, the material airlock, the cable penetrations of inspection equipment, the containment maintenance ventilation systems (TL23), the main steam piping (RA) and the feedwater system (RL) penetrations; the seals of blind-flanged penetrations of ice-filling pipes are also included.

Source of data

Data is obtained from the power companies' leak-tightness test reports submitted by the licensees to STUK for information within three months from the completion of an annual outage. STUK calculates the total as-found leakages, since the reports give total leakages as they are at the end of the annual outage (i.e. after the completion of repairs and re-testing).

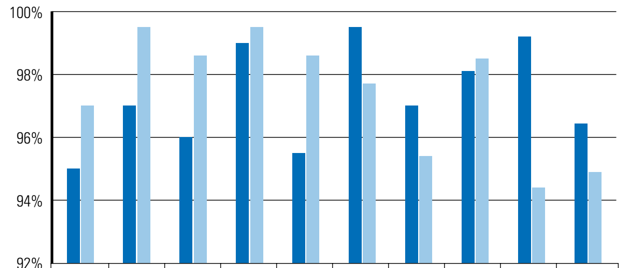
Purpose of the indicator

This indicator is used to follow the integrity of the containment isolation valves, penetrations and airlocks.

Responsible unit/person

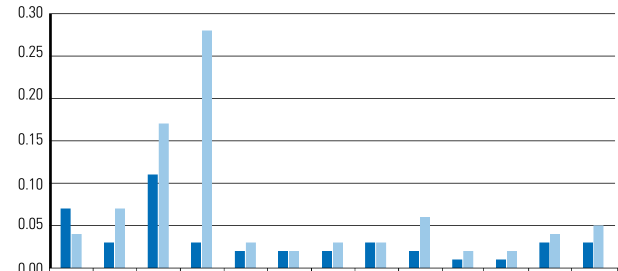
Reactor and safety systems (REA)
Päivi Salo

Isolation valves passing the leakage test at the first attempt, Olkiluoto NPP



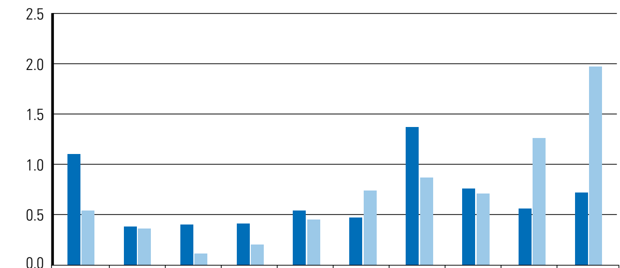
	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
LO1	95.0	97.0	96.0	99.0	95.5	99.5	97.0	98.1	99.2	96.4
LO2	97.0	99.5	98.6	99.5	98.6	97.7	95.4	98.5	94.4	94.9

Combined leak rate of containment penetrations and air locks compared to the leak limit, Loviisa NPP



	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
LO1	0.07	0.03	0.11	0.03	0.02	0.02	0.02	0.03	0.02	0.01	0.01	0.03	0.03
LO2	0.04	0.07	0.17	0.28	0.03	0.02	0.03	0.03	0.06	0.02	0.02	0.04	0.05

The overall as-found leakage of outer isolation valves compared with the highest allowed overall leakage of outer isolation valves, Loviisa NPP



	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
LO1	1.10	0.38	0.40	0.41	0.54	0.47	1.37	0.76	0.56	0.72
LO2	0.54	0.36	0.11	0.20	0.45	0.74	0.87	0.71	1.26	1.97

Interpretation of the indicator

Loviisa

The overall as-found leakage of the outer isolation valves in Loviisa 1 increased, but remained clearly below the limit set. In Loviisa 2, the overall as-found leakage continued to increase, and based on the first tests exceeded the limit set for overall leakage. Three outer isolation valves with plenty of leakage accounted for 84% of the overall as-found leakage. They will be tested together with the inner isolation valves of the line. The leak test results of a valve pair in the cable room extinguishing system was also high in 2012. The leak test results of valve pairs in the fuel pool cooling system and the reactor coolant system purification system, which have had plenty of leakages in the past, were acceptable in 2012. After the repair of the valves, the overall as-found leakage fell back to below the set limit. Since 2010, the leak test result of at least one outer valve has been high each year (around 55% of the limit set for as-found leakages). The increase of as-found leakages is caused by these single major leakages.

The percentage of isolation valves that passed the leak test at the first attempt has remained high.

The overall as-found leakage of containment penetrations, which at Loviisa includes the leak test results for the personnel airlock, the emergency personnel airlock, the material airlock, the reactor pit, inward relief valves, cable penetrations and bellow seals (RA, RL, TL23), was low at both plant units.

Olkiluoto

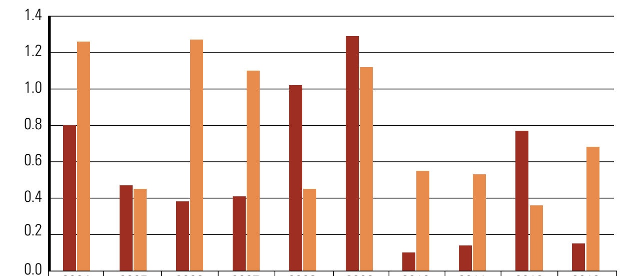
The overall as-found leakage of the outer isolation valves in Olkiluoto 1 decreased when compared to the previous year and remained clearly below the limit set in the OLC.

The overall as-found leakage of the outer isolation valves of Olkiluoto 2 increased when compared to the previous year, but remained clearly below the limit set in the OLC.

The percentage of isolation valves that passed the leak test at first attempt has remained high for both plant units.

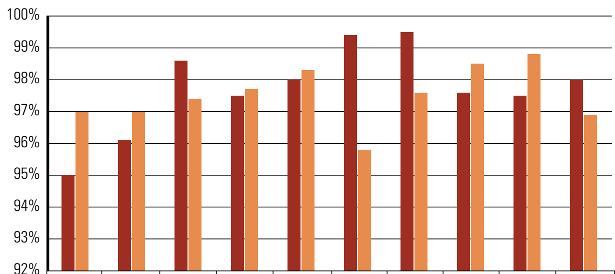
The total as-found leakage rate of containment penetrations, in which TVO includes leakages in the upper and lower personnel airlocks, the maintenance dome and the containment dome, has remained small for both plant units.

The overall as-found leakage of outer isolation valves compared with the highest allowed overall leakage of outer isolation valves, Olkiluoto NPP



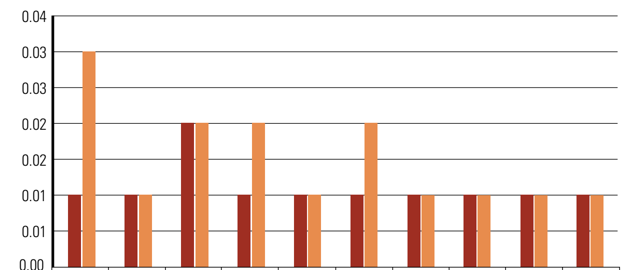
	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
OL1	0.80	0.47	0.38	0.41	1.02	1.29	0.10	0.14	0.77	0.15
OL2	1.26	0.45	1.27	1.10	0.45	1.12	0.55	0.53	0.36	0.68

Isolation valves passing the leakage test at the first attempt, Olkiluoto NPP



	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
OL1	95.0	96.1	98.6	97.5	98.0	99.4	99.5	97.6	97.5	98.0
OL2	97.0	97.0	97.4	97.7	98.3	95.8	97.6	98.5	98.8	96.9

Combined leak rate of containment penetrations and air locks compared to the leak limit, Olkiluoto NPP



	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
OL1	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01
OL2	0.03	0.01	0.02	0.02	0.01	0.02	0.01	0.01	0.01	0.01

APPENDIX 2 Occupational radiation dose distribution at Loviisa and Olkiluoto nuclear power plants in 2013

According to the Radiation Decree, the annual effective dose from radiation work for a worker must not exceed 50 mSv while the average over any period of five years must remain below 20 mSv.

The highest individual dose incurred at Finnish nuclear power plants was 8,6 mSv. This dose was accumulated from work at the Loviisa nuclear power plant. The highest individual dose for a Finnish nuclear power plant worker in the five-year period from 2009 to 2013 was 43,4 mSv. The dose was accumulated at the Loviisa nuclear power plant.

dose range (mSv)	number of persons by dose		
	Loviisa	Olkiluoto	total*
< 0,1	816	1695	2429
0,1–0,49	191	454	642
0,5–0,99	102	175	256
1,00–1,99	91	124	204
2,00–2,99	45	36	92
3,00–3,99	23	14	39
4,00–4,99	13	10	28
5,00–5,99	6	4	12
6,00–6,99	2	1	5
7,00–7,99	0	3	4
8,00–8,99	1	1	2
9,00–9,99	0	0	0
10,00–10,99	0	0	0
11,00–11,99	0	0	0
12,00–12,99	0	0	0
13,00–13,99	0	0	0
14,00–14,99	0	0	0
15,00–20	0	0	0
> 20	0	0	0

* The data in this column include Finnish workers who have received doses also at Swedish nuclear power plants. The same person may have worked at both Finnish nuclear power plants and in Sweden.

Source: STUK's dose register

APPENDIX 3 Exceptional operational events at nuclear power plants in 2013

Loviisa nuclear power plant

Faulty connections in Loviisa 1 I&C system

During the inservice testing of the I&C system at Loviisa 1 on 10 January 2013, it was noted that two of the boron feed pumps would not have operated properly in the event of an accident. The pumps would not have started automatically if the reactor had cooled down too quickly.

Automatic starting of the pumps had been prevented when the plant unit was shut down for repairs on 25 September 2012. At that time, representatives of the power plant noted that preventing automatic starting of the pumps was not necessary during the repair outage in question. They failed to remove this task from the plant's shutdown instruction, however, which means that automatic starting of the pumps was prevented by bypassing them. Such bypassing is usually recorded in the plant's work management system so that all temporary connections can be reliably removed prior to the subsequent startup of the plant unit. Using forms that are manually filled out is also allowed in some cases. The form filled out in connection with this bypassing incident could not be traced when investigating the event. It is likely that the form was not properly archived in a folder in the control room. Thus, no information about the bypassing was available during the startup of the plant unit and the bypass connection was not removed.

The reactor of a nuclear power plant is shut down with the help of the control rods in the event of an accident. The detected fault would not have prevented the shutting down of the reactor. Boron is supplied to the reactor under specific accident conditions to verify that the reactor has shut down. The detected fault would have prevented automatic starting of the pumps, but they could still have been started manually. Furthermore, the plant has other safety systems that can used to supply boron to the reactor. Thus, the event did not pose any risk to the plant, people or the environment.

The representatives of the power plant eliminated the fault immediately after its detection. They also inspected other similar connections at both plant units and found no other non-conformances. The power plant will specify its procedures to prevent reoccurrence of the event. In the future, all such entries will be made in a new work management system that will be commissioned in a couple of years.

There was a similar event at Loviisa 2 in 2008: at that time, I&C system connections had not been restored, either. An extensive and thorough investigation of the event and its underlying causes was conducted. It was observed that the simulation practices have not been properly specified and are not consistent. The power plant implemented corrective measures after the event to prevent its reoccurrence. The underlying causes of the new event are not the same, and thus it cannot be deemed to have been caused by improper corrective measures of the previous event.

On the INES scale, the event is rated at Level 1.

