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Regulatory oversight of nuclear safety in Finland

Annual report 2010

Erja Kainulainen (ed.)

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Radiation and Nuclear Safety Authority

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Management review

In 2010, Finnish nuclear power plants caused no danger to the plant environment or employees. No events with safety implications for the safety of the environment or people took place at these power plants. The collective doses of employees were low and radioactive emissions into the environment were very low. Radioactive waste generated in operational processes at the nuclear power plants accumulated as anticipated. Its processing and final disposal in underground facilities took place in a controlled manner.

The factors behind the events in the operating year relate to errors in plant operation, plant modification planning and implementation as well as in the manufacture of equipment. Functional tests performed on a regular basis revealed that the new electric pilot valves of the main valves of the reactor depressurization system did not operate in a normal way, which is a noteworthy issue for the safety of the Olkiluoto nuclear power plant. The reactor overpressure protection would have nevertheless functioned thanks to spring-loaded pilot valves. It was discovered that the reason for the electric pilot valve failure was a change in the valve coating material made by the valve manufacturer. At the plant, the material became oxidized and the corrosion products made the valve jam. At the Loviisa power plant, two events occurred in which radioactive substances were released uncontrollably in the plant area. In one of the events, radioactive resin was released into the plant ventilation system due to a design and operating error of the liquid waste solidification facility as well as a measurement error in the facility. In the other event, radioactivity was released into the plant yard from a fuel transport cask which had not been carefully cleaned. Ensuring safety and maintaining plants require that the organisation operating the plant is constantly alert and maintains its competence.

At Loviisa and Olkiluoto, modifications required for safety improvement continued to be carried out in plant systems, components and structures and in operating methods. At the Loviisa power plant, the suction strainers of the low pressure emergency cooling system and the containment spraying system, which are required in accident conditions, were improved by means of installing higher density mesh elements in them. The modification serves to ensure fuel cooling in accident conditions by means of preventing materials coming loose from, for example, heat insulation from being carried on to the reactor core via the emergency cooling system. At Loviisa 2, about 600 metres of piping was replaced in the auxiliary sea water system, which is significant for reactor cooling. The most demanding phases of the Loviisa I&C systems upgrade have proved to be difficult both in terms of design and safety regulation, and it has not been possible to implement the modifications in the originally planned sequence. The power company decided to postpone modifications to the most safety-significant systems for future years. The operating licence for the Loviisa unit 2 reactor pressure vessel was renewed until 2030.

A modernisation project extending over several years was launched at the Olkiluoto power plants. The project aims to prolong the plants' lifetime and to improve their availability. At Olkiluoto 1, the implementation of the project started with the replacement of the inner isolation valves of the main steam system, upgrade of the low pressure turbines, modernisation of main service water pumps, and the upgrade of the generator cooling water system. TVO is also extending the spent nuclear fuel storage in Olkiluoto. At the same time, the storage structures will be modified in order to comply with new safety requirements.

No changes with important safety implications took place in the power companies' organisations. The organisations of the two power companies have functioned in a systematic and development-oriented manner. Both power companies should carry on with the improvement of their management and activities. In particular, measures aimed at successful performance of plant modification projects should be completed and the management of subcontractors, spare parts and procurement activities should be further developed by both power companies for ensuring that products and services comply with requirements.

Problems with the Olkiluoto 3 project are the same as earlier. The most important unsettled issues relate to I&C design, for which the plant supplier and TVO have not been able to demonstrate how the independence of different I&C systems has been ensured. Guidance and supervision of subcontractors at the construction site and manufacturing sites require constant vigilance and improvement by the plant supplier and TVO. In early autumn 2010, STUK observed deficiencies in the design and manufacturing of emergency generators. Installation of the emergency generators in Olkiluoto was interrupted for evaluation of the situation and STUK started investigations for assessing the functioning of the organisations. Even if the measures taken by TVO and the plant supplier with a view to emphasising safety culture in the project have advanced, ensuring and maintaining the top priority of safety and quality require constant measures and exemplary activities from the project organisations' management.

Decisions-in-principle were made on two new nuclear power plant construction projects. STUK participated as an expert in parliamentary committee sessions preparing the decisions. The level of requirements to be set for the new power plants and expectations concerning the implementation oversight of the power plant projects were discussed by STUK and the power companies planning these projects. The discussions were held as part of the overall revision of the YVL Guides.

STUK's work input in the regulatory oversight of each of the operating nuclear power plants was equivalent to approximately 12 person-years. The amount of work performed on the regulatory oversight increased slightly from the previous years. The objectives set for regulatory oversight were attained. Nearly 35 person-years were used for reviewing the design and overseeing component manufacturing and construction of the Olkiluoto 3 unit, which is about the same as in 2009. The amount of work will remain at least the same in 2011 and 2012, when there will be a large amount of installation work and the operating licence application for the plant will be reviewed. The current financing practice for regulatory operations, i.e. direct invoicing from the licensees according to STUK's actual costs, has proven to function very well and, thanks to this, operations could be increased to meet actual needs.

As part of the constant improvement of safety and preparation for the nuclear power plant projects mentioned above, STUK continued the revision of its YVL Guides. In the new guides, STUK will present detailed requirements for safety and safety regulation. For fixing the requirements which are important for the design of the new power plants, STUK set up special working groups to which outside experts were invited, mainly from the power companies. The objective of the working groups was to establish a level of requirements so that the power companies would be able to discuss the Finnish level of requirements with plant suppliers. The aim is to have the new guides completed by the end of 2011.

Posiva Oy continued the construction of the underground research facility for the final disposal of spent nuclear fuel under STUK's oversight. The oversight is organised in the same way as for the construction of nuclear facilities because what is being built is de facto the first phase of the final repository. The access tunnels and shafts leading to the research facility will form part of the final repository, assuming that the project proceeds as planned. STUK continued preparations for reviewing the construction licence application by assessing the scope of the preliminary application documentation and the needs for supplementing it with regard to the actual construction licence application. As part of the preliminary application documentation, STUK assessed several analyses relating to the long-term safety of final disposal and factors relating to the reliability of engineered barriers such as a copper canister as well as the status of the overall design of the facility. At the same time, STUK assessed Posiva's research, development and design work programme extending until 2012. STUK provided the Ministry of Employment and the Economy with a statement concerning the status of the preparation of the construction licence application and Posiva's three-year programme. Meticulous preparation is necessary because no similar project has been implemented anywhere in the world and there is a willingness to use the Finnish model as an example in many other countries. In order to support its own staff and also to ensure the credibility of the project internationally, STUK has a permanent international expert group with representation from various fields of science and technology.

The implementation of nuclear safeguards in Finland required by the Non-Proliferation Treaty is functioning without problems, and no remarks were made based on international inspections. The number of inspection visits to plants by the IAEA and the Commission remained at the 2009 level, but, in addition to nuclear power plants, other inspection sites were added to the regulatory control programme. International nuclear safeguards were applied to both the Olkiluoto 3 construction site and Posiva's underground research facility for nuclear waste, even if these do not yet involve any actual nuclear material. A model of nuclear safeguards applicable to the final disposal of spent nuclear fuel was elaborated in parallel with the regulation of construction work.

STUK participated actively in international nuclear safety cooperation. A total of nearly six person-years was spent on this work. In particular STUK participated in the harmonisation of international nuclear safety requirements in the working groups of the International Atomic Energy Agency, European safety authorities and the OECD Nuclear Energy Agency. In addition, STUK was invited to several cooperation meetings and seminars to speak about its experience from the regulation of the new facilities. In order to share this experience, STUK also organised an international conference which was attended by over 200 foreign and about 50 Finnish experts.

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 2010 included the design, 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 basics of the nuclear safety regulation included as part of STUK's responsibilities, 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 revision.

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 chapter 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. Summaries are included for the development of the plants, their safety and nuclear waste management. The report also includes a description of the oversight of the functions and quality management of organisations, oversight of operating experience feedback activities, and the results of these oversight activities. The radiation safety of nuclear facilities is examined using employees' individual doses, the collective doses, and the results of emission and environmental radiation monitoring. 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 functions of the licensee and 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) under construction in Olkiluoto, as well as the assessment and oversight of the research, development and design work being carried out to further specify the safety case for final disposal are included in the report.

The section concerning nuclear non-proliferation describes the nuclear non-proliferation control for Finnish nuclear facilities and final disposal of spent nuclear fuel, as well as measures required by the Additional Protocol of the Safeguards Agreement. In addition, it describes the control of the transport of nuclear materials and the oversight of the nuclear test ban.

In addition to actual safety regulation, the report describes safety research, regulatory indicators and regulation development, 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.

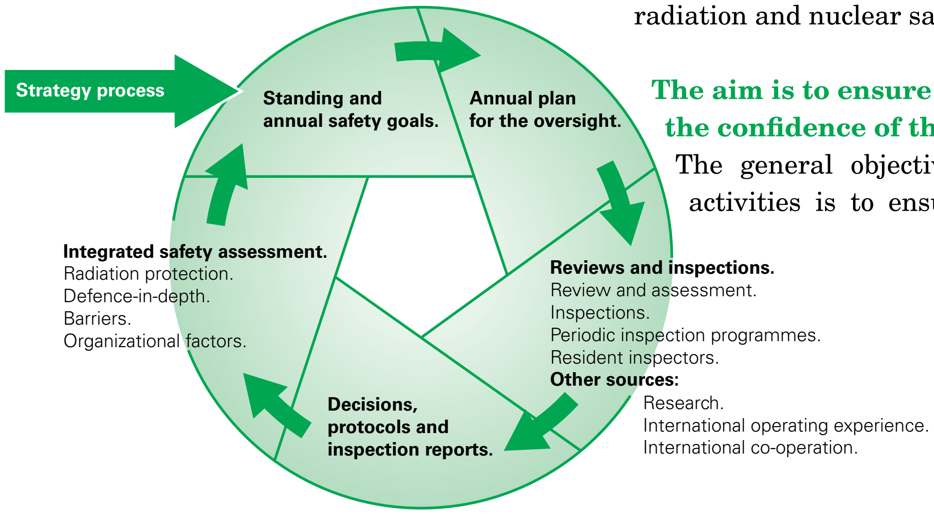
Contents

1 Fundamentals of nuclear safety regulation

Regulatory control by STUK is based on the Nuclear Energy Act.
The Radiation and Nuclear Safety Authority (STUK) is responsible for the regulatory control 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



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 facillities; 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.

facilities, 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.

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 Advisory Commission was appointed on 1 October 2009, and its present term of office continues until 30 September 2012.

The Chairman of the Commission is customer manager Seppo Vuori (VTT, Technical Research Centre of Finland) and the vice-chairman is Professor Riitta Kyrki-Rajamäki (Lappeenranta University of Technology). The members are customer director Rauno Rintamaa (VTT), country director Timo Okkonen (Inspecta Oy), senior researcher Ilona Lindholm (VTT), senior inspector Miliza Malmelin (Ministry of the Environment) and Dr. Sc. (Tech.) Antero Tamminen. Professor Jukka Laaksonen, Director General of STUK, is a permanent expert to the Commission.

The role of committees was reconsidered in conjunction with appointing the Commission, and the decision was taken to revise their duties. Currently, 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 questions of principle, more extensive than before, will be brought to them for preparation. Experts from England, France, Sweden, Germany, Switzerland, Hungary and the USA have been invited to join the Committees. The Committees convene a few times a year. The members of the actual Commission also participate in the work of the Committees.

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 requi-

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 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.

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 2009, a total of 300,000,000 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 2009, the average value of the SDR was 1.10 euro. As a result of international negotiations completed in 2004 concerning the renewal of the Paris/Brussels nuclear liability agreements, funds available for compensation will be more than tripled compared with the current situation in the near future. Finland has also decided to enact a law laying down unlimited licensee liability. The legislative amendment has not taken effect as yet, but is pending the entry into force of the relevant international agreements.

The ascertaining of the contents and conditions of a licensee's insurance arrangements in Finland belongs to the Insurance Supervisory Authority. It 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 approved by the Insurance Supervisory Authority or in accordance with the Paris Convention and approved by the authorities of the sending state.

rements. STUK's operations are guided by annual follow-up plans, presenting the key items and activities for inspection and review. STUK carries out 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 and detailed approach of STUK's inspection activities are described in the YVL Guides issued by STUK. Guide YVL 1.1 describes the monitoring and inspection procedures at a general level, while the detailed procedures are described in other YVL Guides. The purpose of monitoring 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 monitoring, STUK ensures that the licensee meets its responsibilities. STUK monitors 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 monitoring 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 monitoring 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 monitoring 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, an interim safety assessment is carried out during the licence period. The scope of the interim assessment 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 Technical Specifications, the Final Safety Analysis Report and the operating and maintenance procedures – have changed. STUK supervises 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 licence holder 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.

Monitoring 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 Government Decision VNA 733/2008, 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.

The National Data Centre (NDC), which is based on the CTBT, contributed to the work of the Preparatory Commission for the Comprehensive Nuclear-Test-Ban Treaty Organisation (CTBTO) in establishing a cost-effective NDC organisation that is functional from the Finnish perspective.

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 Feb1977	9 May 1977	510/488	PWR, Atomenergoexport
Loviisa 2	4 Nov 1980	5 Jan 1981	510/488	PWR, Atomenergoexport

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

Olkiluoto NPP

Plant unit	Start-up	National grid	Nominal electric power, (gross/net, MW)	Type, supplier
Olkiluoto 1	2 Sep 1978	10 Oct1979	910/880	BWR, Asea Atom
Olkiluoto 2	18 Feb 1980	1 Jul 1982	890/860	BWR, Asea Atom
Olkiluoto 3	Construction license granted 17.2.2005		about 1,600 (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.

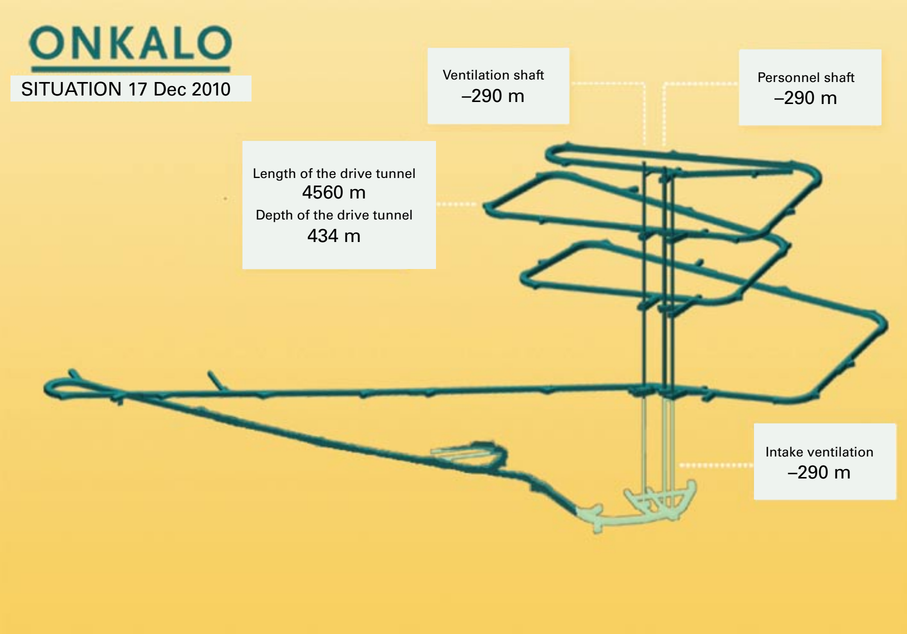


Figure 2. Plan of the underground rock characterisation facility (Onkalo) and status of the construction on 17 December 2010 (Posiva Oy).

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 2010, the excavation of the drive tunnel had reached a depth of 430 m, and the length of the tunnel was 4500 m. In addition, all three shafts had been quarried using raise boring techniques to a depth of 290 m.

FiR 1 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 began operations in March 1962, and its current operating licence will expire at the end of 2011. The reactor is used for the fabrication of radioactive tracers, activation analysis, student training and Boron Neutron Capture Therapy (BNCT) treatment of tumours, as well as the development of therapeutic methods.

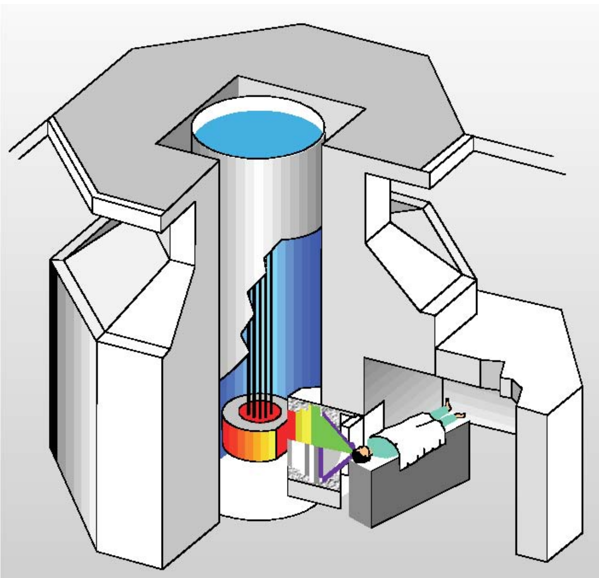


Figure 3. FiR 1 research reactor and the BNCT station.

- 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

3 Development and implementation of legislation and regulations

Upper level regulations are up-to-date

In 2010, there were no nuclear safety legislation amendments falling within STUK's mandate. The amendment of the Nuclear Energy Act and Nuclear Energy Decree and its supplementary Government Decrees on the safety of nuclear power plants (733/2008), on the security in the use of nuclear energy (734/2008), on emergency response arrangements at nuclear power plants (735/2008) and on the safety of disposal of nuclear waste (736/2008) were completed in 2008. In 2010, STUK started planning to introduce some amendments to both the Nuclear Energy Act and the Government Decrees issued in 2008. The most important amendments relate to the transfer of STUK's inspection activities to external actors and to the consideration of a number of new safety regulations, which have taken form as a result of WENRA cooperation. In the year under review, a revision project of the Nuclear Liability Act was launched. The revision envisions, among others, the provision of unlimited liability of the licensee.

YVL Guide updates were implemented

YVL Guides are detailed safety regulations for nuclear facilities and issued by STUK on the basis of the Nuclear Energy Act and the relevant Government Decision. In addition to requirements for the safety of nuclear facilities, the guides also describe STUK's regulatory procedures. STUK issues a separate decision on how a new or revised YVL Guide applies to operating nuclear facilities, or those under construction, and to licensee operations. The preparation of implementation decisions for YVL Guides which were published earlier continued in 2010. YVL Guide 5.8 on hoisting and transfer appliances was the last guide in the present form for which implementation decisions were prepared in the end of the year.

STUK did not continue to prepare YVL Guide updates in their present form. In future years, YVL Guides will be published and grouped in line with the overall revision of the Guide system, and each Guide will be outlined in a new way in terms of its content.

The revision of YVL Guides is progressing

The structural revision of the YVL Guides was initiated in 2005 by assessing the existing Guides and defining the development objectives. The overall objective is to improve the internal consistency of the regulations and, in particular, to clarify the requirements laid down in the Guides. The requirements will be numbered to make it easier to find individual requirements in the Guides. This will also enable the Guides to be amended with regard to individual requirements. The objective is to have a new set of YVL Guides completed by the end of 2011. A working group was appointed to support STUK's experts in the preparation work for each new Guide. In addition to STUK, Teollisuuden Voima Oyj, Fortum Power and Heat Oy, Fennovoima Oy and Posiva Oy are represented in the groups. The support groups discuss the main content of the Guides already during their preparation, thus improving the openness of regulatory work and reducing the overall period of time spent in their preparation. An upper level follow-up group of representatives from the above organisations has also been set up for the project. In 2010, the preparation of the Guides of the new type continued. The plan is to prepare a total of 38 of these new Guides, half the number of current YVL Guides. At the end of the year, drafts of different levels were available practically for all Guides and the first Guides had already reached a stage where a statement on them could be issued by the Advisory Committee on Nuclear Safety.

STUK Guide extranet opened

At the beginning of the year, a decision was made to implement a service by means of which parties from outside STUK could also give their comments on regulatory Guides under preparation. The STUK Guide extranet, which opened in the late summer of 2010 (https://ohjeisto.stuk.fi), makes publicly available drafts 2 and 4 of the new YVL Guides under preparation and ST Guides under revision. The public can give their comments on Guide drafts, anonymously if they wish. In addition, registered users approved by STUK can upload commenting documents and read feedback from other users.

Structure of the new YVL guides

A **Safety management of a nuclear facility**	**B** **Plant and system design**
A.1 Regulatory control of the safe use of nuclear energy A.2 Siting of a nuclear facility A.3 Management systems of a nuclear facility A.4 Organisation and personnel of a nuclear facility A.5 Construction of a NPP A.6 Operation and accident management of a NPP A.7 Risk management of a NPP A.8 Ageing management of a nuclear facility A.9 Reporting on the operation of a nuclear facility A.10 Operating experience feedback of a nuclear facility A.11 Security arrangements of a nuclear facility	B.1 Design of the safety systems of a nuclear facility B.2 Classification of systems, structures and equipment of a nuclear facility B.3 Safety assessment a NPP B.4 Nuclear fuel and reactor B.5 Reactor coolant circuit of a NPP B.6 Containment of a NPP B.7 Preparing for the internal and external threats to a nuclear facility B.8 Fire protection of a nuclear facility
C **Radiation safety of a nuclear facility and environment**	**D** **Nuclear materials and waste**
C.1 Structural radiation safety and radiation monitoring of a nuclear facility C.2 Radiation protection and dose control of the personnel of a nuclear facility C.3 Control and measuring of radioactive releases to the environment of a nuclear facility C.4 Radiological control of the environment of a nuclear facility C.5 Emergency preparedness arrangements of a NPP	D.1 Regulatory control of nuclear non-proliferation D.2 Transport of nuclear materials and waste D.3 Handling and storage of nuclear fuel D.4 Handling of low- and intermediate-level waste and decommissioning of a nuclear facility D.5 Final disposal of nuclear waste D.6 Uranium mining
E **Structures and equipment of a nuclear facility**	
E.1 Manufacture and use of nuclear fuel E.2 Construction plan of mechanical equipment and structures of a nuclear facility E.3 Manufacture, installation and commissioning of mechanical equipment and structures of a nuclear facility E.4 Verification of strength of pressure equipment of a nuclear facility E.5 In-service inspections of pressure equipment of a nuclear facility E.6 Buildings and structures of a nuclear facility E.7 Electrical and I&C equipment of a nuclear facility E.8 Inspection and testing organisations	

Figure 4. The structure of the new YVL guides by the end of 2010.

4 Regulatory oversight of nuclear facilities and results in 2010

4.1 Loviisa nuclear power plant

4.1.1 Overall safety assessment of the Loviisa NPP

STUK oversaw the safety of the Loviisa power plant and assessed its organisation and personnel's competence in different areas by means of reviewing documents 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 operation did not cause a radiation hazard to the workers, population or environment. Occupational radiation doses and radioactive releases into the environment were low and below the prescribed limits. The licensee has operated the Loviisa power plant in a safe manner and in compliance with YVL Guides. Emergency preparedness at the Loviisa power plant complies with set requirements.

According to the tests and inspections carried out, the condition of the containment and the primary circuit, which prevent the release of radioactive material into the environment, are in compliance with requirements. A small fuel leak was detected at Loviisa 1 in November and STUK regularly followed its development at the plant. The detected leak was insignificant for the radiation safety of the environment, because the radioactivity is contained in the primary circuit and inside the containment. The leak at Loviisa 1 was located during annual maintenance in 2010, and the fuel assembly with the leaking rod was removed from the reactor.

Plant operation has been systematic and safe. Two exceptional events with safety implications were reported. Both concerned the transportation of radioactive substances out of controlled systems or buildings. Both events were rated at level 1 on the International Nuclear Event Scale (INES). Because the amount of released radioactivity was small, the events were insignificant for the radiation safety of the environment. A root cause analysis was conducted for the events. Three events were classified as operational transients and one of these led to a reactor trip. System and equipment failures had only a minor safety impact for the plant. Annual maintenance was implemented as planned in terms of nuclear and radiation safety.

During the year under review, several modifications were implemented for improving plant safety. The suction strainers of the low pressure emergency cooling system and the containment spraying system, which are required in accident conditions, were improved by means of installing higher density mesh elements in them. The modification serves to ensure fuel cooling in accident conditions by means of preventing materials coming loose from, for example, heat insulation from being carried to the reactor core via the emergency cooling system. At Loviisa 2, about 600 metres of pipeline was replaced in the safety-significant auxiliary sea water system. The poor condition of the pipeline was detected in 2008. The modifications have gone well.

The implementation of the second phase of the Loviisa I&C upgrade (LARA) has been postponed until 2014. The second phase will include the upgrade of the most important I&C systems in terms of safety of the nuclear island and I&C of the most important safety functions, such as emergency power supply. The delay of the I&C upgrade will require the licensee to take measures to ensure the sufficient scope of maintenance measures and spare parts service for the existing I&C systems and equipment.

With a view to ensuring safety, Fortum Power and Heat Oy and its organisation at the Loviisa power plant have mainly operated in a systematic and development-oriented way. Organisational changes continued in 2010 due to personnel chang-

Operating licence for the reactor pressure vessel of Loviisa 2

The licences regarding the use of the reactor pressure vessels of the Loviisa NPP are granted for fixed periods. The licence granted in 1994 regarding the continued use of the reactor pressure vessel of Loviisa 2 was valid until the 2010 refuelling outage. At the end of 2009, Fortum Power and Heat Oy submitted an application to STUK concerning the continued use of the reactor pressure vessel of Loviisa 2 until the refuelling outage in 2030.

Neutron radiation has detrimental effects on the structural materials of the reactor pressure vessel. High-energy particles cause changes in the micro structure of steel, increasing the ductile-to-brittle transition temperature that characterises the fracture behaviour of ferritic steel. The plastic deformation ability of the steel in lower temperatures is weakened, and the steel becomes brittle. If the structure is subjected to a major stress in such a temperature and the relevant point has a sufficiently large initial crack, the crack will rapidly propagate and the structure ruptures. A large stress at a low temperature may occur, for example, in an emergency cooling situation where temperature differences cause major stresses. The sensitivity of the transition temperature to neutron radiation is increased by the impurities present in steel. These impurities (phosphorus and copper) are present in the core area weld seam of Loviisa 2's reactor pressure vessel.

The material samples kept under radiation inside the reactor pressure vessel of Loviisa 1 were tested in 1980. The test results indicated that embrittlement had progressed considerably faster than the plant supplier's prognosis suggested. After that, several modifications have been made at both plant units for slowing down the embrittlement process and for reducing the loads.

The determination of the ductile-to-brittle transition temperature used in the analysis is based on the test results obtained from radiation monitoring samples. When the transition temperature is known, the quantitative value of fracture toughness as a function of temperature can be determined according to the "Master Curve" method. Fortum has commissioned the Technical Research Centre of Finland (VTT) to assess the fracture toughness, the toughness at which crack propagation arrests of the weld material and base material of the pressure vessel and the cladding tearing resistance. The values for fracture toughness and the arrest are based on determining the toughness of representative samples as a function of radiation dose, and these results are used as such, i.e. the initial state of the material and the change in ductile-to-brittle transition temperature are not calculated separately. This places particular requirements on the representativeness of samples. Fortum has produced a report regarding the representativeness of the radiation monitoring samples. The "Master Curve" method developed by VTT has become an established method around the world, and it can be used to reduce the uncertainty factors associated with determining the fracture toughness.

The reactor pressure vessels of the Loviisa plant are inspected at least every eight years in order to detect any faults. The area of Loviisa 2's pressure vessel closest to the reactor core was inspected using non-destructive methods (US and eddy current) during the 2010 outage.

Fortum Power and Heat Oy submitted a revised safety analysis in support of its application. The deterministic analysis was revised in its entirety compared with the analysis of the 1994 application. The analyses were carried out using the same principles as were used for the reactor pressure vessel of Loviisa 1 in connection with the operating licence of 2004. The most notable difference is the determination of the ductile-to-brittle transition temperature described above.

STUK reviewed and evaluated the re-interpretation of radiation monitoring results, analyses and other grounds for continuing the use of the reactor pressure vessel submitted by Fortum Power and Heat Oy. STUK produced a safety assessment with the following key conclusions:

- *The rate of re-embrittlement has been determined sufficiently conservatively.*
- *The deterministic analysis shows that the reactor pressure vessel maintains its integrity in all postulated load situations.*
- *The fracture risk calculated on the basis of a probabilistic analysis is only a minor contributor to the overall risk of an accident resulting in a large release.*

STUK approved the use of the reactor pressure vessel of Loviisa 2, in line with the application submitted by Fortum Power and Heat Oy, until the refuelling outage in 2030.

Table 1. Events at the Loviisa plant units subject to special reports 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
* Entry of low activity rinsing water to the auxiliary building ventilation system at Loviisa 1:llä		•	1
* Spread of contamination in conjunction with transfers of spent fuel			1

* Power company conducted a root cause analysis of the event

es in the management of the plant. According to STUK's assessment, the changes had no impact on ensuring the nuclear safety of the plant. With a view to ensuring the safe operation of the plant, the operating processes of the organisation must be further improved, particularly in terms of developing the management system, ensuring the quality assurance of procurement activities and development of methods for safety culture. The project management programme for Loviisa power plant has progressed in a systematic manner and the induction training delivered in connection with annual maintenance is well-functioning. In terms of power company resource management, STUK paid attention to spare parts management at the plant. Deficiencies became evident as a result of equipment failures, because in these cases the plant did not have enough parts to repair the equipment within the limits set by the operational limits and conditions. The issue requires that the power plant takes measures in order to ensure continued safe operation.

The operating licence for the Loviisa 2 reactor pressure vessel was renewed until 2030. The previous operating licence expired with the 2010 annual maintenance. STUK approved the renewal of the operating licence on the basis of Fortum's analyses and application. During annual maintenance, a periodic pressure test of the reactor pressure vessel was performed. The test serves to ensure the structural integrity of the reactor pressure vessel and the primary circuit. The operating licence for the Loviisa 1 reactor pressure vessel is valid until 2012. The operating licences for the actual plant units are currently valid until 2027 for Loviisa 1 and until 2030 for Loviisa 2.

4.1.2 Plant operation, operational events and prerequisites of safe operation

Compliance with the operational limits and conditions (OLC)

The operational limits and conditions of the Loviisa power plant are up-to-date and well-defined. In 2010, no situations were observed in which the plant would have been in non-compliance with the operational limits and conditions. STUK has inspected compliance with the operational limits and conditions and the up-to-dateness of the document in conjunction with the reviews of modifications, tests and the analyses, and when overseeing the testss and the licensee's operations at the plant. After the annual maintenance outages had ended, STUK inspected whether the operational limits and conditions are up-to-date and the plant unit's state is in compliance with the operational limits and conditions prior to granting permission for unit start-up.

Fortum submitted to STUK for approval eight amendment proposals for the operational limits and conditions. The need for the amendments in the operational limits and conditions was caused by modifications implemented for severe accident management, clarification needs arising as a result

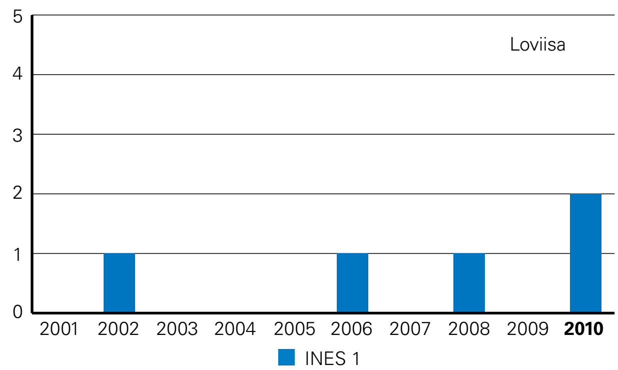


Figure 5. INES classified events at the Loviisa plant (INES Level 1 or higher).

of safety analyses, changes in the testing of some equipment which is important in terms of safety, and the introduction of a new type of fuel. STUK found the amendments acceptable.

The power company applied for STUK's permission for seven planned deviations from the operational limits and conditions. Three of these related to fault repairs or to making repairs possible, one to the change of mode of operation while part of the steam line radioactivity measurements were faulty, and three to modifications in connection with the overhaul of the seawater bar screens. STUK approved the applications because the deviations had no significant safety implications for the plant or the environment.

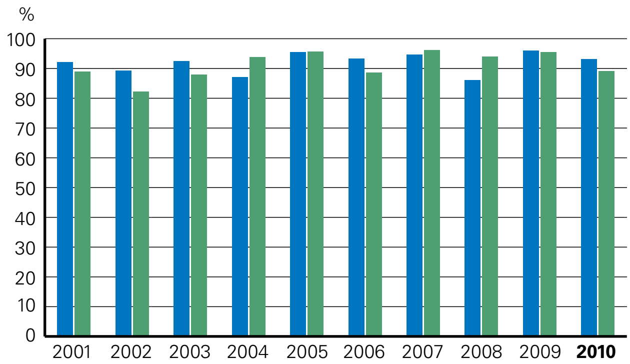


Figure 6. Load factors of the Loviisa plant units.