Some of the requirements of the operational limits and conditions were not taken into account during the startup stage of the Loviisa 1 annual outage

During testing implemented at the startup stage after the annual outage of Loviisa 1 on 5 September 2013, it was noted that two of the valves influencing pressure control of the reactor coolant system did not fully open. The valves were moved, which made them operate normally. The fault did not reappear in further tests conducted, and the licensee deemed the valves operable. The underlying cause of the fault remained unclear.

According to the operational limits and conditions (OLC), the startup of a plant unit may not be started once a valve fault has been detected. However, the startup of Loviisa 1 – or, in practice, the adjustment of the boron acid concentration in the reactor coolant system – was continued even though the fault had not been fully processed.

The event was caused by a human error. At the time, the personnel of the plant were adjusting the boron acid concentration of the reactor coolant system, which is a task requiring high precision, and they were also studying the unexpected valve faults. This is why they failed to notice that the valve faults occurred at a stage when the OLC require discontinuation of the startup until the fault has been eliminated. At the time of the event, the employees believed that the plant unit had already reached a stage where the OLC no longer pose this limitation.

The valve fault did not compromise plant safety, because other equipment was also available for pressure control of the reactor coolant system. The event did have safety significance, however. The licensee must make sure that the plant unit is always operated in compliance with the operational limits and conditions. If any non-conformances occur, the licensee must carefully investigate them and prevent their reoccurrence by implementing corrective measures. Based on the investigation of this event, the licensee will clarify the operational limits and conditions and provide additional training for the employees on the significance of the operational limits and conditions.

On the International Nuclear Event Scale (INES), the event was rated as Level 0.

Some of the requirements of the operational limits and conditions were not taken into account during the repair of a valve in the fuel pool cooling system of Loviisa 1

On 18 September 2013, the operators at Loviisa power plant noted that a valve included in the Loviisa 1 fuel pool cooling system did not provide a signal for whether it was open or closed. The signal was obtained after someone went onsite and touched the limit switch. The licensee decided to inspect the limit switch and drafted a work order to that effect.

The valve is located in a pipeline going through the containment. According to the operational limits and conditions (OLC), repairs can be implemented during the plant unit's power operation, but the valve paired with the valve to be repaired in the same pipeline must be closed if the work will make the valve unavailable, or if the work will take more than 24 hours. A starting permit for the work was issued and the work took more than 24 hours. The requirement on closing the valve pair was not taken into account when processing the work permit. Due to this human error, the valve paired with the valve being repaired was not closed until 3 October 2013, i.e. there was a delay of more than 24 hours.

The fuel pool cooling system is used to remove residual heat from the spent fuel stored in the spent fuel pools. It consists of two separate cooling circuits. Normally, one of the circuits is in operation and the other acts as a backup circuit. The repairs of the valve and the delay in closing the second valve did not compromise cooling because the devices remained operable throughout the event. On the International Nuclear Event Scale (INES), the event was rated as Level 0.

Control rod drive mechanism failure and repair outage at Loviisa 2

Two control rods at Loviisa 2 jammed during testing prior to plant startup after the annual outage in September. The control rods were made operational, however, and they moved normally during retests. The licensee issued a permit to go ahead with the plant unit startup. The underlying cause of the jamming remained unclear.

STUK required that the licensee study the underlying causes of the jamming and supervise the system's operability more carefully than normal until the next annual outage. The licensee decided to perform additional tests on the control rods during the plant unit's fuel cycle 2013–2014. The first test took place on 14 October 2013. At that time, one of the control rods jammed again. It was the same control rod that jammed during the testing at the startup stage. The licensee decided to implement a repair outage to study and eliminate the cause of this control rod movement failure..

During the Loviisa 2 repair outage (from 15 to 20 October 2013), the mechanisms of two of the control rod drives were replaced and the detached mechanisms were inspected. The cause of the control rod drive mechanism failure was found to be a faulty bearing in the motor. The underlying cause of the bearing fault could not be determined, and studies are still ongoing. The licensee stated, however, that the fault was eliminated when the mechanism was replaced.

The second control rod that had jammed during the startup stage after the annual outage operated normally during testing in October and its mechanism was deemed fine when inspected after detaching. The cause of the jamming in September could not be ascertained. One possibility is that there was a minor control rod misalignment that was eliminated in September when the assembly was moved downwards.

STUK supervised the study and repair of the fault onsite. Furthermore, STUK reviewed a report on the fault and repairs before issuing a permit to start the plant unit after the repair outage.

All of the control rods operated normally during testing at the startup stage after the repair outage. STUK required that operability of the system be monitored more carefully than normal until the next annual outage.

On the International Nuclear Event Scale (INES), the event was rated as Level 0.

Control rod fault and repair outage at Loviisa 2 (see the event description above)

It was observed in tests implemented in connection with the startup of Loviisa 2 after the annual outage that two control rods of the reactor jammed. When the control rods were retested, one of them still jammed. This malfunction would have prevented the planned gravitational operation of the control rod. The other control rods were deemed operable in the retests. The malfunctioning control rod was replaced with a spare part and inspected by means of dismantling during a repair outage implemented on 15–20 October 2013. It was noted during the inspection that a cylinder roller bearing at the top end of the control rod mechanism's motor occasionally got jammed when it was manually rotated. The radial clearance in between the bearing's inner and outer race was too small, and the bearing rollers did not freely rotate between the races. Fortum was initially of the opinion that the problem was caused by a factory defect, but it subsequently turned out that the bearing's customised inner and outer race had been accidentally mixed up with the races of a similar bearing in another assembly. As a corrective measure, Fortum added a note to the maintenance procedures for the control rods, instructing employees that the identification numbers of a bearing's inner and outer race must be checked prior to assembly.

Lead blankets accidentally left on top of reactor coolant system pipes in steam generator room

At the beginning of the annual outage, employees of Fortum noticed that plastic-covered lead blankets used for radiation protection had been accidentally left on top of pipes inside the reactor pressure vessel's thermal barrier during the previous annual outage. Such blankets were found on top of reactor coolant and safety injection system pipes and on the floor of the room. The blankets on the floor had apparently been placed on top of some pipes but had dropped onto the floor when the temperature increased.

Such lead blankets are used as radiation protection to lower the radiation dose of the maintenance and inspection personnel. The radiation protection blankets should be removed from all rooms that will be closed when the plant is in operation prior to startup, but not all of the blankets had been removed after the annual outage of 2012.

When the blankets were found, the outer surfaces of the affected pipes were cleaned and inspected using a variety of methods. No indication suggesting that the integrity of the pipes had been compromised by the lead blankets was found in these studies. In addition to the studies implemented by Fortum, an external expert assessed the potential risks caused by the lead to the surface coating, because a comprehensive assessment of the consequences of this unexpected event was deemed necessary. STUK accepted these studies and their justification prior to issuing a plant startup permit after the annual outage.

Programmable technology in auxiliary voltage relays installed into safety classified ventilation system switchgears

Fortum observed that there were auxiliary voltage relays including programmable technology in the ventilation system switchgears of the new I&C building of the Loviisa power plant. The voltage relays were replaced with non-programmable types during the 2013 annual outage, because the programmable relays had not been approved for the task. The programmable technology was not detected or suspected when the relays were being acquired. Due to the programmable technology, there was a theoretical chance of a more extensive common-cause failure of the relays. That is why a decision to replace them was made. Around 200 relays were replaced. The relays were located in a safety class 2 switchgears. The relays were there to issue an alarm on undervoltage of the control circuit and, in the case of circulating water pumps, initiate switching to the backup pumps, which means that they had safety significance, but that their safety significance was not major in terms of overall safety.

Relay faults in emergency diesel generators at Loviisa power plant

Two of the emergency diesel generators of Loviisa 2 did not operate as planned during testing in December 2013. The generators started operating normally during retesting, however. The underlying cause of both of the events was a temporary malfunction of a relay (electromechanical switch). The relays in all diesel generators at the Loviisa power plant were replaced.

Both Loviisa plant units have four diesel generators that start when necessary to supply power to the plant's safety systems. Operability of the diesel generators is verified by testing them every four weeks. The relay malfunction was such that it would have delayed the automatic emergency startup of the diesel generator and, if escalated, could have prevented automatic emergency startup of the diesel generator when needed. In addition to the diesel generators, the plant includes other electricity supply systems that can be used to maintain the safety functions if normal power supply is lost.

The event was rated as INES Level 1.

Problem with sample flow of an activity monitor during a planned release

Around 180 cubic metres of low-activity evaporator bottom waste water was released from the Loviisa power plant into the sea as planned between 19 and 21 December 2013. When around two thirds of the planned volume had been released, it was observed that the sample flow going to a monitor that was monitoring the radioactivity in the discharge line was too low. Thus, the monitor that was monitoring the activity of the releases failed to correctly measure the releases on 19 December 2013. The release remained clearly below the annual release limit based on samples taken from the letdown tanks, however.

A decision was made to limit the flow of the planned release to around half of the normal flow rate. The flow rate was decreased by throttling specific valves in the plant's systems. This action excessively decreased the pressure of the letdown line, however, which decreased the sample flow to the activity monitor too much for the monitor to operate correctly. Operating requirements for the activity monitor are included in the plant's operational limits and conditions (OLC). The OLC state that no radioactive materials may be released from the plant if the activity measuring in the discharge line is inoperable. When the problem was detected on 20 December 2013, the operation of the activity monitor was corrected by changing the throttling of a valve so that the desired discharge line pressure could be reached to ensure proper sample flow to the activity monitor.

The monitor monitoring the radioactivity of the liquid release discharge line makes sure that no abnormal releases end up in the sea. The monitor will close the discharge line if the radioactivity level exceeds a specific level.

During the planned release, it was verified that radioactive materials cannot enter the discharge line from anywhere else than the tanks being drained. The activity monitor is not used to specify the releases. Instead, the releases of radioactive materials are always specified by taking samples from the discharge tank prior to releasing the material into the sea. During the planned release, around 1 GBq of evaporator bottom waste water was released. This amounts to around 0.1% of the annual discharge limit.

The event was classified at INES Level 0.

Olkiluoto nuclear power plant

Defects in maintenance of a reactor coolant pump in Olkiluoto 2

Reactor coolant pumps were maintained during the annual outage of Olkiluoto 2 on 30 May. An impeller was accidentally replaced with a sealing plug of the wrong type in one of the reactor coolant pumps. The wrong plug type was detected when more water than normally started to leak from the reactor pressure vessel into the reactor coolant leakage drain system. The reactor coolant purification system was being simultaneously maintained, and due to process connections made for maintenance purposes, radioactive coolant entered a room in the reactor building. When the fault was observed, the sealing plug was replaced with a plug of the correct type and the room was decontaminated.

The reactor coolant pumps at Olkiluoto 1 and 2 are located at the bottom of the reactor pressure vessel. Special attention must be paid to the maintenance of these pumps because a leak at the bottom of the reactor pressure vessel is always a major risk in plants of this type. In this case, the wrong plug type only slightly increased the risk of a bottom leak because the bottom was being sealed by the plug and a flange that was used instead of the pump's motor. Furthermore, if there had been a bottom leak, the coolant that was drained from the reactor could have been replaced with water from the safety injection systems.

The power company identified several human errors as the underlying causes of this event. These human errors are linked to the plant's work procedures and communication. Because of this event, the power company will start storing sealing plugs of different types at different locations and make the necessary changes in the procedures.

The event caused no risk to the plant, people or the environment. On the International Nuclear Event Scale (INES), the event was rated as Level 0.

Non-compliance in management of work pertaining to reactor cooling at Olkiluoto 2

During the annual outage of Olkiluoto 2, TVO observed that one of the heat exchangers used to cool spent nuclear fuel was dirty. Dirt will deteriorate the performance of a heat exchanger, which is why TVO decommissioned the heat exchanger for cleaning on 9 June 2013. TVO inadvertently started this maintenance action at the wrong time. Other annual outage works on the cooling system were being simultaneously carried out, and thus some of the requirements on operability of the systems and equipment in the operational limits and conditions (OLC) were no longer met.

The reactor pressure vessel cover is opened during each annual outage in order to replace nuclear fuel and conduct other work inside the pressure vessel. The reactor pressure vessel is located at the bottom of the reactor refueling cavity, which means that the reactor pressure vessel and the refueling cavity will become a single space once the cover is open. The spent nuclear fuel in the reactor core still generates heat, which means that its cooling must also be ensured during an annual outage. The coolant in the reactor pressure vessel and the refueling cavity as well as the systems and equipment cooling the coolant take care of this. The event took place towards the end of the annual outage. The work on the inside of the reactor core was already complete and TVO started to decrease the surface level in the reactor refueling cavity in order to replace the reactor pressure vessel cover. Only one of the cooling circuits required by the OLC was available for cooling the coolant because the other heat exchanger was being cleaned.

The event inadvertently violated the OLC because the OLC requirements in a case where the reactor pressure vessel cover is open and a heat exchanger has been disconnected to wash it had not been studied. TVO identified human errors as the underlying cause of the event. Due to this event, TVO will study the procedures used when washing heat exchangers. Furthermore, TVO will assess whether the OLC are sufficiently clear and whether some changes are necessary.

The event caused no risk to the plant, people or the environment. On the International Nuclear Event Scale (INES), the event was rated as Level 0.

Material faults detected during maintenance of emergency diesel generator at Olkiluoto 2

TVO is upgrading the diesel generators in Olkiluoto 1 and Olkiluoto 2. It was observed during repairs in the autumn that the wound core of a rotor manufactured from flat bar copper had been extended with silver solder at some points. In a visual inspection, the subcontractor repairing the generator detected two major indications in one of the solder joints. Furthermore, small indications were detected in two solder joints.

TVO ordered a damage study which proved that there were already cracks in the solder joints when they were made in the 1970s. It was verified by means of electron microscopy that ageing phenomena during operation (such as sparking or fatigue) had not occurred. Most of the cross-section of the joint with the major fault had not been joined. The windings that were cut in order to perform the damage study will be repaired with a qualified soldering method and the quality of the repairs will be verified by means of inspections.

In addition to the indications found in the solder joints, two of the eight stator weld joints in the generator exciter were cracked. Because of this fault, the weld joints of all of the plant's exciters were studied with an endoscope. Another similarly cracked joint was found.

Based on a special report submitted to STUK by the power company, a crack in one or two welds or a deformation of the stator shell does not influence the machine's performance, which means that the machines are operable.

The detected material faults have not rendered the emergency diesel generators of the nuclear power plants inoperable. There are four diesel generators at both of Olkiluoto's operating plants. Their operability is tested monthly.

Non-conformance with administrative procedures when working in a cross-connection room in Olkiluoto 1

The fire extinguishing system in the cable rooms below the relay rooms will be replaced with a new system. Employees were preparing this upgrade at Olkiluoto 1, i.e. fixing housings, hauling tools and other goods, and installing cables. In connection with these preparations, the employees needed to enter a cross-connection room to install a cable. Working in a cross-connection room was not mentioned in the work order given for the preparation work. The employees were allowed to enter the control room's cross-connectionroom alone without any supervising operating personnel. The event did not comply with a requirement included in the operational limits and conditions (OLC) which states that the door of a cross-connection room must always be opened by permanent operating personnel.

The power company identified the underlying causes of the event as defective procedures, lack of communication and defective procedures on entering the cross-connection room. The fact that the work would extend to the cross-connection room was not observed in the planning or kickoff meetings for the work. Due to this event, the power company has determined corrective measures to prevent reoccurrence of the event and to develop operations.

The event caused no risk to the plant, people or the environment. The event was classified at INES Level 0.

APPENDIX 4 Licences in accordance with the Nuclear Energy Act by STUK in 2013

Teollisuuden Voima Oy

- 21/C42214/2012, 8 January 2013, import from Sweden and possession of nuclear information with safeguards obligation that is required for OL1, OL2 and the spent fuel storage. Last date of validity 31 December 2030.
- 1/C42214/2013, 22 February 2013, import of control rods from Sweden and the United States of America. Last date of validity 31 December 2023.
- 7/C42214/2013, 10 July 2013, import of radioactive waste generated when scrapping decommissioned turbines and heat exchangers from Sweden. Last date of validity 31 December 2014.
- 9/C42214/2013, 29 October 2013, import of nuclear fuel with Euratom obligation code “S” from Sweden (OL2 E34). Last date of validity 31 December 2014.
- 10/C42214/2012, 31 October 2013, import of nuclear fuel with Euratom obligation code “P” from Sweden (OL2 E34; part of a batch). Last date of validity 31 December 2014.
- 11/C42214/2013, 29 October 2013, import of nuclear fuel with Euratom obligation code “S” from Sweden (Optima3 test). Last date of validity 31 December 2014.
- 12/C42214/2013, 4 November 2013, import of nuclear fuel with Euratom obligation code “S” from Germany (OL1 E36). Last date of validity 31 December 2014.
- 13/C42214/2013, 4 November 2013, import of nuclear fuel with Euratom obligation code “S” from Germany (Atrium 11 test). Last date of validity 31 December 2014.
- 14/C42214/2013, 17 December 2013, OL1/2 – import of nuclear information concerning HGNE reactor coolant pumps and an amendment of licence 19/C42214/2012 on holding data. Last date of validity 31 December 2020.
- 1/G42214/2013, 22 February 2013, OL3 – import of a control rod drive mechanism and two rod guide tubes from France. Last date of validity 31 December 2015.
- 4/G42214/2013, 25 September 2013, OL3 – extending the validity period of import licences 5/G42214/2010 and 5/G42214/2011 so that the last date of validity will be 31 December 2016.
- 13/M42214/2012, 8 January 2013, OL4 – import and possession of nuclear information concerning an APR 1400 plant from South Korea. Last date of validity 31 December 2030.
- 4/M42214/2014, 8 January 2013, OL4 –transfer of nuclear information concerning an APR 1400 plant to Fortum Power and Heat Oy. Last date of validity 31 December 2030.
- 10/M42214/2013, 7 May 2013, OL4 –transfer of nuclear information concerning APWR, EU-ABWR and APR-1400 plants to Descal Engineering Oy. Last date of validity 31 December 2030.
- 13/M42214/2013, 26 August 2013, OL4 –transfer of of nuclear information concerning an ABWR plant to the Finnish subsidiary of Toshiba International (Europe) Ltd. Last date of validity 31 December 2030.

Fortum Power and Heat Oy

- 1/A42214/2013, 31 January 2013, OL4 –possession and transfer of nuclear information concerning an APR-1400 plant to Teollisuuden Voima Oy . Last date of validity 31 December 2030.
- 19/A43774/2012, 5 February 2013, an operating licence for the sorting and intermediate storage of low-level operational waste in operational waste room no. 3. Last date of validity 31 December 2055.
- 7/A42214/2013, 7 May 2013, import of neutron flux sensors from Russia. Last date of validity 31 December 2013.
- 8/A42214/2013, 27 June 2013, import of wide range neutron flux sensors from France. Last date of validity 31 December 2017.
- 9/A42214/2013, 5 September 2013, import of neutron flux sensors from Russia. An amendment of licence 7/A42214/2013, 7 May 2013. Last date of validity 31 December 2013.

Fennovoima Oy

- 3/J42214/2013, 22 August 2013, import and possession of nuclear information from Russia. Last date of validity 31 December 2023.
- 4/J42214/2013, 17 December 2013, transfer of nuclear information. Last date of validity 31 December 2023.

Others

- 2/Y42214/2011, 15 April 2013, Celer Oy; import, possession and transfer of nuclear information concerning design of sampling autoclaves; an amendment of licence 2/Y42214/2011, 24 May 2011. Last date of validity 31 December 2021.
- 7/Y42214/2013, 8 May 2013, Descal Engineering Oy; OL4 –possession and transfer of nuclear information concerning APWR, EU-ABWR and APR-1400 plants to TVO. Last date of validity 31 December 2030.
- 10/Y42214/2013, 16 September 2013, Elomatic Oy, possession and transfer of nuclear information on design of sampling autoclaves. Last date of validity 31 December 2023.
- 11/Y42214/2013, 16 September 2013, Platom Oy, transfer of nuclear information on design of sampling autoclaves. Last date of validity 31 December 2021.
- 12/Y42214/2013, 23 October 2013, Ab Solving Oy, possession of nuclear information on design of sampling autoclaves. Last date of validity 31 December 2021.

APPENDIX 5 Periodic inspection programme of NPPs in 2013

Inspections included in the periodic inspection programme focus on safety management, operational main processes and procedures, as well as the technical acceptability of systems. The inspections verify that safety assessments, operation, maintenance and protection activities (radiation protection, fire protection and security) of the facility comply with the requirements of nuclear safety regulations.

Periodic inspection programme 2013, Loviisa

Management, management system and personnel

A1 Management and safety culture, 23–24 January 2014

The inspection of Loviisa nuclear power plant's management and safety culture focused particularly on liability of the management on management system assessments and improvements, the process-based management system, and the manner in which the management processes projects and non-conformances. Nine people were interviewed during the inspection. An independent assessment of the coverage and functionality of the management system as laid down in Guide YVL 1.4 has been implemented at the Loviisa power plant. Recommendations included in the assessment report were reviewed by the management of the power plant. Development of the process-based management system is still in progress, and the management of the power plant is currently reassessing the power plant's key processes. Based on the inspection, an investment and project portfolio management team established by the power plant has worked in line with the power plant procedures and its working methods have been functional. The power plant management is of the opinion that the current non-conformance management system is functional. Development needs mentioned in the interviews included the need to improve the manner in which corrective measures are specified to ensure proper allocation of measures and resources. STUK required that the management of the Loviisa power plant must improve the monitoring of development measures and the assessment of their impact. Furthermore, the power plant must implement a classification procedure for measures in compliance with the plant procedures.

A2 Personnel resources and competence, 13–14 May 2013

The inspection of personnel resources and competence focuses on planning and allocation of the power company's personnel resources, maintenance and development of the personnel's competence, and supervisory work. The inspection in 2013 focused particularly on the functionality of procedures pertaining to the development of competence. Functionality of the procedures was verified by interviewing personnel of the maintenance unit. Furthermore, the training team organisation, its goals, its indicators, its resources and its non-conformance management system were studied. The Loviisa competence development procedures include general procedures complying with the YVL Guides. Based on the interviews included in the inspection it seems, however, that there are differences in how the procedures are applied. STUK required that the training team of the Loviisa power plant study the competence management methods and tools used at the power plant and use the results of the study to develop the power plant's procedures and methods as well as their application. Furthermore, the power plant must verify that all persons working in positions important to safety complete their refresher training in compliance with the power plant's requirements.