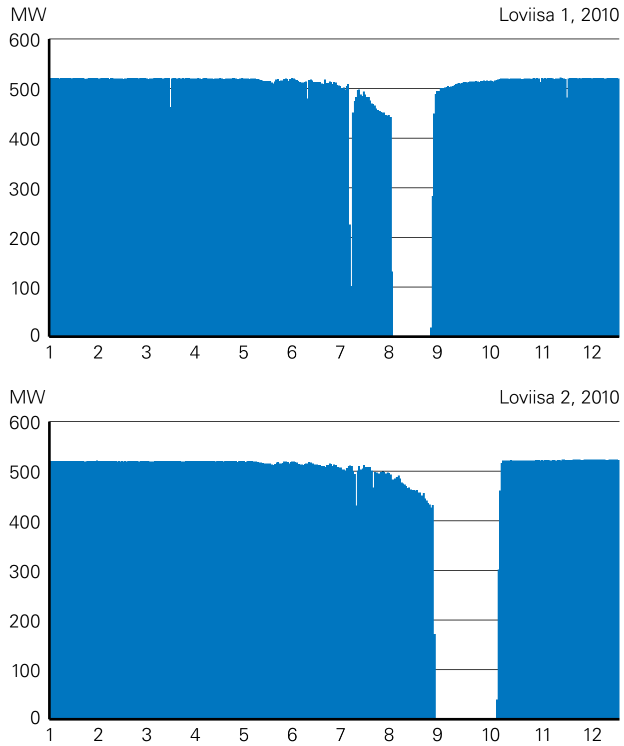


Figure 7. Daily average gross power of the Loviisa plant in 2010.

Operation and operational events

The load factor of Loviisa 1 was 93.1%, while that of Loviisa 2 was 89.1%. The annual maintenance outages have a major impact on the load factors. The outage at Loviisa 1 lasted for 25 days and the outage at Loviisa 2 lasted for 40 days. The losses of gross energy output due to operational transients and component malfunctions were 0.5% at Loviisa 1 and 0% at Loviisa 2.

***Slightly radioactive water-resin mixture** was transported to the venting line of the resin tank at the liquid waste solidification plant of Loviisa NPP and from there to the ventilation system of the auxiliary building as a result of overfilling the resin tank when it was being rinsed. As a consequence of the event, the design of the solidification plant and other similar systems was inspected, the liquid level measurement in the tanks will be improved and the operating instructions of the solidification plant will be further specified so that overfilling of the tank can no longer occur. Commissioning of the liquid waste solidification plant has not been continued after the event.*

***Radioactive particles** fell on the security-fenced yard of the Loviisa NPP from an inadequately cleaned transport vessel for spent nuclear fuel during the period 10 May to 9 June 2010 when spent fuel was being moved to the spent fuel interim storage from Loviisa 1. Most of the radioactive particles were found near the fuel transport route and the rest from the landfill site of the plant. The yard and the landfill site were cleaned of any radioactive particles. The event did not cause any hazard to the plant personnel, inhabitants in the neighbouring areas or the environment. In order to prevent the recurrence of similar events, the methods and instructions used for transfer operations will be revised and advanced radiation protection training will be organised for the personnel carrying out fuel transfers. In addition, improvements will be made in the fuel container transfer trolley in order to prevent the spreading of contamination.*

***The operators of Loviisa 1 shut down the reactor** by triggering a reactor trip as a result of malfunction detected when testing the steam line isolation valve and the automatic turbine trip that followed. During the event, the plant operated as planned with regard to protective systems, and the event had no impact on the safety of the plant or its surroundings.*

The events are described in more detail in Appendix 3.

Annual maintenance at Loviisa 1

Annual maintenance at Loviisa 1 was a short maintenance outage. The plant unit was shut down for annual maintenance on 8 August 2010 and connected back to the national grid on 2 September 2010.

The main focus during the maintenance outage was on refuelling and reactor dismantling and reassembly work. Work with important safety implications included reconditioning of the seal slots of the flange faces of reactor pressure vessels and the 17-year maintenance of one emergency diesel generator where the diesel engine was replaced with another that had undergone a total overhaul.

Slightly increased activity concentrations were detected in the reactor coolant water at Loviisa 1 in October 2009, which indicated a fuel leak. Because a leak was suspected, all fuel assemblies in the reactor were inspected. The leak was located in one fuel assembly that was removed from the reactor and moved to the fuel pool for storage.

In the plant I&C systems modernisation project, the core outer temperature measurements were connected to the internal core measurement system, and modifications were made to the software of new systems on the basis of requirements identified during the previous fuel cycle.

Annual maintenance at Loviisa 2

Annual maintenance at Loviisa 2 was an extended maintenance outage that takes place every eight years. The outage began on 4 September 2010 and ended on 13 October 2010.

In addition to refuelling, extensive inspections, repairs and modifications were carried out during the outage. The inspections included the periodic inspections of pressure vessels and pipelines. All fuel from the reactor was moved to the refuelling pool for the duration of inspections of the reactor pressure vessel and reactor internals.

As part of the ongoing plant I&C systems modernisation project, modifications were made to the core internal temperature measurement system, and modifications were also made to the software of new systems on the basis of requirements identified during the previous fuel cycle.

The primary and secondary circuits were subjected to pressure tests that are performed every eight years. In the tests, the structural strength and leak tightness of the circuits are tested using a pressure 1.3 times the design pressure, i.e. 178 bar abs for the primary circuit and 73 bar abs for the secondary circuit. The steel containment of the reactor building was subjected to a leak tightness test, carried out at four-year intervals using its design pressure of 1.7 bar abs.

During the pressure test of the primary circuit, a manual shutoff valve in the pressurizer blowdown line was leaking hot and mildly radioactive water inside the containment building through a faulty stuffing box. After the leak was detected, the persons participating in the inspection left the building and the pressure test was interrupted. The leak did not cause injuries or significant releases in the containment building or outside it. The reactor did not have any fuel during the pressure test. STUK approved the power company's report regarding the event and the pressure test was successfully completed after repairing the valve.

During fuel transfers inside the reactor, the intermediate shaft of one control rod fell on top of the bayonet joint of the fuel extension connected to it. The intermediate shaft was inspected after the event and found to be free of any damage. The joint between the intermediate shaft and the fuel extension was tested and found to function normally. The impact of the falling shaft on structures was analysed, and it was found that the fall only caused minor deformations on the intermediate shaft and the point of impact. The event was caused by improper fixing of the intermediate shaft on the transfer tool. The lifting tool was inspected and found to be in operating condition. The movements of the subject control rod were monitored particularly closely during the control rod test run carried out during reactor start-up and no irregularities were observed.

Operation and operational events

Plant operation has been systematic and safe. No events with significant safety implications took place in plant operation. Two events with dispersion of radioactive materials were reported. Three events were classified as operational transients. One of these led to a reactor trip.

In 2010, the risks caused by detected component malfunctions, preventive maintenance and other events at the Loviisa plant were about 9.7% and about 5.2% of the expected value of the annual accident risk calculated using the plant's risk model for Loviisa 1 and Loviisa 2, respectively. The values are higher than in 2009, which may be caused by the change of the data gathering method and by changing over to different calculation software. The most significant in terms of accident risk were the failures of the emergency diesel generators and the ventilation systems.

Annual maintenance outages

Annual maintenances at the Loviisa plant units were carried out safely and all maintenance work was completed within the planned scope. In recent years, the plant has paid special attention to work planning and induction training of contractors as well as to safe performance of work. During annual maintenance, STUK carried out an inspection in line with the periodic inspection programme for establishing the competence of the workers involved in maintenance and their familiarity with procedures (induction, meetings, work supervision, work order practice, etc.). The inspection assessed the functioning of operating experience utilisation and the feedback system, and the realisation of cleanliness, order, and radiation and fire safety in annual maintenance by means of monitoring operating and maintenance activities. Based on the inspection, it was stated that the annual maintenance activities at the Loviisa power plant are well organised and in compliance with good safety culture. Yet there is scope for improvement in cleanliness and order, the marking of plant storage areas, work and fire fighting arrangements. No events with significance to nuclear or radiation safety took place during annual maintenance.

STUK used a total of 369 working days for the regulatory oversight of the annual maintenance outages including oversight work performed by experts from various fields such as equipment and system inspections at the plant site, and walkdown inspections. In addition, two resident inspectors worked regularly on site.

Fire safety

Ensuring fire safety was one of the focus areas of STUK's regulatory oversight in 2010. A plant-specific guide was prepared for making observations at the power plant. The guide also helps inspectors other than those with fire prevention expertise to make observations concerning fire safety. During annual maintenance at Loviisa 1, STUK's resident inspectors detected a considerable amount of temporary, partly flammable fire load in the reactor coolant pump room, which had been brought and stored there against Fortum's working instructions. The fire load, which was not necessary for work, was transferred to safe containers after STUK remarked on it. The assessment of the observation concluded that the ignition of the fire load would have led to a fire inside the containment which would have been difficult to extinguish, and it would have caused damage to the equipment and structures inside the containment. As a result of the observation, Fortum initiated an investigation in order to minimise the fire load of the solvents used in cleaning, to improve their storage and to identify training needs to prevent the same issue happening again.

Maintenance of the plant fire alarm and fire extinguishing systems has been carried out according to the condition monitoring programme.

4.1.3 Ensuring plant safety functions

No such failures were observed during the year in the plant's safety functions or in the systems, equipment and structures executing them, which would have prevented the fulfilment of the safety function. Faults detected in the plant emergency diesel generators are discussed in detail in chapter 4.1.4.

At the Oskarshamn power plant in Sweden, an analysis has been carried out concentrating on the effects of voltage drops of long duration on the pump motors in safety systems. According to the analyses, the pump motors of safety systems can overheat in an undervoltage situation. As a result, STUK requested Fortum to conduct an analysis of the impact of an extended grid undervoltage situation on power plant equipment. The analysis was completed in 2010 and submitted to STUK for review. The review of the analysis by STUK is underway.

In 2009, more risk-significant ventilation system failures were detected at the Loviisa power plant than earlier. There were several failures in 2010, too, but their number decreased slightly. STUK called attention to the number of ventilation system failures and pointed out during a periodic inspection programme inspection the need to clarify the responsibilities for the Loviisa power plant ventilation system and to nominate a person responsible for the system. The aim is to ensure that the Loviisa power plant takes better care of preventive maintenance, maintenance and ageing management of the ventilation systems.

Based on the safety analyses conducted during the operating cycle, the power company considered it necessary to make modifications in the operation of the pressure emergency water tanks of the low pressure emergency cooling system. The modification serves to prevent the nitrogen in the water tank from getting into the reactor so that heat transfer from the reactor can be provided reliably when necessary. The modifications concern the throttles of the nitrogen line connected to the pressure emergency water tanks, emergency operating procedures, water level in the tanks and the operational limits and conditions for the system. STUK approved the modifications before they were implemented at the power plant.

During annual maintenance, modifications were carried out for ensuring secondary circuit safety functions in the event of a high-energy pipe break in the control room building. The safety functions were ensured by means of installing devices, I&C and measurements with different operating principles in parallel with the existing equipment to fulfil and control the safety functions. The modifications implemented during this annual maintenance aim to protect devices and measurements realising safety functions (restraints and jet shields for steam pipelines) and to ensure the use of the steam generators for removing residual heat from the primary circuit (replacement of the steam manifold separating valve and new minimum circulation lines of the residual heat removal system pumps). The corresponding modifications at Loviisa 1 were made in 2008.

4.1.4 Integrity of structures and equipment

Fuel leak

Slightly increased activity concentrations were detected in the reactor coolant water at Loviisa 1 in October 2009, which indicated a minor fuel leak in one fuel rod. The activity concentration of the reactor coolant was monitored by regular measurements until annual maintenance in the summer of 2010. The leak remained small throughout the operating cycle. In order to find the leaking fuel assembly, all the fuel assemblies in the Loviisa 1 reactor were inspected during annual maintenance in 2010. The leaking assembly was located and removed from the reactor.

Emergency diesel generator failures and spare parts stock

In conjunction with its inspections and regulatory oversight activities, in 2009 STUK called attention to the numerous failures of the emergency diesel generators and the scant stock of their spare parts and the poor availability of parts. As the emergency diesel generators generate electricity for equipment and systems which are important in terms of plant safety in cases of loss of offsite power, their reliable operation is extremely important. STUK requested Fortum to prepare a report on the issue. STUK assessed the report to be inadequate because it did not examine in sufficient detail the electrical and I&C part of a diesel generator, the reliability of the diesel generators and the risk-significance of failures. Fortum submitted further clarifications by the end of 2010. STUK continues to review the issue.

Repair of the seal grooves of the reactor flange face in annual maintenance at Loviisa 1

The integrity of the flange joint between the reactor pressure vessel and its lid is a salient factor for the tightness of the primary circuit. The tightness of the reactor pressure vessel and its lid is based on double seal grooves in which a nickel sealing wire is inserted. When the lid is closed and the bolts are tightened the sealing wire is pressed into the groove, which gives it a triangular shape.

The first defects which required local repair were detected in these sealing grooves in periodic inspections at Loviisa 2 in 2005. Similar defects were also detected in subsequent inspections at Loviisa 1. Investigations revealed that the reason for the defects was stress during operation. The increase of the defects is also due to defects in workmanship of the rustproof weld surfacing of the flange face. The detected defects are a result of ageing, therefore the number of defects can be expected to increase with service life.

In order to ensure the tightness of the primary circuit, Fortum decided to repair completely the sealing grooves of two inner sealing groove zones of the Loviisa 1 reactor pressure vessel flange face during annual maintenance in 2010. The aim is to carry out corresponding repair work at Loviisa 2 in 2012.

A STUK-approved pressure vessel manufacturer carried out the repair work on the flange faces of Loviisa 1 according to a plan approved by STUK during annual maintenance in 2010. STUK oversaw the repair work and approved the completed work in a construction inspection carried out before raising pressure in the primary circuit

The repair plan approved by STUK is based on removal of the inner sealing grooves by machining, mechanised TIG filler welding and machining of new sealing grooves. The manufacturer used machining equipment which had been included in the original plant supply and which had been modernised to meet present-day requirements. The roughness of the sealing counter face on the reactor lid was levelled by machining. The lid needed no repair welding.

The TIG welding instruction which was followed in the repair work had been qualified by means of a procedure qualification test, which had undergone non-destructive and destructive testing under third-party supervision in the spring of 2010. Fortum obtained STUK's approval for the plan before starting the procedure qualification test.

Fortum had analysed in advance the risks during the performance of work and prepared a safety assessment of the implementation of work. Thanks to careful advance planning, no problems were encountered in this demanding work and the qualitative objects were fulfilled.

Stud bolts of a primary water purification system flange joint

A broken stud bolt was found during the preparations for a pressure test of the primary circuit which was carried out in conjunction with annual maintenance at Loviisa 2. The stud bolt was in the flange joint between the bonnet and the body of a valve in the primary water purification system. It was found out that the breaking of the bolt was due to the wrong bolt material, which was not of the designed type. The joint of the valve had been tight during operation, but the broken stud bolt decreased the reliability of its tightness. As a result of the observation, the integrity of the stud bolts on the valves of the same type was controlled before the primary circuit pressure test by means of visual inspection and tightening the studs to the defined torque. After the pressure test, the type of material of these stud bolts was inspected and three stud bolts were detected which were made from the wrong type of material. The defective stud bolts were replaced with approved spare part stud bolts. Due to this event, a corresponding inspection of stud bolts will be carried out at Loviisa 1 during annual maintenance in 2011.

> ***Pressure equipment manufacturers, and inspection and testing organisations***
>
> *STUK approved, pursuant to the Nuclear Energy Act, four manufacturers of nuclear pressure vessels for the Loviisa plants 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, seven testing organisations to carry out tests related to the manufacture of mechanical equipment and structures. Testing operatives from three different testing organisations were approved to carry out periodic tests of mechanical equipment and structures pursuant to YVL 3.8.*

Periodic inspections

No significant issues with safety implications were observed in the extensive inspections of the Loviisa 2 primary circuit carried out during annual maintenance. The inspections of the reactor pressure vessel revealed no readings exceeding approval limits. Four defects exceeding the ASME XI standard were detected in one weld of the reactor pressure vessel lid. Fortum conducted an analysis of the defects and submitted a report on them to STUK for approval. According to STUK's assessment, the defects detected in the weld do not endanger plant safety, but STUK requested a reinspection of the defects during the following annual maintenance in order to assess the expansion of the defect. An internal inspection of the protective tubes of the control rod drive mechanism revealed a defect exceeding the approval limit in one protective tube weld. For this reason, the protective tube was replaced with a spare part tube.

The periodic inspections of registered pressure equipment were implemented according to plans for both plant units. In all, 43 inspections were carried out at Loviisa 1, three of them in STUK's inspection domain. A total of 78 inspections were carried out at Loviisa 2, 44 of them in STUK's inspection domain.

4.1.5 Development of the plant and its safety

At the Loviisa power plant, there are several major reconstruction projects underway with the objective of extending the service life of plant systems, structures and equipment. In connection with the renovations, modifications will also be implemented with a view to further improving plant safety. The most important ongoing renovation in terms of duration and extent is the I&C modernisation project of the Loviisa power plant.

The projects relating to the development of the plant and its safety take into account the requirements presented in the YVL Guides set down by STUK. The modifications implemented in 2010 complied with the plans and turned out well. The delay of the I&C modernisation project will require the licensee to take measures to ensure a sufficient scope of maintenance measures and spare parts service for the existing I&C systems and equipment.

Development projects in the field of the handling and storage of reactor waste are discussed in chapter 4.1.6.

Loviisa power plant I&C modernisation project

Fortum will upgrade the I&C systems controlling the systems and equipment of both plant units in Loviisa. The control rooms of the plant will also be re-equipped. The modernisation involves replacing the control, protection and monitoring systems implemented using conventional hard-wired technology with software-based technology. The modification also applies to the control room interfaces, where screen-based control is introduced as the main method. The intention is to keep most of the existing field instrumentation unchanged.

The reliability of I&C functions against internal and external hazards will be improved by improving the independence of redundant functions or back-up functions. Two new buildings have been built for both plant units to accommodate the new systems. The main supplier of I&C systems is a consortium formed by Areva NP GmbH and Siemens AG. They also perform the installation work.

The I&C modernisation project will be implemented in phases. During the first phase, part of the I&C system controlling and limiting reactor power and its control room user interface were upgraded. The first phase was implemented at Loviisa 1 in 2008 and at Loviisa 2 in 2009. The power company has changed the phasing of the revision from four to three phases, which will be implemented mainly during annual maintenance outages. The implementation of the second phase of the Loviisa I&C upgrade has been postponed until 2014. The second phase will involve Safety Class 2 and 3 systems such as the reactor protection system RPS and the preventive protection system PPS. At the end of 2010, STUK issued a decision on the architecture of automation. No fundamental changes were required in the architecture, but the documentation will be harmonised and clarified. A considerable amount of system description material will be submitted to STUK for review in early 2011.

Fuel transfer machine modernisation

Fortum is modernising the fuel transfer machines at the Loviisa power plant. The modernisation involves an upgrade of the electrical and I&C systems of the fuel transfer machine, which is based on the technology of the 1970s, and possibly an increase of the height of the transfer machine bridge, which can be implemented either by modernising the present machine or replacing the machine. The reason for the height increase is that it would make it possible to install permanent safety handrails around the fuel pools. Now it is necessary to remove the handrails when the machine passes by. At the same time, preparations are being made for extending the runway of the machine, which would allow rerouting of the heavy lifts done with the reactor building crane and which would decrease the risk of core damage caused by falling heavy loads. Fortum submitted a conceptual design plan for the modernisation to STUK in June 2010. STUK has reviewed the conceptual design plan and requested to supplement it with regard to quality management and the classification of the systems, among other things. Fortum will submit an updated conceptual design plan to STUK in early 2011.

Modernisation of the reactor building cranes

The reactor building cranes at both Loviisa units, so-called Polar cranes, are due to be modernised in the next few years. The modernisation is intended to extend the service life of the Loviisa 1 and Loviisa 2 Polar cranes for another 30 years, also taking into account the need for the cranes during the decommissioning of the plant. The usability and safety of the cranes will be improved by modernising their operating mechanisms and electrical and I&C systems. STUK reviewed and approved a conceptual design plan for the project in September 2010.

Improvement of safety system suction strainers

During annual maintenance at Loviisa 2, the suction strainers of the low pressure emergency cooling system and the containment spraying system, which are required in accident conditions, were improved by means of installing higher density mesh elements in them. In accident conditions caused by a pipe break, fibres coming loose from pipe heat insulation can accumulate in the suction strainers. The aim is to prevent fibres from entering the reactor core via the emergency cooling system, because blockages caused by large amounts of fibres could lead to overheating of the reactor core. Higher density mesh elements improve the filtering capacity of the suction strainers, thus reducing significantly the amount of fibres being carried into the reactor core compared with the old suction strainer structure. The same modification is planned for implementation at Loviisa 1 in 2012.

Replacement of pressure side auxiliary sea water piping at Loviisa 2

During annual maintenance at Loviisa 2, the pressure side piping of both auxiliary sea water subsystems were replaced. These subsystems constitute part of the cooling chain of the safety systems. The auxiliary sea water system consists of two redundant subsystems. The main task of the system is to provide cooling water supply for the safety system heat exchangers. It was detected during annual maintenance in 2008 that the inside surface of the piping was worn. The piping was replaced one subsystem at a time so that the other line remained operable. About 600 metres of pipeline was replaced.

4.1.6 Spent nuclear fuel storage and low- and intermediate-level waste

STUK inspected, in accordance with the inspection programme, the low- and intermediate-level waste management and final disposal of waste materials at the Loviisa power plant. The inspection of low- and intermediate-level management focused on the situation of the development project for low- and intermediate-level waste processing, the arrangements at the liquid waste solidification facility, waste accounting, organisation and instructions. No significant issues with safety implications requiring corrective actions were observed in the inspections.

Two events occurred in low- and intermediate-level waste management and interim storage of spent nuclear fuel in 2010. The events were rated at level 1 on the INES scale. The events are described in more detail in Appendix 3 to the Report.

The processing, storage and final disposal of low- and intermediate-level waste (so-called operating waste) at the Loviisa power plant were carried out as planned. The volume and activity of low- and intermediate-level waste in relation to generated electrical power remained relatively low compared with most other countries. Contributing factors include the high quality requirements for nuclear waste management and nuclear fuel, the planning of maintenance and repair operations, decontamination, component and process modifications, as well as waste monitoring and sorting, which enable some of the waste with a very low radioactive substance content to be cleared from control. In 2010, quantities of maintenance waste below the activity limits and scrap metal were cleared from control at the power plant, with STUK's approval. In addition, the power plant employs efficient procedures for reducing the volume of waste subject to final disposal.

Construction and commissioning of a liquid waste solidification facility

A solidification facility for liquid radioactive waste has been constructed on the Loviisa plant site. The solidification facility processes the radioactive evaporation residues generated at the power plant and the radioactive ion exchange resins from the purification filters. Prior to commissioning the soli-

Volumes of nuclear waste

The volume of spent nuclear fuel stored on-site at the Loviisa power plant at the end of 2010 was 4,147 assemblies (500 tU), an increase of 186 assemblies (22.4 tU). At the end of 2010, the total volume of finally disposed low- and intermediate-level waste was 1,682 m³. The total increase of volume from 2009 is 71 m³. Approximately 49% of the waste has been finally disposed of.

dification facility, a test programme will be carried out and approved to ensure that the solidification facility systems function as planned. The tests are to ensure, among other things, the functioning of the I&C system, the correctness and adequacy of the information transmitted by the process measurement devices, and waste package activity determination. The power company initiated the commissioning phase of the solidification facility construction project (LOKIT) during 2006 by carrying out system- and plant-level tests using inactive substances. STUK approved in 2008 the results of the pre-operational tests carried out using radioactive evaporation residues. Pre-operational tests were started using resin waste in May 2009, but they were interrupted, because the level measurement of the proportioning tank did not operate reliably.

STUK approved in March 2010 the pre-inspection material for resin proportioning system repairs submitted by Fortum Power and Heat Oy. During preparations for the repairs, the resin tank was overfilled in connection with its flushing on 30 March 2010, and slightly radioactive water-resin mixture entered into the gas exhaust line of the tank and from there into the ventilation system of the auxiliary building.

The commissioning of the liquid waste solidification facility has not been continued after the event. Fortum examines the process design and instructions for the facility. Liquid waste will be prevented from entering the ventilation system from the gas exhaust line by means of process modifications. The tank level measurements will be improved in order to avoid similar overfilling of the tank. The instructions for the solidification facility will also be clarified.

Development of low- and intermediate-level waste processing

Fortum has improved low- and intermediate-level waste management at the Loviisa power plant by introducing centralised facilities for waste processing, activity determination and interim storage. At the same time, decontamination facilities and equipment were upgraded. The former machine and electrical repair shops in the non-controlled area were converted to these purposes. These shops moved to a new building in 2009.

Construction of the facilities advanced as planned. In the first quarter of 2010, Fortum Power and Heat Oy carried out pre-operational tests of the ventilation and radiation measurement systems of the new waste management facilities. In the second quarter of 2010, STUK carried out an inspection for assessing the prerequisites for enlargening the controlled area of the power plant with the new facilities. The inspection focused on radiation protection arrangements, ventilation systems and building technology. The new waste management facilities were put into use in the summer of 2010.

Extension of the final disposal facility for plant waste

Extension of the final disposal facility for plant waste has been launched at the Loviisa power plant. A new maintenance waste tunnel and a connecting tunnel will be excavated in the final disposal facility. At this stage, the maintenance waste tunnel will be used for sorting and interim storage of plant waste. Later on the stored waste will be cleared from control.

In accordance with the Ministry of Employment and the Economy's statement, the extension could be implemented as a plant modification with licensing provided by STUK. In addition, Fortum has to submit an application to STUK for a licence for operations before the deposit tunnel is commissioned for waste storage. In June, Fortum submitted to STUK a licence application including a description of the plant modification and updates to the preliminary safety analysis report. STUK approved the licence application for extending the VLJ Storage with regard to the maintenance waste and connecting tunnels in September 2010. Excavation of the facilities started in October 2010 and the facilities will be completed by the end of 2011.

Provisions for the costs of nuclear waste management

Pursuant to Section 88, Subsection 2 of the Nuclear Energy Act, Fortum submitted waste management schemes to the Ministry of Employment and the Economy at the end of June. The waste management schemes include data about radioactive waste generated by the end of each year, measures and costs. The schemes also included an estimate of the situation in 2013–2014. Fortum has to supplement the waste management schemes and related calculations every third year.

STUK reviewed the documents submitted in compliance with the Nuclear Energy Act and provided the Ministry of Employment and the Economy with a statement on them. In its statement, STUK assessed the technical plans and cost estimates on which the financial provision is based and stated that these had been appropriately drawn up. Fortum's extent of liability is EUR 943.7 million at 2010 prices. A total of EUR 44.8 million has been reserved for regulatory oversight costs. Fortum's share of this sum is EUR 19.2 million.
It has been estimated that the cost of decommissioning will be EUR 319 million at late 2010 prices. The amount of work needed is about 2,955 person-years and about 27,800 m^3 of waste subject to final disposal will accumulate.

Other plans for nuclear waste management

In accordance with Section 74 of the Nuclear Energy Decree, Fortum submitted a report on the plans for the implementation of nuclear waste management activities to the Ministry of Employment and the Economy at the end of September. The report contains a detailed plan for the next three years and a general account of the measures planned for the next six years. STUK issued a positive statement to the Ministry of Employment and the Economy on 5 October 2010. The plan will be updated every third year.

Several development projects are underway or being planned with regard to nuclear waste management, spent nuclear fuel storage and decommissioning. In the field of reactor waste management, the Loviisa power plant is currently conducting a comprehensive investigation of waste storage issues encompassing the extension of the final disposal facility. The Loviisa power plant also has a number of long-term tests in progress with a view to ensuring the safety of final disposal. The Loviisa power plant is increasing spent fuel interim storage capacity by means of taking into operation high-density fuel racks. A new project involves an assessment of the technical impacts of higher fuel burnup and its impact on total costs of nuclear waste management. The Loviisa power plant will perform separate risk assessment of decommissioning of the power plant, and the impact of decommissioning of one unit on the operation of the other unit.

4.1.7 Functioning of organisations and quality management

Based on STUK's regulatory oversight, it can be stated that, with a view to ensuring safety, Fortum Power and Heat Oy and its organisation at the Loviisa power plant have mainly operated in a systematic and development-oriented way. In terms of the functioning of the organisation, STUK evaluated selected topics relating to the structure, processes and resources of the organisation during the year under review.

Organisational changes continued in 2010 due to personnel changes in the management of the plant. STUK considered the changes acceptable after receiving from Fortum a supplemented safety assessment of the impact of the organisational changes on nuclear safety.

With regard to organisational operating processes, STUK assessed in particular the management system, procurement activities, safety culture evaluation methods, training activities and project management of the Loviisa nuclear power plant. Based on the inspections, STUK stated that the project management development programme for Loviisa power plant has progressed as planned. Development of the power plant's management system towards a process-based management system is still incomplete and, according STUK's estimate, its completion will require from Fortum clarification of responsibilities and evaluation of the development measures taken for ensuring their successful outcome. The power plant must also improve the guiding function of self-assessments in order to improve its management system on the basis of results. For ensuring the conformity

WANO Peer Review

A peer review carried out by WANO (the World Association of Nuclear Operators) took place at the Loviisa power plant during 15–26 March 2010. In addition to WANO personnel, the review group also has experts working at the NPPS of other countries. The purpose of this peer review is to promote the best practices of the nuclear industry among the community of nuclear power operators and to identify areas in need of development in the organisation being reviewed. The results of the review carried out in March were still processed under the supervision of WANO representatives during the period 25–29 October 2010 when the observations were analysed in order to identify root causes that could be addressed in order to develop the operations more extensively. The power plant identified development actions to be taken on the basis of the review, and WANO will assess the situation in its follow-up inspection in 2012.

of its purchases, the plant must further elaborate its guidelines for procurement activities and supplier monitoring procedures. In order to ensure the evaluation and development of a safety culture, Fortum must, according to STUK's assessment, see to it that the concepts used in its safety culture are harmonised and understood and that the responsibilities for evaluating and developing the safety culture are clear. In conjunction with the oversight of annual maintenance, STUK evaluated the effectiveness of induction training. It was considered to be functioning.

In terms of power company resource management, STUK paid attention to spare parts management at the plant. Deficiencies in resource management became evident as a result of certain equipment failures, because in these cases the plant did not have enough parts to repair the equipment within the limits set by the operational limits and conditions. Deficiencies were detected in spare parts for the emergency diesel generators, electronic boards of the plant I&C system and steam line radioactivity measurement devices. STUK has not discovered any substantial deficiencies in the power plant's human resources. STUK participated in oral examinations of shift personnel where the shift managers and operators working in the control rooms proved that they are conversant with all salient matters related to plant operation and safety. In 2010, STUK approved 22 operator licences, four of which were granted to new operators. STUK approved six persons as operator-trainees.

4.1.8 Operating experience feedback

STUK assessed the power company's operating experience feedback activities on the basis of submitted reports and inspections within the periodic inspection programme. During the year under review, two INES level 1 events occurred: migration of radioactive resin into a ventilation duct at the liquid waste solidification facility on 30 March 2010, and the dispersal of radioactivity when spent fuel was transferred on 9 June 2010. The licensee conducted root cause analyses of the events. In addition, root cause analysis reports on the 2009 events were submitted: An unclear situation in the transfer of a control rod absorber element on 28 August 2009, and the dispersal of contamination in the controlled area on 14 August 2009. On the basis of the analyses, operating methods have been elaborated for spent nuclear fuel handling, work risk assessment and the technical design of projects, among other things. Developing the root cause analysis method used in the analyses into a functioning tool demonstrates significant positive development in terms of event analyses at the Loviisa power plant.

Other analyses intended for improving operations were also applied at Loviisa, such as the Stream Analysis method. This forms a basis for the development of a long-term programme and objectives for operating experience feedback, trend monitoring for deviations and near miss situations, criteria and timing for event studies.

In Loviisa, a total of 58 unexpected operation-related events were recorded for 2010, 28 analyses of these events have been completed. These events include, for example, air conditioner contactor problems, high pressure boron pump problems and breaking of a transformer spring washer during maintenance. A total of 12 operational event reports and two special reports on these events were submitted to STUK. Because of the big difference between the numbers of completed and incomplete reports, the Loviisa power plant must speed up prompt preparation of operational event reports.

Procedures for utilising international operating experience at the Loviisa power plant function well. Foreign event reports and events are reviewed extensively and the corrective actions taken on their basis are well-justified and traceable. Fortum itself conducts pre-screening of the reports coming from various sources, mainly via the IRS system maintained by WANO and IAEA/NEA. The selection criterion for events to be taken to the International operating experience team is their safety significance for the Loviisa power plant. It would be possible still to boost the operating experience feedback activities and the monitoring of the effectiveness of these activities, and to improve them by means of a unified operating experience feedback database covering both internal and external operational events. The Loviisa power plant is expecting that the development of Fortum group-level databases would bring forth improvement for the needs of the operating experience feedback activities as well.

The event at the Loviisa power plant in which radioactive resin migrated into a ventilation duct from a mixing tank at the liquid waste solidification facility was reported by STUK to an operating experience feedback database maintained by the IAEA.

4.1.9 Radiation safety of the plant, personnel and environment

Occupational radiation safety

STUK carried out a radiation protection inspection according to the periodic inspection programme at the Loviisa plant, focusing on employees' radiation protection in particular.

In the inspection, STUK stated that radiation protection at the Loviisa power plant is generally functioning well in terms of methods, work approaches, instructions and work planning. Based on the inspection, STUK requested to investigate the state of the doors on the border of the controlled area (tightness, markings and locking) and to clarify the radiation protection instructions for the handling of protective equipment.

The dosimeters used for measuring the occupational radiation doses underwent their annual test. The test comprises irradiating a sample of dosimeters at STUK's measurement standard laboratory and reading the doses at the power plant. The test results were acceptable.