The Loviisa power plant must also supplement its personnel planning methods to ensure that it can manage both resources needed in development/projects and resources needed in regular work. Based on the incpection non-conformances observed in internal audits are properly processed by the training team.

A3 Functionality of management system and quality management, 16–17 April 2013

The status of the requirements made in the previous inspection was verified and the management of non-conformances was discussed in the inspection of the functionality of the management system and quality assurance. STUK interviewed four supplier-auditors of the Loviisa power plant to verify their auditing competence and the qualification procedure. Furthermore, action plans and resources of the quality management team were studied. Three of the five requirements made in the previous audits were deemed complete. These requirements concerned procurements, supplier audits and the management of non-conformances. Two of the requirements were further specified: the Loviisa power plant must verify that all procedures important to safety are up to date, and the power plant must submit to STUK for information updated plans of the maintenance and operating units, results of the measures included in the plans and information on any measures that were not updated as planned. Furthermore, the power plant must submit to STUK a plan of action including measures that will be applied to improve the quality of documents to be submitted to STUK. STUK noted that the resources of the quality management team are meagre when taking into account the team's workload.

Plant safety and its improvement

B1 Assessing and improving safety, 26 November and 3 December 2013

The inspection on assessing and improving safety mainly focused on modification processes at the Loviisa power plant and measures implemented to develop the modification process, particularly identifying areas requiring safety significant modifications and their progress in the modification process. Furthermore, STUK assessed the periodic safety review functions at the Loviisa power plant. STUK noted that the actions and methods used at the Loviisa power plant are sufficient to verify that all modification needs significant to safety are identified. STUK observed in the inspection that the power plant is planning a large number of modifications in the next few years compared to its available resources. The power plant aims at improving its modification processes by making more comprehensive modification plans before starting any installation work at the plant. To collect the data needed to develop the modification process, STUK required that separate indicators for the process must be drafted. Fortum must submit the periodic safety review of the Loviisa power plant to STUK by the end of the year 2015. According to STUK's inspection results, drafting of the review and compilation of the necessary documentation seem to have gotten off to a good start.

B2 Plant safety functions, 6–7 June 2013

The inspection of plant safety functions focused on the management of reactivity. Here, the term 'management of reactivity' refers to procedures and systems used to verify that the reactor is shut down and the reactor and the fuel pools remain subcritical. STUK noted based on the inspection results that the procedures applied to management of reactivity at the Loviisa power plant and in the technical support unit of the Loviisa power plant are appropriate and the organisation's resources, competence and orientation procedures are sufficient. Communication between the Loviisa power plant and the technical support unit, located at Keilaniemi in Espoo, is functional but there is still some room for improvement in meeting practices and other issues. Defects observed in the updating of procedures are already being monitored by Fortum itself. The processing of non-conformances and procedures used to verify learning from operating experience were proper in all inspected areas.

B2 Plant safety functions, 30 October 2013

The inspection of plant safety functions focused on procurement and the monitoring of nuclear fuel. STUK inspected the power company's nuclear fuel procurement and monitoring processes, as well as the procedures and resources. STUK stated that Fortum's fuel procurement and monitoring practices are functional and comply with the requirements. Operations are systematic and are based on appropriate procedures, and the responsibilities have been clearly defined. Behaviour of the fuel is systematically monitored at the Loviisa power plant. The monitoring operations also provide excellent operating experience data. Operating experience feedback from other countries is comprehensively utilised in the operations as well. Problems with the system used to inspect fuel have delayed studies. STUK observed in its inspection the following issues that require further attention: resources in fuel delivery control, monitoring the operations of third-party inspectors at the fuel manufacturing plants and the more visible role of the management in the procurement of fuel.

B3 PRA and management of safety

A inspection on using the probabilistic risk analysis (PRA) in the management of safety focused on, for example, the current status of PRA updates, procedures, training, PRA modelling principles in issues concerning residual heat removal, processing of non-conformances linked to PRA and communications. Fortum has developed the planning process of its annual outages by taking into account the risk-informed data provided by the PRA in more detail. STUK stated after the inspection that more communication and training about annual outage risks observed in the PRA must be provided to ensure that the employees participating in the annual outages are better aware of the key risks and how they can mitigate the risks.

B4 Operating experience feedback, 21 October and 5 November 2013

In its inspection of the operating experience feedback, STUK assessed the power plant's operating experience feedback processes, their organisation, related procedures and related methods. The inspection included verification, with the help of example cases, how observations and non-conformances detected in audits and operating experience from other plants are processed at the Loviisa power plant. The Loviisa power plant still has room for improvement when it comes to implementing corrective measures determined based on operating experience and monitoring the success of these measures. Furthermore, the power plant must submit an assessment of the implementation and impact of these measures to STUK in connection with its annual report.

Operational safety

C1 Operational activities, 26–27 February 2013

The inspection of operational activities focused on the operating unit's responsibilities and duties during modifications. This is a topical issue because of events that took place in 2012, the I&C system upgrade and a periodic safety review that will take place in 2015. Various organisations and organisational units participate in implementing modifications, and challenges involved management and communications. In the inspection, methods used in operational activities were studied by verifying the power plant's procedures, interviewing power plant personnel, verifying modification documentation and conducting an inspection round onsite. No significant new development needs were observed in the inspection. The power plant has submitted reports on non-conformances pertaining to modifications in connection with its event reports. Based on the inspection STUK required changes of the coverage of procedures used during the commissioning stage of modifications and completion of a modification started during the 2012 annual outage (disassembling decommissioned equipment, onsite markings).

C2 Plant maintenance, 27–28 November 2013

STUK assesses the condition monitoring of plant components important to safety which the licensee performs during operation, shutdowns and startups of the plants. Condition monitoring may be continuous or be based on periodical measurements or observations. The purpose of the inspection was to verify that the scope and implementation method of the condition monitoring of different plant components is sufficient when taking into account their impact on safety. Other inspected issues included the detection of leaks, vibration monitoring, monitoring of loose objects and load monitoring of Loviisa 1. Long-term monitoring of the inservice testing of safety systems has a key role in the condition monitoring of components. After the inspection, STUK required that Fortum study the opportunities to develop the long-term condition monitoring of safety systems and equipment. Furthermore, Fortum must study the opportunity to determine a total heat transfer coefficient for heat exchangers in connection with the inservice testing of the residual heat removal chain to monitor performance of the heat exchangers and receive advance information about changes in their performance.

C3 Electrical and I&C systems, 12–13 November 2013

The electrical engineering part of STUK's inspection focused on the procedures used when processing non-conformances, the monitoring of the ageing of electrical equipment, the quality control of spare parts, relay protection and the maintenance of emergency diesel generators. In the I&C part of the inspection, STUK assessed the development of the I&C design and implementation process, the structure of technical instructions on the installation process, the management of ageing and qualification, inservice testing instructions, construction inspection requirements for I&C equipment, the condition of installations, the installation implementation method used in specific parts of the containment and the management of non-conformances. Based on the electrical engineering inspection, STUK required a report on the processing method of non-conformances and improvements in the condition monitoring of diesel generators. Furthermore, STUK required that the power company issue a report on the thermal relays and fuses used to protect electrical motors. Based on the I&C inspection, the power company must update the electricity and I&C installation planning procedure, study the construction planning methods of load-bearing I&C equipment and supplement the operational limits and conditions in terms of the inservice inspections of the preventive protection system.

C4 Mechanical engineering, 1 November 2013

In the mechanical engineering inspection, STUK assessed the operation and maintenance of safety-classified hoisting device units and particularly how the power plant has verified the safety of hoisting accessories. A particular focus area in the inspection of the organisation was the processing of non-conformances. STUK observed that there is need to update the hoisting device and hoisting accessory classification, the currently valid design documentation and maintenance programmes, and submit clarifying summaries to STUK. STUK also required from the power company reports on strength calculations and the adequacy of visual inspections.

C5 Structures and buildings, 24–25 April 2013

In the inspection of structures and buildings at the Loviisa power plant, the maintenance procedures of structures, buildings as well as seawater channels and tunnels were assessed. In addition, the results of inspections carried out by the power company and the modifications made were discussed. The scope of the inspection included the organisation of the power company, inspection procedures issued by the power company, inservice inspections by the power company, repairs and modifications, supplementary construction works onsite and other inspections within the area of responsibility. Four requirements were presented during the inspection on quality management, performance of structural engineering inspections, measures taken based on the inspection results and maintenance of procedures pertaining to the area of responsibility.

C6 Information security, 4–5 November 2013

STUK's inspection of information security and data management involved the technical and administrative information security at the Loviisa power plant. During the inspection, STUK assessed responsibilities and duties of the information security organisation as well as their cooperation with other units. Other issues included risk assessments, processing design basis threats (DBT) at the Loviisa power plant and taking into account information security in supplier assessments.

C7 Chemistry, 13–14 May 2013

Key areas in the inspection of chemistry included implemented organisational changes, quality management at the chemical laboratory, functionality of the maintenance process for continuously operating analyzers and the processing of non-conformances. The chemical laboratory has introduced a new procedure that specifies not only the qualifications required from the personnel but also how these qualifications must be verified. In the inspection, STUK noted that training of the personnel of the Loviisa power plant chemical laboratory is being systematically managed. This is important, because the organisation has lost some key competence in the past few years. The laboratory's quality management was assessed in terms of the validation of chemical measurements. The operations are systematic, reports are comprehensive and based on results from intercalibration projects and the results are highly reliable. In terms of the liability for the maintenance of the continuously operating chemical analyzers, STUK required that it be clarified and standardised in the various procedures. The laboratory handles the daily monitoring and management of chemistry well, but STUK found some room for improvement in the preparation of the system lay-ups systems during future longer annual outages. In terms of the processing of non-conformances, STUK noted that the laboratory had not exceeded any of the required deadlines and all corrective measures had been performed.

C8 Annual outage, 18 August – 23 September 2013

STUK completed an inspection during the annual outage of Loviisa 1 and Loviisa 2. In this inspection, STUK studied more than twenty sectors and jobs. The inspection objects included shoe boundaries and markings pertaining to radiation protection, heavy lifting in the reactor building, the handling of nuclear fuel, three separate modifications, four separate jobs on mechanical equipment, physical protection and the management of non-conformances. During this inspection, STUK monitored the work done at the plant, conducted onsite inspection rounds and interviewed employees. Based on the inspection, STUK gave eight requirements involving the development of operations and documentation. These requirements related to heavy lifting in the reactor building, I&C procedures and work on mechanical equipment. Nothing out of the ordinary was observed at most of the inspection sites. Furthermore, STUK observed some excellent operating practices and signs of continuous improvement of the operations of the plant.

Personal and plant protection

D1 Radiation protection, 23–24 October 2013

The radiation protection inspection covered the nuclear power plant's radiation protection, radiation measurements, emissions monitoring and environmental monitoring. A special focus area in 2013 was operative radiation protection. In this inspection, STUK assessed radiation protection procedures, the role of radiation protection in the work permit processing procedure, communications and the processing of non-conformances in the organisation. STUK found some room for improvement in keeping some procedures up to date and keeping the procedures used in case of exceptional situations clear. Furthermore, STUK required that more detailed descriptions of the processes that have been found functional – such as radiation protection training and the reducing of radiation doses – be added to the plant's procedures. In addition, the power company must study applicability of the method used when determining neutron doses to the transfer of spent nuclear fuel.

D2 Fire protection, 20–21 March 2013

The fire protection inspection included assessing the effectiveness of the Loviisa power plant's fire protection arrangements and the operations of the power plant, as well as inspecting the implementation of plans on modifying the fire protection arrangements. Focus areas of the inspection included non-conformances, the processing of non-conformances and the implementation of modifications. The inspection focused on the processing of non-conformances in particular, i.e. how the power plant had processed requirements and observations made during inspections by STUK, the power company and other organisations, and what kind of corrective measures had been implemented. The inspection also included studying changes made in the protection unit organisation and deputy arrangements as well as a review of fire extinguishing and fire detection system inspections and the processing of non-conformances observed in these inspections. STUK required after the inspection that the maintenance instructions be updated, non-conformances observed in the saving of testing records be corrected, a fire water system condition evaluation by an inspection organisation be implemented as part of the intermediate assessment of the operating license, and a form used to manage service lives be supplemented with information pertaining to systems included in the scope of system liability, such as the fire detection system. The power plant had not updated the maintenance procedures or corrected the non-conformances in the saving of maintenance records, as required by STUK in the previous inspection, which is a deficiency in the processing of non-conformances.

A positive observation made during the inspection concerned modifications the power company plans to implement to improve fire safety (such as replacing the generator transformers, upgrading the fire detection system and upgrading the fire extinguishing system in the reactor coolant pump room).

D3 Emergency preparedness, 5 November 2013

The STUK inspection on emergency preparedness covered the nuclear power plant's emergency preparedness arrangements, procedures and training. Experiences on emergency preparedness from the past six years, as well as experience and feedback from emergency preparedness drills, were inspected. All the equipment and tools pertaining to emergency preparedness, such as the automatic environmental radiation measuring system, meteorological measurements, communications devices and emergency preparedness facilities, were inspected. Special attention was paid to personnel planning and quality management. STUK required that the power company draft a report on repairs and modifications that have been implemented on the renewed data transfer system that will process the plant's process measuring data during an emergency. Furthermore, the power company must create systematic practices to monitor the implementation of emergency response training plans and verify that the people included in the emergency preparedness organisation regularly participate in drills. STUK noted that the emergency preparedness arrangements of the Loviisa power plant are in order and the organisation has received the required training in compliance with the emergency response plan. The Loviisa power plant emergency response plan and the related procedures are up to date. The power plant quickly reacts to any observed non-conformances and usually speedily launches corrective measures. The duties of some of the people included in the organisation should be developed to ensure that the power plant complies with the requirements of the amended nuclear safety regulations.

D4 Physical protection, 28 May 2013

In the inspection of physical protection, STUK assessed Fortum's physical protection arrangements in different physical protection zones of the Loviisa power plant. The inspection focused mainly on the resources needed to maintain and plan the physical protection, training and drills, previous inspections, development measures and their current status, a new alarm centre and status with an upgrade of the surveillance system. STUK also studied the management of non-conformances. STUK noted during the inspection that more resources have been added to the physical protection organisation and the training programme for Fortum's protection organisation has been implemented as planned. STUK also noted that experiences gained from drills should be consistently studied to make sure that lessons are learned from them. The transfer of the alarm centre to the new safety surveillance system (TUVA) will take place in stages. STUK conducted a separate inspection of the upgrade in June. A modification of the plant's fence was deemed to comply with the plans in the inspection. The power plant borders in terms of authority and the practices used to submit safety classified information were also discussed during the inspection.

Nuclear waste and its storage

E1 Operating waste, 11–12 June 2013

STUK regulates and inspects the processing and final disposal of radioactive operational waste at the Loviisa power plant. Low- and intermediate-level operational waste is generated during maintenance and repairs as well as during the treatment of circulating water. An inspection of operating waste focused on remarks made during the last inspection, development since the last inspection and any important issues that have occurred. Issues studied during the inspection included the processing of non-conformances, procedures for exemption from radiation control and personnel issues. The condition of facilities in which waste is processed and stored, radiation levels in these facilities, their classification and their markings were studied during the site visit. No significant non-conformances or development needs were detected in the inspection. STUK posed a demand relating to the waste accounting of dry silos in the reactor buildings and at the spent nuclear fuel storage facility of the Loviisa power plant. The licensee must pay more attention to the documentation of waste during waste accounting, in order to verify that the material accounts always include a note of the related component as well.

E2 Repository for operating waste, 30 –31 October 2013

STUK inspected the final disposal of radioactive operating waste at the Loviisa power plant by assessing procedures relating to the repository, the maintenance of the repository and the repository's organisation. Other issues studied included implemented repairs and modifications and results of inspections by the power company, such as groundwater chemistry measuring results for the repository cave, as well as hydrological and rock mechanics monitoring measurements. No non-conformances were detected in the inspection. STUK found some room for improvement in the content of the reports on the repository cave's monitoring measurements, however.

Special issues

F1 LARA, 6 November 2013

The inspection of the Loviisa power plant I&C upgrade (the LARA project) included review of issues that were not resolved in previous inspections. Inspected issues included configuration management procedures, methods and responsibilities for the management of non-conformances, competence and operations of the auditing team and installation control procedures. STUK stated after the inspection that the procedures used in the management of non-conformances and the operations of the auditing team comply with the requirements. STUK will continue monitoring compliance with the configuration management requirements, since the configuration management is still being developed as a subproject of the Loviisa power plant's periodic safety review.

F2 Compliance with procedures influencing startup chemistry in Loviisa 1, 1–2 September 2013

In an inspection carried out by STUK without advance notification, STUK assessed the power company's procedures applied to the maintenance and supervision of the chemical conditions in systems important to safety. The inspection particularly focused on practical procedures used to verify integrity of the reactor coolant system by minimising the generation, migration and deposition of corrosive substances on the surfaces of pipes in the steam generators. When the Loviisa power plants are started after an annual outage, special attention must be paid to the purity of the water circulating in the systems, because any impurities left on the surfaces after maintenance will dissolve in the water. In the past few years, the operational limits and conditions (OLC) for chemistry have been exceeded during the startup of the plant units because of inadequate water flow. If there are too many impurities in the water, a defect in the heat transfer tubes of the steam generators is much more likely. The chemical laboratory is in charge of measuring these impurities and announcing the results to the control room operators, so that the operators can take the necessary action to decrease the level of impurities. The inspection started when the plant was being started up, and its primary goal was to monitor purity of the water in the steam generators. Based on several results of the water circulation chemistry analysed by the power plant, the operational limits and conditions were met. Replacement of the water in the steam generators also complied with the plans. The control room operators implemented a new procedure when starting up the plant: the new procedure better takes into account the purity of the water circulating in the circuits. Due to technical reasons pertaining to the process, the water could not be replaced fast enough at a latter stage of the startup process, which caused the level of impurities to increase. The problem was corrected based on measuring data submitted by the chemical laboratory to the control room, however.

Periodic inspection programme 2013, Olkiluoto

Management, management system and personnel

A1 Management and safety culture, 21–22 August 2013

The inspection of the management and safety culture focused on assessing functionality and coverage of the management system, current status and development of the management system processes, and non-conformances observed in management reviews and their monitoring. Individual employees were interviewed prior to the inspection. According to TVO, the management systems of the operating Olkiluoto plant units and Olkiluoto 3 will be gradually merged, and the combined plant will operate under the same principle as the currently operating plants. This statement and the related risk assessment could not be verified during the inspection, however. TVO must make sure that its risk assessments will take into account the changes in the organisational structure and operating procedures that will take place when preparing for the commissioning of Olkiluoto 3. Furthermore, STUK required that the processing and documentation of management reviews must be verifiable in the next inspection of the TVO management system by STUK. The power plant's operative team has studied a report on an assessment of the functionality and coverage of the management system and named people in charge of all the recommended measures. The operating processes have been presented as graphs in a standardised manner based on the operating handbook, but they have not been presented to the process owners yet.

A1 Management (physical protection), 26–27 November 2013

STUK conducted an extra inspection at the Olkiluoto plants, titled 'Physical protection as part of the management system'. STUK assessed how the processes related to physical protection are described in the ERP system, how physical protection is taken into account in the risk management process, and how the management can verify the functionality of physical protection. Furthermore, discussions on how physical protection has been taken into account when assessing and developing the organisation's (safety) culture were conducted. Nuclear safety must be a balanced entity where the importance of each sector (safety, physical protection, nuclear non-proliferation control) under different circumstances is studied to achieve the best overall level of safety. STUK required after the inspection that the descriptions included in the ERP system must be updated to comply with the activities in practice. TVO had updated the information security requirements for procurement. STUK considers the implementation of these requirements successful and important, and asked that the requirements be submitted to STUK for information purposes.

A2 Personnel resources and competence, 25–26 September 2013

The inspection on personnel resources and competence focused on the implementation and assessment of TVO's trainee programme, a resource management development project, as well as duties, resources and development of the personnel development unit. Individual interviews of participants in the trainee programme were conducted prior to the inspection. Two of the latest HR auditing reports and minutes of office meetings from 2012 and 2013 were verified. TVO has launched a resource management development project (REHA). STUK will monitor the development of procedures and methods pertaining to HR planning and the allocation of resources in connection with this project. TVO must submit the REHA project plan and a project status report to STUK by March 2014. The fact that the personnel development unit failed to complete a self-assessment has been noted as a minor non-conformance in two consecutive audits. TVO stated that an agreement on completing the self-assessment in 2013 has been made. STUK required that TVO submit to STUK a report on the self-assessment implementation method and conclusions.

A3 Functionality of the management system and quality management, 7–8 November 2013

The inspection of the functionality of the management system focused on a modification development project, TVO's assessments and development of supplier approval, duties, responsibilities and resources of the quality and environmental unit, an external quality management system assessment and the processing of non-conformances. The inspection included a verification of the supplier assessment process based on information obtained from TVO's data systems. TVO develops its supplier assessment and approval practices, but has failed to determine requirements on the competence of people performing supplier audits and the maintenance of their competence as required by STUK. TVO has not created procedures and documentation on the basis on which the competence of auditors is verified.

Plant safety and its improvement

B1 Assessment and improvement of safety, 6–7 November 2013

The inspection on assessing and improving safety mainly focused on TVO's modification process and measures implemented to develop the modification process, such as identifying areas requiring modifications to improve safety and monitoring the progress of such modifications. Furthermore, STUK inspected TVO's operations pertaining to the renewing of the operating license for Olkiluoto 1 and Olkiluoto 2. Based on the inspection results, TVO's operations and procedures to identify areas requiring modifications to improve safety are sufficient. TVO has clarified its modification process so that they guide people more clearly. TVO's goal is to start testing the new process after the 2014 annual outages. STUK will actively monitor the progress of the process and required that TVO submit a status report to STUK prior to the 2014 annual outages. The operating license for Olkiluoto 1 and Olkiluoto 2 is valid until the end of 2018. TVO has drafted a plan for creating the documentation needed when renewing the operating license and named people in charge of the documentation.

B2 Plant safety functions, 10–11 October 2013

The inspection of plant safety functions focused on the management of reactivity. Here, the term 'management of reactivity' refers to procedures and systems used to verify that the reactor is shut down and the reactor and the fuel pools remain subcritical. STUK noted that TVO's procedures for the management of reactivity are adequate. The organisation's resources, competence and orientation are also sufficient. STUK noted that TVO is monitoring the delays in the updating of procedures itself. TVO's non-conformance monitoring system is functional, and all issues pertaining to the processing of non-conformances and learning from operating experience are fine. According to STUK's assessment, criticality safety and related competence have been well taken into account at the plant and are continuously developed. Procedures are supplied to the employees doing related work onsite, and they have been provided the necessary training. Of the training offered to external parties, the training of loading supervisors has clearly been developed. Based on the inspection, TVO is properly managing all systems linked to the management of reactivity and their operability is being monitored and developed both in the short term and long term.