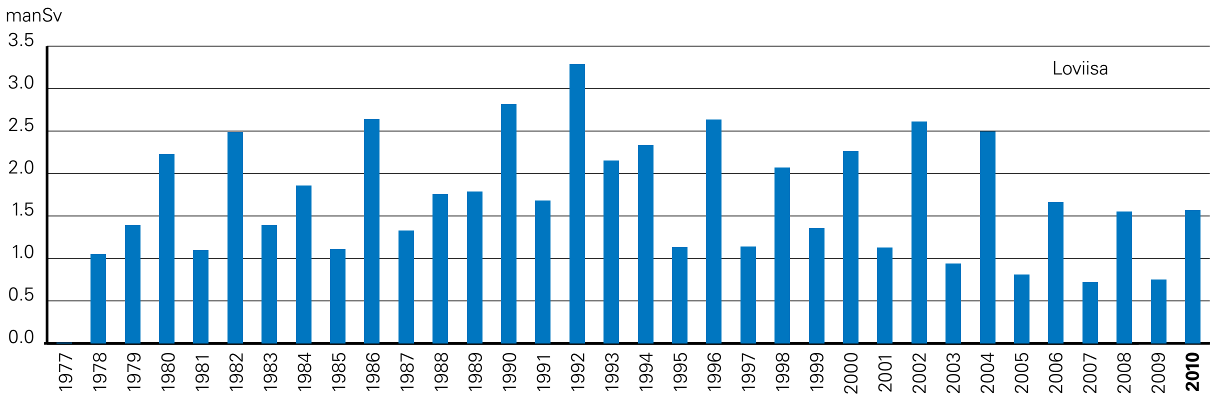


Figure 8. Collective occupational doses since the start of operation of the Loviisa nuclear power plant.

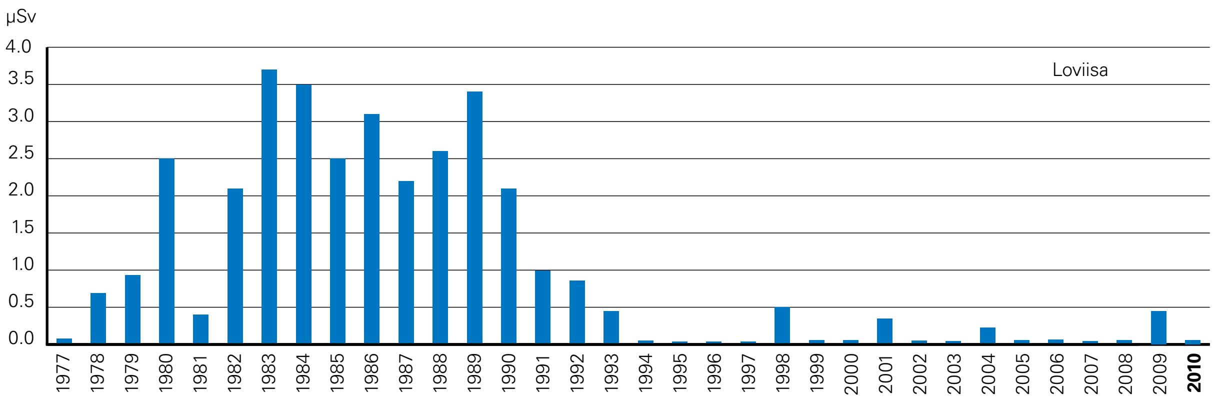


Figure 9. Annual radiation doses to the critical groups since the start of operation of the Loviisa nuclear power plant. Over the recent years, the doses to the critical groups have remained below one percent of the set limit, 0.1 milliSv.

Table 2. Radioactive nuclides originating from the Loviisa NPP, found in the environmental samples.

Types of samples containing radionuclides originating from the NPP. Figures in the table indicate the number of samples of a certain sample type in which each radionuclide was detected. Several different nuclides may be found in the same sample.

Type of sample / radionuclide	H-3	Mn-54	Co-58	Co-60	Ag-110m	Te-123m	Sb-124	Total
Fallout	–	–	–	–	1	–	1	2
Seabed fauna (Saduria Entomon)	–	–	–	–	1	–	–	1
Aquatic plants	–	7	3	9	9	1	4	33
Sedimenting materials	–	–	–	10	3	–	–	13
Seawater	5	-	-	-	-	-	-	5
Total	5	7	3	19	14	1	5	54

STUK carried out specific radiation protection inspections during annual maintenance outages. In the inspections, STUK assessed the radiation protection personnel's operations, training and resources. At the same time, STUK assessed the operations of employees in radiation work performed in the controlled area. It was concluded that radiation protection at the plant units mainly functions well. Based on the inspection, it was stated that the radiation protection personnel's and the cleaning contractor's responsibilities must be clarified with regard to the handling of protection equipment used in the controlled area, shoe boundaries for preventing contamination spreading must be made uniform and their tidiness improved.

The fundamental bases for radiation protection is to keep radiation levels low. The Loviisa power plant's objective is to reduce the release of antimony (Sb-122 and Sb-124) into the primary circuit. The plant is planning to replace the reactor coolant pump seals with an antimony-free material. This measure would reduce in future radioactivity in the primary circuit and consequent radiation exposure of the power plant workers.

Radiation doses

The collective occupational radiation dose was 0.67 manSv at Loviisa 1, and 0.90 manSv at Loviisa 2. According to STUK's YVL Guide, 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 1.22 manSv per Loviisa plant unit. This limit value was not exceeded at either plant unit.

The time used for annual maintenance outages was long, and the amount of work with significance for radiation protection was higher than normally, which resulted in a total collective dose that was higher than that of the previous year. The collective occupational radiation doses at the Loviisa power plant were higher than the average collective occupational radiation doses of employees working on pressurized water reactors in OECD countries.

Occupational radiation doses of nuclear power plant workers mostly accumulate in work carried out during annual maintenance outages of the plant units. At the Loviisa nuclear power plant, only about one-twentieth of the annual collective occupational radiation doses accumulate in work carried out during normal operation. The highest individual radiation dose incurred during the outage amounted to 7.9 mSv at Loviisa 1, and to 12.5 mSv at Loviisa 2. The highest individual radiation dose incurred during the outages at both plant units amounted to 15.8 mSv.

The individual radiation dose distribution of workers at the Loviisa and Olkiluoto nuclear power plants in 2010 is given in Appendix 2.

Radioactive releases and environmental radiation monitoring

Radioactive releases into the environment from the Loviisa nuclear power plant were well below authorised annual limits in 2010. Releases of radioactive noble gases into the air were approximately 6 TBq (as Kr-85 equivalent radioactivity), which is approximately 0.03% of the authorised limit. The releases of radioactive noble gases were dominated by argon-41, which is the activation product of argon-40, originating in the air space between the reactor pressure vessel and the main concrete shield. Releases of iodine into the air were approximately 48 TBq (as I-131 equivalent radioactivity), which is approximately 0.02% of the authorised limit. The emissions through the vent stack also included radioactive aerosols amounting to 0.1 GBq, tritium amounting to 0.3 TBq and carbon-14 amounting to approximately 0.3 TBq.

The tritium content of liquid effluents released into the sea, 17 TBq, was less than 12% of the release limit. The total activity of other nuclides released into the sea was about 0.2 GBq, which is 0.02% of the plant location-specific release limit.

The calculated radiation dose of the most exposed individual in the vicinity of the plant was about 0.06 µSv per annum, i.e. less than 0.1% of the set limit (Appendix 1, indicator A.I.5c). The average person living in Finland receives the equivalent radiation dose from natural and spatial radiation sources in about 30 minutes.

A total of 300 samples were collected and analysed from the terrestrial and aquatic environment surrounding the Loviisa power plant during 2010. External background radiation and the exposure to radioactivity of people in the surroundings were also measured regularly. Extremely small amounts of radioactive substances originating in the nuclear power plant were observed in some of the analysed environmental samples. The amounts are so small that they are insignificant in terms of people's radiation exposure.

4.1.10 Emergency preparedness

STUK oversees the preparedness of the organisations operating nuclear power plants to act in abnormal situations. No such situations occurred at the Loviisa power plant in 2010.

The emergency preparedness arrangements at the Loviisa power plant fulfil the key requirements; this was verified during emergency preparedness inspection as part of the periodic inspection programme. The objects of the inspection included the preparedness organisation's resources, training and alert arrangements, revision of the structure and content of emergency preparedness instructions, and radiation measurements in the surroundings and meteorological measurements on-site. An emergency preparedness exercise for the Loviisa power plant and a rescue operation exercise for its surroundings were conducted in March. A personnel mustering exercise was organised at the Loviisa power plant in December. The power plant also organises fire training and drills, with the fire brigade of the plant and the fire and rescue services of the surrounding municipalities participating.

The Loviisa power plant, STUK and Eastern Uusimaa Fire and Rescue Services maintain preparedness for the eventuality of a nuclear accident at Loviisa. In 2010, training of the preparedness organisation continued on the tasks of actors and cooperation in a nuclear accident.

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 and personnel's competence in different areas by means of reviewing documents 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 operation did not cause a radiation hazard to the workers, population or environment. Occupational radiation doses and radioactive releases into the environment were low and clearly below the prescribed limits. The licensee has operated the Olkiluoto power plant in a safe manner and in compliance with YVL Guides. Emergency preparedness at the Olkiluoto power plant is in compliance with requirements.

According to the tests and inspections carried out, the condition of the containment and the primary circuit, which prevent the release of radioactive material into the environment, are in compliance with requirements. A minor fuel leak was detected at Olkiluoto 1 just before annual maintenance; the leak was located and the leaking fuel assembly was removed from the reactor. A minor fuel leak was also detected at Olkiluoto 2 during the 2009–2010 operating cycle; the leak was located and the leaking fuel assembly was removed from the reactor during annual maintenance. Soon after annual maintenance a new fuel leak was detected at Olkiluoto 2, which, according to monitoring measurements, has remained small. The detected leaks are insignificant for the radiation safety of the environment, because the radioactivity is contained in the primary circuit and inside the containment.

Plant operation has been systematic and in compliance with the operational limits and conditions (OLC) and guidelines. In the year under review, one reactor trip occurred as a result of the erroneous closing of an inner isolation valve on the main steam line during power increase after annual maintenance. Two exceptional events with safety implications were reported: a failure of a new type of electric pilot valve in the relief system and transfer of wrong fuel assemblies to the reactor building fuel pool. Both events were rated at level 1 on the International Nuclear Event Scale (INES). It was found that the reason for the relief system pilot valve failure was that the supplier had deviated from the requirements set for the product without TVO being aware of it. TVO has launched measures for ensuring that suppliers and subsuppliers become conscious of the requirements for supplies.

The overall impact of the events on plant safety was insignificant. TVO has prepared no root cause reports during the year and, on the whole, very few root cause analyses have been conducted during the past few years. In STUK's opinion, it would be worthwhile to conduct root cause analyses on a regular basis, both in order to find the root causes of events and to maintain and develop analysis methods.

Annual maintenance of the plant units was implemented as planned in terms of nuclear and radiation safety. Because a significant part of the modification design documents were submitted

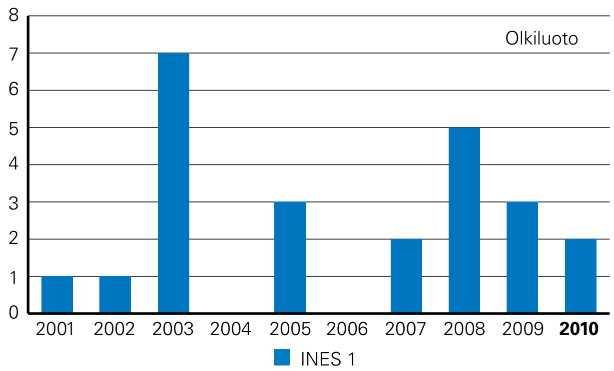


Figure 10. INES classified events at the Olkiluoto plant (INES Level 1 or higher).

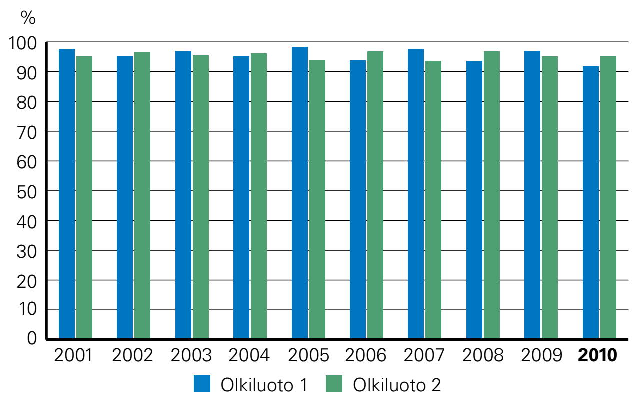


Figure 11. Load factors of the Olkiluoto plant units.

Operation and operational events

The load factor of Olkiluoto 1 was 91.8%, while that of Olkiluoto 2 was 95.2%. The annual maintenance outages have a major impact on the load factors. The outage at Olkiluoto 1 lasted for 26.5 days and the outage at Olkiluoto 2 lasted for 11.5 days. The losses in gross energy output due to operational transients and component malfunctions were 0.6% at Olkiluoto 1 and 1.4% at Olkiluoto 2.

***A reactor trip occurred at Olkiluoto 2** when the inner isolation valve of one main steam line closed when the reactor power was being increased after the annual maintenance outage. The isolation valve closed because its control valve opened. This, in turn, was caused by the unexpected opening of a connection in the nitrogen line. The investigations carried out led to the conclusion that the connection had been originally made incorrectly. Following the event, all other similar connections were inspected.*

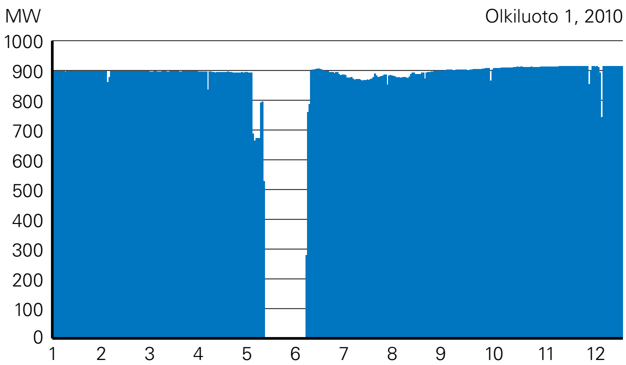
***Incorrect settings were detected in the I&C of main coolant pumps at Olkiluoto 1 and Olkiluoto 2** during the annual maintenance outage in the spring. This could have resulted in the main coolant pumps stopping quicker than planned in certain rare transient situations. This could have led to a temporary disturbance in fuel cooling.*

***A fault was detected in the electrical control valves of the blowdown system of Olkiluoto 1** in tests carried out before the annual maintenance outage. Three out of the five valves of new design had jammed due to oxidation of the coating material inside the control bush. Following the observation, corrective measures were also taken at Olkiluoto 2.*

***At Olkiluoto 2, one of the neutron flux measurements** in the reactor protection system was inoperable for about two weeks in August–September. The measurement was switched off for the duration of the periodic test carried out at the end of August so that the false alarms and functions caused by the test could be avoided. Contrary to the instructions, the bypass links were not removed after the test in spite of the fact that they were signed off on the work records as having been removed. The bypass was detected in conjunction with another periodic test about two weeks later, and the measurement was restored to operable condition. The measurement was not required during the time it was inoperable, as they are only used when the reactor power is less than 8%, and the power of the plant unit was higher than that during the whole period. The protection function would have been activated if required because the three other measurements were operable and two measurements are enough to trigger the protection. TVO will investigate the reasons for the event and also carry out a more extensive survey of methods used in the field. The corrective actions will be determined on the basis of the investigations.*

The events are described in more detail in Appendix 3.

to STUK only shortly before the start of annual maintenance and because their content did not comply with requirements, STUK requested TVO to improve its modification work and annual maintenance planning processes. With a view to improving planning, TVO has suggested corrective actions relating to improvement of preliminary planning of modification work and instructions for it, and training; these actions are to be implemented before the next annual maintenance in 2011.



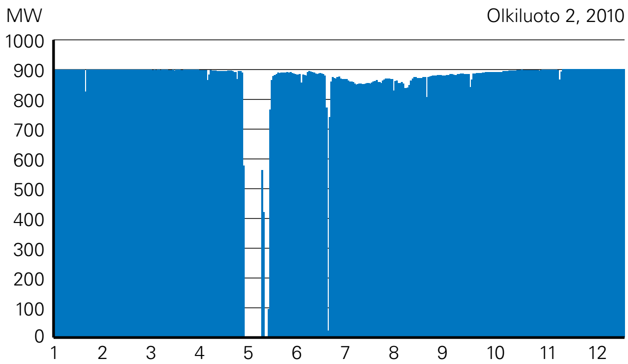


Figure 12. Daily average gross power of the Olkiluoto plant in 2010.

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

Event	Non-compliance with the OLC	Special report	INES rating
Incorrect settings in the I&C of main coolant pumps at Olkiluoto 1 and 2		•	0
Blowdown system failure at Olkiluoto 1 and repair outage at Olkiluoto 2		•	1
Use of a wrong fresh fuel delivery lot in fuel transfer planning at Olkiluoto 1			1

During the year, several modifications were implemented for plant safety improvement. A modernisation project extending over several years was launched at the Olkiluoto power plant. The project aims to prolong the plant's lifetime and to improve the plant's availability. At Olkiluoto 1, the implementation of the project started with the replacement of the inner isolation valves of the main steam system, upgrade of the low pressure turbines, modernisation of main service water pumps and the upgrade of the generator cooling water system. The project will continue in the coming years with the upgrade of the generator and the low voltage switchgear. At Olkiluoto 2, the implementation phase will start in 2011. TVO is also extending the spent nuclear fuel storage at Olkiluoto. At the same time, the storage structures will be modified in order to be in compliance with new safety requirements. Based on its inspection, STUK stated that the extension of the storage fulfils safety requirements in principle, after which TVO started the storage extension work.

With regard to ensuring plant safety, TVO's organisation has operated in a systematic and development-oriented way. TVO has a project underway on the management of human errors with the objective of improving the safety of the personnel and the plant. With regard to organisational operating processes, STUK has found both in periodic inspections and assessments of operational events that there are development needs not only in terms of improving modification work management but also in terms of the quality management of TVO's procurement process and ensuring competence in data security. With regard to personnel resourcing and competence, STUK has called attention to the fact that TVO does not employ a uniform procedure for outsourcing personnel resources and ensuring their competence, particularly in projects. On the other hand, other actions have been initiated and completed for better project management.

Annual maintenance at Olkiluoto 2

The refuelling and maintenance outage of Olkiluoto 2 took place during the period 2–14 May 2010. The outage lasted two days longer than planned. This was due to the repair of a fault detected in the safety I&C of main coolant pumps and faults in the fuel transfer machine.

Almost one-fourth of the nuclear fuel in the reactor was replaced with fresh fuel during the outage. In other respects, the work carried out consisted mainly of inspections, maintenance, repairs and tests of systems, components and structures. The most notable operations were the leak tightness tests of about two hundred containment isolation valves, the containment leak tightness test, control rod replacements and inspections as well as inspections of the low-pressure turbines and sea water condensers. The cracks earlier observed in the equipment are regularly monitored during annual maintenance outages. No new faults were detected during the annual maintenance of 2010, nor were there any changes in earlier indications.

During the 2009–2010 fuel cycle, a minor yet exceptional quantity of radioactive materials was detected in the reactor coolant, and it was assumed to be caused by a minor leak in fuel cladding. During the annual maintenance outage, all fuel assemblies were inspected and the leaking assembly was removed from the reactor.

4.2.2 Plant operation, events during operation and prerequisites of safe operation

Operational limits and conditions (OLC)

TVO has kept the operational limits and conditions of the Loviisa power plant up-to-date. In 2010, no situations were observed in which the plant would have been in non-compliance with the operational limits and conditions. STUK has inspected compliance with the operational limits and conditions

Annual maintenance at Olkiluoto 1

The maintenance outage at Olkiluoto 1 took place during the period 16 May–12 June 2010 and lasted approximately 26.5 days. The outage lasted about one day longer than planned. The delay was caused, among other things, by clarification of problems encountered in modification work on the turbine plant.

Major modification works were carried out during the annual maintenance outage. Of these, the ones significant to safety included the replacement of inner isolation valves of the main steam lines, replacement of pipes in the seawater systems and modernisation of the measurement of the radiation measurement system of one main steam line. The other major modification works included modernisation of the main seawater pumps, replacement of the low-pressure turbines and modernisation of the generator cooling system.

In addition to modifications, inspections, maintenance, repairs and tests of systems, equipment and structures were performed. Examples of these include the maintenance of safety system pumps, the leak tightness tests of almost two hundred containment isolation valves, the replacement of two main coolant pump motors with overhauled ones, the periodic inspections of electrical systems, the replacement of electrical switches and the inspections of pressure equipment. The inspections of level measurements of the reactor pressure vessel revealed that the impulse tubes were in need of cleaning. According to TVO, the deposits had not yet affected the operability of measurements and the measurement results during the previous fuel cycle. Following the observation, TVO will increase the frequency of inspections on the impulse tubes.

About one-fifth of the reactor fuel was replaced during the annual maintenance outage. The fresh fuel assemblies had been moved to the fuel pool in the reactor hall earlier in the spring to wait for their transfer to the reactor core. In early June, TVO realised that 36 fuel assemblies of the wrong delivery lot had been transferred to the pool. These assemblies were left in the fuel pool, and the correct assemblies were transferred from the store to the reactor. The fuel assemblies are not of identical composition, because different lots may differ from each other, for example, with respect to their uranium 235 content and neutron-moderating materials. It is important from the point of controlling reactivity that the different properties of fuel assemblies are taken into account. In this case, the properties of the wrong fuel assembly lot did not significantly differ from those of the correct lot, which is why the reactor safety would not have been compromised even if the subject lot of fuel had ended up in the reactor. TVO will develop its procedures so that similar events can in the future be prevented. The event was caused by an error in the document concerning the transfers of fresh fuel. The safety of the reactor or the employees was not compromised. On the INES scale, the event is rated at level 1.

Just before the annual maintenance outage, a minor yet exceptional quantity of radioactive materials was detected in the reactor coolant, and it was assumed to be caused by a minor leak in fuel cladding. The leaking assembly was located and removed from the reactor during the annual maintenance outage.

After the maintenance outage, the plant unit was synchronised with the national grid on 12 June 2010, but about three hours later, the unit was disconnected from the grid and a partial reactor trip occurred. This was caused by the settings of a generator cooling system flow meter that was replaced during the annual maintenance. The flow transmitters were replaced and the plant unit was re-synchronised with the national grid.

and the up-to-dateness of the document in conjunction with review of modifications and safety analyses, and when overseeing the tests and the licensee's operations at the plant. After the annual maintenance outages ended, STUK inspected whether the operational limits and conditions are up-to-date and the plant unit's state is in compliance with the operational limits and conditions prior to granting permission for unit start-up. TVO has continued development work on the operational limits and conditions for improving the justifications for requirements and clarifying the requirements.

During the year, TVO submitted to STUK for approval 21 amendment proposals for the operational limits and conditions. The amendments were mainly due to plant modifications such as the replacement of inner isolation valves on the Olkiluoto 1 main steam lines and the upgrade of the plant radiation measurement system. In these cases the requirements for the operation and testing of

Maintenance outages

Olkiluoto 2 had a maintenance outage during 24–25 June 2010 due to replacement of pilot valves in the blowdown system. The ten electrical pilot valves of the new type, installed in the blowdown system during the annual maintenance outage in May, were replaced because of the faults detected at Olkiluoto 1 (Section 4.2.3).

Olkiluoto 1 had a maintenance outage on 18 December 2010 due to the repair of a control valve in the fresh steam line leading to the reheater. The valve behaved erratically by closing a few times for a short while, which in turn caused an unbalance on the turbine side. The steam coming from the reactor is led from the HP turbine to the LP turbines via two reheaters. In the reheaters, the steam is dried and heated. Heating is performed in two steps in the reheaters: in the first step, heating is achieved by bled steam from the HP turbine and, in the second, by fresh steam. The subject control valve is in the fresh steam line leading to the second reheater. Closure of the valve causes an unbalance on the turbine side. The problems in heating the steam also affect the plant efficiency.

the devices differed from the requirements for the decommissioned devices. The operational limits and conditions were amended also on the basis of operational experience and the amendment needs observed in the periodic revision of the operational limits and conditions.

The power company applied for permission from STUK for 10 planned deviations from the operational limits and conditions (Appendix 1, indicator A.I.2). Five applications concerned modification work, two concerned the locating of fuel leaks and three testing and measurements. For example, in the three cases TVO wanted to make the plant radiation measurement system inoperable for the period of installing and testing the new devices in order to avoid unnecessary alarms and protection functions. Since the planned deviations had no significant safety implications, STUK approved the applications.

Operation and operational events

Plant operation has been systematic and in compliance with the operational limits and conditions. In the year under review, one event led to a reactor trip. Other significant events included a failure of a new type of electric pilot valve in the relief system, transfer of the wrong fuel assemblies to the reactor building, and a setting in the reactor coolant pump I&C.

STUK carried out four periodic inspections on plant operation, which focused on equipment failures, operational events, operations during annual maintenance and operating experience feedback activities. The requirements which came up in these inspections concerned, among other things, improvement of structural fire protection during annual maintenance, the placing of emergency exit signs, and the distribution and preparation times of event reports.

In 2010, the risk caused by detected component malfunctions, preventive maintenance and other events, which caused inoperability of components and system at the Olkiluoto 1 plant, was 11.4%, and at the Olkiluoto 2 plant 6.3%, of the expected value of the annual accident risk calculated using the plant's risk model. In addition to these causes, the risk was affected by initiating events; closing of the inner isolation valves of the main steam system at Olkiluoto 2 and the consequent reactor trip were classified as such. The risk increase caused by this initiating event was 21% of the expected value of the annual accident risk calculated using the risk model. The calculated values were higher than in 2009, but are still within the normal range. Among other component failures the most important were diesel generator failures.

Annual maintenance outages

Annual maintenance at the Olkiluoto plant units was carried out safely and all maintenance work was completed within the planned scope. Annual maintenance creates the preconditions for operating the power plant safely during the following operating cycles. Any safety-significant modifications must be approved by STUK before their implementation in annual maintenance. Because a significant part of the modification documents were submitted to STUK only shortly before the start of annual maintenance and because STUK concluded that their content was incomplete, STUK requested TVO to improve its procedures concerning modification work performed in annual maintenance and, in particular, its annual maintenance planning processes. STUK's periodic inspection carried out during annual maintenance focused on the use of the OLC and instructions, emergency exit signs for fire and emergency preparedness situations, and induction training of contractors. Based on the inspection, STUK identified a need for improvement in fire protection during annual maintenance, the up-to-dateness of instructions, and in the follow-up documenting of corrective actions defined on the basis of events. The representatives of contractors interviewed during annual maintenance felt that they had received sufficient guidelines and guidance for their work.

STUK used a total of 270 working days for the regulatory oversight of the annual maintenance outages, including oversight work performed by experts from various fields, such as equipment and system inspections at the plant site, and walkdown inspections. In addition, two resident inspectors worked regularly on site.

Fire safety

Ensuring fire safety was one of the focus areas of STUK's regulatory oversight of annual maintenance in 2010. A plant-specific guide was prepared for making observations at the power plant. The guide also helps inspectors other than those with fire prevention expertise to make observations concerning fire safety. Based on regulatory oversight, STUK required improvement of some structural fire protection arrangements during annual maintenance, such as the placing of emergency exit signs. STUK also noted that fire doors are sometimes unnecessarily chocked open, due to which compartmentalisation is lost. STUK required chocking to be removed.

TVO is improving plant fire safety by means of plant modifications based on the concept of continuous improvement. According to STUK's regulatory oversight, maintenance of the plant fire alarm and fire extinguishing systems has been carried out according to the condition monitoring programme.

4.2.3 Ensuring plant safety functions

No such failures were observed during the year in the plant's safety functions or in the systems, components and structures executing them which would have prevented the fulfilment of the safety function.

Failures of electric pilot valves of the relief system

In accordance with a periodic testing programme, TVO carried out testing of the relief train valves when Olkiluoto 1 was being shut down for annual maintenance. The function of the relief system is to limit reactor pressure via releasing steam generated in the reactor into the containment when the normal steam route to the turbine island is blocked. The system consists of a total of 14 pipelines. When tested, two relief valves did not operate as planned, hence TVO decided to inspect their electric pilot valves during the annual maintenance outage. The inspections revealed that three electric pilot valves had jammed. All three jammed valves were of a new type; five valves of the same type had been installed at Olkiluoto 1 the year before. All in all, there are 10 electric pilot valves, and five other electric pilot valves were of an old type. It was decided to upgrade the valves to make their maintenance at the plant easier.

The reason for the jamming was the oxidation of the internal coating material of the valve guide bushing. The manufacturer had changed the coating material without informing TVO. The chrome coating material was not suitable for the environmental conditions at the plant and started to become oxidized during the operating cycle. Corrosion products filled the space between the guide bushing and the valve piston, which made the valve jam. As a result of the pilot valve jamming, the main valve did not operate as planned either, and the main valve, which had opened during testing, had to be forced to close. TVO removed the new electric pilot valves from Olkiluoto 1 during annual maintenance, and reinstalled valves of the old type. Regardless of the jamming of the pilot valves, the function of the relief system (reactor overpressure protection) was not jeopardised, because, in addition to the electric pilot valves, the operation of the main valves is controlled by pressure-operated pilot valves. These were found to be in working order.

Ten electric pilot valves of the new type were installed at Olkiluoto 2 during annual maintenance carried out in early May before the failures at Olkiluoto 1 were observed. The working order for the valves installed at Olkiluoto 2 during annual maintenance was checked by carrying out testing during Olkiluoto 2 start-up. Because the valves installed at Olkiluoto 2 were of the same type as those at Olkiluoto 1, experience from Olkiluoto 1 presented a risk that the valves would fail in the 2010–2011 operating cycle. TVO decided to replace eight new valves with valves of the old type. The unit was shut down for the maintenance outage on 25 June 2010. Two valves were replaced with valves which had been modified after the failure. In these valves, the guide bushing coating is different, and the clearance between the guide bushing and the piston is bigger. The valves operated acceptably when they were tested during unit start-up and in periodic testing in November 2010.

The relief valve failure did not jeopardise the safety of the plant or its environment. On the INES scale, the event is rated at level 1. Following the event, TVO has launched measures to improve its supplier management.

Setting error in the reactor coolant pump I&C system at Olkiluoto 1 and Olkiluoto 2

During the 2010 annual maintenance outage, a setting error was detected in the safety I&C system related to the Olkiluoto 1 and Olkiluoto 2 frequency converters. As a result of this error, the pumps would have stopped sooner than planned in some rare common cause failure situations, which could have resulted in a heat transfer crisis for part of the fuel after a sudden stop of coolant flow. The function of the reactor coolant frequency converters is to supply the six reactor coolant pumps with the necessary power and control their rotation speed.

The detected error had been present in the I&C system since the commissioning of the upgraded I&C system. The fault was corrected by means of the replacement of components with components of the correct size on a frequency converter electronic board controlling the slowing of the speed. After the repair, the functioning of the I&C system was tested and ensured that it is in compliance with requirements. TVO submitted a special report to STUK. STUK reviewed and approved the report and oversaw the repair and testing activities at the power plant.

Diesel generator failures

When performing an emergency diesel generator test run on 18 August 2010, it was noted that the generator did not produce voltage. Based on a visual inspection by TVO, it was concluded that the generator exciter had failed. The exciter is located inside the generator. After the inspections by TVO, the generator was delivered to the service centre of ABB Oy Service, Nokia, for more detailed investigation. ABB found several instances of damage in the exciter. TVO submitted a repair plan for the repair, which was approved by STUK. Following the failure, TVO is preparing a plan for regular service and inspections of the generators.

Malfunction of the outer isolation valves of the steam lines

In 2009, a malfunction of the outer isolation valve on the main steam line was detected at Olkiluoto 1. It was caused by a gear on the actuator opening and closing the valve. The gear was broken by fatigue resulting from long use. All of these gears were replaced with new ones at Olkiluoto 1 and 2 after the malfunction had been detected. Some of the gears removed showed early signs of cracks due to fatigue. STUK required that TVO find out the reason for the gear damage and launch corrective measures. In late 2009, TVO submitted a report on the issue. Reducers of the broken type were manufactured in the 1990s and they have been installed on the actuators of the outer isolation valves since 1996. In 2000, the actuator manufacturer replaced the reducer in question with a new bigger gear. According to the manufacturer's calculations, the stress in the gears of the new reducer is smaller, which makes them last longer than the old model. TVO has had one reducer of the new type investigated with destructive testing. It was found in the inspection that the reducer fulfils the design requirements set for it.

Safe operation of the plant in offsite power grid voltage drop conditions

At the Oskarshamn power plant in Sweden, an analysis has been conducted of the effects of voltage drops of long duration on the pump motors in safety systems. TVO has conducted similar analyses at the Olkiluoto 1 and 2 units. The analyses were completed in 2010 and submitted to STUK for review. The review of the analyses by STUK is underway.

4.2.4 Integrity of structures and equipment

No significant faults or signs of wear were detected during 2010 in the integrity of equipment or structures critical to plant safety.

Fuel leakages at Olkiluoto 1 and 2

Just before the annual maintenance outage at Olkiluoto 1, a slight amount, but different from the normal situation, of radioactive substances was detected in reactor coolant; this was assumed to be due to a small leak in the fuel cladding. The leaking fuel assembly was located in annual maintenance and removed from the reactor.

Also in the 2009–2010 operating cycle of Olkiluoto 2 a small number of radioactive substances were detected in the reactor coolant; this was assumed to be due to a small leak in the cladding tube of one fuel rod. All fuel assemblies in the reactor core were inspected during annual maintenance. The leaking fuel assembly was located in the inspection and removed from the reactor. About two weeks after the unit start-up, however, a new fuel leak was observed. The magnitude and development of the leakage has been monitored throughout the operating cycle with regular measurements. The leak has remained small until the end of 2010.