B3 PRA in management of safety, 10 September 2013

STUK inspected TVO's use of probabilistic risk analyses (PRA) in the management of safety by assessing the status of PRA updates and the most important reactor coolant system leak events in terms of the PRA during the annual outage. STUK also assessed communications and the manner in which non-conformances from the PRA are processed. The PRA updating schedule proposed by TVO has been revised, but all of the PRA sections will be updated prior to the renewal of the operating license for Olkiluoto 1 and Olkiluoto 2. After the inspection, STUK stated that TVO uses PRA as a versatile tool to support the management of safety and no non-conformances were observed in the inspection.

B4 Operating experience feedback, 11–12 November 2013

In its inspection of the operating experience feedback, STUK assessed the power plant's operating experience feedback processes, their organisation, related procedures and related methods. The inspection included studying, with the help of example cases, how observations and non-conformances detected in audits and operating experience from other plants are processed at the Olkiluoto power plant. STUK noted that TVO's operating experience feedback process is well-organised, and the procedures and resources are sufficient, even though the person in charge of many of the duties has been replaced. TVO is developing procedures to ensure that operating experience feedback from the construction and commissioning of Olkiluoto 3 can also be utilised.

Operational safety

C1 Operational activities, 21–22 March 2013

The inspection of operational activities focused on the operating unit's responsibilities and duties during modifications. Various organisations and organisational units participate in implementing modifications, and challenges involve management and communications. In the inspection, methods used in operational activities were studied by verifying the power plant's procedures, interviewing power plant personnel, verifying modification documentation and conducting an inspection round onsite. No significant new development needs were observed in the inspection. Similar issues and development areas as in the licensee's own internal reviews were voiced during the interviews. There is room for improvement in, for example, testing, scheduling (schedules are often too tight) and cooperation between different technological sectors. Based on the inspection, STUK required that the power company update its modification procedures and assess whether the device position and room markings of the repository cave for low and intermediate-level waste comply with the procedures.

C2 Plant maintenance, 20–21 November 2013

STUK inspected maintenance of the plant by assessing the condition monitoring of plant components important to safety which the licensee performs during operation, shutdowns and startups of the plants. Condition monitoring may be continuous or be based on periodical measurements or observations. The purpose of the inspection was to verify that the scope and implementation method of the condition monitoring of different plant components is sufficient when taking into account their impact on safety. The inspection focused on TVO's condition monitoring methods and the key role of the persons responsible for equipment in monitoring the operability of the equipment. TVO's condition monitoring during operations is extensive, and units from both the operational organisation and the maintenance organisation participate in the condition monitoring processes. Based on the inspection, STUK required that TVO submit to STUK a summary of all the methods (sensory observations, continuous/periodic measurements, etc.) that it uses to monitor the operability of safety-classified systems, structures and equipment as well as the operating environment during operation of the plant.

C3 Electrical and I&C systems, 13–14 March 2013

The electrical engineering inspection focused on relay protection, monitoring the ageing of electrical equipment, processing of non-conformances, spare part maintenance, utilisation of operating experience feedback and condition monitoring of condensers. No significant non-conformances were detected in the inspection. STUK required that TVO submit to STUK reports on, for instance, the testing of thermal relays, the implementation of preparations during operation, the methods used to ensure monitoring of statutory electrical engineering requirements, the management of minor additional modifications and the utilisation of electrical engineering operating experience.

The I&C inspection focused on the maintenance of measuring accuracy, the I&C design and implementation process, the management of ageing and qualifications, the management of non-conformances, configuration management, communications and products that do not comply with their specifications, such as micro cartridge fuses. Room for improvement was observed in the management of measuring accuracy: areas requiring improvement include the traceability of accuracy requirements, the process used to ensure that all issues influencing measurements are taken into account and specific calibration procedures. TVO will continue developing the I&C design and implementation process to comply with the standards. TVO must draft a report on the instrumentation required when managing accidents to indicate how the instrumentation will be qualified for accidents. Room for improvement in the verification of modification documentation and configuration management were observed during the inspection. Identified development needs include improving communications during projects. Furthermore, the power company must submit a report on identification of products that do not comply with their markings.

C4 Mechanical engineering, 14–15 October 2013

The mechanical engineering inspection focused on actions of the operation and maintenance organisation that verify the reliability of pumps, compressors and fans important to safety, as well as their motors. A special focus area was the processing of non-conformances. Other focus areas included leaks in the reactor's service water system's pressure measuring nozzles and a test of a reactor coolant pump during the annual outage to study the impact of a planned modification on the pump's vibration. STUK noted that availability of competent personnel onsite has been verified to a sufficient extent even though several people in charge of the operation and maintenance of pumps, compressors and fans have been replaced. Furthermore, STUK noted that the non-conformance processing system in the licensee's operating and maintenance organisation is fine. STUK required from the power company a report on loose screws in rotating parts that have led to harmful vibration at the plant. STUK found room for improvement in the maintenance intervals of safety-classified valves and the inspections and tests used to verify operability of valves.

C5 Structures and buildings, 9–10 October 2013

In the structural engineering inspection at the Olkiluoto power plant, STUK assessed the maintenance procedures of structures, buildings as well as seawater channels and tunnels. The scope of the inspection included the organisation of the power company, inspection procedures issued by the power company, inservice inspections by the power company, repairs and modifications, supplementary construction works onsite and other inspections within the area of responsibility. Furthermore, STUK verified the execution and results of the power company's own inspections. Issues that require further monitoring observed by STUK include the recording of requirements, the numbering of procedures and the need to update modification work procedures.

C6 Information security, 1–2 October 2013

STUK's information security inspection focused on the technical and administrative information security of Olkiluoto 1 and Olkiluoto 2, as well as the preparations made by TVO for future commissioning of Olkiluoto 3. Focus areas of the inspection included the information security organisation and its operations, assessment and management of risks, the management of targets to be secured, information security of technical tools used to monitor safety, as well as the information security training programme and its implementation.

C7 Chemistry, 14–15 November 2013

In the inspection of chemistry, STUK assessed the power company's procedures applied to the maintenance and supervision of the chemical conditions in systems important to safety, as well as the monitoring of the radionuclide content of the reactor coolant system. Focus areas in 2013 included release measuring at Olkiluoto 1 and Olkiluoto 2, quality management in the laboratory, chemical conditions, migration of activity and the laboratory's emergency preparedness actions. STUK found room for improvement in the power plant's procedures on sampling in the measuring system of releases into the sea. The action limits have not been exceeded in any measurements important to safety. The laboratory of the operating plant units has systematically practiced its emergency preparedness actions. All of the laboratory personnel working in the controlled area participated in training on sampling. The following training/development needs were identified in the laboratory: increasing the amount of training on radiometers, improving awareness of the access routes in case of an accident and minimising contamination at the laboratory during sampling. An issue requiring special attention detected by STUK is the planning of sample pickup routes in case of an emergency.

C8 Annual outage, 12 May – 13 June 2013

During the annual outages of Olkiluoto 1 and Olkiluoto 2 from 12 May to 14 June 2013, STUK performed an inspection of the power plant's operations used to maintain safety, as well as the operations used to manage and control operations during an annual outage. STUK studied TVO's procedures in a total of thirteen sectors. The inspection scope included, for example, hot work sites, shoe boundaries, refueling, physical protection, maintenance procedures and employee training. STUK made observations varying in importance during this inspection. Based on the inspection results, STUK required from TVO reports on coverage of the inservice testing procedures for the I&C system and process measurements that are not included in the scope of regular calibration. Furthermore, STUK posed demands on updating the rod cluster control assembly condition monitoring programme and improving the spark protection at one permanent hot work site.

Personal and plant protection

D1 Radiation protection, 18–19 April 2013

Special focus areas in the radiation protection inspection included operative radiation protection, radiation protection procedures and the role of radiation protection when processing work permits. Other issues studied included communications, the processing of non-conformances and the planning process of the most important work in terms of radiation safety to be completed during the 2013 annual outage. TVO submitted to STUK a report on implementing dosimetry under various exceptional conditions where the dosimeters are unavailable. STUK required that the power company draft a technical procedure on the dosimetry arrangements under exceptional conditions by the end of 2013. TVO must submit to STUK a summary of updates of the computer-based orientation training. Furthermore, the power company must submit to STUK a plan on studying neutron radiation exposure of employees participating in the transport of spent nuclear fuel based on the most recent data. Olkiluoto power plant has an ALARA team consisting of experts in various fields of technology. The team regularly meets to discuss radiation protection issues. STUK noted based on the inspection that the ALARA programme has been developed and greatly expanded in the past few years, and other radiation protection procedures have also been developed.

D2 Fire protection, 17–18 September 2013

In a fire protection inspection carried out by STUK at Olkiluoto, the processing of previous issues was continued, TVO's plans pertaining to the condition of the fire extinguishing and fire water system were assessed and functionality of TVO's fire protection organisation was assessed. Based on the inspection results, STUK required that TVO verify the sufficiency of the fire brigade personnel by also taking into account the additional personnel required by Olkiluoto 3 and the Posiva repository. TVO will submit a report regarding the issue to STUK.

D3 Emergency preparedness, 3–4 June 2013

The inspection of emergency preparedness at the Olkiluoto power plant included all of the fields included in emergency preparedness. The inspection also included verifying the current status of emergency preparedness measures implemented, based on requirements posed by STUK in its previous decisions. In the review of 2012, STUK required that the power company obtain more resources for drafting the emergency response plan. TVO responded to the demand by STUK by, for instance, revising its emergency preparedness training organisation. However, the expected number of new resources was not gained. TVO has introduced satellite phones to be used as a backup communications connection with the authorities. The system is regularly tested by opening a test connection to STUK. STUK requested from TVO further reports on the updated emergency response plan that the power company submitted to STUK for approval.

D4 Physical protection

The inspection of physical protection included TVO's safety organisation at operating plants and plants under construction. Focus areas included training and drills on maintaining physical protection, status with the requirements posed in previous inspections, development measures and their status as well as the status of the physical protection at Olkiluoto 3 during construction. Discussions on events pertaining to physical protection and policies, practices and modifications pertaining to physical protection were conducted during the inspection. It was noted that training for the TVO safety organisation was realised as planned in 2013. No requirements were issued by STUK after the inspection.

Nuclear waste and its storage

E1 Operating waste, 30 September – 1 October 2013

STUK inspected the processing and final disposal of radioactive operating waste at the Olkiluoto power plant. Low- and intermediate-level waste is generated during maintenance and repairs as well as during the treatment of circulating water. STUK assessed development since the last inspection and any important issues that have occurred since the last inspection. Focus areas included non-conformances, HR planning, radioactive waste stored in the reactor building and the transport of waste. During the plant rounds, STUK studied the condition of facilities in which waste is processed and stored, radiation levels in these facilities, their classification and their markings. No significant non-conformances or development needs were detected in the inspection.

Special issues

F1 Expansion of spent nuclear fuel storage facility, 28–29 November 2013

In the inspection of the spent nuclear fuel storage facility (KPA storage facility) at Olkiluoto, STUK assessed the licensee's procedures in commissioning of the expanded storage facility. The inspection aimed at assessing the commissioning organisation, its resources and its readiness for commissioning. The inspection scope also included quality management procedures and documentation, and a visit to the spent nuclear fuel storage facility.

TVO has created a separate organisation for the commissioning of the expansion of the spent nuclear fuel storage facility. Based on an assessment made after the inspection, STUK noted that TVO has sufficient personnel resources to commission the expanded spent nuclear fuel storage facility. It was also noted that TVO has utilised the experiences gained during the readiness and commissioning inspections of the concrete structures manufactured during the Olkiluoto 3 project. Feedback issued by the steering group and commissioning team, as well as information obtained from non-conformance reports, have also been utilised. Utilisation of the experiences obtained from another plant unit was deemed a good practice.

The inspection scope also included quality assurance of the welding of pool lining plates, which was implemented in compliance with TVO's procedures. The quality assurance procedures were apparently insufficient, however, because STUK observed non-conformances in the welding quality in its own inspections. STUK required that TVO submit to STUK for information a report on the reasons why the non-conformances were not detected in TVO's own inspections prior to the commissioning inspection of the pool lining.

APPENDIX 6 Construction inspection programme of Olkiluoto 3 in 2013

The objective of the Olkiluoto 3 construction inspection programme is to verify that the operations required by the construction of the unit ensure a high quality implementation according to the approved plans and in compliance with official regulations, without compromising the operating units within the site. The inspection programme assesses and oversees the licensee's operations in constructing the unit, implementation of procedures in various technical areas, the licensee's competence and use of expertise, the processing of safety issues and the quality management and control. The inspection programme of Olkiluoto 3 was launched in 2005 when construction of the unit started. The number of annual inspections has varied between nine and fifteen.

In 2013, nine inspections included in the construction inspection programme were carried out, four of which focused on the main operations of the Olkiluoto 3 project, and ten on work processes (Table 1). Special focus areas of the inspections included quality management, I&C and electrical engineering, commissioning procedures, TVO's commissioning inspection procedures and preparation of TVO's operating organisation for the future operation of the unit. Below is a brief description of the inspection findings for which STUK required improvements from TVO. On the whole, the inspections have led to the conclusion that the procedures and resources of TVO's organisation are adequate.

Table 1. Inspections within construction inspection program in 2013.

Subject of inspection	Inspection date
Main functions	
Quality management – general procedures	26–27 March 2013
Project management and management of safety	22–23 May 2013
Quality management – quality management during commissioning and management of final documentation	20–21 November 2013
Work processes	
Procedures during commissioning inspections of mechanical equipment	30–31 January 2013
Chemistry – flushing and preservation of turbine island systems	19–20 February 2013
Commissioning – TVO's process for overseeing commissioning activities and for approval of test results	15–16 May 2013
I&C	17 September 2013
Electrical engineering	19–20 September 2013
Utilisation of PRA	27 November 2013

The quality management inspection included the status of requirements from previous quality management inspections and TVO's procedures in assessing, approving and supervising suppliers. STUK stated in its 2012 inspection that TVO had developed the procedures based on an investigation of the procurement of emergency diesel generators and their auxiliary systems in 2011, but the results of the investigation had not been effectively utilised in developing the procedures and methods. STUK required a new assessment on the issue from TVO. During the inspection, TVO presented its systematic process of reviewing the investigation results to develop its operations. TVO's new assessment on the measures taken based on the investigation results will be soon completed. STUK has required in its previous inspections that TVO revise its document management process so that no unfinished issues will be submitted to STUK for review, and the assessment on compliance with safety requirements made in connection with TVO's own review will be clearly traceable. Since TVO had not revised its procedures, STUK required a written description of development measures. A new issue dealt within the inspection was TVO's procedures when assessing, approving and supervising suppliers. The inspection results show that TVO has not specified detailed competence requirements for people assessing the acceptability of subcontractors. Furthermore, TVO's internal procedures do not include any principles based on the safety classification of the object to be used when making decisions on assessments. TVO must specify these parts of its procedures. Furthermore, in the assessment reports the assessment object and its scope must be determined in a more detailed manner as required in TVO's internal procedures.

The inspection on the management of the Olkiluoto 3 project and the management of safety focused on TVO's project management's actions related to the utilisation of experience from the construction, the identification and processing of safety issues, risk management, indicators and assessing the functionality of safety culture reviews. In terms of the utilisation of experience from the construction, STUK required that TVO review the root causes of non-conformances in its annual analysis of non-conformances. The management of TVO must determine goals for the analysis and utilisation of construction experience, so that the lessons learned will be available not only to the Olkiluoto 3 project but also to TVO's other projects.

In the inspection on quality management during commissioning and management of final documentation, STUK required that TVO specify how the graded approach will be applied to targeting supervision during commissioning. Furthermore, TVO must specify its plans on how the procedures for the Olkiluoto 3 project (TVO's own procedures and the plant supplier's procedures), as well as the procedures for TVO's operating plant units, will be applied to Olkiluoto 3 after the loading of fuel.

In the inspection on procedures of commissioning inspections of mechanical equipment, TVO's actions, supervision and control were assessed by interviewing people in charge of commissioning inspections and people who have participated in commissioning inspections, as well as by reviewing examples of completed commissioning inspections. In the inspection it was found that commissioning inspections in the turbine island prior to the start of the actual commissioning period are well under way, but schedules for the reactor island have not been specified yet because of the delayed construction schedules. No requirements were issued during the inspection, and STUK noted that TVO is, as a general rule, well prepared for the commissioning inspections.

In the turbine island, STUK inspected chemical cleaning and preservation methods and procedures for process systems as well as documentation on completed actions. The inspection results show that TVO is not sufficiently familiar with the plant supplier's flushing, cleaning and preservation procedures, and there was some discrepancy between the procedures. Based on the example studied it seemed that TVO had not participated in the decision-making process under exceptional situations where the procedures had to be interpreted. STUK required that TVO review said procedures with the people monitoring and controlling the flushing, cleaning and preservation, and that TVO correct the discrepancies in the procedures. Furthermore, TVO must participate in the decision-making in any exceptional situations pertaining to flushing, cleaning and preservation.

The inspection on commissioning focused on assessing the procedures related to performing the commissioning tests, as well as on the review and approval of test results. Examples from already completed and currently ongoing test runs were used in the inspection. STUK did not find any faults with TVO's procedures during the inspection. STUK requested that TVO submit to STUK for information a procedure on the handling of modifications onsite that was presented during the inspection.

The I&C inspection focused on supervision plans and procedures of the I&C unit of TVO's Olkiluoto 3 project and how TVO is preparing for the I&C installation and commissioning stages. The general impression of TVO's preparations was good and STUK did not impose any requirements during this inspection.

In the electrical engineering inspection, STUK assessed TVO's non-conformance management procedures in the installation of electricity systems and equipment, the personnel resources available to TVO during the commissioning of electricity systems, and the management of the revisions of procedures and tests during the commissioning stage. During this inspection, TVO presented the current status of electrical cabling onsite. In connection with this inspection, STUK requested from TVO a report on how compliance with the requirements of the electric shielding and power distribution of 'parallel cabling' can be proven. The term 'parallel cabling' refers to power being supplied to one electric consumer with more than one cable.

In the inspection on the utilisation of the probabilistic risk analysis (PRA), TVO's procedures in reviewing and utilising the PRA and monitoring work on the PRA during plant design, construction and commissioning were evaluated. During this inspection, TVO presented the current status of the PRA models and their delivery schedule, the available resources and the actions TVO has taken to verify correctness of the PRA. The inspection team studied the interface between the PRA and configuration/change management. STUK did not pose any requirements in this inspection.

APPENDIX 7 Inspection programme during the construction phase of Onkalo in 2013

The objective of the construction-time inspection programme is to verify that high-quality implementation of approved plans is ensured in the construction of the underground research facility, with compliance with official regulations and without jeopardizing safe final disposal. The inspection programme includes assessment and monitoring of Posiva's operations in building Onkalo, the procedures applied to various parts of the construction work, the management of Onkalo research and monitoring, the management of safety and the quality assurance of the implementation. STUK prepares annual plans for Onkalo inspections.

Subject of inspection		Time of inspection
Management system		
ONP-A1	Management system	–
Planning and management		
ONP-B1	Project management and control	–
ONP-B2	Safety management	–
ONP-B3	Project quality management	–
ONP-B4	Planning and management of the research and monitoring programme	–
ONP-B5	Design of Onkalo	–
Implementation		
ONP-C1	Site inspection and monitoring procedures	5-6 June 2013
ONP-C2	Drilling and modelling	–*
ONP-C3	Foreign substances	4-5 December 2013
ONP-C4	Excavation and EDZ	–
ONP-C5	Onkalo in-flows	6 -7 November 2013
ONP-C6	Monitoring and research methods	–

"–" denotes that the inpection being not carried out in 2013, as planned in ONP programme

"–*" denotes the inspection being not carried out in 2013, but postponed to the inspection programme for Posiva's construction licence application period in 2014.

APPENDIX 8 Inspection programme for Posiva's construction licence application period

In early 2013, STUK launched an inspection programme for Posiva's construction licence application period. The goal of the programme is to assess Posiva's procedures to ensure the construction of a safe encapsulation facility and a repository that is of a high quality. Some of the reviews and inspections included in the programme also involve Posiva's suppliers whose actions are significant in terms of nuclear safety and radiation safety. The goal with these reviews and inspections is to assess the supervision and control measures Posiva uses for its suppliers and the functionality and effectiveness of related procedures. STUK submitted the requirements on supplier reviews to Posiva, and Posiva is obligated to complete the corrective measures required. STUK drafted and submited to Posiva a bi-annual inspection plan.

In 2013, the inspection plan consisted of eight inspections and reviews, of which six involved the Posiva organisation and two involved Posiva's suppliers. Below are brief descriptions of the inspections and reviews, as well as the key observations made based on which STUK had required improvements from Posiva. STUK stated in its summary of the results that Posiva must further develop its activities and processes on implementing the construction project. The management system and the functions described do not yet fully comply with STUK's requirements. STUK will complete a comprehensive assessment of the current status in 2014 when processing the construction licence application.

Inspection programme for Posiva's construction licence application period in 2013.

Subject of inspection	Time of inspection
Quality assurance	26-27 February 2013
Inspections of Posiva's suppliers (Rock engineering design organization)	14 March 2013
Inspections of Posiva's suppliers (Rock engineering design organization)	25 March 2013
Management of requirements	11-12 June 2013
Research activities	11 September 2013
Preparation for construction stage	3-4 October 2013
Selecting and supervising suppliers	17-18 September 2013
Management of research and development (R&D) plans	11-12 November 2013

Quality assurance

In this inspection, STUK assessed the quality assurance of Posiva's nuclear waste facility construction project. The assessment covered quality assurance during the preparation stage and the planning of quality assurance during construction. After theinspection, STUK required that Posiva specify and document the procedures it will use to verify that all issues important to nuclear and radiation safety will be processed at the predetermined organisational levels and, if the safety significance warrants it, also by the management of the licensee's project organisation. The inspection also covered the activities of Posiva's safety team. The team controls and supervises the company's activities pertaining to the quality targets and issues statements on these issues to the company. STUK required that Posiva ensure that the role of the quality target controller and supervisor issued to the safety team will be realised during the construction project and the construction project preparation stage. Furthermore, STUK required that Posiva implement a systematic communications method for important management system modifications, as well as their implementation among its own personnel and, to the extent necessary, also among Posiva's suppliers working at the plant site.