Periodic inspections

The periodic inspections of registered pressure equipment were implemented according to plans for both plant units. Altogether 59 inspections of pressure equipment were carried out at Olkiluoto 1, 17 of these were in the inspection mandate of STUK. At Olkiluoto 2, all 10 were carried out by an inspection organisation, because the pressure equipment to be inspected belongs to Safety Classes 3, 4 and EYT. STUK oversaw the operations of the inspection organisation. No significant issues with safety implications were observed in the periodic inspections of the pressure equipment in 2010.

Pressure equipment manufacturers and inspection and testing organisations

A total of 19 nuclear pressure equipment manufacturers were approved for the Olkiluoto plant (plant units Olkiluoto 1, 2 and 3). STUK approved 22 testing organisations to carry out tests related to the manufacture of mechanical equipment and structures for the Olkiluoto plants and three inspection organisations to carry out inspections on structural plans of mechanical devices and structures, as well as structural and commissioning inspections. Testing operatives from two different testing organisations were approved to carry out periodic tests of mechanical equipment and structures pursuant to YVL 3.8.

4.2.5 Development of the plant and its safety

During the year, the Olkiluoto nuclear power plant implemented large modifications improving plant safety and the availability of the plant.

During the maintenance outage at Olkiluoto 1, the implementation of the PELE project (Plant Efficiency improvement Lifetime Extension) started with the replacement of the inner isolation valves of the main steam system, upgrade of the low pressure turbines, modernisation of the main service water pumps and the upgrade of the generator cooling water system. The project will continue in the coming years with the upgrade of the generator and the low voltage switchgear. At Olkiluoto 2, a corresponding upgrade project will be started during the 2011 outage.

The upgrading and repair project of the fine screening units in the sea water screening system, which started in 2007, was completed when the last of the eight screens was modernised. The radiation measurement system upgrading project continued, and one of the radiation measurement devices of the Olkiluoto 1 main steam system was upgraded in order to gather operating experience. The other three devices will be upgraded in annual maintenance in 2011.

It was observed in 2008 that the penetrations of pipes that led through the walls of emergency cooling system pump rooms, the so-called H rooms, had not been appropriately sealed. The penetrations were repaired immediately to ensure watertightness. In that case it was a temporary repair and the penetrations were replaced in 2010.

In 2009, STUK reviewed a periodic safety assessment of Olkiluoto units 1 and 2. In its decision on the periodic safety review, STUK required that TVO carry out an assessment of the application of the diversity principle at the power plant during 2010 and prepare an action plan for further development of the diversity principle for ensuring the safety functions. At the end of 2010, TVO submitted to STUK an overall report on the issue and an action plan. The actions include, among other things, a preliminary plan for removing residual heat via an alternative heat transfer route.

Replacement of the inner isolation valves of the main steam pipes at Olkiluoto 1

The main steam line isolation valves inside the containment were replaced at Olkiluoto 1 during annual maintenance in 2010. The corresponding Olkiluoto 2 valves are to be replaced during annual maintenance in 2011. The function of the valves is to isolate the reactor pressure vessel and prevent the loss of reactor coolant and releases of radioactivity outside the containment. The valves also function as a backup for the isolation valves outside the containment.

One reason for the valve replacement was the tendency of the old valves to close as the steam flow increases. In a situation where one valve closes, the steam flow through the other valves increases and this can make them close, too. The near simultaneous closing of all the steam line isolation valves causes a greater pressure rise and load on the reactor pressure vessel than the closing of one valve only.

The new valves are wedge gate valves, which operate on a medium (steam) and on pressurization principle. This type of valve does not have the risk of self closing caused by a steam flow increase. The factory acceptance test of the valves revealed that the partial stroke function intended for periodic testing did not operate as planned, and the partial stroke related parts were removed from the valves before their installation at the power station. Provisions have been made for reinstalling the partial stroke function, and it will be possible when the manufacturer has demonstrated through extensive factory acceptance tests that partial stroke functions as planned.

STUK reviewed and assessed the valve design documentation before manufacturing, oversaw that manufacturing was in compliance with requirements, oversaw the factory acceptance tests at the manufacturer's site, installation and test runs at the power plant. The test runs of the valves were carried out in June according to the test programme. Leak-tightness tests, valve movement tests in cold and hot state, and testing with steam flow at 60% power of the plant were carried out acceptably.

Upgrade of the plant radiation measurement systems

In a radiation measurement device upgrade project, practically all stationary radiation measurement devices will be replaced at Olkiluoto 1 and Olkiluoto 2. The first new devices were installed and operational in 2008. At the end of 2010, there were over 10 renewed stationary radiation monitors at each plant unit. In addition, several new devices have been installed for test operation while the old devices were still in use. Apart from the existing measurements, some completely new measurements will be installed in the project. The purpose of the test operation is to compare the measurement results of the new devices with the measurement results of the old devices. The aim has been to place the new devices in more representative places according to operating experience gained. Another aim has been to find alarm limit set values that would be optimal in terms of radiation safety and plant process monitoring.

In 2010, TVO continued the revision of the personnel monitoring system. A new system was installed in the outage building already in 2009. Most of the workers involved in annual maintenance go through the outage building. In 2010, the upgrade covered the separate access routes to the spent fuel storage, both plant units and the chemical laboratory. The radiation measurement system upgrade will still continue in the next few years.

Replacement of pipe penetrations in the emergency cooling system pump rooms

By the autumn of 2010, TVO replaced all rubber collar pipe penetrations below elevation +10 in the emergency cooling system pump rooms, the so-called H rooms, with type-approved fire and pressure penetrations. All in all, the modification involved over 60 penetrations. STUK had earlier made a remark to the power company about the condition of the penetrations. TVO examined all the similar original penetrations at the plant by means of testing and assessing their compliance with fire, ventilation and water-tightness requirements, and analysed the risks to plant safety. Based on the risk analysis results, the impact of the conditions of the penetrations was about 3% of the PSA model annual core damage frequency.

Replacement of low voltage switchgear

TVO has launched a project on the replacement of the low voltage distribution system switchgear at Olkiluoto 1 and 2 (the SIMO project). The reason for the replacement is the growth of the maintenance costs due to ageing and a need to modernise the switchgear to fulfil present-day requirements for plant and personnel safety. The replacement project is mainly targeted at switchgear and related transformers for electric power systems important to safety. TVO replaced the medium voltage switchgear (6.6 kV) in 2005 and 2006. Voltage in the units' low voltage grids range from 24 V DC to 660 V AC. The switchgear supply power to the electric and I&C systems and devices of the units.

In the 2010 annual maintenance outage, TVO carried out the first switchgear installations in an electric power system which is less important to safety. The objective was to gain experience from switchgear installation and commissioning. TVO is planning to start the installation and commissioning of the switchgear important to safety during annual maintenance at Olkiluoto 2 in 2011. The project will be mainly implemented during annual maintenance outages and it will last several years.

4.2.6 Spent nuclear fuel storage and low- and intermediate-level waste

STUK inspected, in accordance with the periodic inspection programme, the low- and intermediate-level waste management and final disposal of waste materials at the Olkiluoto power plant. The inspection of low- and intermediate-level waste management focused on the situation of waste management development projects, waste accounting, organisation and guidelines. The inspection concerning the final disposal facility for low- and intermediate-level waste focused on the maintenance procedures for the concrete and rock structures of the final disposal facility. No significant issues with safety implications requiring rectification were observed in the inspections.

> ***Volumes of nuclear waste***
>
> *The volume of spent nuclear fuel on-site at the Olkiluoto plant at the end of 2010 was 7,436 assemblies (1,316 tU, tonnes of original uranium), an increase of 224 assemblies (39 tU) in 2010.*
>
> *At the end of 2010, the total volume of finally disposed of low- and intermediate-level waste was 5,315 m³. The total increase in volume from 2009 is 127 m³. Approximately 81% of the waste has been finally disposed of.*

The treatment, storage and final disposal of low- and intermediate-level waste ("plant waste") at the Olkiluoto power plant were carried out as planned and no significant events in terms of plant or environmental safety were evident. The volume and activity of low- and intermediate-level waste in relation to generated electrical power remained relatively low compared with most other countries. Contributing factors include the high quality requirements for nuclear waste management and nuclear fuel, the planning of maintenance and repair operations, decontamination, component and process modifications, as well as waste monitoring and sorting, which enable some of the waste with a very low radioactive substance content to be cleared from control. In 2010, maintenance waste below the activity limits to be taken to the local landfill for burial, waste oil to be delivered to Ekokem Oy, recycling metal and scrap metal and a site hut delivered for reuse were cleared from control with STUK's approval. In addition, the power plant employs efficient procedures for reducing the volume of waste subject to final disposal. In May, TVO delivered the decommissioned reheaters stored in the plant area to Studsvik Nuclear AB, Sweden, for treatment. Radioactive material was separated in the treatment process and it will be returned to TVO for final disposal in Olkiluoto. The remaining metal will be cleared from control and delivered to recycling. STUK approved TVO's transport licence applications and transport plans for transporting the reheaters to Sweden and returning the separated radioactive waste to Olkiluoto.

Provisions for the costs of nuclear waste management

Pursuant to Section 88, Subsection 2 of the Nuclear Energy Act, TVO submitted waste management schemes to the Ministry of Employment and the Economy at the end of June. The waste management schemes include data about radioactive waste generated by the end of each year, measures and costs. The schemes also included an estimate of the situation in 2013–2014. TVO has to supplement the waste management schemes and related calculations every third year.

STUK reviewed the documents submitted in compliance with the Nuclear Energy Act and provided the Ministry of Employment and the Economy with a statement on them. In its statement, STUK assessed the technical plans and cost estimates on which the financial provision is based and considered them appropriate. TVO's extent of liability is EUR 1179.1 million at 2010 prices. A total of EUR 44.8 million has been reserved for regulatory oversight costs. TVO's share of this sum is EUR 25.6 million.

It has been estimated that the cost of decommissioning will be EUR 177.3 million at late 2010 prices. The volume of waste for final disposal will amount to about 26,600 m^3.

Other plans for nuclear waste management

In accordance with Section 74 of the Nuclear Energy Decree, TVO submitted a report on the plans for the implementation of nuclear waste management activities to the Ministry of Employment and the Economy at the end of September. The report contains a detailed plan for the next three years and a general account of the measures planned for the next six years. STUK issued a positive statement on the material to the Ministry of Employment and the Economy on 5 October 2010. The plan will be updated every third year.

Development projects underway or under planning relating to nuclear waste management, spent nuclear fuel storage and decommissioning include, among others, the following projects. The Olkiluoto power plant is preparing plans for arranging operating waste management for the Olkiluoto 3 unit. The power plant also has several of long-term tests in progress with a view to ensuring the safety of final disposal. The Olkiluoto power plant is increasing spent fuel interim storage capacity by means of extending the spent fuel storage. A new project involves an assessment of the technical impacts of higher fuel burnup and its impact on total costs of nuclear waste management. At the Olkiluoto power plant, new studies relating to decommissioning include the effect of the clearance limits of the latest regulatory requirements on the scope of dismantling and the first decommissioning plan for Olkiluoto 3.

The extension of spent fuel storage

TVO is extending the spent nuclear fuel storage at Olkiluoto (so-called KPA Storage) with three additional pools. At the same time, the storage structures will be modified in order to be in compliance with new safety requirements. The capacity of the Olkiluoto spent fuel storage will be sufficient until 2014; the extension will increase the capacity for spent fuel from the Olkiluoto units 1–3. At the end of 2009, TVO submitted applications documents concerning the extension of the storage to STUK for approval.

The extension of the storage is designed to fulfil new safety requirements, the most important among which include a requirement to withstand a crash by large civil aircraft and seismic requirements. In conjunction with the extension, the structures of the existing storage will also be taken into account for fulfilling requirements. In connection with the safety assessment of the storage, STUK reviewed the needs to update earlier design bases and safety analyses, the resources and operating methods of TVO's project organisation, structural design bases for the storage and the procedures employed by TVO for ensuring the safety of the operating storage. Based on its review, STUK stated that the extension of the storage fulfils safety requirements. During construction, STUK will review, among other things, the detailed design bases for aircraft crash protection and a description of how the extension will be fitted with the operating storage.

In 2010, TVO carried out the excavation of the storage bottom rock and started to build the concrete structures by levelling the bottom and pouring the base slab. The construction of the concrete structures is supervised by an inspection organisation approved by STUK.

4.2.7 Functioning of organisations 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. In terms of the functioning of the organisation, STUK evaluated selected topics relating to the structure, processes and resources of the organisation during the year under review. In 2010, TVO did not make any changes with important safety implications to its organisational structure.

TVO has a project underway on the management of human errors with the objective of improving the safety of the personnel and the plant. Among other things, the project aims to develop work kick-off and closing meetings and make them part of well-established operations in 2012. With a view to improving human activities, TVO commissioned a survey of training impact evaluation, which was required by STUK in 2009. The survey was to gather information about of different methods and experiences and to identify development areas in TVO's functions. The survey provided good basic information for further development of training activities and training impact evaluation.

With regard to organisational operating processes, STUK has found both in periodic inspections and assessments of operational events that there are development needs in TVO's procurement process, modification management and data security management. Observations concerning modifications and development activities launched by TVO are discussed in more detail in chapter 4.2.5.

In order to improve the procurement process, TVO has to pay attention to the functioning of the process and its quality management. TVO must improve and clarify the assessment of the suppliers' and subsuppliers' conformity, definition of the requirements for the products to be procured, communication of requirements to suppliers and exchange of information with suppliers and subsuppliers so that TVO could be sure that it and the supplier of a product and its subsuppliers have a shared understanding of the requirements for the product and of product quality management. STUK has required stronger management of the supply chain, because this has a fundamental impact on the safety and successful implementation of modifications.

With regard to personnel resourcing and competence, STUK has called attention to the fact that TVO does not employ a uniform procedure for outsourcing personnel resources and ensuring their competence, particularly in projects. STUK required TVO to improve its project management procedures in these areas. TVO is currently taking action to improve project management. As a result of STUK's regulatory oversight, it has also become evident that TVO has to clarify the duty descriptions of key roles which are fundamental for data security and related competence and training needs. In addition, TVO has to assess whether its data security training is sufficient and to create a follow-up procedure for ensuring sufficient data security expertise in TVO's organisation.

STUK participated in examinations of shift personnel where the operators working in the control rooms prove that they are conversant with all salient matters related to plant operation and safety. STUK approved 27 operator licences for Olkiluoto 1 and Olkiluoto 2 and granted four new trainee operator licences in 2010. In the second half of 2009, as part of control room work, the control room personnel tested so-called supervised rest, which aims at improving alertness levels. Persons working the night shift were offered an opportunity to take a rest break, half an hour at the most. The experiences gained were good, so the practice was made permanent with STUK's approval in 2010.

4.2.8 Operating experience feedback

STUK assessed operating experience feedback activities and corrective actions on the basis of submitted reports, oversight visits and inspections within the periodic inspection programme. During the year under review, two INES level 1 events occurred: failures of a new type of pilot valve in the relief system and an error in transfer of fresh fuel. The power company did not prepare root cause reports on the events and, in general, no root cause analyses were submitted during the year. On the whole, TVO has conducted very few root cause analyses during the past few years. The use of root cause analysis methods in performance development has substantially declined, and the methods have not been maintained or further developed. It would be worthwhile conducting root cause analyses on a regular basis to ensure thorough assessment of events and to develop analysing activities and maintain competence.

At TVO, operating experience feedback reports are processed by an operating experience team (KÄKRY). The team gives recommendations to the line organisation, which makes the necessary decisions on implementation. TVO will develop the operating experience database (OPEX) so that it will better serve users' needs focusing on systems governed by the operational limits and conditions, improving its user-friendliness and reporting functionalities. Corrective actions taken in consequence of events are monitored with the KELPO application, which is also currently under further development.

A total of 20 analyses were conducted for unexpected operation-related events which occurred in 2010; of these 12 event reports and two special reports were submitted to STUK. TVO has improved the preparation of event reports, for example, by means of increased follow-up of preparation and setting deadlines for it.

TVO has elaborated its international operating experience feedback procedures to be well-functioning and started the screening of IRS reports coming from the IAEA database by the operating experience team (KÄKRY), among other things. In screening international operating experience (WANO, IRS and NRC reports) and its assessment, TVO used to draw strongly on EFRATOM, an operating experience organisation jointly established by Swedish power companies, Westinghouse, and Vattenfall Group's training centre (KSU). EFRATOM's screening criteria have been found to be insufficient for the needs of Olkiluoto 3. Operating experience feedback activities have also been included in the training programme for the Olkiluoto 3 operating personnel. TVO intends to develop the operating experience database into a tool to be used of by all TVO employees.

STUK reported the electric pilot valve failure observed in the Olkiluoto 1 relief system to an operating experience feedback database maintained by the IAEA. During 2010, EU Clearinghouse prepared a Topical Study report on the malfunctions of the electrical systems at Olkiluoto 1 and Forsmark 2. A decision to prepare the report had been made in the meeting of the Technical Committee of the IRS coordinators of the IAEA. Experts from STUK, TVO and the Swedish Radiation Safety Authority (SSM) were involved in the preparation of the report.

4.2.9 Radiation safety of the plant, personnel and environment

Occupational radiation safety

STUK carried out a radiation protection inspection according to the periodic inspection programme at the Olkiluoto power plant, focusing on employees' radiation protection in particular. In the inspection, STUK inspected radiation protection methods and procedures, guidelines, work planning and operations of the contractor carrying out radiation protection work. Based on the inspection, STUK required TVO to provide a clarification of its quality control concerning the contractor carrying out radiation protection in annual maintenance and TVO's supplier approval procedure for the contractor.

The dosimeters used for measuring the occupational radiation doses underwent their annual test. The test comprises 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 specific radiation protection inspections during the annual maintenance at the Olkiluoto plant units. In the inspections, STUK assessed the radiation protection personnel's operations, training and resources. At the same time, STUK assessed the operations of employees in radiation work performed in the controlled area. Based on the inspections, it was stated that the power plant's radiation protection functions in an acceptable way. Radiation protection personnel resources were better than normal because the operating personnel of Olkiluoto 3 provided labour force for radiation protection. In addition, the power plant introduced technical and IT administration improvements in radiation protection, which made it possible to control occupational radiation doses and contamination better than before. During the inspections, observations were made of individual issues for improvement relating to the use of protective equipment and to shoe boundaries. STUK will continue to assess radiation protection resources, the use of protective equipment in radiation work and the functioning of the shoe boundaries in its future inspections.

Double monitoring of personal contamination was introduced to the exit routes from the controlled area of the Olkiluoto power plant units, laboratory and spent fuel interim storage in the spring of 2010. For the first time, the new monitoring arrangement was put into operation in the outage building the year before. The modification served to unify the exit arrangements from the controlled area and improve personal radiation safety. An employee has to measure himself or herself twice. The first measurement controls the cleanliness of the protective equipment. The second measurement checks the person for external or internal contamination.

Table 4. Radioactive nuclides originating from the Olkiluoto power plant, found in the environmental samples.

Number of environmental samples containing radionuclides originating from the NPP (several different nuclides may be found in the same sample)

Type of sample	H-3	Mn-54	Co-60	Total
Aquatic plants	–	6	11	17
Sedimenting materials	–	–	8	8
Seawater	1	–	–	1
Air sampling	–	–	2	2
Fallout	–	–	2	2
Total	1	6	23	30

Radiation doses

The workers' collective occupational radiation dose was 0.71 manSv at Olkiluoto 1 and 0.19 manSv at Olkiluoto 2. According to STUK's YVL Guide, the threshold for one plant unit's collective dose averaged over two successive years is 2.5 manSv per gigawatt of net electrical power. After the power upgrade, it means a dose value of 2.20 manSv at Olkiluoto 1 and 2.15 manSv at Olkiluoto 2. This limit value was not exceeded at either plant unit.

The collective dose of the Olkiluoto workers was the lowest in the history of the power plant, regardless of the maintenance outage at Olkiluoto 1,

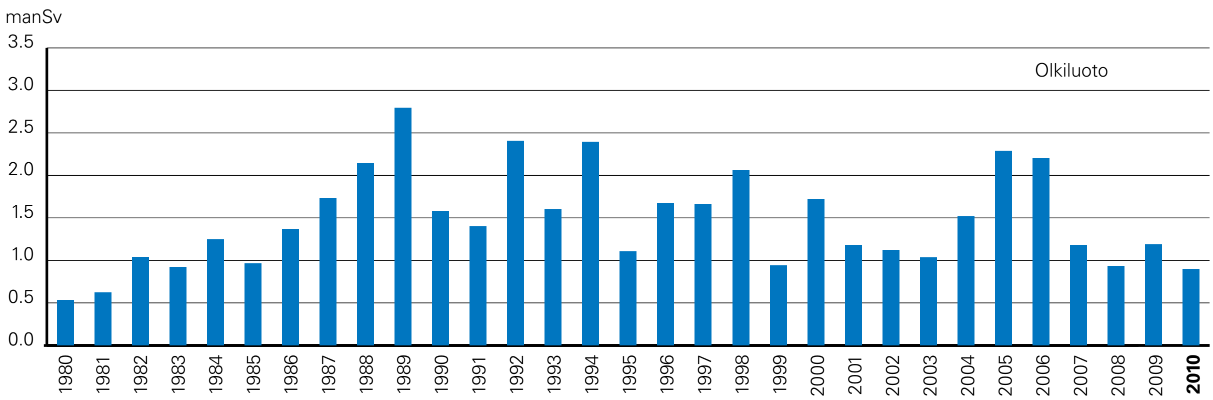


Figure 13. Collective occupational doses since the start of operation of the Olkiluoto units 1 and 2.

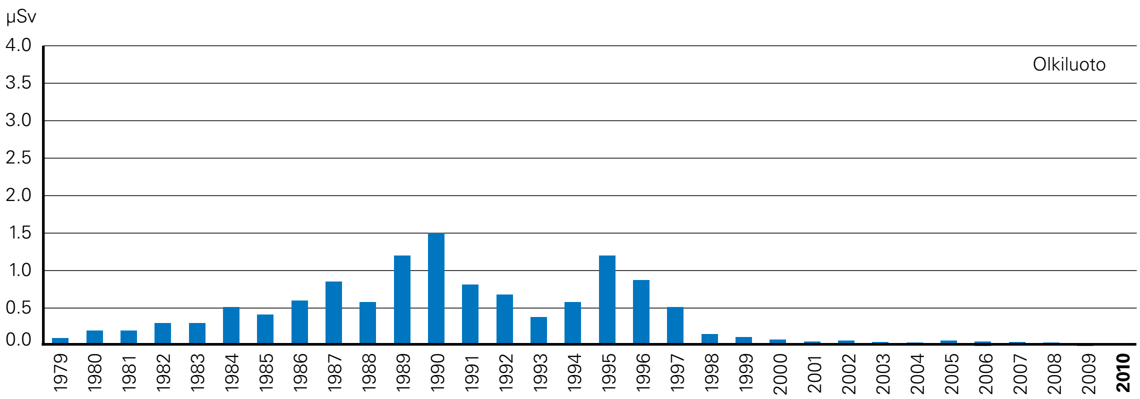


Figure 14. Annual radiation doses to the critical groups since the start of operation of the Olkiluoto units 1 and 2. Over the recent years, the doses to the critical groups has remained below one percent of the set limit, 0.1 milliSv.

which was very extensive in terms of the number of personnel and amount of work involved. The collective radiation dose of the Olkiluoto power plant workers was clearly below the average collective radiation dose for workers working on BWRs in the OECD countries.

Occupational radiation doses of nuclear power plant workers mostly accumulate in work carried out during annual maintenance outages. The collective radiation dose due to operations during the outage at Olkiluoto 1 was 0.64 manSv, and the collective radiation dose due to operations during the outage at Olkiluoto 2 was 0.13 manSv. The radiation levels at the turbine plants also continued to decrease thanks to the new steam dryers. The new dryers installed in 2005 and 2006 remove moisture from the steam effectively, and they clearly reduce the transportation of radioactive substances to the turbines.

The highest individual radiation dose incurred during the annual maintenance outages amounted to 9.0 mSv at Olkiluoto 1, and to 1.3 mSv at Olkiluoto 2. The highest individual radiation dose incurred during the outages at both plant units amounted to 9.1 mSv. The highest individual radiation doses at Olkiluoto have been less than 10 mSv during the last four years. The individual radiation dose distribution of workers at the Olkiluoto and Loviisa nuclear power plants in 2010 is given in Appendix 2.

Radioactive releases and environmental radiation monitoring

The measurement results of the replaced monitoring sensors of the weather mast on-site were assessed in cooperation between STUK, the Finnish Meteorological Institute and TVO. The new sensors which were introduced in late 2008 and the data transmission have functioned well, with the exception of individual device failures in 2010.

Radioactive releases into the environment from the Olkiluoto nuclear power plant were well below authorised annual limits in 2010. Releases of radioactive noble gases into the air were approximately 0.6 TBq (as Kr-87 equivalent radioactivity), which is approximately 0.003% of the authorised limit. Releases of iodine into the air were approximately 94 TBq (as I-131 equivalent radioactivity), which is approximately 0.1% of the authorised limit. The emissions through the vent stack also included radioactive particulate matter amounting to 12 MBq, tritium amounting to 0.3 TBq and carbon-14 amounting to approximately 0.7 TBq.

The tritium content of liquid effluents released into the sea, 1.5 TBq, is approximately 8% of the annual release limit. The total activity of other radionuclides released into the sea was 0.2 GBq, which is about 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 about 0.03 microSv, i.e. less than 0.03 % of the set limit (Appendix 1, indicator A.I.5c). The average person living in Finland receives the equivalent radiation dose from natural and spatial radiation sources in about 15 minutes.

A total of 300 samples were collected and analysed from the terrestrial and aquatic environment surrounding the Olkiluoto power plant during 2010. External background radiation and the exposure to radioactivity of people in the surroundings were also measured regularly. Extremely small amounts of radioactive substances originating in the nuclear power plant were observed in some of the analysed environmental samples. The amounts were so small that they were insignificant in terms of public radiation exposure.

4.2.10 Emergency preparedness

STUK oversees the preparedness of the organisations operating nuclear power plants to act in abnormal situations. No such situations occurred at the Olkiluoto power plant in 2010.

The emergency preparedness arrangements at the Olkiluoto power plant fulfil the key requirements; this was verified during emergency preparedness inspection as part of the periodic inspection programme. The objects of the inspection included the preparedness organisation’s resources, training and alert arrangements, revision of the structure and content of emergency preparedness instructions, and radiation measurements in the surroundings and meteorological measurements on-site. The inspection also concerned preparedness training of the contractors and workers working in the annual maintenance of the operating plant units and on the Olkiluoto 3 and Onkalo construction sites. Fire training and drills are also organised, with the fire brigades of the plant and the fire and rescue services of the surrounding municipalities participating. An emergency exercise was conducted at the Olkiluoto nuclear power plant in November. At the same time, it was a nuclear security exercise with participants from the power plant, from STUK, the fire and rescue service, and the police.

Cooperation between the licensee and the authorities for maintaining emergency preparedness has continued in a cooperation group which started to plan an exercise which would involve emergency preparedness at the Olkiluoto power plant and rescue operations in its surroundings. The exercise is to be conducted in 2011.

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 is based on the observations made by STUK in the review of plans, the oversight of manufacturing, construction and installation, results of the construction inspection programme during construction, oversight of the plant vendor and its subcontractors, as well as experience acquired as a result of interactions between STUK, TVO and the plant vendor.

Detailed design of the plant systems continued in 2010. To some extent the plans still do not meet the objectives set for them in terms of quality and content, and hence STUK required further clarification of the plans. At the end 2010, design of the systems was still unfinished, especially that of the I&C systems and some individual equipment—for example, the fuel handling equipment. A key area, which requires actions by the licensee and the plant vendor are the failure analyses for the process, electric and I&C systems, which prove the fulfilment of the design bases.

Regarding the I&C systems, STUK is still waiting for the design of overall architecture preceding system design to be supplemented with unambiguous requirements for design, and that the I&C architecture created on the basis of the requirements is described. In 2009, STUK required that the requirements set in STUK's regulatory guides and decisions for the independence of the redundant I&C systems and for the failure criteria to be conformed with are taken into account in design. STUK also required that the realisation of the requirements for independence and failure criteria must be demonstrated by means of analyses. At the end of 2010, these issues remain unsettled. Yet in the documents received so far, STUK has not identified any needs for changes in architecture level solutions which the licensee would not have promised to implement in its reports. The plant vendor and TVO must pay special attention to the completion of the design and assessment of the I&C systems, and to compliance with safety requirements.

Construction work at the plant site is near completion. The inner containment was post-tensioned during 2010. The cylindrical part of the containment has also been concreted. Concrete construction has proceeded almost without problems, and the procedures created for determining readiness for concrete casting have been proven to function well. These procedures have served to ensure that the plant vendor and TVO have inspected and approved the structure to be concreted and the plans for the concreting before STUK is requested to give permission to start the work.

Installation of platform and support steel structures inside the buildings has also started. The safety significance of the platforms has increased, because, in contrast to the original designs, pipings and devices with significant safety implications are supported on them. STUK has observed several needs for clarifications and supplementing in the design and structural plans of these steel platforms. This has led to a situation in which there are steel platforms on the construction site for which the construction inspections and installation are waiting for the structural plans to be supplemented, and partly also for reinforcement of the structures.

Several non-conformances were detected in the manufacture of mechanical equipment in 2010. In the background of the manufacture quality problems one can find several deficiencies in the flow of information between organisations, familiarity with nuclear industry requirements and their communication, and in follow-up of procedures relating to quality management. With a view to planning effective corrective and preventive actions, STUK required that the licensee settle the observed quality problems in addition to the technical problems.

Installation of the primary circuit and other equipment and pipelines important to the safety continued in 2010. By the end of the year, the primary circuit equipment had been installed with the exception of one primary circuit hot leg and steam generator. No significant quality management non-conformance was observed in installation of the main mechanical components of the nuclear island. In the inspections of electric cabling, it was noted that installation had not been performed fully in compliance with principles approved by STUK to separate safety-classified cables from other cables. STUK required that cabling be made to comply with the approved plans and that TVO intensify its supervision.

In 2010, STUK carried out a second follow-up inspection concerning the assessment and improvement of the safety culture at the Olkiluoto 3 construction site. Based on the inspection, STUK stated that TVO and the plant vendor have organised and created systematic procedures for monitoring and assessing the safety culture at the Olkiluoto 3 construction site. STUK required, however, that in addition to the actions taken for assessing and improving the safety culture TVO must clarify the development needs for quality management, organisations' operations and the safety culture lying behind the construction quality problems and deviations. According to the non-conformance management procedures applied by STUK in the project, non-conformances are divided into technical and functional non-conformances. In its regulatory oversight STUK has observed that as a result of this division the processing of technical non-conformance is limited to their technical processing and correction. As a rule, no effort is made to identify the deficiencies which lie behind technical non-conformance and relate to quality management, operations or safety culture of the organisation involved in the supply. As a result of this, corrective or preventive actions which are necessary in terms of development and conformance are neither defined nor implemented. In 2011, STUK will follow the development of the safety culture at the Olkiluoto 3 construction site and the effects of the development measures.

During construction, TVO and the plant vendor have been able to take into account the modification needs which have emerged as design of the different technical areas has become more detailed. Manufacturing and installation defects have either been corrected so that the original quality requirements are fulfilled, or it has been demonstrated by means of additional inspections or analyses that the requirements are fulfilled. The deficiencies in the work of different parties and in product quality have resulted in additional work to assess and solve the problems. This has had an impact on the progress of the project, not on the fulfilment of its quality requirements. In summary, based on the results of regulatory activities, STUK can state that the original safety objectives of the plant can be achieved.

4.3.2 Design and planning

Plant and system design

STUK continued to review the overall architecture of the I&C systems. STUK has required that TVO and the plant vendor specify unambiguous requirements for the design of the I&C system overall architecture, and that the I&C architecture created on the basis of the requirements is described. The architecture descriptions submitted to STUK require supplementing especially with regard to the presentation of the connections between the I&C systems. In terms of safety, it is particularly important to specify unambiguous requirements for the independence of different I&C systems involved in the architecture, because different I&C systems back each other up. Another issue with particular safety significance has been the specification of the failure criteria to be observed in the I&C systems—the internal redundancy of the systems improves the reliability of their operation in case of device and other failures. STUK has also required that the realisation of the requirements for independence and failure criteria must be demonstrated by means of analyses. These analyses have not been submitted to STUK so far.

STUK mainly completed the review of the reports on internal and external hazards and their updates. The analyses showed that the separation principle decided on earlier allows the consequences of internal and external hazards to be minimised.

STUK continued to review the detailed design of process, auxiliary and electrical systems. In 2010, the main part of the final system design of the process, ventilation and electrical systems was reviewed. The most important deficiency found in the review concerned the common cause failure analysis of the systems and their independence from each other. STUK required the analysis to be further defined for ensuring the realisation of the diversity principle in the implementation of the plant safety functions. STUK received no update of the analysis during 2010. STUK still continues to review some system descriptions and some system descriptions are expected to be updated according to STUK's decisions.

Transient and accident analyses

In 2010, STUK reviewed an analysis of the cooling of the spent fuel pool in a situation in which the normal cooling system does not function. STUK required that the analysis be supplemented with more detailed data of the assumptions and their justifications used in the analysis. In addition, STUK requested to submit for approval the description of release dispersion and dose calculation computer codes used in the analysis. STUK also reviewed an analysis which presents the behaviour of the Olkiluoto 3 unit in a malfunction of the normal main grid connection. In this case the plant power supply will be provided via an offsite backup supply connection. The analysis submitted to STUK was preliminary, and STUK will continue to review the issue with the final analysis.