Inspections of Posiva's suppliers

STUK focused on two suppliers who provide Posiva with research activities. The goal with these insepctions was to assess the suppliers' operations in general and verify their performance with the help of already completed studies ordered by Posiva. The inspection also focused on verifying Posiva's supplier control and supervision procedures. After theinspection, STUK required that Posiva arrange safety culture training also for its key suppliers, who are important to long-term safety of the nuclear fuel repository. Furthermore, STUK required that Posiva verify that these suppliers in particular are familiar with the requirements of STUK's YVL Guides to the extent they are related to their assignments. In terms of the implementation of research activities, STUK required that Posiva participate in all reviews important to safety.

Management of requirements

In Posiva's requirement managementinspection, STUK focused on the current status of Posiva's requirement management procedures to be used in the construction project in particular. The assessment focused on compliance with the requirements of STUK's YVL Guides in the requirement management procedures and realisation of requirement management in project management and the organisation. After this inspection, STUK required that Posiva ensure, when developing the requirement specifications, that the management procedures will ensure traceability and consistency of the requirements posed. Furthermore, STUK required that Posiva ensure that the requirements for specifying and managing requirements laid down in STUK's YVL Guides will be met with the requirement management procedures Posiva plans to use.

Research activities

The quality assurance inspection on research activities covered Posiva's internal and external research activities. The inspection assessed several issues linked to research activities: the Posiva organisation in charge of research activities, as well as updated management system procedures pertaining to research activities. Reviewed issues included Posiva's procedures used when supervising the suppliers from whom it orders studies and Posiva's research supervision development projects. One of the key issues in this inspection was quality assurance for research reports. After theinspection, STUK issued several observations that Posiva can use as an aid when developing its operations. Issues that require special attention include the roles of supporting teams working at the R&D unit (their roles should be specified in the management system manual) and the need to make the management process of the R&D unit's personnel resources more systematic. Based on observation about Posiva's auditing activities, STUK recommended that Posiva standardise its criteria for development proposals on internal audits.

Preparation for construction stage

In 2013, Posiva continued its preparations for the construction stage of the project. STUK's inspection focused on Posiva's processes, procedures and methods pertaining to the construction of the encapsulation facility and repository. The inspection assessed the construction project as a whole and the subprojects for construction of the encapsulation facility and repository.

After theinspection, STUK required that Posiva pay attention to standardising and reconciling the planning of subprojects in so far as the subprojects could influence the management of safety and quality. Furthermore, STUK required that Posiva verify that the implementation process for the encapsulation facility and repository will have access to a detailed action plan and schedule drafted by the solution management process of the encapsulation facility and repository. After the inspection, STUK required that Posiva prepare a task-specific training plan, including all the people who will be involved in duties important to safety during the project, in compliance with STUK's YVL Guide requirements.

As a conclusion of theinspection, STUK stated that it was unable to verify whether Posiva's project planning and management is at a stage where it is ready to start construction of the encapsulation facility and repository. STUK will assess the construction readiness in a further inspection on the preparation for construction by 30 June 2014.

Selecting and supervising suppliers

In 2012, Posiva noted in a comparison of YVL Guides in connection with its construction licence application that Posiva's procedures for selecting and supervising suppliers need to be developed so that they will comply with STUK's draft YVL Guides YVL A.3 and YVL A.5. The status of this development work was assessed in a inspection of supplier selection and supervision. The key observation made was that Posiva's development work is still unfinished. During theinspection, Posiva stated that it will continue the development of its procedures and assess the progress of the development work by comparing it with the requirements of the new YVL Guides to be published at the end of the year. STUK will review Posiva's procedures and their compliance with the requirements again in early 2014. STUK also reminded Posiva of an issue that requires specific attention regarding the approval of suppliers. In Posiva's procedure, the approval of suppliers is processed by means of both auditing reports and supplier assessment reports. STUK is of the opinion that the procedure should be clarified by clearly specifying a process stage at which an approval will be reached.

Management of research and development (R&D) plans

In the inspection of the management of R&D plans, STUK focused on assessing Posiva's procedures in the management of R&D. The inspection focused on compliance with STUK's YVL Guides in the management of R&D at the organisational level and at the project level. Furthermore, procedures used by Posiva when creating R&D programmes and plans as well as procedures used by Posiva to monitor their progress were reviewed. The inspection studied R&D based on the needs of the construction project and the licensing process. After theinspection, STUK required that Posiva develop procedures that will ensure that Posiva submits regular reports to STUK on any changes in construction and R&D to make sure that STUK will be able to comment any changes made in the plans and their safety significance in due time. Posiva is also required to verify competence of people in duties important to safety in its own organisation. After the review, STUK issued several observations that Posiva can use as an aid when developing its operations. These included development of the R&D risk management process to cover the impact of the realisation of risks in a single project on the implementation and schedules of other projects. Posiva should also assess the need to develop the version management of plans, particularly in the case of long and complex projects.

APPENDIX 9 Nuclear materials in Finland on December 31.12.2013

Location	Natural uranium kg	Enriched uranium kg	Depleted uranium kg	Plutonium kg	Torium kg
Loviisa plant	–	635 920	–	5 752	–
Olkiluoto plant	–	1 563 865	–	11 313	–
VTT / FiR 1 research reactor	1 511	60	~0	~0	~0
Other facililties	5 384	< 1	1 568	~0	~3,5

APPENDIX 10 Assignments funded by STUK in 2013

Safety of nuclear power plants

Most of the assignments in the 2013 plan for technical support assignments were inspection and assessment tasks regarding the regulatory oversight of Olkiluoto 3 as part of STUK's decision-making. Due to the delays in the Olkiluoto 3 construction project, some of the assignments proposed for 2013 were postponed until 2014.

Of the assignment proposals for 2013, 27 were related to the regulatory oversight of the construction of Olkiluoto 3, eleven to the operating Olkiluoto plant units and two to new nuclear power plant projects.

In 2013, the total costs of the technical support assignments amounted to around EUR 885,000. The most important assignments pertaining to the construction of Olkiluoto 3 that were completed during the year were:

- Analyses for verifying emergency operating procedures
- Comparison analyses using the model TRAB-3D/SMABRE for EPR plants
- Comparison calculations on the population radiation doses given in the final safety analysis report
- Safety culture follow-up study.

Safety of the final disposal of nuclear waste

Regulatory oversight of nuclear fuel by the Radiation and Nuclear Safety Authority involves the research, development and design of the project on a repository for spent nuclear fuel, construction of waste facilities and waste management at the nuclear power plants. As an aid for its decision-making and regulatory oversight, STUK uses external experts and projects on special issues. In 2013, the technical support programme for the oversight of nuclear waste management (VATU2013) included assignments to oversee the construction of the underground research facility (Onkalo) as well as assignments related to the preliminary review of the construction license for the repository built by Posiva. Separate framework agreements were signed by several external experts (13 agreements in total). In 2013, the total costs of the technical support assignments amounted to around EUR 600,000. The assignments and framework agreements involved the following subjects linked to the regulatory oversight of nuclear waste management:

- A consultant on rock construction to support the regulatory oversight of the construction of Posiva's underground research facility and repository
- A safety case
- Long-term safety analyses
- Technical release barriers
- Chemical and biological properties of buffer and backfilling materials
- Physical and mechanical properties of buffer and backfilling materials
- Design and mechanical strength of shield canisters
- Properties of spent nuclear fuel
- THMC modelling for the buffer material and evolution in the adjacent area
- Repository, natural release barriers
- Hydrogeology
- Hydrogeochemistry, geochemistry, paleohydrogeochemistry
- Rock mechanics
- Biosphere
- Structural geology
- Seismology
- Glacial earthquakes
- Quality management
- Assessment of Posiva's scenario process
- Assessment of Posiva's *expert elicitation* process
- Assessment of interaction between water and rock material, as well as drift properties of the bedrock
- Further development of impact matrix analysis tool
- State-of-the-art assessment on corroding of copper in clean, oxygen-free water
- Characterisation of the buffer and tunnel filling materials

APPENDIX 11 Glossary and abbreviations

ALARA (as low as reasonably achievable)
radiation protection optimisation principle, according to which exposure must be limited to being as low as reasonably achievable

BWR
boiling water reactor

CBRN (chemical, biological, radiological and nuclear)
chemical, biological, radioactive and nuclear weapons or hazards, for example: ”protective measures taken against CBRN weapons or hazards”

Euratom
for nuclear material safeguards, Euratom refers to the European Commission units responsible for nuclear material safeguards: Directorate General for Energy and Transport, Directorates H and I

FSAR
Final Safety Analysis Report

IAEA
International Atomic Energy Agency

INSAG
International Nuclear Safety Group; organisation called by the Director General of IAEA

IRS
International Reporting System for Operating Experience operated jointly by the IAEA and OECD/NEA

ITDB
Illicit Trafficking Data Base, an IAEA database to which member states deliver data on deviations observed as regards nuclear substances and radiation sources.

KYT
Finnish nuclear waste management research programme

LARA
I&C renewal project at the Loviisa power plant

MDEP, Multinational Design Evaluation Programme
A multinational cooperation programme evaluating the practices and requirements of authorities related to the licensing of new nuclear power plants

NKS (Nordisk kärnsäkerhetsforskning)
Nordic safety research programme

OECD/NEA
Nuclear Energy Agency of the Organisation for Economic Co-operation and Development

OLC
Operational Limits and Conditions (previously Technical Specifications)

Onkalo
underground research facility for the final disposal of spent nuclear fue

PRA, Probabilistic Risk Analysis

PWR, pressurised water reactor

SAFIR, Safety of nuclear power plants
Finnish publicly funded national nuclear power plant research programme

SAGSI, Standing Advisory Group on Safeguards Implementation;
an international team of nuclear material safeguard experts called by the Director General of the IAEA

WANO, World Association of Nuclear Operators

WENRA, Western European Nuclear Regulators' Association

VVER (Vodo-Vodyanoi Energetichesky Reactor)
Russian pressurised water reactor; Loviisa 1 and Loviisa 2 are VVER-440 reactors

nuclear material
special fissionable material suitable for the creation of nuclear energy, such as uranium, thorium or plutonium

nuclear commodity (or: nuclear material)
nuclear material referred to above or another material referred to in Section 2, Paragraphs 4 and 5 of the Finnish Nuclear Energy Act (deuterium or graphite), device, system and information (Section 1, paragraph 8 of the Nuclear Energy Decree).

nuclear material accounting and control manual
manual to be used by an organisation in possession of nuclear commodities, describing the nuclear commodity safeguards and accounting system

nuclear non-proliferation manual
manual to be used by a future possessor of nuclear commodities, describing the measures to secure the requirements of nuclear safeguards

regulatory control of nuclear non-proliferation
monitoring operations to prevent the proliferation of nuclear weapons; operations consist of nuclear safeguards and the monitoring of the nuclear test ban

EIA procedure
Enviromental Safety Assessment

YVL Guides
STUK guides containing detailed requirements set for the safety of nuclear power plants. A comprehensive reform of the YVL guides was practically completed at the end of 2013 when 40 guides came into force on 1.12.2013 and will be applied as such to new nuclear facilities.