Probabilistic risk analyses (PRA)

During 2010, STUK did not engage much in the review of probabilistic risk analyses (PRA) of Olkiluoto 3, because these materials were not submitted to STUK as provided by a schedule presented earlier. Furthermore, the PRA documentation which has been submitted for information will change as the design becomes more detailed. For the aforementioned reason, STUK continued to assess the realisation of the fundamental design principles affecting plant safety in the detailed design documentation for systems and structures in 2010. The main documents consisted of system preinspection documents, topical reports and structural plans for the fuel handling systems. In addition, the aim has been to ensure that adequate provisions have been taken against internal events (such as internal fires and flooding) and external events. As for the PRA documentation which has been submitted for information, the scope of the documentation has been assessed, especially that of the level 2 PRA, which had the most serious deficiencies at the construction licence application stage.

Radiation safety

As part of its inspection of process systems, STUK reviewed the requirements for radiation safety, such as radiation shielding, equipment layout, accessibility and decontamination possibilities. STUK reviewed and approved the reports on concentration of radioactive substances in the systems, radiation shielding in rooms and radiation classification of rooms, and radiation protection in accidents.

The Ministry of Employment and the Economy submitted to the European Commission the data on radioactive releases and waste from Olkiluoto 3 referred to in Article 37 of the Euratom Treaty in January 2010. A Commission Expert Group meeting was held in Luxemburg on 14–15 April 2010, in which representatives from the Ministry of Employment and the Economy, STUK, TVO and AREVA participated on behalf of the Olkiluoto 3 project. On 28 July 2010, the Commission issued a statement concluding that the implementation of the plan for the disposal of radioactive waste from the Olkiluoto 3 unit is not liable to result in the radioactive contamination of the water, soil or airspace of another Member State.

Fire safety at the plant

STUK reviewed structural fire hazard analyses (FHA), the purpose of which was to demonstrate that the plant fire compartment structures will withstand the fire loads in all potential fire situations. In addition to the structural fire hazard analyses, STUK received for review fire hazard functional analyses (FHFA) showing the impact of fires on the safety functions of the plant. STUK required an interface analysis of the method descriptions of fire hazard functional analyses (FHFA) and probabilistic fire analyses (fire PRA) to be conducted for ensuring that no principal contradictions remain between the two analyses. In addition, STUK required an assessment to be made of the adequacy of the fire compartmentalisation in large cable rooms in case of fire protection system failures in situations when, for example, fire dampers will not close and ventilation remains in operation.

VTT Technical Research Centre of Finland continued to investigate the fire safety of the fire-retardant (Fire Retardant Non Corrosive, FRNC) power and I&C cables to be installed at Olkiluoto 3. The fire characteristics of the FRNC cables proved to be better than what VTT estimated on the basis of the first tests in 2008. Based on VTT's study completed in 2009, it was concluded that the fire retardant characteristics of the tested cables are sufficient in design basis situations for cable rooms, and that the projected fire compartmentalisation is sufficient. A corresponding study of FRNC type instrumentation cables was conducted in 2010. VTT will submit to STUK a summary report on the FRNC cable studies and validation of a cable fire model in March 2011. After that, STUK will conduct an overall assessment of the acceptability of the fire risk of FRNC cables.

The plant vendor and the power company concluded that flooding caused by a possible rupture in the fire water pipeline in the annulus space between the inner and outer (structural protection against aircraft crash) containment walls threatens plant safety functions. A plan for reducing the flooding risk from the fire water system in the annulus space was submitted to STUK for review. STUK reviewed the plan in 2010 and required some clarifications of the flooding risk analyses, among others, in relation to the operator's actions.

Design of components and structures

STUK continued the review of detailed plans for Safety Class 2 components and structures in 2010. The key objects of this review were the construction and work plans of concrete and steel structures, as well as the construction plans of pressure equipment.

STUK has reviewed and approved nearly all construction plans of the safety classified concrete structures. In contrast, a considerable part of the design documentation for the steel platforms which were originally intended just as service platforms still remains to be reviewed. The safety significance of the steel platforms has increased, because, in contrast to the original designs, pipings and devices with significant safety implications are supported on them. This concerns about 150 steel platforms. STUK has reviewed design documentation for these steel platforms and observed several deficiencies, which also partly require structural changes.

STUK continued to review the final strength analyses for the main components of the primary circuit in 2010. Supplementary and revision documents for the strength analyses were submitted to STUK; these documents include the changes made during manufacturing. The review of pre-service inspection programmes for the in-service inspections and periodic inspection programmes of pressure vessels, heat exchangers, pumps, valves and pipelines, and qualification documents for inspection systems as per Guide YVL 3.8 continued during 2010.

Design of the nuclear island pipelines continued during 2010. STUK received for review a considerable amount of documentation relating to the isometrics, supporting structures and stress analyses of pipelines, and construction plans for Safety Class 1 and 2 valves. In 2010, the volume of STUK's review work increased as a result of the great number of revision materials; the revisions concerned valve documents in particular.

During 2010, STUK reviewed the design documentation of the fuel handling system and its revisions. Design of the electrical and I&C systems of the fuel handling system and Safety Class 3 cranes continued in 2010. No required electrical or I&C design documents were submitted to STUK for assessment. Safety Class 3 cranes were put to installation use on the Olkiluoto 3 construction site before the design documents of the electrical and I&C system were approved, which is required by the safety classification. The procedures relating to the acceptability of the use of the cranes on the construction site, and to their use in installation were assessed by STUK. The use of the cranes in installation was further assessed in terms of conformity by approved crane inspectors, which is required by occupational safety legislation. STUK will approve the final commissioning of the hoisting and transfer equipment before fuel is transferred to the reactor. The assessment of the factory acceptance tests of the equipment of the fuel handling systems was postponed in many cases due to the delays in the design of the electrical and I&C systems.

Design and manufacturing of the auxiliary equipment of the emergency diesel generators continued in 2010. Towards the end of 2010, STUK observed deficiencies in the functioning and control of the supply chain of the plant vendor, the diesel generator supplier and its subcontractors. Several deficiencies had been detected already earlier in

Manufacture of reactor coolant pipes

STUK has been overseeing the manufacture of reactor coolant pipes by regular visits. The manufacture of forged parts of the reactor coolant pipes began in 2005, and they were manufactured again in 2008 in order to achieve a smaller and more homogenous grain size in the material than in the first, rejected pipes. Grain size homogeneity is a prerequisite for inspecting the pipes using ultrasonic technology. STUK approved the material characteristics of the forged parts in early 2009. The first welded seam between a straight forged part and a bent forged part joined with it was made in spring 2009. When inspecting the weld, the manufacturer detected indications of fracture on the outside surface of the base metal of the straight part at about a distance of 2 mm from the fusion line. Welding work was suspended for a closer investigation of the defects and for finding out their significance and cause. On the basis of the preliminary clarifications received, STUK gave permission to continue welding work on the next corresponding weld. This weld was inspected according to a more detailed programme, but the inspection revealed no manufacturing defects. But identical defects occurred again in the third weld. STUK stopped welding work and requested TVO to find out whether similar defects are present in the pipe structure at different depths of the weld. The manufacturer and TVO supplemented their investigations of the formation mechanism and safety significance of the defects. STUK concluded that the investigations show that there are no indications below the surface of the pipe. STUK gave permission to repair the surface indications and to continue welding.

Factory welding of the reactor coolant pipe prefabricates was completed during the autumn. As the pipes were being finished, repairs made by welding were detected on the inside and outside surfaces of the pipes; these repairs had not been appropriately documented in accordance with the pipe manufacturing instructions. The observation was made in an inspection carried out by the manufacturer's inspection organisation and TVO. Pipe manufacturing was halted due to the observation. The repairs had been made to fill some notches a few millimetres deep which had emerged during manufacturing and inspections. STUK gave permission to continue the manufacturing of the pipes after the plant vendor and TVO had submitted a report on how the technical acceptability of the repairs and the flaws in the manufacturer's quality control will be assessed and handled.

In 2010, crack-like surface defects were observed in the bent pipe sections at the bend area in final inspections performed after the pickling treatment of the reactor coolant pipes. The work for establishing the mechanism creating them and eliminating it delayed the delivery of pipes and their installation. It was assessed that the faults had developed in connection with the induction bending process as a result of deformations in the bent area and linear machined surfaces. The defects were removed by final grind.

the construction plans of the auxiliary equipment of the emergency diesel generators. Problems with the design and manufacturing of the auxiliary equipment delayed installation work in the diesel buildings, and in late 2010 installation work was interrupted. STUK set up an investigation group to untangle the problems with the design, manufacturing and supervision of the auxiliary equipment of the emergency diesel generators. The investigation group's report will be completed in the spring of 2011.

Software-based I&C is often embedded in equipment and devices commonly used in industry; the I&C is used for controlling the device's functions. TVO has suggested to use this kind of equipment in Olkiluoto 3 systems with significant safety implications. In nuclear power plant applications, it is required that software-based I&C, depending on the safety class of the device, is qualified in compliance with a nuclear standard or other standard intended for safety-critical purposes. However, devices used in industrial applications may not have this kind of qualification, and, on the other hand, according to TVO it is not possible to find on the market devices or equipment manufactured in compliance with nuclear standards. STUK has required the plant vendor and TVO to analyse the software of these devices in order to ensure that their operation is reliable enough. Approval of the issue did not make any significant progress in 2010.

4.3.3 Construction

Construction oversight by STUK focused on the manufacture and installation of Safety Class 2 steel and concrete structures in particular. STUK inspected the readiness to start the concreting of Safety Class 2 concrete structures and authorised the start of concrete casting. These concrete structures include the containment wall and its internal structures. Concrete casting has been successful from a technical point of view. For example, provisions have been made for power failure during casting so these have not been detrimental to the quality of concrete casting.

In late summer and autumn, STUK carried out inspections concerning the readiness to start post-tensioning of the Safety Class 2 inner containment and protective grouting of the post-tensioning cables before granting permission to start this work. The inspections went well and STUK made no remarks concerning the site operations.

The procedures for ascertaining readiness for concrete casting, post-tensioning and grouting have been proven to function well. These procedures have served to ensure that the plant vendor and TVO have inspected and approved the structure to be concreted and the plans for the concreting before STUK is requested to give permission to start the work.

In contrast, there have been many quality non-conformances when screeding has been applied by shotcreting on the bedding for steel lining of pools which will contain radioactive substances during future operation, and when welding the lining plates. Structures have had to be disassembled, work plans revised and procedure qualification tests repeated, and structures repaired before reaching an acceptable result. This work will still continue in 2011.

4.3.4 Manufacture

Manufacture of main components

The reactor pressure vessel, steam generators (4 pcs) and pressurizer of the Olkiluoto 3 unit were delivered to the construction site in 2009. The construction inspection of the pump housings of the reactor coolant pumps was carried out and the pump housings delivered to the plant site during 2010. The construction inspections of the reactor coolant pipe prefabricates were completed during 2010. The prefabricates were delivered to the plant site with the exception of one pipe section of hot leg no. 1.

STUK oversaw the manufacture of the reactor coolant pumps and the control rod drive mechanisms by regular visits to the plant vendor's factory in France. A test run of two coolant pumps was performed with the manufacturer's test equipment during 2010. Three pumps were tested in 2009. The construction inspections of the pumps and their electric motors will be continued in 2011.

The manufacture of the control rod drive mechanisms made progress so that it was possible to start the pressure tests of the pressurized bodies during 2010. The first control rod drive mechanisms were assembled for functional tests during 2010. The functional tests revealed, however, that the control rod drive mechanisms were scratched in the tests and the tests were postponed until 2011.

The construction inspection of the internals of the reactor pressure vessel, their hoisting device and storing racks was carried out in the Czech Republic in late 2010. The internals were delivered to the installation site in December 2010.

Manufacture of other equipment

During 2010, STUK oversaw and inspected, besides the main components, the manufacture of Safety Class 1 and 2 pipelines, tanks, heat exchangers, pumps, valves and steel structures as well. STUK has maintained permanent oversight at the German factory manufacturing pipeline prefabricates. The prefabrication of pipelines was also supervised at the Olkiluoto harbour. STUK also oversaw and inspected the manufacture of fuel handling equipment and the fuel building crane.

In addition to overseeing the manufacture of pressure equipment and steel structures, STUK has overseen and inspected the manufacture of emergency diesel generators used for emergency power supply and their auxiliary equipment.

STUK's construction inspections, intended to ensure that the manufacture of components conforms with requirements, still revealed issues preventing the inspections from being carried out as planned. The most serious of these issues concerned the equipment's readiness for inspection and open issues related to construction plans. As early as 2008, STUK required TVO and the plant vendor to ensure before the inspections that the prerequisites for construction inspections are present. TVO and the plant vendor have now changed their supervision and inspection procedures so that the aim is to ensure readiness for inspection prior to STUK's inspection.

4.3.5 Installation work

Installation of the main components in the nuclear island started with the installation of the reactor pressure vessel in June. After that, installation work continued with the reactor coolant system and its components (reactor coolant pump housings, pressurizer and steam generators). By the end of the year, most of the installation work on the reactor coolant system had been completed—one reactor coolant system hot leg and the related steam generator will be installed in early 2011.

STUK oversaw the installation of the reactor coolant system with increased effectiveness. More of STUK's on-site checkpoints were added to the plans for equipment installation at Olkiluoto. As a whole, the installation of the reactor coolant system went well. One weld in the reactor coolant system cold leg had been ground too thin so that the thickness of the material was 1 mm less than designed. The plant vendor was able to show with calculations that this reduction in thickness had no implications for the strength of the weld. STUK inspected and approved the deviation.

Installation of equipment, pipelines and their support structures with safety implications for the nuclear island continued. STUK oversaw installation work and carried out installation inspections of completed installations as required by the YVL Guides. Prior to STUK's inspection, installation must be approved by the plant vendor and TVO. Steel lining of the emergency cooling water pool was completed, and a leak test of the pool was performed by filling the pool with water. The test was accepted. Work and inspections continued on the reactor pools and fuel building pools. STUK approved the use of the reactor building lifting hoist in installation work, for example, for hoisting the main components into their places. Installation of the emergency diesel generators also started, but the plant vendor interrupted the installation as a result of confusions about the design and manufacture.

Installation of electrical devices and cables in the nuclear island started towards the end of 2009, and they continued throughout 2010. Cable laying was performed mainly in the cable room below the switchgear rooms in the safeguard buildings and in the room below the control room false floor. In early 2010, installation of medium and low voltage switchgear and distribution and variable transformers started in the electrical equipment rooms of the safeguard buildings. Installation of the uninterruptible emergency power supply system devices (rectifiers, battery banks, inverters and converters) also started during 2010. Coupling work on the switchgear and uninterruptible emergency power supply system components started in mid-2010.

STUK has overseen installation of electrical systems by means of inspection visits of the construction site. In late 2010, STUK's inspection revealed that the approved principles to separate safety-classified cables from other cables had not been fully followed when installing cable trays and cables. STUK required corrective actions from TVO to re-install cabling in compliance with the approved plans.

STUK inspected TVO's installation supervision in several inspections carried out in accordance with the construction inspection programme during 2010 in order to ensure the adequacy of TVO's supervision procedures. In support of STUK's regulatory oversight, an independent assessment of TVO's installation supervision was commissioned. Daily inspection rounds served to oversee that approved instructions and procedures were followed in the installation work. STUK also participated in quality audits carried out by the plant vendor and TVO at the plant site for subcontractors.

4.3.6 Preparations for commissioning

The review of technical and administrative procedures for commissioning and corresponding instructions continued in 2010. The suggested procedures have mainly been acceptable. The management procedures for modifications made during commissioning are still unclear and require clarification.

In 2010, STUK started to review the test programmes related to the commissioning of Olkiluoto 3. Pre-operational test programmes for systems and some transient test programmes were submitted to STUK for approval. About one-third of the system test programmes was reviewed in 2010. As a rule, the quality of the test programmes has been rather good—in the case of some test programmes STUK considered that it was not ready to carry out the review before the design of the particular system is completed.

STUK has also assessed a preliminary version of the operational limits and conditions for the operation of the plant. The assessment focused on general requirements and administrative procedures. System-specific limits and conditions were yet not assessed. It was required that some amendments and clarifications are made in the general requirements.

Training of the operating personnel for the plant and their induction continued during 2010. The future operating personnel participated in the processing of technical documents and, in this way, also became familiar with the plant and their future duties. The group of operators attending training passed written examinations in the spring and all were granted trainee licences. The results of the written examinations were good.

The acceptance tests of the training simulator being built at the plant started in late spring. The delay in the design of the I&C system of the Olkiluoto 3 unit has delayed the construction schedule of the training simulator. The training simulator must be available for operator training no later than a year before loading fuel in the reactor. The readiness of the simulator for training will be demonstrated by means of tests. STUK has required TVO to present a summary report on the test results and justifications for the acceptance of the simulator. STUK has required that it receives descriptions of the test runs for assessing them, and STUK has also reserved a right to attend the tests.

4.3.7 Functioning of organisations and quality management

The total numbers of workers at the Olkiluoto construction site was 4,500 persons at the end of 2010. Of these, about 4,140 belong to plant vendor's organisation and about 340 to TVO's project organisation. TVO's project organisation consists of its own project personnel (about 70), persons from TVO's line organisation (about 60) and consultants (about 210). In 2010, STUK assessed the structure of the project organisation and the challenges it sets to managing the organisation and ensuring competence. Based on the assessment, the project organisation and its structure can be considered appropriate.

TVO's quality assurance unit monitors the quality and quality management of the Olkiluoto 3 project by means of critical or significant non-conformances observed in the operations of the plant vendor and its subcontractors, product non-conformances, audit results and compiling and analysing statistics on data about causes of non-conformances. In 2010, TVO continued to elaborate the statistics and analysis of data about causes of non-conformances. During 2010, audits were postponed because the project and related work were implemented on a schedule which is slower than anticipated.

In 2010, the quality assurance unit shifted, according to its plans, the focus of its supervision from factory supervision to supervising that the installation and manufacturing organisations' activities conform with requirements at the Olkiluoto 3 site. In order to support regulatory activities and decision-making, STUK commissioned an external, independent review of the functioning and effectiveness of TVO's equipment installation management process in the spring of 2010.

The most serious quality problems in the Olkiluoto 3 project related to quality management in the manufacture of the Polar crane and ensuring its conformance, communicating and managing the quality requirements for the emergency diesel generators (EDG) in a long supply chain, and quality management of the manufacturer and manufacturing of the low pressure emergency cooling system (JNG). In 2010, STUK approved that in terms of nuclear and radiation safety it is possible to put the Polar crane first to installation use and later make it conform with nuclear and radiation safety requirements. STUK observed several significant quality management non-conformances in the design documentation of the emergency diesel generators and (EDG) and equipment. Based on the inspection observations, it was also reasonable to assume that the requirements concerning the emergency diesel generators had not been appropriately passed on in a long and complicated supply chain. In order to find out the scope, significance and development needs of the quality management non-conformances in the emergency diesel procurement activities, STUK launched a separate investigation in December 2010. The investigation will be completed during 2011. The plant vendor detected significant quality non-conformances in the manufacturer's welds of the low pressure emergency cooling system (JNG) and transferred the equipment to another manufacturer for repair. The plant vendor started the repair work without a repair plan approved by STUK.

In the background of the manufacturing quality problems one can find several deficiencies in the flow of information between organisations, familiarity with nuclear industry requirements and their communication, and in the observance of procedures relating to quality management. With a view to planning effective and sufficient corrective and preventive actions, STUK required that the licensee solve the observed quality problems in addition to the technical problems. The licensee should pay more attention to the fact that any human and organisational factors behind technical problems should be analysed more effectively than at present and that corrective action is taken promptly following the results of the analysis. The licensee must ensure that the corrective actions are implemented throughout the supply chain.

Safety culture at the Olkiluoto 3 construction site

In August 2008, STUK carried out an inspection of the safety culture at the Olkiluoto 3 construction site because there had been suggestions in public that problems and quality or industrial safety deficiencies may not be freely brought up at the site. Following the inspection, it was found that it would be beneficial to have more open and effective communications at the site. STUK required TVO to draw up a plan for assessing and developing the safety culture on site.

In 2009, STUK carried out a follow-up inspection to review the implementation and impact of safety culture development measures. It was noted in the inspection that TVO has established a safety culture team to follow and develop safety culture and hired a person who speaks with people at the construction site and observes the site safety culture. TVO has also defined safety principles for the construction site. Based on the inspection, STUK required TVO to further develop its operations with the aim of assessing and developing on-site safety culture in a systematic way.

In 2010, STUK carried out a second follow-up inspection concerning the assessment and improvement of the safety culture at the Olkiluoto 3 construction site. Within the framework of the inspection, workers, foremen and management of the plant vendor's subcontractors were interviewed in work areas important to nuclear safety. The interviews helped to find out how well the representatives of the subcontractors were aware of their work area's significance to nuclear safety, quality requirements for their work, work instructions and how to act in problem situations. Based on the inspection, STUK stated that TVO and the plant vendor have entrusted and created systematic procedures for monitoring and evaluating the safety culture at the Olkiluoto 3 construction site. The plant vendor has taken an active role in familiarising and training subcontractor companies in the safety culture requirements observed at the Olkiluoto 3 construction site. In addition, since late 2010 the plant vendor has required that its subcontractor companies engage in safety culture self-assessment and prepare a safety culture development plan. Respectively, it is TVO's task to observe, interview and carry out surveys concerning the safety culture at the construction site and any changes in it. During 2010, TVO prepared a summary of the safety culture at the Olkiluoto 3 construction site and a development plan for it. Based on inspection observations, STUK has required that, in addition to the actions taken for assessing and improving the safety culture, TVO must clarify the development needs for quality management, organisations' operations and safety culture lying behind the construction quality problems and nonconformances. In 2011, STUK will follow the progress of TVO's and the plant vendor's development measures and their effects on the safety culture at the Olkiluoto 3 construction site.

4.4 Preparation for new projects

In 2008 and 2009, Teollisuuden Voima (TVO), Fortum and Fennovoima (FV) submitted applications for the Government's decision-in-principle for building new nuclear power plant units in Finland. Pursuant to the Nuclear Energy Act, the decision-in-principle process involves a preliminary safety assessment by STUK. STUK completed it in October 2009 when the preliminary safety assessment for Fennovoima was also submitted to the Ministry of Employment and the Economy. The Government gave a negative decision-in-principle to Fortum's application and made decisions-in-principle in favour of TVO's and Fennovoima's new nuclear power plant units on 6 May 2010. In its decision concerning Fennovoima, the Government brought down the number of possible new units from two to one. In the same context, the Government made a decision-in-principle in favour of Posiva's application for final disposal of spent nuclear fuel arising from TVO's new nuclear power plant unit. Parliament ratified the Government's decisions-in-principle before its summer recess on 1 July 2010. After the Government had made the decisions-in-principle Fortum ended its Loviisa 3 project.

In the spring of 2010, STUK held discussions with the power companies on specific issues relating to the new power plant projects. These discussions took place within the framework of the revision of STUK's regulatory guides. The specific issues, which concerned severe accidents, security, layout and separation, I&C, mechanics and nuclear waste, were discussed in technical specific working group meetings. Based on these meetings, background memos were prepared for new YVL Guides. On account of the new nuclear power plant projects the discussions were essential, because these projects will be implemented in compliance with new YVL Guides. According to the projected schedule of the guide revision, a new set of guides will be ready by the end of 2011.

Pursuant to the Nuclear Energy Act, the next licensing stage for a new nuclear power plant unit is the construction licence stage. In its decision-in-principle, the Government stipulated that the power companies shall apply for permission to start the construction of a new power plant unit (construction licence) as provided in the Nuclear Energy Act within five years from Parliament's approval of the decision-in-principle.

STUK has started preparations for the projects by setting up an oversight project to manage preparatory work. In the first phase, the project will involve assessment of tender documents submitted by the power companies to STUK for information. Discussions with the power companies on the issue commenced in late 2010. The tasks of the oversight project for the new projects include setting the objectives for safety assessment at the construction licence stage, influencing the power companies' activities and organisational readiness, communication with the power companies concerning readiness of design and suitability of different plant options, and site localities. During 2010, STUK reviewed at the power companies' request their requirements for the design and implementation of new nuclear power plants. The oversight project's task is to develop STUK's project oversight practices. Within the framework of oversight practice development, work on analysing the experience gained in the Olkiluoto 3 project started at the end of 2010.

4.5 FiR 1 research reactor

The FiR 1 research reactor has continued to operate regularly. The use of the reactor has involved radiotherapy of patients, isotopic irradiation for research purposes and basic education of university and higher education institution students from Espoo, Lappeenranta, Stockholm and Uppsala.

STUK carried out inspections on the operational safety, physical protection and emergency preparedness, nuclear safeguards and radiation protection of the FiR 1 reactor in accordance with the annual plan. Inspection remarks concerned, among other things, repair of the reactor control rod motor, instructions for use and resources available for annual inspections. The FiR 1 reactor safety documents required by the Nuclear Energy Decree are assessed and reviewed regularly. STUK approved a revised emergency preparedness manual and a nuclear safeguards manual during 2010.

STUK approved the new substitute for the manager responsible for the FiR 1 reactor and replacement of the person in charge of physical protection.

In 2010, the renewal of supervisor and operator licences concerned two supervisors and four operators. In November, an examination of supervisors and operators was arranged at the FiR 1 reactor.

The nuclear safety of the FiR 1 reactor, the condition of its structures, systems and components, as well as the human resources and the related operating plans, are sufficient for continued safe operation. The current operating licence period will expire at the end of 2011. The Ministry of Employment and the Economy, STUK and VTT Technical Research Centre of Finland started discussions on the preparation of a licence application in 2010. VTT submitted to the Ministry of Employment and the Economy an application for licence renewal at the end of November. STUK will prepare its statement and safety assessment during 2011.

5 Regulatory oversight of the spent nuclear fuel disposal project

From the perspective of nuclear energy legislation, the spent nuclear fuel disposal project may be broken down into five main stages:

1. *research stage:* from the 1970s to the Government's decision-in-principle
2. *research construction stage:* from the decision-in-principle to the construction licence; comprises the ongoing construction of an underground research facility, Onkalo
3. *construction stage:* from the construction licence to the operating licence
4. *operating stage:* from the operating licence to decommissioning
5. *terminal stage:* from decommissioning to the termination of the licensee's waste management obligation. When the final disposal of nuclear waste has been carried out acceptably, the licensee's waste management obligation ends and the responsibility for the nuclear waste disposed of is transferred to the State.

In 2001, Parliament ratified the decision-in-principle issued by the Government one year before that the final disposal of spent nuclear fuel in the bedrock at Olkiluoto is in line with the overall good of society. The decision-in-principle states that the spent nuclear fuel disposal project may proceed to the construction of an underground research facility and more detailed investigation. With this statement, the Government has indicated how far the implementation of the final disposal project may proceed pursuant to the decision-in-principle, taking into account that the underground research facility, Onkalo, referred to in the decision-in-principle is designed to form a part of the final disposal facility to be constructed later.

After receiving the decision-in-principle, Posiva began investigations regarding the suitability of the final disposal site in Olkiluoto. The construction of the underground research facility started in 2004. Since the research facility is designed to form a part of the final disposal facility to be constructed later, it will be constructed in accordance with the requirements concerning nuclear facilities with corresponding regulatory oversight.

5.1 Spent nuclear fuel disposal project

In 2010, at the "research construction stage", the preparation of the final disposal project advanced both in terms of the construction of Onkalo and the preparation of the construction licence application documentation. In the construction of Onkalo, Posiva reached the projected final disposal depth of 420 metres. In 2010, STUK inspected and approved the last safety-significant design documentations according to which Posiva will carry out the remaining excavation of Onkalo.

In relation to the construction licence documentation, STUK provided the Ministry of Employment and the Economy in September 2010 with statements concerning the state of construction licence application preparation and the plans of the companies with nuclear waste management obligations for the next three years. These statements were based on the draft documentation for the construction licence application submitted by Posiva and on Posiva's R&D programme (TKS-2009).

5.1.1 Regulatory oversight of the Onkalo underground rock characterisation facility

The construction of Onkalo is divided into five excavation stages. In 2010, excavation stages four and five were being implemented. During the year, construction proceeded from chainage 4,055 metres to 4,560 metres (to a depth of 433 metres). STUK's oversight covered geological mapping and surveys of the rock to be excavated, excavation of the access tunnel with the drilling and blasting method, raise boring of vertical shafts, sealing the rock with grouting and reinforcement of the rock, and review of the safety documents.

Site inspections

Posiva's construction organisation and its operating methods were the focus of the Onkalo construction inspection programme. In addition, STUK carried out regular inspections to the construction site, about twice a month depending on the situation in the construction work. Issues related to the construction and the oversight of the construction of Onkalo were discussed at monitoring meetings about once a month. During the year, STUK monitored the progress of the construction of Onkalo as follows:

- Due to water leakage, sealing of the excavated access tunnel was performed once by means of grouting. Rock bolting to reinforce the rock proceeded to 4,538 metres. Rock surrounding the personnel and inlet air shafts was reinforced by grouting between 286 and 437 metres.
- Posiva decided to change the rock construction contractor for the last implementation stage of Onkalo, Tunnel Contract 5. The new contractor (Destia Oy) started excavation work at the end of implementation stage 4. STUK inspected the new contractor's capacity to carry out the rock construction of Onkalo in accordance with approved plans and considered it sufficient.
- STUK carried out inspections of starting preparedness at the junction area of excavation stage 5 and the technical facilities projected at a depth of 437 metres. When carrying out the inspection of the junction area, STUK required there to be capacity to carry out reinforcement demonstrated in practice as a precondition for continuing the inspection. In the continuation of the inspection, STUK determined the starting preparedness to be sufficient with some remarks and STUK granted permission to start the construction of the technical facilities with remarks which concerned missing rock engineering plans. STUK also required a report on the reasons for the significant updates of approved plans.
- STUK carried out eight inspections in order to give permission for shotcreting of excavated rock surfaces. The aim of the inspections is to ensure the sufficient scope and correctness of the survey data before the rock surfaces are covered by shotcreting.
- Site monitoring meetings discussed regularly the state of the design and construction of Onkalo and research conducted in the Onkalo research facilities. Research concerned, among other things, the durability of the rock on the surface of the deposit hole. In addition, the monitoring meetings were presented with outlines of the development work on rock suitability criteria (RSC) conducted in the Onkalo test or demonstration tunnels.
- The installation of heat, water, air conditioning and electrical systems in Onkalo continued as planned.

STUK carried out nine inspections according to the inspection programme. The inspections concerned:

- Posiva's management system;
- Planning and management of the research and monitoring programme;
- Management and control of the Onkalo project;
- The design of Onkalo;
- Boring and modelling done in the Onkalo area:
- Development of excavation work methods;
- Limiting the amount of groundwater leakage into Onkalo by grouting (excessive grouting can disturb the bedrock's favourable chemical conditions);
- Use and amount of foreign materials which could disturb the bedrock's chemical conditions (for example, explosives, concrete, fuels); and
- Onkalo's impact on the hydrochemical conditions in Olkiluoto, among other things, on surveying the salinity of the bedrock groundwater.

Based on the inspections, STUK required improvements in the instructions and procedures concerning the construction of the research facility. Examples of the requirements and remarks include:

- Improvement of the reliability of forecasts of the excavation damaged zones in the bedrock model, traceability of changes made in the Onkalo monitoring programme, and compilation of the annual Onkalo research programmes;
- Development of a procedure which ensures the fulfilment of the qualification requirements defined for a contractor; and

- Working up measures and plans for solving the problems encountered in the hardening of grout mass.

STUK's regulatory oversight of Posiva's subcontractors was based on the safety significance of the work they perform. STUK participated as an observer in Posiva's audits, which concerned the excavation contractors for Onkalo, SK-Kaivin Oy and Destia Oy.

Construction document reviews

STUK approved the updated Onkalo classification document submitted by Posiva. The document presents the division of the systems and structures to be implemented into classes in accordance with their safety implications. New systems had been added in the classification document in connection with its updates and their classifications and documents had been updated according to STUK's earlier requirements.

STUK processed the design documents of the last stage of Onkalo, Tunnel Contract 5 (TU5), and their updates. The documentation included rock engineering standard and implementation designs, reinforcement calculations, forecasts of bedrock and stress-induced damage. The standard designs describe the design bases and optional solutions which are used in Onkalo's implementation. Monitoring procedures for the repository facilities will also be developed in conjunction with the review of the designs.

STUK approved the standard designs covering the whole last stage with remarks, which concerned missing and incomplete plans; for example, rock reinforcement plans, which STUK required to be submitted before excavation work starts. In 2010, the excavation of the last stage included the junction area and technical facilities at a depth of 437 metres. Test or demonstration tunnels are due to be excavated in 2011. The review of the supplemented designs for these tunnels started at the end of 2010.

Posiva presented to STUK a delivery plan for Onkalo plans and an update of the construction communication plan. STUK reviewed designs submitted according to these plans. They included Onkalo rock engineering, main, constructional, architectural, rock, heat, water and ventilation and automation designs and research plans for Onkalo, including plans for pilot boring and a research plan for the last stage of Onkalo.

In addition, the following materials were submitted by Posiva to STUK for review:

- update of Posiva's operating system
- Preliminary Safety Analysis Report for Onkalo
- monitoring and maintenance programme for the Onkalo project
- update of directions for boring and drilling in the Onkalo area
- instructions for excavation damaged zone management
- Posiva's reports on the falling of a rock slab from the unreinforced tunnel ceiling and the management of the issue at the site.

5.1.2 Assessment and regulation of research, development and design activities to further specify the safety case for final disposal (R&D monitoring)

The Ministry of Employment and the Economy required in 2003 that Posiva submit a report on the preparation of the construction licence application for the encapsulation and final disposal facility in 2009. Posiva submitted the required documents to the Ministry in conjunction with a three-year plan for nuclear waste management R&D work. At the end of 2009, Posiva also submitted to STUK drafts of the documents required in a construction licence application.

STUK reviewed the scope of the material. The review focused on the submission of materials presented in the Nuclear Energy Decree, Government Decree on the Safety of Disposal of Nuclear Waste and STUK YVL Guides. The most important among these include a safety analysis report, a classification document, a probabilistic risk analysis, an account of construction quality management, a plan for nuclear safeguards arrangements, preliminary plans for safety and preparedness arrangements, and a safety case for long-term safety. The results of the scope review were made use of in further processing of the material.

STUK submitted to the Ministry of Employment and the Economy in the third quarter of 2010 statements on preliminary application material and a three-year programme for nuclear waste management R&D work. For the statement STUK carried out an inspection which dealt with construction quality management, safety and preparedness arrangements, arrangement of nuclear safeguards, projected construction quality management, design of the encapsulation and final disposal facilities, and analyses conducted with a view to demonstrating the long-term safety of operations and final disposal. In addition to Finnish experts, STUK was supported by experts from Switzerland, Sweden, the United Kingdom, Germany and the USA.

STUK arrived at the following conclusions concerning the preliminary application material and the R&D plan:

- The account of the construction licence material submitted by Posiva mainly covers the materials required by the Nuclear Energy Decree and the Government Decree on the Safety of Disposal of Nuclear Waste (736/2008).
- Posiva's R&D plan presents extensively and clearly the present state of the spent fuel final disposal project and the R&D plans for the following years 2010–2012. In contrast to earlier plans, the programme gives a better-defined picture of the present situation, the safety issues to be investigated, and the plans to solve these issues.
- Posiva is currently working on the issues described below, which are critical in terms of schedule for the construction licence application. In STUK's opinion, their processing and summarising of the results by the time of the construction licence application submission call for special attention by Posiva.
  - Creation of scenarios complying with STUK's requirements and describing the whole final disposal system, and an analysis of the release and transportation of radionuclides according to these scenarios.
  - R&D work required for establishing the functioning of engineered barriers and, in particular, that of the buffer.
  - Development work on the bedrock classification system, establishing the functioning of the system and demonstration of the implementation of the final deposition holes and deposition tunnels in Onkalo.
- The goal of Posiva's R&D work is to be ready to submit a construction licence application for a spent nuclear fuel encapsulation and final disposal facility in 2012. In STUK's opinion, the schedule for gaining this goal is tight. Some of the long-term research conducted in R&D will continue after 2012. It is probable that some preliminary results of these research projects will be available before the submission of the construction licence application, but the final results will be available only after 2012.

In addition to the statements, STUK and Posiva held issue-specific meetings which discussed in more detail STUK's observations about the preliminary construction licence application material. Having submitted its statements to the Ministry of Employment and the Economy, STUK continued to process the application material. On the basis of the application material, STUK aims to conduct a safety analysis, in the same way as will be done on the basis of the construction licence application to be submitted in 2012. The safety analysis will be completed in early 2011.

6 Regulatory oversight of nuclear non-proliferation

6.1 The basis, subjects and methods of regulatory control of nuclear materials

Regulatory control of nuclear materials and activities is based on the Nuclear Energy Act, Nuclear Energy Decree and on international treaties

Safeguarding nuclear materials and nuclear activities is a prerequisite for the peaceful use of nuclear energy. Finland has in place a national state system of accounting for and control of nuclear material (SSAC), maintained by STUK.Provisions on the control system are laid down in section 118 of the Nuclear Energy Decree, and its purpose is to carry out the safeguards for the use of nuclear energy that are necessary for the non-proliferation of nuclear weapons and to ensure that the activities are compliant with the obligations set out in international nuclear energy agreements and treaties.

International safeguards are implemented by the International Atomic Energy Agency (IAEA) and the European Commission's Directorate General for Energy, Directorates D and E, "Euratom". IAEA safeguards are based on the Non-Proliferation Treaty and the Safeguards Agreement (INFCIRC/193) signed by non-nuclear weapon EU Member States, the European Atomic Energy Agency and the IAEA, as well as the Additional Protocol of the Safeguards Agreement (INFCIRC/193/Add.8). EU safeguards are based on the Euratom Treaty and Commission Regulation EURATOM No. 302/2005. According to section 63 of the Nuclear Energy Act, STUK's presence is required in inspections performed by the IAEA and the European Commission in Finland.

In addition to nuclear material accounting and control, the countries must declare to the IAEA nuclear facility sites, research and development projects related to the nuclear fuel cycle, as well as the manufacture of certain, separately defined, components in the nuclear field and their export. The operators provide both the Commission and STUK with reports on nuclear materials in accordance with the Commission Regulation. STUK submits to the IAEA and the Commission the declarations concerning Finland and facilities in Finland required by the Additional Protocol. In support of its controls, the IAEA gathers information from open sources, uses satellite imagery and collects environmental samples. The Additional Protocol allows the IAEA more extensive access rights to inspect nuclear activities throughout the country.

In the IAEA's new, strengthened safeguards ("Integrated Safeguards"), the regulatory controls under the Nuclear Safeguards Agreement and under the Additional Protocol have been integrated so that the IAEA performs fewer routine inspections, but it has the option of carrying out inspections giving either no notice at all or very short notice on plants and activities related to the nuclear fuel cycle. The Integrated Safeguards of the IAEA are implemented in Finland from 15 October 2008. The national safeguards maintained by STUK allow the Integrated Safeguards of the IAEA being efficiently carried out in Finland so that the IAEA can satisfy itself that the member country has no unreported activities related to the nuclear fuel cycle and that the member state observes its obligations under the nuclear non-proliferation agreement. STUK has enhanced its inspectors' capabilities to participate in the IAEA's unannounced inspections (UI) or short notice random inspections (SNRI).

In parallel with the reform of the IAEA's regulatory control, the Commission has also developed its inspection activities. In 2009, the number of inspections carried out by the IAEA and the Commission decreased significantly: in 2008 the IAEA carried out altogether 26 and the Commission 25 inspections, whereas in 2009 the IAEA carried out only 11 inspections and the Commission 13 inspections. In 2010, both the IAEA and the Commission carried out 19 inspections. The increase in the number of inspections carried out by the IAEA and the Commission was due to fact that the IAEA performed three short notice random inspections and one unannounced inspection, and the fact that it carried out two inspections more than earlier at the Loviisa plant and the first inspections at the geological repository. The Commission participated in all but two inspections performed by the IAEA. STUK provides the Commission with reports on all nuclear materials inspections. The number of inspections by STUK increased primarily as a result of inspections on the inventories of holders of small quantities of nuclear materials. STUK carried out a total of 49 inspections in 2010.

STUK applies its regulatory control to all nuclear fuel cycle-related activities

STUK's nuclear safeguards apply to all nuclear fuel cycle activities as well as to nuclear items accounting and control systems, import, use, transport, storage, transfers, removal from use and final disposal. Nuclear items include nuclear materials (uranium, plutonium and thorium), certain other substances (deuterium and graphite), as well as nuclear devices, equipment, software and technology. Most nuclear materials in Finland (99.8%) are contained in nuclear power plants. A few consignments of fresh nuclear fuel are imported to Finland and transported within the country annually.

STUK inspects holders of nuclear items and stakeholders in the nuclear industry through facility and transport inspections and document reviews. At facilities, STUK verifies that the quantity of nuclear items and their physical location

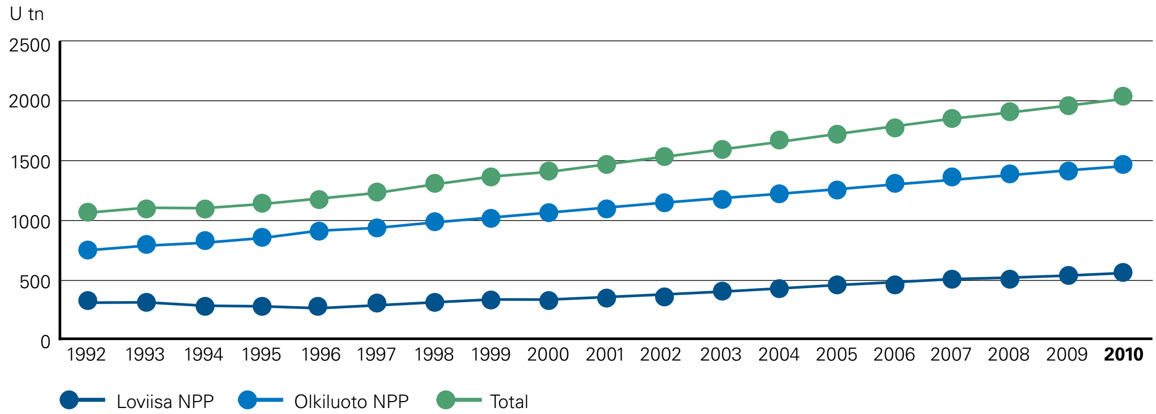


Figure 15. Amount of uranium in Finland.

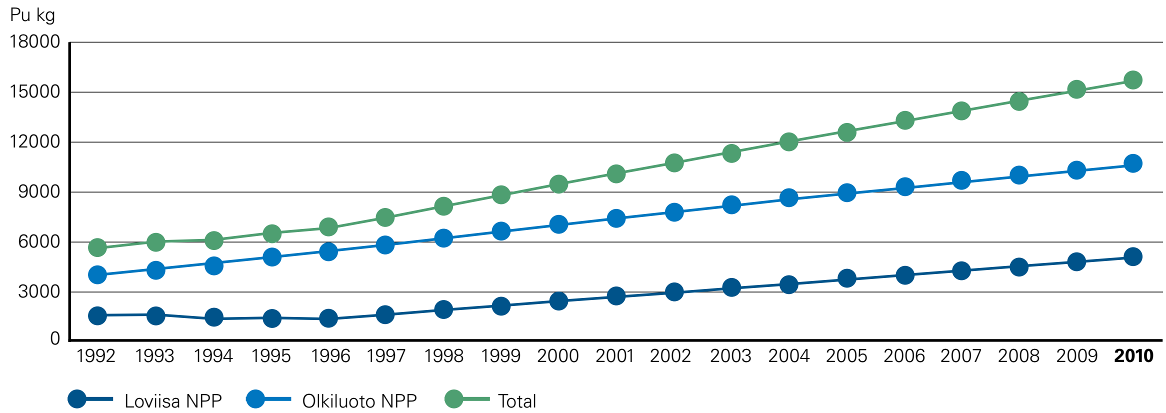


Figure 16. Amount of plutonium in Finland.

Table 5. Amounts of nuclear materials in Finland 31 December 2010.

Location	Natural uranium kg	Enriched uranium kg	Depleted uranium kg	Plutonium kg	Torium kg
Loviisa plant	–	561 875	–	5 075	–
Olkiluoto plant	–	1 453 831	–	10 610	–
VTT / FiR 1 research reactor	1 511	60	~0	–	–
Other facililties	~ 2344	~ 1,7	~ 1694	~ 0	~ 5

comply with accounting records. STUK reviews the documents on the facilities' safeguards: reports, notifications and nuclear safeguards manuals, and grants the licences required by legislation. In addition, STUK is responsible for the activities associated with the approval of international inspectors.

The technical analysis methods applied in safeguards contribute to ensuring that nuclear materials and operations are in accordance with the declarations and that there are no undeclared activities or materials. STUK applies non-destructive methods and environmental sample analyses to verify that the information notified by the facilities regarding nuclear materials and their use—for example, the degree of uranium enrichment as well as fuel burn-up and the cooling period—is correct and complete.

The quantities of nuclear materials in Finland by material category are shown in Figures 15 and 16, and in Table 5. The licences granted by STUK pursuant to the Nuclear Energy Act are listed in Appendix 4.

Regulatory control of transfers of nuclear items

In order to prevent the proliferation of nuclear weapons and sensitive nuclear technology, STUK controls the transfer of nuclear items and cooperates with Customs, the Police and other public authorities. A licence granted by either STUK or the Ministry for Foreign Affairs is required for the import and export of nuclear item. Permission from STUK, as well as transport and safety plans approved by STUK, are required for the transport of nuclear materials. Customs and STUK co-operate in preventing illegal imports and exports at national borders.

Security arrangements and cooperation between authorities

The purpose of the oversight of non-proliferation is to ensure that appropriate security arrangements are in place for nuclear items. In this context, the expression "security arrangements" refers to the deterrence, prevention and detection of and response to illegal activities related to nuclear and other radioactive materials, as defined by the IAEA under the heading of Nuclear Security. In addition, co-operation in the field of nuclear security includes acting as the contact authority of Customs in measures required by irregularities observed in radiation monitoring at national borders and also as an expert in developing these radiation monitoring operations.

Safeguards regarding the final disposal of nuclear fuel

The final disposal of nuclear fuel in inaccessible underground premises poses new kinds of challenges for nuclear safeguards. It is no longer possible to verify nuclear material after encapsulation in the same way as in traditional facilities or long-term storage. STUK has obligated Posiva Oy, the company in charge of the disposal project, to ensure the implementation of nuclear safeguards during the construction of Onkalo, the underground research facility, as it is designed to become part of a final disposal facility. The aim of the obligation is to ensure that all necessary information on the final disposal facility will be available in due course, and that it will be possible to show that no undeclared facilities or operations relevant to nuclear safeguards exist in the final repository area.

The nuclear safeguards at the final disposal facility must be implemented in such a way that international regulatory organisations can conduct their regulatory obligations in an appropriate way: the IAEA must be able to satisfy itself that there are no undeclared nuclear activities in Finland during the operation of the repository or after its closure. The Commission satisfies itself that the operator employs adequate measures for carrying out nuclear safeguards in the repository. Nuclear safeguards at a repository pose enormous challenges as there is no experience of a similar facility anywhere in the world. Both the IAEA and the Commission plan and implement their own control and inspection procedures on the basis of declarations made by the operator and the State.

In early 2009, the IAEA and the Commission finalised the official Design Information Questionnaires needed for declaring the Basic Technical Characteristics (BTC) of a final disposal facility. In November 2009, Posiva Oy submitted the preliminary BTC for the Onkalo underground rock characterisation facility. The delivery of the Basic Technical Characteristics enabled the initiation of international nuclear safeguards of final disposal in 2010. A description of the facility area was produced for the repository in 2010 as part of Finland's annual declaration submitted in compliance with the Additional Protocol.

6.2 Nuclear safeguards, activities and results in 2010

Licences and approvals

In 2010, STUK granted 11 import licences to TVO and one import licence to Fortum for nuclear items and materials.

Two projects related to the uranium production cycle were initiated in 2010. Norilsk Nickel Harjavalta Oy was granted a licence to produce, store and possess natural uranium which is generated as a by-product of the process industry. Talvivaara Sotkamo Oy submitted its licence application to the Government for uranium mining and milling operations. Both companies supplied the preliminary Basic Technical Characteristics of their plants to the Commission and STUK and were provided with Material Balance Area codes for reporting their operations.

STUK approved three transport plans for fresh nuclear fuel. In 2010, fresh fuel was imported by Finnish nuclear power plant operators from Sweden, Spain and Russia. STUK granted approval for one type of transport package design.

In 2010, STUK approved the responsible person for nuclear safeguards at TVO and the deputy of this person. In addition, STUK approved the responsible manager and the manager's deputy at Norilsk Nickel Harjavalta. STUK is also in possession of nuclear materials, and the operations require that a responsible manager and the manager's deputy are approved. During 2010, STUK had a responsible manager but no deputy to this manager.

In 2010, STUK approved eight new Commission (Euratom) inspectors and 16 new IAEA inspectors to carry out inspections in Finland.

During 2010, STUK reviewed the research and development plan (TKS-2009), the preliminary construction licence application and update to the nuclear non-proliferation manual submitted by Posiva in late 2009. The statements issued regarding the TKS report and the preliminary construction licence application required that their sections dealing with nuclear safeguards must correspond to the nuclear non-proliferation manual approved by STUK. The required additions to the nuclear non-proliferation manual were the descriptions of the activities compliant with the Additional Protocol, submission of basic technical characteristics and production of thesite declaration, as well as the description of the process according to which Posiva verifies the correctness of the above information and submits it to STUK and the European Commission.

Declarations pursuant to the Additional Protocol to the Safeguards Agreement

Declarations pertaining to Finland, required under the Additional Protocol, totalled 19 in 2010, and they were submitted within the time limits set out in the Protocol. STUK inspected the reports produced by the operators and sent the annual reports to the IAEA. STUK also reported quarterly the details of entries pursuant to the Additional Protocol. The Commission submitted to the IAEA the declarations pertaining to Finland under its responsibility.

Inspections as part of nuclear safeguards

In 2010, STUK carried out a total of 49 nuclear safeguards inspections in Finland. Of these, the Commission participated in 19 and the IAEA in 19 inspections. STUK carried out 10 inspections at the Loviisa nuclear power plant; the Commission participated in three and the IAEA in four of these inspections. STUK carried out 17 inspections at the Olkiluoto nuclear power plant; the Commission and the IAEA participated in eight of these inspections. Three of the inspections carried out at Olkiluoto were short notice random inspections of nuclear materials initiated by the IAEA. The IAEA picks the targets for these inspections using random sampling (annually no less than one per four nuclear power plant reactors and one at a spent fuel storage facility): the first inspection concerned Olkiluoto 1 and the two others the spent fuel storage facility at the Olkiluoto power plant. In Loviisa, the IAEA performed one unannounced inspection. In 2010 STUK, the IAEA and the Commission carried out joint inspections of nuclear material inventories of the FiR 1 research reactor operated by VTT and the Laboratory of Radiochemistry at the University of Helsinki. The IAEA made two complementary accesses for inspecting nuclear activities, one at STUK and the other at Posiva site. STUK carried out inventory inspections on four small holders of nuclear materials.

In 2010, STUK verified data on nuclear materials and their use by means of applying non-destructive methods to 65 spent fuel assemblies at the Olkiluoto power plant and to 47 spent fuel assemblies at the Loviisa power plant.

STUK inspected one transport of fresh fuel and one transport of nuclear waste in 2010. The records of international transfers of nuclear fuel owned by TVO were inspected with respect to the fuel consignments destined for the Olkiluoto power plants in 2010 and with respect to natural uranium in TVO's storage facilities outside Finland.

STUK carried out three periodic safeguards inspections to the final disposal facility construction site.. The inspection verified that the underground premises of the final disposal facility's Onkalo part are as declared. The IAEA and the Commission carried out the first inspection of design information on 2 March 2010. At the same time, STUK carried out its periodic inspection of the underground facilities. The IAEA inspected the disposal facility construction work above ground during its complementary access on 15 June 2010. STUK and the Commission participated in the inspection that was the first complementary accessever made by the IAEA to a disposal facility construction site. A planning meeting was organised with Posiva, the IAEA and the Commission in November regarding the implementation of safeguards during final disposal. This so-called Six-Party Meeting was attended by Swedish authorities and operators (Six-Party: the IAEA, the Commission, STUK, Posiva, SSM, SKB) as well as by observers from Germany and Belgium.

On the basis of inspections carried out, STUK has been able to satisfy itself that the licensees and other operators had appropriately fulfilled the obligations of nuclear non-proliferation, and that no undeclared items or activities existed.

The results of the inspections and audits show that Finnish plants manage their nuclear safeguards. The inspected items, materials and activities were consistent with the declarations made by the operators, and no items or activities conflicting with the declarations were found. The IAEA or the Commission made no remarks concerning the inspections. All of the facilities operated in a way that facilitated STUK's fulfilment of the obligations of the international agreements in the nuclear field signed by Finland.

Enhancement of radiation control at national borders

Customs and STUK launched a joint project for revising radiation control at national borders. The project is called RADAR. The project will be implemented during 2009–2014, and it includes equipment purchases, an update of common operational methods and instructions, as well as a training plan and provision of training together with the Customs School.

The 2010 budget was EUR 1.25 million, and it was used for updating control equipment at the eastern border and at the harbours of Helsinki and for equipping them with neutron detectors. As a result, control capabilities at the eastern border are now appropriate. The modification and construction work as well as repairs carried out by Customs at their stations require constant maintenance and sometimes also purchases of new equipment.

The direct passenger traffic from St. Petersburg to Helsinki that began in 2010 required a quick investment decision to be made regarding radiation control equipment at Eteläsatama Harbour. The equipment is expected to be in operating condition in February 2011. Extension work is also in progress at Länsisatama Harbour. The radiation control system is installed in the course of construction work so that the controls are operational when the traffic starts. The radiation control system at Vuosaari Harbour will be supplemented, and the negotiations regarding offers were conducted during 2010. The equipment will be delivered during the first half of 2011.

The procurement and tendering process for equipment at Helsinki Airport began in July 2010. The equipment supplier will be selected in March 2011, and the delivery time will be about four months.

Manual measuring devices were procured for Customs; they are also able to detect radioactive matter. The equipment was handed over to Customs in February–April 2010.

STUK and the Customs School organised a trainer training course jointly with the European Commission in February–April 2010. The training took place in Helsinki and at the Joint Research Centre of the Commission in Ispra, Italy. During 2010, Customs officials trained as trainers provided training to about 170 of their colleagues at their own Customs stations around Finland.

6.3 The Comprehensive Nuclear Test Ban Treaty

The Comprehensive Nuclear Test Ban Treaty (CTBT) prohibits all nuclear testing. The Treaty was opened for signing in 1996. It will enter into force after ratification by 44 separately designated states. Of these, nine are yet to sign the Treaty. Finland ratified the Treaty in 1999, and a total of 182 countries had signed and 153 counties had ratified the Treaty by the end of 2010. Adherence to the Treaty is monitored by a global network consisting of 321 stations. Of these, 80 stations detect radioactive particles in the atmosphere and 40 are also capable of detecting radioactive xenon gas. The other stations measure seismic, hydro-acoustic or infrasound waves. The measurement results of the monitoring system are available to all Member States.

The Preparatory Commission for the Comprehensive Nuclear-Test-Ban Treaty Organisation (CTBTO), which convenes in Vienna, is preparing for the Treaty's entry into force. All signatory states are represented in the Commission. The Provisional Technical Secretariat, whose tasks include constructing and maintaining the international monitoring system, operates in Vienna as well.

The National Data Centre (NDC), based on the CTBT and operating in conjunction with STUK, contributed to the work of the Preparatory Commission for the Comprehensive Nuclear-Test-Ban Treaty Organisation (CTBTO) in establishing a cost-effective NDC organisation that is functional from the Finnish perspective. The automatic analysis software used for the NDC's own routine monitoring analysed on average almost 800 spectra per day towards the end of 2010. Routine monitoring is facilitated by an alarm system transmitting data on unusual observations to NDC personnel. During 2010, noble gas analysis systems were developed for the NDC.

In May, the NDC made several interesting radionuclide observations in its own analyses from two stations located close to each other. The observations were reported to Finnish cooperation bodies, and the NDC exchanged information regarding them with the Technical Secretariat of the CTBTO as well as with other international partners. The observations were caused by an unidentified radionuclide emission. The observations do not indicate that a nuclear test had been carried out.

7 Nuclear security

STUK oversaw the security of nuclear plants by carrying out inspections as part of the periodic inspection programme and the construction inspection programme, by reviewing documents related to the implementation of security measures and by overseeing operations at the plant sites. The focus of security was on the implementation of the requirements set out in the updated Nuclear Energy Act that entered into force in 2008 and in the Government Decree on the Security in the Use of Nuclear Energy (734/2008) at the nuclear plants. The final report of the IPPAS (International Physical Protection Advisory Service) assessment carried out in 2009 was prepared at STUK.

STUK confirmed the security standing orders (section 7 n of the Nuclear Energy Act) of both the Olkiluoto and Loviisa NPPs during 2010. The security standing order of VTT's research reactor (FiR 1) is currently being inspected by STUK, and statements were requested from the Ministry of the Interior and from the Advisory Committee on Nuclear Security in December 2010. The security plans of both NPPs are currently being reviewed by STUK.

The operational activities of organisations responsible for security were brought into compliance with the new legislation both in Olkiluoto and Loviisa. Personnel of the security organisations of both NPPs were trained in accordance with the new regulations in order to enable operational activities. The forcible means equipment of security personnel referred to in section 7 l of the Nuclear Energy Act was updated in cooperation with the police in order to clarify the licensing procedures and in order to provide training. A training programme regarding certain forcible means equipment was prepared as the result of cooperation with the Police College of Finland. STUK approved the proposals of both NPPs for the outfits of security personnel with the aim of allowing personnel to be identified and their operational authorisation clarified.

The Advisory Committee on Nuclear Security convened twice during 2010. The issues discussed in Committee meetings included both the security standing orders of NPPs and other topical issues related to nuclear security.

In Loviisa, the implementation of security during the extension of the VLJ Storage (plant waste) was a subject of regulatory control. The exercise related to security, originally planned for 2009, was only carried out in 2010 due to the H1N1 epidemic.

The security in Olkiluoto was assessed by an external team. STUK participated in the process as an observer, and the results of the assessment were discussed during an inspection carried out by STUK as part of the periodic inspection programme. The Olki10 exercise was carried out in Rauma under the guidance of the Emergency Services College, and STUK also participated. The main focus of the exercise was on countering illegal activities as part of an emergency situation. The security related to the extension of the interim storage for spent fuel was inspected and approved by STUK before commencing construction work. The work of inspecting security matters related to the periodic safety review of Olkiluoto (OLMATA) continued at STUK during 2010.

In addition to the aforementioned subjects of regulatory control, the Nuclear Security Unit of STUK also participated in the inspection of security for Posiva's Onkalo site, in the regulatory control of security of high-level radiation sources in cooperation with the Radiation Practices Regulation Department of STUK, as well as in the oversight of security for nuclear materials in cooperation with the Nuclear Waste and Material Regulation

Department of STUK. STUK inspected and approved the updated transport security plans of both NPPs for the transport of fresh nuclear fuel. STUK inspected the security of transports on site.

Regarding regulations, the preparations are in progress for YVL Guide A.11 (Security of nuclear facilities), and draft no. 2 (L2) was sent for comments to the licence holders in November 2010. The preparatory work for the regulation also includes a section concerning the Design Basis Threat (DBT) which was prepared in cooperation with other authorities, in particular with the Finnish Security Intelligence Service (Supo). STUK also participated in the work of the International Atomic Energy Agency (IAEA) for preparing instructions regarding nuclear security as well as in other international activities regarding security by attending various meetings and seminars.

The findings of regulatory oversight indicate that the security measures of operators of nuclear power plants in Finland prevented, in cooperation with authorities, any illegal activities detrimental to the operation and safety of nuclear facilities.

8 Safety research

The purpose of publicly funded safety research is to ascertain that the authorities have adequate expertise available, including concerning unforeseeable issues affecting the safety of nuclear facilities. Safety research is divided into two research programmes, of which SAFIR2010 focuses on nuclear power plant safety and KYT2010 on strategic analyses 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 is not granted for 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 research needs related to nuclear safety. STUK issued its statement on the projects under the publicly-funded SAFIR2010 research

Nuclear safety research in Finland

In Finland, nuclear safety research is conducted by research institutions, universities and utilities operating nuclear power plants. In general terms, nuclear safety research comprises two distinct areas of research: nuclear power plant safety and nuclear waste management.

Public research programmes related to nuclear safety continuing until the end of 2010 are the nuclear power plant safety research programme SAFIR2010 (2007–2010) and the national nuclear waste management research programme KYT2010 (2006–2010). The new research programmes SAFIR2014 and KYT2014 will begin at the beginning of 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 expertise. Further information on the projects is available on the websites of the research programmes at http://virtual.vtt.fi/virtual/safir2010/, http://virtual.vtt.fi/virtual/safir2014/ and http://www.ydinjatetutkimus.fi.

Pursuant to Finnish legislation, the parties with nuclear waste management obligations are unambiguously responsible for the design, implementation and cost of managing the waste they have produced, including the associated research and development work. Regarding final disposal, this research and development work is carried out by Posiva Oy with its extensive research programme.

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.

Finnish actors have also preliminarily charted issues related to the technology, safety and economy of new-generation GEN4 reactors. GEN4 research is financed within the four-year Sustainable Energy (SusEn) research programme of the Finnish Academy of Science and Letters, launched at the beginning of 2008. Research into fourth-generation reactors is part of energy technology research.

programme for 2010 in January, and a corresponding statement on the KYT2010 programme in February. Research results were presented at seminars dedicated to the SAFIR2010 and KYT2010 research programmes (websites: http://virtual.vtt.fi/virtual/safir2010/ and http://www.ydinjatetutkimus.fi/tiedotteetmain.html).

The core areas of the SAFIR2010 programme are fuel and reactor physics, the structural safety of the reactor circuit, thermal hydraulics and accident analyses. A slightly lesser focus is placed on organisations and human factors, automation and the control room, and the employment of probabilistic risk analysis in safety management and control. The funding of the SAFIR2010 research programme totalled EUR 7.2 million in 2010, which represents about half of nuclear facility safety research in Finland. The research programme provided funding to 33 research projects in various areas of research. The areas of research under SAFIR2010 and their shares of the total funding are shown in Figure 17.

The SAFIR2010 safety research programme supports the safe operation of existing nuclear power plants, and also prepares for the development of

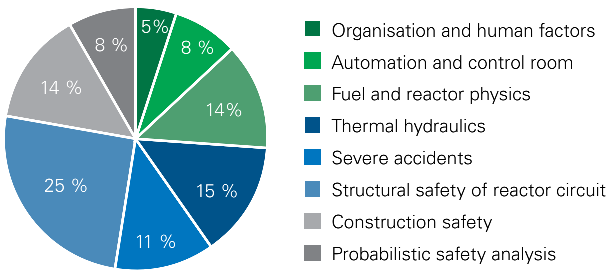


Figure 17. Research areas of SAFIR2010 programme and their shares of the total funding in 2010.

the capabilities required by new plant projects. The expertise created during the research programme has been utilised, inter alia, in assessing the safety of the Olkiluoto 3 plant unit under construction. Experts, calculation methods and test equipment have been deployed on issues related to the ageing management of plant materials, structures and equipment and to the review of accident analyses, and, in particular with regard to the Olkiluoto 3 plant unit, to assessing the quality and manufacturing methods of the reactor and primary circuit, to estimating the fire resistance of cables and to verifying analyses regarding aircraft impact. The technical investigations regarding reliability have studied, among other things, fires and the effect of fire-fighting equipment installations on the ability to control fires. Research into extreme weather conditions has provided new information regarding extreme weather conditions possibly experienced in the plant localities as well as on preparations for them.

Planning work for the new four-year research programme began in 2010. The Ministry of Employment and the Economy appointed a planning group and appointed an expert from STUK to chair the group. The planning group consisted of experts from all interest groups associated with the research. The new skeleton plan was prepared in a strategic process. The skeleton plan is used to describe the needs of research when making project applications. STUK participated in the work of the management and support teams of the new SAFIR2014 programme for preparing a new project package for 2011. The budget of the SAFIR2014 research programme for 2010 is EUR 9.6 million. Of this total funding, EUR 5.2 million comes from a fund operated in parallel to the National Nuclear

Waste Management Fund. The amount is EUR 2.2 million higher than in previous years because Parliament approved the decisions-in-principle regarding two new nuclear power plants in the summer 2010. The licence holder's obligation to provide funding for safety research begins with the decisions-in-principle.

The funding of the KYT2010 research programme totalled EUR 1.7 million in 2010, The research programme provided funding for 21 research projects that represented all subjects of the programme—safety assessment, strategic studies and studies of social impact. The KYT steering group gave its funding recommendations to the Ministry of Employment and the Economy, relying on the assessments of the support group. The studies mainly concentrated on the safety assessment of final disposal of nuclear fuel, such as engineered barriers (9), bedrock and groundwater (2), and the release and transportation of radionuclides (7). In 2010, the programme also included one social research project and two strategic research projects. Figure 18 shows the relative shares of these areas of the total funding.

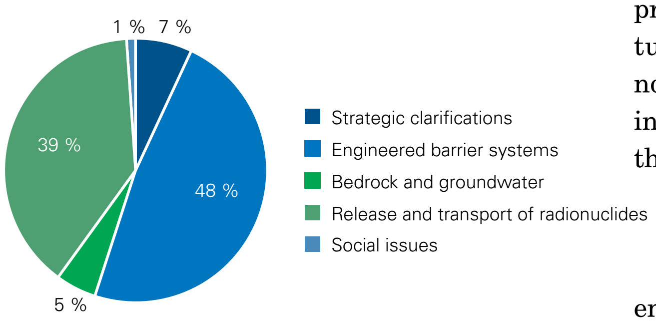


Figure 18. Research areas of KYT2010 programme and their shares of the total funding in 2010.

Training in the field of nuclear waste management has been rather patchy in Finland, and each operator has trained its own experts. Following an initiative by a working group established within KYT, a nuclear waste management piloting course of two and a half days was organised in 2010 through the joint efforts of organisations operating in the field of nuclear waste management at Aalto University. The intention is to repeat the course in 2011 and develop it into a national training event.

In 2010, the Ministry of Employment and the Economy convened a planning group to prepare a new framework programme for the research programme for 2011–2014 (http://www.ydinjatetutkimus.fi/haku11/kyt2014_puiteohjelma_luonnos%2015092010.pdf). STUK actively participated in the work of the planning group. The contents of the framework programme consists of key areas of research for national competence, and the intention is to establish coordinated projects in subject areas deemed most salient. A total of 36 research project proposals were submitted for the new KYT2014 programme, and the work of evaluating them is in progress.

9 Regulatory oversight of nuclear facilities in numbers

9.1 Review of documents

In all, 4,269 documents were submitted to STUK for review in 2010. Of these, 2,054 concerned the nuclear power plant under construction, and 262 were related to the repository of spent nuclear fuel. 3,872 document reviews were completed, including documents submitted in 2010, those submitted earlier and licences granted by STUK in accordance with the Nuclear Energy Act, which are listed in Appendix 4. The average document review time was 103 days. The number of documents and their average review times in 2006–2010 are shown in Figure 19. Figures 20, 21 and 22 present the distribution of document review times for the different plant units.

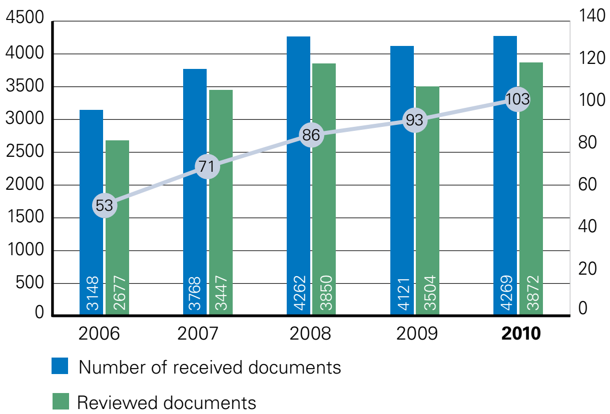


Figure 19. Number of documents received and reviewed as well as average document review time.

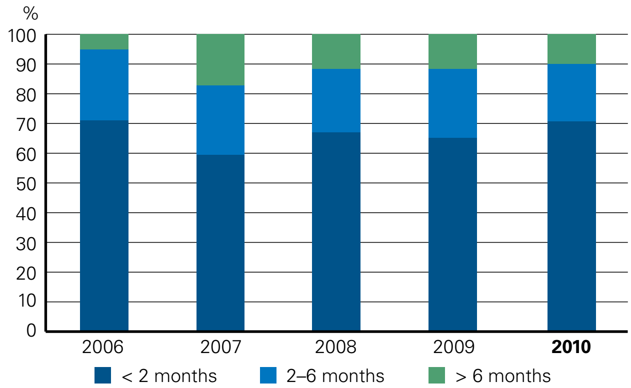


Figure 20. Distribution of time spent on preparing decisions on the Loviisa plant.

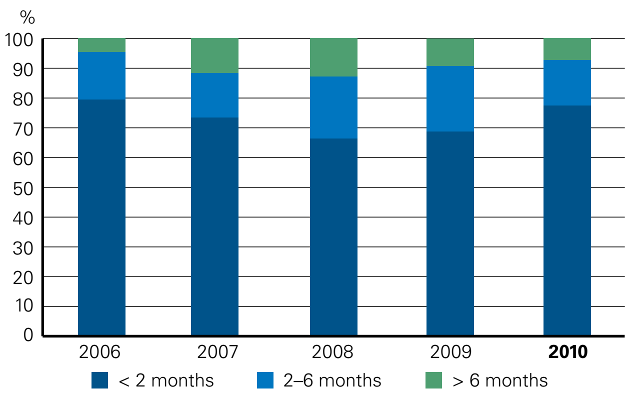


Figure 21. Distribution of time spent on preparing decisions on Olkiluoto plant units 1 and 2.

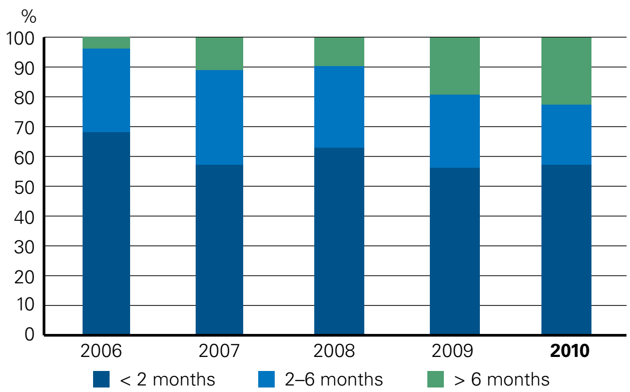


Figure 22. Distribution of time spent on preparing decisions on Olkiluoto plant unit 3.

9.2 Inspections on site and at suppliers' premises

Periodic inspection programmes

The 2010 periodic inspection programme (Appendix 5) was planned to include 22 inspections at the Loviisa plant and 23 at the Olkiluoto plant. STUK carried out 11 inspections within the Olkiluoto 3 construction inspection programme (Appendix 6) and 11 inspections within the Onkalo construction inspection programme (Appendix 7). The most relevant findings of the inspections are presented in the chapters on regulatory oversight

Other inspections at plant sites

A total of 904 inspections on site or at suppliers' premises were carried out in 2010 (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 partial inspections, such as a review of results documentation, an inspection of a component or a structure, a pressure or leakage test, a functional test or a commissioning inspection. Of the inspections, 256 were related to the regulatory oversight of the plant under construction and 648 to that of the operating plants.

The number of inspection days on site and at component manufacturers' premises totalled 3,508. This number includes not only inspections pertaining to the safety of nuclear power plants, but also those associated with nuclear waste management and safeguards, and audits and inspection of the underground research facility at Olkiluoto. In addition, a total of 311 inspection days outside normal working hours were spent at operating nuclear power plants, mostly during annual maintenance outages, as well as 126 inspection days at the plant under construction. Six resident inspectors worked at the Olkiluoto power plant and two resident inspectors at the Loviisa power plant. The number of on-site inspection days in 2006–2010 is shown in Figure 23.

9.3 Finances and resources

The duty area of nuclear safety regulation included basic operations subject to, and 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 co-operation, as well as emergency response and communications. Basic operations not subject to a charge are publicly funded. Overheads from rulemaking 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.

In 2010, the costs of the regulatory oversight of nuclear safety subject to a charge were EUR 16.5 million. The total costs of nuclear safety regulation were EUR 18.1 million. Thus the share of activities subject to a charge was 90.9%.

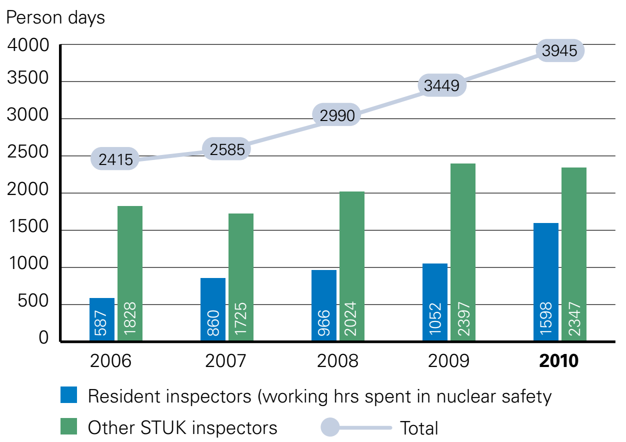


Figure 23. Number of inspection days onsite and at component manufacturers' premises.

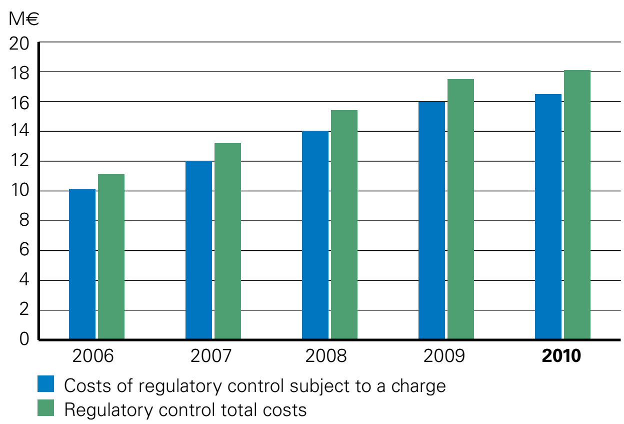


Figure 24. Income and costs of nuclear safety regulation.

The income from nuclear safety regulation in 2010 was EUR 16.5 million. Of this, EUR 2.8 million and EUR 11.4 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 of the Loviisa and Olkiluoto nuclear power plants also includes the costs invoiced for the safety assessment of the new nuclear power plant projects. The income from the inspection and review of Posiva Oy's operations was EUR 2.1 million. Figure 24 shows the annual income and costs from nuclear safety regulation in 2006–2010.

The time spent on the inspection and review of the Loviisa nuclear power plant was 13 person-years, i.e. 9.1% of the total working time of the nuclear regulatory personnel. For the Olkiluoto nuclear power plant's operating units it was 11.7 person-years, which accounts for 8.2% of the total working time. In addition to the regulatory oversight of the operation of nuclear power plants, the figure includes safeguards of nuclear materials. The time spent on inspection and review of Olkiluoto 3 was 34.6 person-years, i.e. 24.2% of the total working time. Work related to the new power plant projects accounted for 0.4 person-years, i.e. 0.3% of the total working time. The time spent on nuclear waste management inspection and review was 10.6 person-years. The time spent on international co-operation regarding regulatory oversight of nuclear safety was 5.6 person-years, and that spent on the FiR 1 research reactor was 0.2 person-years. The working time spent on small-scale users of nuclear material was 0.04 person-years. Figure 25 shows the division of working hours of the personnel engaged in nuclear safety oversight (in person-years) by subject of oversight in 2003–2010.

Where necessary, STUK commissions independent safety analyses and research in support of regulatory decision making. Figures 26 and 27 show the costs of orders in 2006–2010. The costs for 2010 mainly relate to reference analyses and independent assessments made for the plant unit under construction, to inspections carried out by external experts and to the reviews of safety documentation for the final disposal of nuclear waste. Appendix 8 lists the STUK-financed, nuclear power plant safety-related commissions in 2010. The reviews of the safety documentation for the final disposal of nuclear waste are discussed in section 5.1.2.

The distribution of the annual working time of the nuclear safety regulatory personnel to different duty areas is shown in Table 6.

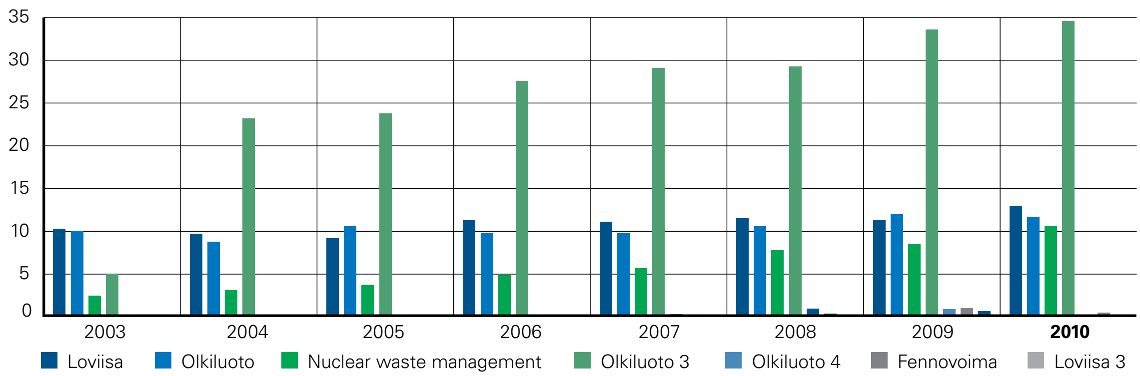


Figure 25. Distribution of working hours (person-years) of the regulatory personnel by subject of oversight in 2003–2010.

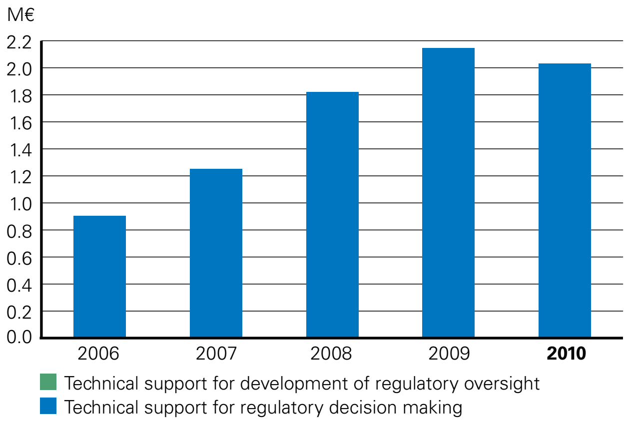


Figure 26. The costs of research and commissioned work pertaining to the safety of nuclear power plants.

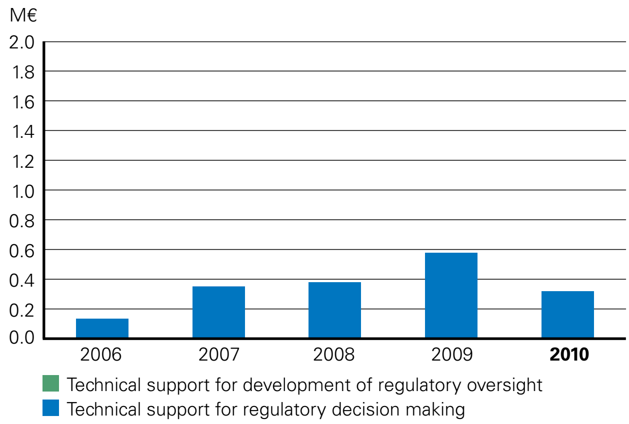


Figure 27. The costs of research and commissioned work pertaining to nuclear waste management and nuclear non-proliferation.

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

Duty area	2006	2007	2008	2009	2010
Basic operations subject to a charge	53.6	55.7	60.7	68.0	70.5
Basic operations not subject to a charge	5.7	6.1	6.3	6.6	7.8
Contracted services	3.0	2.2	2.2	1.7	1.9
Rule-making and support functions	28.8	30.3	31.5	33.6	38.2
Holidays and absences	20.0	19.1	21.1	23.5	24.3
Total	111.0	113.4	121.8	133.5	142.9

10 Development of regulatory oversight

10.1 STUK's own development projects

In December 2009, STUK set up a project management procedure development project (PROHAKE) with the aim of drawing up guidelines for the Nuclear Reactor Regulation and Nuclear Waste and Material Regulation Departments on procedures to be followed in oversight projects. The guidelines were completed in late 2010. The guidelines lay out criteria for project set-up for regulatory oversight work, project classification principles, tasks and responsibilities of a project organisation, life cycle and procedures for an individual project, and oversight project portfolio management. A flow-chart illustrating the project process and templates for project documentation (including a project plan, progress report and evaluation report) were prepared as an appendix to the guidelines. Regulatory oversight projects will be established in particular for licensing new nuclear facilities, periodic safety reviews of operating facilities and for supervising large plant modification projects.

Changes in practices and the organisation were updated in the quality manual

A total of 26 guides were updated in the quality manual for nuclear safety regulation, and appendices of 20 guides updated. Four new guides and 16 new appendices to different guides were completed. The new guides concern general principles of the above mentioned project operations, reporting stipulated by the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management, use of STUK's new records management system in nuclear safety regulation and tasks of the new Nuclear Security unit. Updates were prepared for guides due to altered practices and changes in the staff of Nuclear Reactor Regulation and Nuclear Waste and Material Regulation departments.

Implementation of the records management system continued

In 2010, several improvements were made to the records management system introduced in 2009. The reporting functionalities of the system were enhanced so that up-to-date information can be retrieved about matters currently being processed by STUK in terms of the numbers of documents and their processing times.

The records management system's workflow intended for monitoring unfinished matters did not meet the requirements set by STUK, therefore its introduction was delayed and postponed to 2011. Other improvements will also be made to the records management system in 2011.

Introduction of electronic inspection protocols delayed

Over 10 different inspection protocol forms are used in nuclear safety regulation. The manual procedures for these protocols in their current format do not allow optimal information management, such as reports on the effectiveness of STUK's own operations, compilation of statistics on inspection observations and follow-up of remarks made in inspections. Work on the design of the system started in cooperation with experts from the supplier, a consortium of Affecto Oyj and Avain Technologies Oy, in 2009. The first inspection records were due to be introduced in 2010, but as a result of the extent of additional work, which was larger than anticipated (for example, data security audit and off-line functionality), the introduction of the new inspection records was postponed to 2011.

10.2 Renewal and human resources

Training was organised for inspectors concerning nuclear power plant systems and regulatory operations, for example. New STUK inspectors participated in a national training programme in the nuclear safety field (the YK course), which STUK organises together with other actors in the field. The total duration of the seventh YK course was 19 days in six periods. Three phases took place in spring 2010. Ten STUK employees participated in the YK7 course. The YK8 course began in autumn 2010, again with ten STUK inspectors participating. The total number of participants in the YK8 course was 65.

STUK's inspectors also participated in training provided by external enterprises, such as lead auditor training, project operations training, auditing training, and various domestic and international training events. In addition, supervisors in the nuclear safety field participated in leadership and supervisor skills coaching programmes.

As part of the inspectors' expertise development, a survey of the induction of the inspectors hired for nuclear power plant regulation was conducted. Induction programmes will be improved on the basis of the survey results. A communication development project relating to nuclear reactor regulation continued in the form of drafting basic messages for the most important issues.

In 2010, a Master of Science thesis (Risk Follow-up in Regulatory Control of Nuclear Safety) was completed at the department of Nuclear Reactor Regulation. The thesis examines nuclear power plant risk follow-up based on probabilistic risk analysis and, in particular, the incremental conditional core damage probability of operational events.

At the department of Nuclear Waste and Material Regulation, one person completed a doctoral degree with the thesis "Mobile phone use and the risk of brain tumours", and one person completed a Master of Science (Technology) degree. The subject of the Master's thesis was "Application of a Database in a Nuclear Material Verification Measurement Program".

On average, 10.6 days per inspector in the field of nuclear waste and materials regulation and 7.7 days per inspector in the field of nuclear reactor regulation were spent on developing the expertise of STUK's nuclear safety experts in 2010.

Seven new inspectors were hired for nuclear reactor regulation in 2010. They will work in the fields of mechanical equipment inspections and automation technology. Three new inspectors were hired for nuclear waste and material regulation. Their spheres of responsibility will include engineered barriers used in the final disposal of nuclear waste, nuclear waste management at nuclear power plants and safety analyses of final disposal of spent nuclear fuel.

11 Emergency preparedness

In 2010, the Finnish nuclear power plants reported 13 events or failures to the Radiation and Nuclear Safety Authority. The nuclear power plant control rooms tested regularly the secured telephone connection built for emergency situations and real-time data transfer from power plant process computers to STUK's emergency response centre.

STUK organised emergency training and exercises related to nuclear facility and radiation emergencies. The exercises test the operation of the emergency response organisation, the functionality of the emergency response guidelines and the usability of the emergency response premises in practice. Functions, guidelines and tools are upgraded on the basis of the feedback received from the exercises. In addition, they familiarise new personnel with their duties in the emergency response organisation.

In October, STUK and Satakunta Fire and Rescue Service organised a seminar in Tampere on nuclear emergency preparedness with participants from STUK, Fortum, TVO, Fennovoima, Satakunta and Eastern Uusimaa Fire and Rescue Services, and the police.

A rescue exercise for the Loviisa power plant was conducted on 31 March 2010. It was a cooperation exercise for the power plant and the authorities which is conducted every third year. The specific targets of the exercise included a change of shift in protracted emergency situations and the transfer of environment radiation measurement data by means of protected information systems. At the conclusion of the exercise, the participants had to estimate how operations would be carried on for a whole 24 hours and what resources would be necessary. About 60 organisations and about 400 persons took part in the exercise.

The emergency exercise at the Olkiluoto power plant was held on 28 January 2010 as a surprise drill. Its time was announced in advance with two months' accuracy. The participants included the Olkiluoto power plant, STUK, the Finnish Meteorological Institute and Satakunta Fire and Rescue Services in Rauma. The exercise was short and it ended after office hours. It was based on imaginary hypothetical event and real meteorological conditions. The drill focused on how to raise the alarm, start activities and get organised, make an initial status assessment and convey it.

A training-type emergency exercise was conducted in connection with a nuclear security event at the Olkiluoto nuclear power plant in November. The participants included representatives from the power plant, STUK, the police and the fire and rescue services.

12 Communication

Nuclear safety communication on STUK's web pages

A column called Nuclear Safety Now was published on STUK's web pages in May 2010. The column features topical issues relating to nuclear facilities which STUK does not issue as press releases. The column news can be subscribed to as RSS feeds.

Towards the end of 2010, 10 items of news were published in the Nuclear Safety Now column. They mainly reported those events in operating nuclear power plants which had minor safety implications and thus rated at the zero level on the INES scale.

STUK also opened a service in which new radiation and nuclear safety related guides and guides under revision are published already at their preparation stage. The Guide extranet service also allows all those interested to read draft guides and give comments on them. The first YVL Guides to be revised were included in the service for comments at the end of the year. At the same time, a press release was issued about the service.

In 2010, the Parliament of Finland approved the building of two new nuclear reactors. Nuclear safety issues related to these projects aroused a lot of discussion. In particular, people were concerned about the plants' protective zones and the number of people living in the protective zones, which lead to some debate in the media on the potential locations of the new nuclear power plants. STUK's experts gave many interviews on the new nuclear power plant projects and, among other things, also on welding work performed on Olkiluoto 3, both to Finnish and foreign media.

Four press releases on nuclear safety were published. In addition to the Guide extranet service, STUK released information about an expert evaluation report according to which the SAFIR2010 research programme on nuclear power plant safety is functioning well.

In the summer, two press releases were published on the Olkiluoto 3 project. The press releases reported that the project automation design had made progress and that further investigation had found the reactor coolant pipes of the reactor circuit to comply with regulations.

In May, nuclear safety issues were also on the agenda at two events held for reporters. STUK arranged a morning coffee meeting with local reporters in Rauma in which STUK experts from Helsinki and local inspectors from Olkiluoto spoke about STUK's role and activities as the nuclear safety supervisor in Olkiluoto. Seven reporters attended the meeting. They were interested most in news about Olkiluoto 3 and the ageing of the operating units.

The "Säteilyn Salat Pro 2" (Secrets of Radiation) advanced course delivered as a one-day training session in Helsinki gathered together 25 reporters who had attended the "Säteilyn Salat" course. The theme of the day was the use of radiation in medicine, but the floor was also given to lectures on topical nuclear safety issues including new nuclear power plant projects in Finland and Russia and the challenges presented by the nuclear power plant location site.

STUK's Alara magazine dealt with nuclear safety issues from many different standpoints in the course of the year. Among other things, the magazine explained what the three Ss of nuclear safety—safety, security and safeguards—aim at and reported what people in northern Finland think of nuclear power's impact on health. Alara also estimated whether there will be enough competent people available for nuclear energy in the future and stressed that people living in the neighbouring areas of a nuclear power plant must be protected from radiation in any situation.

The last thematic issue of the year on nuclear safety focused on safety culture in the field of nuclear power. The article considered what the criteria for good safety culture are and how every employee at a nuclear power plant can be motivated to take safety into account in his or her work.

13 International cooperation

International conventions

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 Finnish national report, which was submitted to the IAEA, functioning as the Convention's secretariat, according to the agreed schedule in the autumn of 2010. Corresponding reports have previously been submitted in 1999, 2002, 2004 and 2007. This latest report will be reviewed by the Contracting Parties at an extensive international conference in Vienna in the spring of 2011. The Convention procedure also provides an opportunity to ask questions about other countries' reports. STUK performed a preliminary review of the reports submitted by Finland's neighbouring countries and the reports of those countries with which STUK has had contacts within the framework of international cooperation. STUK submitted around 70 clarifying questions to the other countries.

The review meeting of the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management convened in Vienna in 2009. The meeting decided on measures to encourage more parties to sign up to the Convention in order to improve the safety of radioactive waste and spent nuclear fuel management and so that communication between the parties would not take place only at meetings held every third year. As agreed, the IAEA arranged two meetings in Paris in June 2010. One of the meetings was intended for attracting new contracting parties and the other was focused on communication issues. At the first of these meetings, STUK gave a speech on informing the general public about questions relating to the final disposal of nuclear waste. STUK started the preparation of the following country report in December 2010.

Cooperation within international organisations and with other countries

The following includes a number of short summaries of the international cooperation domains which were the most significant from a nuclear safety regulation perspective in 2010.

Co-operation within the IAEA

The IAEA continued to revise its safety standards on nuclear safety. STUK had a representative in both the Commission on Safety Standards (CSS) managing the preparation of the safety standards and in the committees dealing with the content of the safety standards, 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 safety standards under preparation. STUK's representatives also participated in expert groups working on the preparation of safety guides concerning the design, safety classification and construction management of power plants, and on a safety case for geological final disposal.

The International Nuclear Safety Group (INSAG) convenes under the auspices of the IAEA at the invitation of the IAEA Director General with the objective of providing strategic opinions for the development of nuclear safety globally. STUK's representative acts as the deputy chairperson of the group. STUK's representative is also included in another group invited by the Director General, SAGSI, dealing with nuclear material safeguards.

STUK's representatives participated in expert teams assembled by the IAEA; the teams reviewed the performance of the nuclear safety regulatory system in China and the USA.

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. STUK's representatives also participated actively in the activities of working groups under the standing committees. 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)

Cooperation within the EU

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 (nuclear safety and nuclear waste management). The cooperation group participates in the preparation of directives pertaining to nuclear safety and coordinates the implementation of directives in the member states. The nuclear waste group chaired by STUK prepared a proposal for a Directive on the safety of nuclear waste management based on which the European Commission issued a draft Directive.

STUK took an active part in the planning and steering of the European coordination centre for nuclear power plants' operational experience feedback network (EU Clearinghouse on NPP OEF). The coordination centre works in conjunction with the European Commission's Institute for Energy, Joint Research Centre (IE-JRC) located in Petten, the Netherlands. One STUK employee works as a national expert at the IE-JRC in Petten. STUK's Director General acts as the chair of the Technical Board of the EU Clearinghouse and STUK's coordinator for international operating feedback as his assistant. STUK's responsible person for the IRS database participates in a group designing the EU Clearinghouse website and database.

MDEP

The Multinational Design Evaluation Programme (MDEP) was originally established on the initiative of the United States nuclear safety authority (Nuclear Regulatory Commission, NRC) with the objective of improving cooperation in the field of the assessment of new nuclear power plants and to develop convergent regulatory practices. Nuclear safety authorities from 10 countries participate in the programme: the USA, South Africa, Japan, Canada, China, Korea, France, Finland, the United Kingdom and Russia. Participants in the programme include only countries with new nuclear power plants at some stage of assessment by the regulatory authorities. Some other countries have also expressed their interest in joining the programme, and criteria for the membership of new countries were adopted at the end of 2010. No new countries were accepted within the programme in 2010. The programme has contracted the OECD Nuclear Energy Agency to function as its secretariat. In addition to meeting arrangements, the secretariat takes care of the library where all the documents are gathered.

The MDEP's work is organised in Design-Specific and Issue-Specific working groups. Currently there are two Design-Specific working groups: the EPR working group and the AP 1000-working group. Finland participates in the EPR working group only. The other countries in the EPR group include France, the USA, the United Kingdom, Canada and China. The Finnish representative is the chairperson of the EPR working group. The EPR group's work was originally a continuation of cooperation between the Finnish and French authorities concerning safety assessment of EPR power plants.

There are three Issue-Specific working groups:

- Vendor Inspection Cooperation Working Group
- Pressure Boundary Codes and Standards Working Group
- Digital Instrumentation and Controls Working Group.

Finland participates in the activities of all three Issue-Specific Working Groups. The objective of the Vendor Inspection Working Group is to achieve an understanding of the participating countries' inspection procedures concerning the manufacturers of primary circuit main components. After the procedural and regulatory differences have been determined, the aim is to utilise inspections carried out by other regulatory authorities when possible. In 2010, the group carried out nine joint inspections. STUK acted as the host organisation in two inspections. The objective of the Pressure Boundary Working Group is the harmonisation of the requirements in different standards, not their complete unification. For harmonisation it is necessary to know the differences between standards and to understand the reasons for them. Phase one deals with Class 1 pressure vessels and phase two is going to deal with Class 1 pipelines, valves and pumps. Phase one is almost complete. The Digital Instrumentation and Controls Working Group aims to promote coordinated development of the IEC and IEEE standards. In addition, some individual issues have been chosen and on which common position type opinions have been drafted.

Besides these working groups, a subgroup acting in conjunction with the Steering Technical Committee has prepared a report on nuclear power plant safety objectives.

WENRA, Western European Nuclear Regulators' Association

STUK participated in the WENRA (Western European Regulators' Association) working groups on nuclear safety, inspection activities, nuclear waste and decommissioning. The groups developed common safety reference levels on the basis of the IAEA standards and discussed regulatory practices in different countries. The leading nuclear safety authorities who comprise the WENRA group have set as their original objective that the requirements for nuclear safety are brought into compliance with these reference levels in the WENRA member states by the end of 2010. The WENRA member countries are close to achieving the objective, but in some countries the updating of the authorities' requirements is taking slightly longer than anticipated. At STUK, the WENRA reference levels will be taken into account in the revision of the YVL Guide revision. The target is to publish the new YVL Guides by the end of 2011. The target schedule for the requirements for nuclear waste storage is the end of 2012; for the requirements for decommissioning, the end of 2013; and for the harmonisation of the requirements for final disposal of nuclear waste, the end of 2015. In 2010, the nuclear safety group also drew up general safety principles for new reactors. In 2010, WENRA established a working group on the inspection of mechanical equipment, which aims to publish a report on inspection practices in WENRA member countries in 2011. WENRA is chaired by STUK's Director General.

VVER cooperation

STUK participated in the co-operation between the regulatory authorities of countries with VVER power plants via the VVER Forum. STUK was elected to chair a working group on regulatory oversight of organisations.

Safety case for geological final disposal

STUK participated in the work carried out by the working group of European authorities (European Pilot Study on Demonstrating the Safety of Geological Disposal), which resulted in a recommendation for safety case content for final disposal at different stages of final disposal. The recommendation will be published in 2011.

Bilateral cooperation

In 2010, STUK continued bilateral cooperation in the form of meetings and conferences with the nuclear safety regulatory authorities of Sweden, Russia, France and the USA, among others.

Participation in cooperation within international organisations in the fields of radiation and nuclear safety regulatory control, bilateral cooperation with various countries, participation in cooperation projects involving several countries, and presentations given at international meetings in 2010 are listed in Appendix 9.

APPENDIX 1 STUK's safety performance indicators for NPPs in 2010

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 indicators weaken, the factors behind the development are defined and changes to plant operation and STUK's oversight of the area are considered. Indicators can also be used to monitor the efficiency and effectiveness of the 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. These three sectors are furthermore divided into a total of 13 sub-areas to be interpreted (see the table below). Indicator A.II.2, Direct causes of events, was omitted from the operational events section. The change was made because it is important to understand even minor events as complex phenomena usually associated with technical, human and organisational factors. It is important to perform an in-depth and diverse analysis, particularly of events that allow organisations to learn significant lessons and improve the safe operation of plants. In its regulatory oversight work STUK has emphasised that efficient learning from events requires the licence holders' procedures and methods related to analysing the events to be developed.

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 mainte-

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__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.

nance and analysis of the indicators. Individual indicators, their maintenance procedures and the interpretation of results are presented at the end of this summary. In 2003, the nuclear safety indicators were first connected with STUK's strategy and reported as part of regulatory oversight of nuclear safety. Indicators monitor the implementation and success of the strategy.

STUK's long-term safety objectives concerning nuclear power plants were as follows in 2010:

- No accidents or serious incidents occur at Finnish nuclear power plants.
- Risks related to a nuclear power plant are managed to decrease or stabilise the accident risk at the plants in the long term.
- Only minor releases of radioactive materials into the environment occur.
- The radiation dose of every employee at the nuclear facility is below the personal dose limit.
- The collective radiation dose for all employees of a nuclear power plant stays below the maximum limit defined in Guide YVL 7.9 when figures from both nuclear power plants are included.

The nuclear safety performance indicators show that the operation and maintenance of the Loviisa and Olkiluoto power plants have complied with these objectives. A brief summary of the safety situation in each plant in 2010 is presented below, followed by the detailed results by indicator.

Results for the safety performance indicators for the nuclear power plants in 2010

Loviisa NPP

Summary

Minor fuel leak at Loviisa 1

In autumn 2009, a minor fuel leak was detected at Loviisa 1. In the leak finding operation carried out during the annual maintenance, the leak was located in one fuel assembly. The leaking fuel bundle was removed from the reactor in the 2010 annual maintenance. The leak was a minor one. Fuel integrity at Loviisa 2 was good. During the past decade, the plant units in Loviisa have experienced few fuel leaks. The leak tightness of the primary circuit and the containment building remained good, albeit that the total as-found leakages of outer isolation valves affecting the leak tightness of the containment building are on the increase.

Operation and maintenance of the plant was appropriate

In 2010, extensive annual maintenance operations were performed in Loviisa, and the large amount of work carried out had the result that part of the employees were exposed to radiation more than normally. However, the radiation protection measures were appropriately carried out, and the exposures of employees were clearly below the individual dose limits set in regulations. The emissions into the environment were also minor and remained clearly under the set emission limits.

The licence holder filed one special report regarding plant operation. A quantity of mildly radioactive water-resin solution was transported to the venting line of the resin tank at the liquid waste solidification plant of Loviisa NPP and from there to the ventilation system of the auxiliary building as a result of overfilling the resin tank when it was being rinsed. As a consequence of the event, the liquid level measurement in the tanks will be improved and the operating instructions of the solidification plant will be further specified so that overfilling of the tank can no longer occur. Commissioning of the liquid waste solidification plant has not been continued yet after the event.

The operators of Loviisa 1 shut down the reactor by triggering a reactor trip as a result of malfunction detected when testing the steam line isolation valve and the automatic turbine trip that followed. During the event, the plant operated as planned with regard to protective systems, and the event had no impact on the safety of the plant or its surroundings.

The calculated risk of accident at the Loviisa power plant has constantly decreased during the last ten years. This is due to both the improved accuracy of risk analyses and, in particular, the significant modifications carried out at the plant for improving plant safety. The most significant accident risks include actions during annual maintenance, such as the lifting of heavy loads in the reactor hall or a power surge caused by sudden dilution of the boron used to adjust reactor operation, oil accidents at sea during refuelling outages, fire and high levels of seawater during power operation. In 2010, the risks arising from operational activities at the Loviisa power plants were assessed to be higher than in the previous years. No particular reason for this has been identified. However, different calculation software and a new method for collecting input data were used in 2010. They have probably affected the results.

The functionality of safety systems is followed at the Loviisa power plant on the basis of unavailability of the high-pressure safety injection system, the emergency feed water system and the emergency diesel generators. The safety performance indicators show that the condition and availability of safety systems remained good. The availability of the emergency feed water systems (RL94/97) can be further improved by planning and implementing the annual maintenance operations of the systems more efficiently. As a whole, the maintenance of and fault repairs to components important to safety was appropriate.

The safety performance indicators show that the operation and maintenance of Loviisa plant units has been compliant with the 2010 strategic objectives of STUK regarding nuclear safety.

Below, the results of the nuclear safety indicators are presented in detail.

Olkiluoto NPP

Summary

Three fuel leaks had a slight negative effect on structural integrity

The reactors of both Olkiluoto plant units had leaking fuel in 2010. A fuel leak was detected at Olkiluoto 1 just before the annual maintenance, and the leaking fuel assembly was removed from the reactor during the 2010 annual maintenance outage. At Olkiluoto 2, the leaking fuel assembly detected in January was removed from the reactor during the annual maintenance outage. A new fuel leak developed at Olkiluoto 2 after the annual maintenance outage. The leak has remained small. Several fuel leaks have occurred at the Olkiluoto plant units during the 2000s. The main reasons for these leaks have been small, loose parts entering the reactor during annual maintenance that have become caught in the fuel assembly structures and broken the fuel cladding with their vibrations. There were no occurrences of leaking fuel in 2008 or 2009, but the number of leaks occurring in 2010 was at the same level as in the middle of the decade.

Based on the water chemistry indicators, the primary circuit integrity of both plant units has, as a whole, remained good. During 2010, the iron concentration in the feed water for the Olkiluoto 1 reactor circuit has been increasing, which is possibly caused by erosion in the feed water pipelines and corrosion in the condensate system heat exchangers. The licence holder has planned an extended inspection of these objects during the 2011 annual maintenance.

The leak tightness of the containment building has remained good. The leak tightness of the containment building is assessed on the basis of the total as-found leakages of plant unit isolation valves, leak tightness tests on isolation valves and the total as-found leakages of containment penetrations (upper and lower personnel airlocks, the maintenance dome and the containment dome).

Component failures caused a slight increase in the risk due to operating activities

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

The Olkiluoto power plant had two events warranting a special report in 2010: a fault was detected in the electrical control valves of the blowdown system of Olkiluoto 1 in conjunction with tests. Three out of the five valves of new design had jammed due to oxidation of the coating material inside the control bush. These valves were taken out of service. When the event was being investigated, it was found that the manufacturer had applied hard chrome plating on the inside of the valve guide bushes contrary to the manufacturing requirements. The event has for its part led to the licence holder starting to develop its procedures related to modifications management and quality management of procurement, 2) Incorrect settings were detected in the safety automation of frequency converters at Olkiluoto 1 and Olkiluoto 2 during the annual maintenance outage in the spring. This could have resulted in the main coolant pumps stopping quicker than planned in certain rare transient situations, which could have led to a heat transfer crisis in part of the fuel. The automation had the now discovered incorrect settings ever since commissioning, which means that the implementation did not comply with the requirements set. The fault was rectified by replacing certain components on the I&C card controlling the rate of slowing down with components of correct values (the events are discussed in more detail in Section 4.2.3 of the report.) In addition, Olkiluoto 2 had one reactor trip. During the past decade, the Olkiluoto plant units have had an average of one rector trip per year. The accident risk indicator for the Olkiluoto power plant has remained virtually unchanged during the last three years. The most important factors affecting the overall accident risk include internal events during power operation, such as component failures and pipe ruptures resulting from operational transients.

The functionality of safety systems at the Olkiluoto power plant is assessed by monitoring the unavailability of the containment building spraying system, the auxiliary feed system and the diesel generators. The indicators describing the containment building spraying system show that no significant deterioration has taken place in the condition of these systems. At Olkiluoto 2 the unavailability of the auxiliary feed water system increased slightly due to the several faults discovered during annual maintenance. The unavailability of diesels increased somewhat as a result of the stator coil of the diesel generator in Olkiluoto 1 failing in connection with periodic testing. As a result of the event, the licence holder will carry out a basic overhaul of the diesel generators in Olkiluoto 1 and 2.

The maintenance of components covered by the Operational Limits and Conditions has been appropriate, although the risks due to operating activities were assessed to have increased slightly as a result of the component failures occurring in 2010.

The safety performance indicators show that the operation and maintenance of the Olkiluoto plant units has been compliant with the 2010 strategic objectives of STUK regarding nuclear safety.

The results of the nuclear safety indicators are presented in detail later in this document.

Safety performance indicators

A.I Safety and quality culture

A.I.1 Failures and their repair

A.I.1a Failures of components subject to the Operational Limits and Conditions

Definition

The number of failures causing unavailability of components defined in the Operational Limits and Conditions (OLC components) during power operation is monitored as an indicator. The failures are divided by plant unit into two groups: failures causing an immediate operation restriction and failures 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 life-cycle management and the development of the condition of components.

Responsible units/persons

Operational Safety (KÄY), resident inspectors
Pauli Kopiloff (Loviisa nuclear power plant)
Jarmo Konsi (Olkiluoto nuclear power plant)

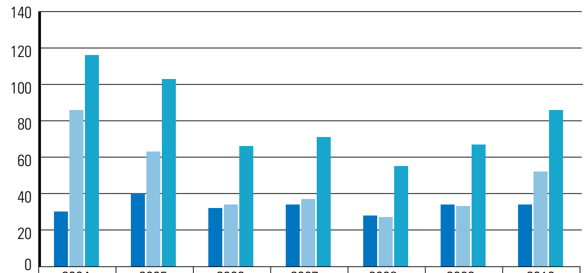
Interpretation of the indicator

Loviisa

In 2010, the number of failures in OLC components causing an operating restriction was 204, while it was 181 in 2009. The number of failures occurring in 2010 was slightly higher than the average of the four preceding years (186). No obvious and significant reason can be seen for this increase.

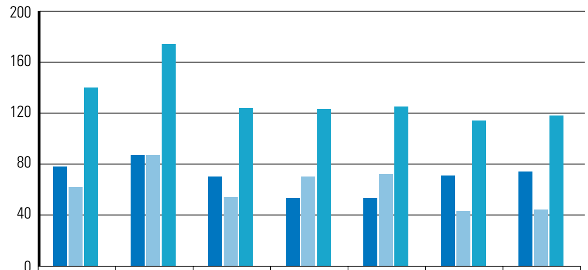
When assessing the whole picture, it can be said that the number of failures occurring annually has remained relatively stable. Any annual variations therein are caused by the random occurrence of failures that are difficult to predict but will occur in any large number of components. Failure detection and anticipation have been continuously improved

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



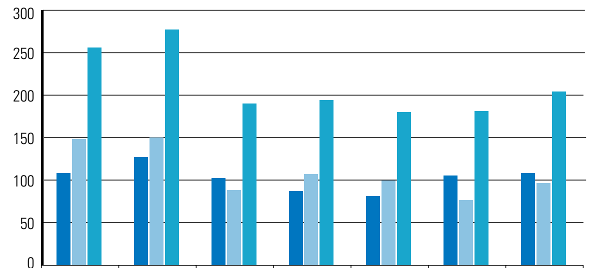
	2004	2005	2006	2007	2008	2009	2010
LO1	30	40	32	34	28	34	34
LO2	86	63	34	37	27	33	52
LO1,2	116	103	66	71	55	67	86

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



	2004	2005	2006	2007	2008	2009	2010
LO1	78	87	70	53	53	71	74
LO2	62	87	54	70	72	43	44
LO1,2	140	174	124	123	125	114	118

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



	2004	2005	2006	2007	2008	2009	2010
LO1	108	127	102	87	81	105	108
LO2	148	150	88	107	99	76	96
LO1,2	256	277	190	194	180	181	204

in plant maintenance operations at Loviisa, and components have been replaced. Thanks to these measures, failures having a significant impact on the safe operation of the plant have not occurred, and the operability of components has remained well under the control of the power plant.

On the above basis, it can be stated that the safety performance indicators or the underlying failure details do not show any negative effects attributable to the ageing of the plant.

Interpretation of the indicator

Olkiluoto

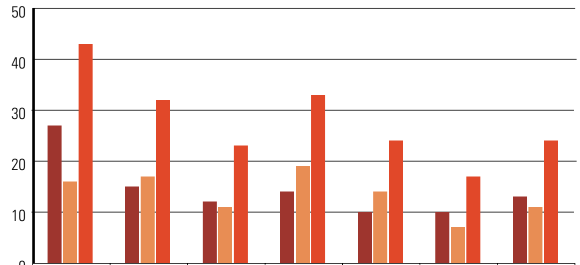
The number of failures occurring during power operation and causing the unavailability of components subject to Operational Limits and Conditions (OLC components) increased somewhat from the previous year. Before that, the number of such occurrences had been decreasing ever since 2007. The number of failures indicates that maintenance work has been successful.

At OL1, the periods of inoperability were short during the first, second and fourth quarter of 2010. The failures causing an immediate operation restriction during the third quarter included the failure of one diesel generator, level measurement of the filtered pressure relief system of the containment and one boron pump.

The stator winding of the diesel generator failed in connection with periodic tests in August, and the generator was replaced with an overhauled one. The other generators of the same type were inspected at both plant units, and visual inspection did not reveal any deviations in them. The failed generator was sent for repairs. No spare generator is available during the repair. Following the incident, the power company has been planning a basic overhaul of the diesel generators that have not had one since 1992–1996.

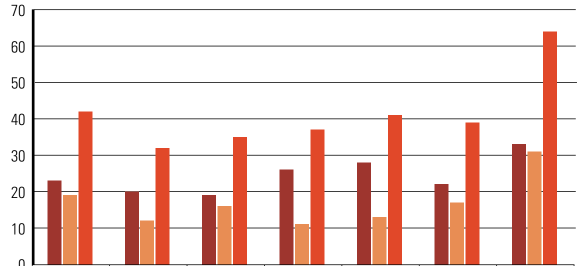
During the first quarter of 2010, the efforts to find the reason for the decreased flow of seawater caused several occurrences of isolation at OL2. In the course of this work, the system components were opened, but no deviations were observed. During this diagnostic work, it was also discovered that the pump motor power supply cables in the system were heating due to the contact resistance at the terminal block. The detected faults were repaired and the measurement procedures improved.

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



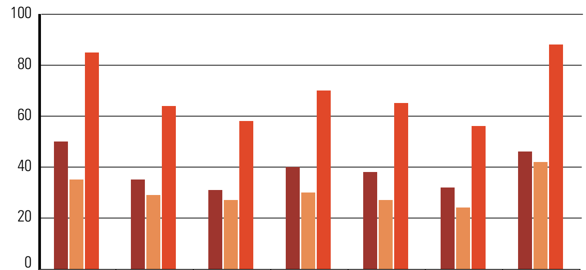
	2004	2005	2006	2007	2008	2009	2010
OL1	27	15	12	14	10	10	13
OL2	16	17	11	19	14	7	11
OL1,2	43	32	23	33	24	17	24

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



	2004	2005	2006	2007	2008	2009	2010
OL1	23	20	19	26	28	22	33
OL2	19	12	16	11	13	17	31
OL1,2	42	32	35	37	41	39	64

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



	2004	2005	2006	2007	2008	2009	2010
OL1	50	35	31	40	38	32	46
OL2	35	29	27	30	27	24	42
OL1,2	85	64	58	70	65	56	88

A.I.1b Maintenance of components subject to the Operational Limits and Conditions

Definition

As the indicator, the number of failure repairs and preventive maintenance work orders for components defined in the OLC are followed by plant unit.

Source of data

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

Purpose of the indicator

The indicator describes the volumes of failure repairs and preventive maintenance and illustrates the condition of the plant and its maintenance strategy. The indicator is used to assess the maintenance strategy executed at the plant.

Responsible units/persons

Operational Safety (KÄY), resident inspectors
Pauli Kopiloff (Loviisa nuclear power plant)
Jarmo Konsi (Olkiluoto nuclear power plant)

Interpretation of the indicator

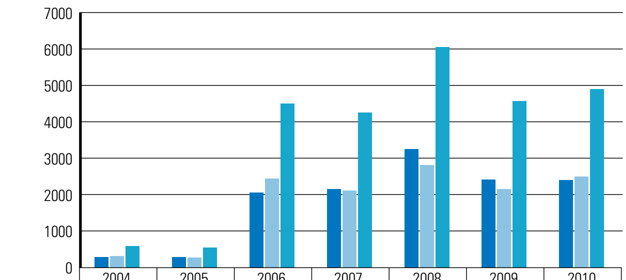
Loviisa

A new IT system was commissioned at the power plant in 2006. The coverage of indicators was improved in conjunction with the IT system revision. The annual maintenance operations also included the work for such components covered by OLC to which no operating restriction applied. Due to the IT system change and the extension and further specification of the scope of the figures, the maintenance figures are only fully comparable for the last five years.

When considering the variation in the volume of failure repairs and particularly in the number of preventive maintenance works, the scheduling of various annual maintenance works (refuelling outage, four-year annual maintenance, brief annual maintenance, eight-year annual maintenance) included in the maintenance strategy of the Loviisa power plant during a four-year cycle should be considered as this can have a significant impact on the annual figures. In 2010, the LO1 unit had a brief annual maintenance and the LO2 unit had an extensive eight-year annual maintenance.

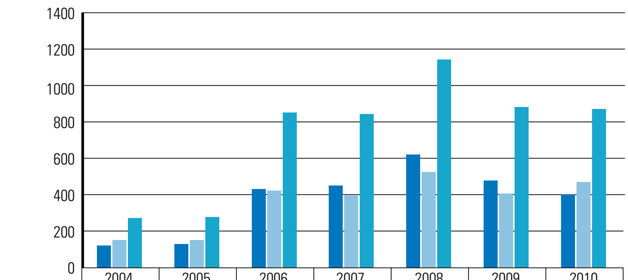
Judging by the data behind the indicator, 2010 was not markedly different from the previous years as concerns preventive maintenance. The ra-

Volume of annual maintenance works of OLC components, Loviisa NPP



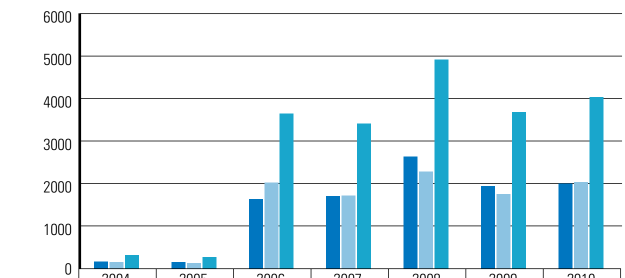
	2004	2005	2006	2007	2008	2009	2010
LO1	282	277	2057	2148	3250	2416	2403
LO2	303	269	2444	2105	2807	2148	2495
LO1,2	585	546	4501	4253	6057	4564	4898

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



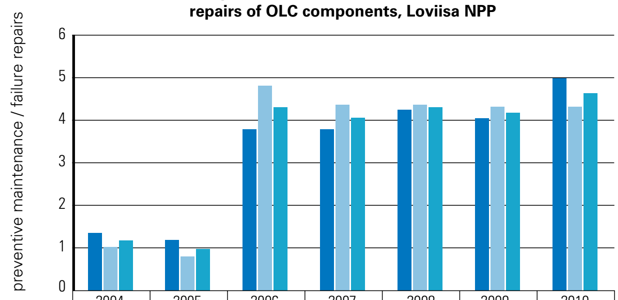
	2004	2005	2006	2007	2008	2009	2010
LO1	120	127	429	448	619	478	401
LO2	150	150	421	393	524	404	469
LO1,2	270	277	850	841	1143	882	870

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



	2004	2005	2006	2007	2008	2009	2010
LO1	162	150	1628	1700	2631	1938	2002
LO2	153	119	2023	1712	2283	1744	2026
LO1,2	315	269	3651	3412	4914	3682	4028

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



	2004	2005	2006	2007	2008	2009	2010
LO1	1.35	1.18	3.79	3.79	4.25	4.05	4.99
LO2	1.02	0.79	4.81	4.36	4.36	4.32	4.32
LO1,2	1.17	0.97	4.30	4.06	4.30	4.17	4.63

tio of preventive maintenance work to fault repairs was 4.6 in 2010, having been 4.2 in 2009. The large proportion of preventive maintenance work reflects the chosen maintenance strategy that allows keeping the number of faults and their impacts at a reasonable level.

The stability of the indicator can be deemed an indication that the maintenance strategy is successful.

Interpretation of the indicator

Olkiluoto

The data for the indicator is obtained from the plant work order system and operating documentation. Due to changes in the work order system implemented by the power company as of 1 January 2006, the data is not comparable with the figures for earlier years. Class 3 data (systems subject to the Operational Limits and Conditions (OLC)) has been removed from the work order classification, since the Class 3 category covers all systems specified in the OLC. Nowhere near all of these systems are subject to restrictions set out in the OLC. Thus this indicator is used to monitor the ratio of the number of preventive maintenance works causing unavailability of components to the number of failure repairs.

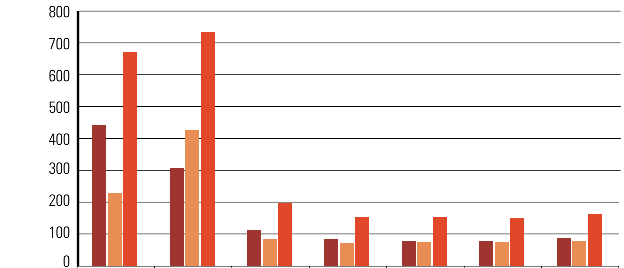
The number of maintenance works causing inoperability of components, included in the indicator, has been decreasing during 2006–2009 due to the decreasing number of fault repairs. In 2010, the number of fault repairs increased while the number of preventive maintenance operations decreased. The total number of maintenance operations causing inoperability was slightly higher than in previous years. The changes can be considered normal annual variations.

The total number of repairs causing inoperability has been on the decline during 2006–2009. However, in 2010 the number was 88 having been 56 in the previous year.

The amount of work causing unavailability of components included in the so-called preventive maintenance packages, carried out for OL2 in the first part of the year and for OL1 in the latter part of the year, dropped by approximately 30% in 2007 compared to 2006. The number remained fairly constant during 2007–2009. In 2010, the number of preventive maintenance operations decreased slightly from the previous year (from 94 to 75). The ratio of preventive maintenance work to fault repairs was 1.20 in 2007 and 1.33 in 2008. In 2009, the ratio was 1.68 and in 2010, it was 0.85.

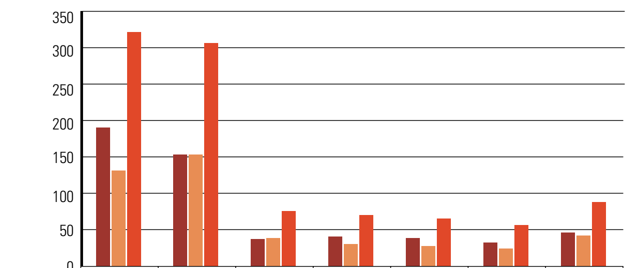
Based on the development of the ratio of preven-

Volume of annual maintenance works of OLC components, Olkiluoto NPP



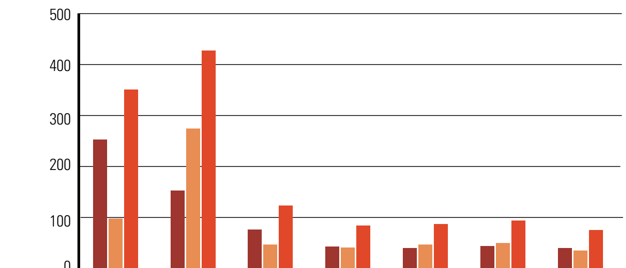
	2004	2005	2006	2007	2008	2009	2010
OL1	443	306	113	83	78	76	86
OL2	229	427	85	71	74	74	77
OL1,2	672	733	198	154	152	150	163

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



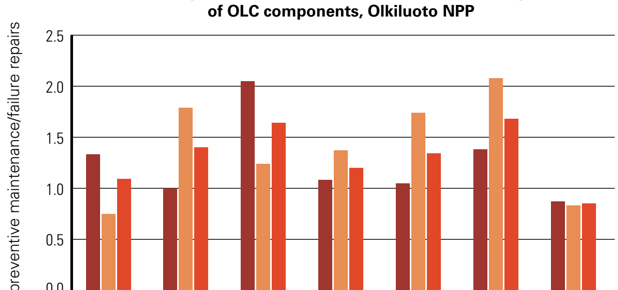
	2004	2005	2006	2007	2008	2009	2010
OL1	190	153	37	40	38	32	46
OL2	131	153	38	30	27	24	42
OL1,2	321	306	75	70	65	56	88

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



	2004	2005	2006	2007	2008	2009	2010
OL1	253	153	76	43	40	44	40
OL2	98	274	47	41	47	50	35
OL1,2	351	427	123	84	87	94	75

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



	2004	2005	2006	2007	2008	2009	2010
OL1	1.33	1.00	2.05	1.08	1.05	1.38	0.87
OL2	0.75	1.79	1.24	1.37	1.74	2.08	0.83
OL1,2	1.09	1.40	1.64	1.20	1.34	1.68	0.85

tive maintenance work to fault repairs and the assessment of the work behind the figures, the maintenance strategy can be considered functional.

A.I.1c Repair time of components subject to the Operational Limits and Conditions

Definition

As the indicator, the average repair time of failures causing unavailability of components defined in the OLC is monitored. With each repair, the time recorded is the time of inoperability. It is calculated from the detection of the failure to the end of repair work, if the failure causes an immediate operation restriction. If the component is operable until the beginning of repair, only the time of the repair work is taken into account.

Source of data

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

Purpose of the indicator

The indicator shows how quickly failed OLC components are repaired in relation 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

Operational Safety (KÄY), resident inspectors
Pauli Kopiloff (Loviisa nuclear power plant)
Jarmo Konsi (Olkiluoto nuclear power plant)

Interpretation of the indicator

Loviisa

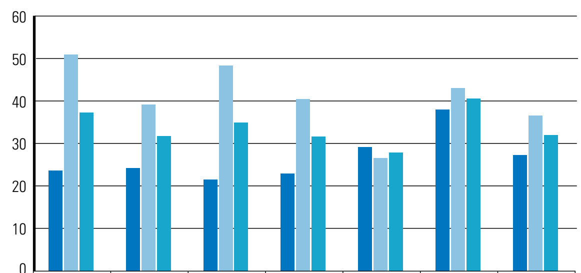
The Operational Limits and Conditions define the maximum allowed repair times for components based on the components' safety significance. The times vary between four hours and 21 days. Failures in OLC components are to be repaired within the allotted time without undue delay.

Due to the small amount of work requiring operation restrictions and the varying allowable repair times, an individual operation may have a significant effect on the indicator value even when it is performed 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 failure repairs in terms of maintenance strategy, resources and efficiency of operations.

The average repair times of failures causing unavailability of components have remained stable at the Loviisa plant for several years. In 2010, the average repair time at the plant units was 31.9 hours while the average for the four preceding years was 39.4 hours. The average repair time of OLC component failures that had an allowed repair time of 72 hours or less was 13.0 hours at LO1 and 14.7 hours at LO2 in 2010.

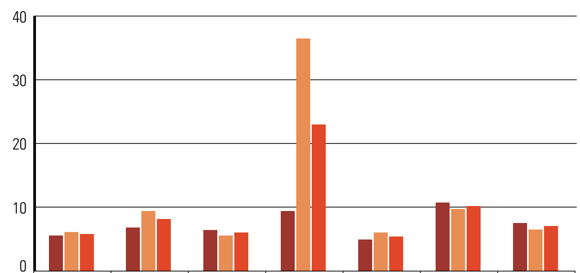
The indicators for 2010 and the underlying information lead to the conclusion that maintenance operations at the power plant are appropriate, but attention should nevertheless still be paid in maintenance to the sufficiency of resources and management of operations so that the faults are repaired without undue delay.

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



	2004	2005	2006	2007	2008	2009	2010
LO1	23.6	24.3	21.5	22.9	29.1	38.0	27.3
LO2	50.9	39.1	48.4	40.4	26.6	43.1	36.6
LO1,2	37.3	31.7	35.0	31.7	27.9	40.6	32.0

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



	2004	2005	2006	2007	2008	2009	2010
OL1	5.5	6.8	6.4	9.4	4.9	10.7	7.5
OL2	6.1	9.4	5.5	36.5	6.0	9.7	6.5
OL1,2	5.8	8.1	6.0	23.0	5.4	10.2	7.0

Interpretation of the indicator

Olkiluoto

The indicator is used to monitor the repair times of components subject to the Operational Limits and Conditions. The repair time allowed in the Operational Limits and Conditions is usually 30 days for faults concerning one subsystem and three days for faults concerning two subsystems. Depending on the system and the component, other allowed repair times may be defined in the Operational Limits and Conditions.

Over a longer period, the average repair time has varied between six and ten hours with the exception of 2007. In that year, repair times increased strongly for both plant units to 1.5 times the previous figure at OL1 and to more than six times the previous figure at OL2. For both plant units, the increase was due to a failure in a single device.

In 2010, the average repair time of failures causing inoperability of components defined in the Operational Limits and Conditions was approximately seven hours for both plant units. This meant a decrease of three hours from the previous year.

On the basis of the 2010 indicators and the data behind them, the plant's maintenance operations meet the requirements.

A.I.1d Common cause failures

Definition

As the indicator, the number of common cause failures of components or systems defined in the OLC is followed.

Source of data

Data for the indicators is collected from the reports by the utilities 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)
Tomi Koskiniemi (Loviisa)
Suvi Ristonmaa (Olkiluoto)

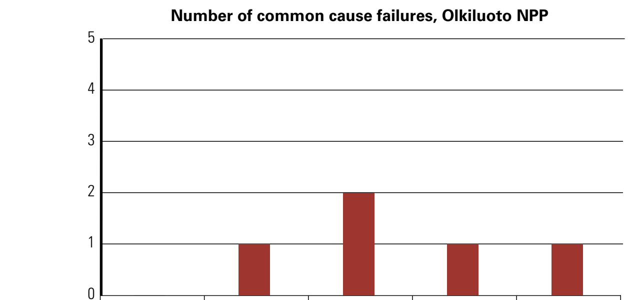
Interpretation of the indicator

Loviisa

In 2010, no safety-significant common cause failures were identified at the Loviisa power plant. The situation is therefore as good as it has been in recent years.

Olkiluoto

There has been no change in the number of common cause failures in the past few years. In Olkiluoto, one safety-significant common cause failure was identified in 2010. Problems were observed in the operation of the blowdown system valves of Olkiluoto 1 during tests carried out before the annual maintenance outage. The fault was located in the electrical pilot valves that were of a new type and had only been in use for one operating cycle. The event is discussed in more detail in Section 4.2.3. The observations made in 2010 included deterioration of reliability of the reactor cooling system due to faults in the gears of valve actuators.



	2006	2007	2008	2009	2010
Olkiluoto	0	1	2	1	1

A.I.1g Production losses due to failures

Definition

As the indicator, the loss of power production caused by failures 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 failures from the point of view of production.

Responsible unit/person

Operational Safety (KÄY)
Tomi Koskiniemi (Loviisa)
Suvi Ristonmaa (Olkiluoto)

Interpretation of the indicator

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

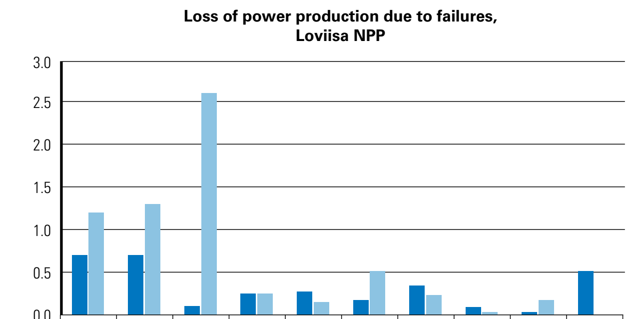
Loviisa

Loviisa 1 experienced higher production losses from component failures than in the previous years. Most of the losses (90%) were caused by the reactor trip that occurred in July. The operators shut down the reactor by triggering a reactor trip as a result of a malfunction detected when testing the steam line isolation valve and the turbine trip that followed. Loviisa 2 had no failures causing loss of production.

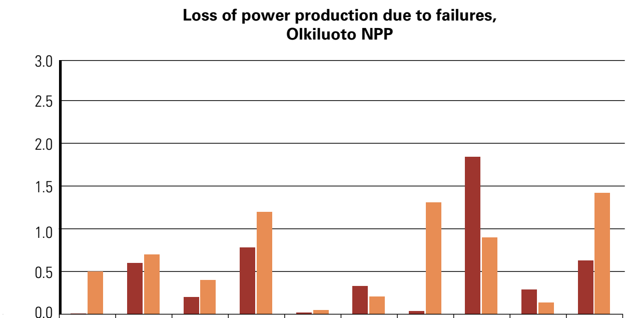
Olkiluoto

The losses of production due to failures were not significantly different from previous years.

The losses of production due to failures at Olkiluoto 2 in 2010 were mainly caused by corrective actions after a reactor trip as well as on the work for replacing the new-type electrical pilot valves in the blowdown system. The decision to replace the valves was taken as a result of the faults detected in the equivalent valves of Olkiluoto 1. More than half of the production losses at Olkiluoto 1 were caused by diagnostic work and repairs regarding incorrect settings in the I&C of main coolant pumps, while the rest was caused by various events, including the operation for limiting the consequences of a fuel assembly leak and repair of the reheater control valve.



	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
LO1	0.70	0.70	0.10	0.25	0.27	0.17	0.34	0.09	0.03	0.51
LO2	1.20	1.30	2.60	0.25	0.15	0.51	0.23	0.03	0.17	0.00



	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
OL1	0.01	0.60	0.20	0.78	0.02	0.33	0.04	1.84	0.29	0.63
OL2	0.50	0.70	0.40	1.20	0.05	0.21	1.31	0.90	0.14	1.42

A.I.2 Exemptions and deviations from the Operational Limits and Conditions

Definition

As indicators, the number of non-compliances with the Operational Limits and Conditions, 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 utilities' activities in accordance with the OLC: compliance with the OLC and identified situations during which it is necessary to deviate from them; of which conclusions can be made as regards the appropriateness of the OLC.

Responsible unit/person

Operational Safety (KÄY)
Tomi Koskiniemi (Loviisa)
Suvi Ristonmaa (Olkiluoto)

Interpretation of the indicator

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

Non-compliance 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 for no events with non-compliance to the Operational Limits and Conditions to occur at the plants. The licensee always prepares a special report on the non-compliance and any corrective action, and submits it to STUK for approval.

Loviisa

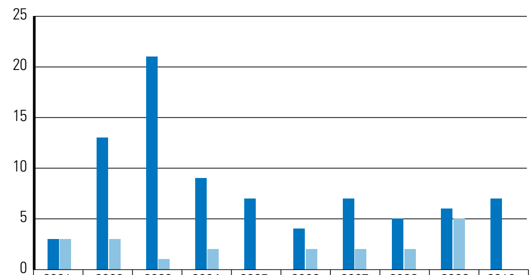
Exemptions

The Loviisa power plant submitted an application for exemption from OLC to STUK in seven different situations during 2010. The number is in line with previous years, as an average of eight exemptions per year has been applied for during the last ten years. Of the applications made in 2010, three were related to repairing faults or to enabling the repairs (failure of the HP boron pump in July 2010, failure of the testing valve in the boron feeding system during the 2010 annual maintenance and the failure of diesel generator EY03 in June 2010), one to the situation where the plant moved from start-up state to power operation during the start-up of Loviisa 2 after the annual maintenance in spite of the fact that part of the activity measurements of the steam line were faulty, and three were related to enabling modification work, two on the LARA I&C in Loviisa 2 and one in connection with the overhaul of the seawater screens. STUK approved all applications because the deviations had no significant safety implications for the safety of the plant or the environment.

Events non-compliant with the OLC

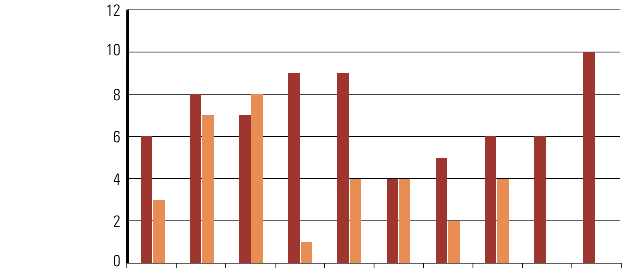
During the year, the Loviisa power plant did not report any situations where the Operational Limits and Conditions would have been breached. In the previous years, there has been an average of two non-compliances with the OLC per year.

Number of deviations from the OLC, Loviisa NPP



	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Exemptions	3	13	21	9	7	4	7	5	6	7
Deviations	3	3	1	2	0	2	2	2	5	0

Number of deviations from the OLC, Olkiluoto NPP



	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Exemptions	6	8	7	9	9	4	5	6	6	10
Deviations	3	7	8	1	4	4	2	4	0	0

Olkiluoto

Based on the results of the last ten years, the Olkiluoto nuclear power plant applies for STUK's approval for non-compliance with the OLC about seven times per year on average. In 2010, there were more applications than on average (10). Five applications were related to modification work (including the replacement of radiation measurement systems at the plant), two to locating a fuel leak and three to tests and measurements. As the planned deviations had no significant safety implications, STUK approved all of the applications. The events related to locating the fuel leak had the result that the OLC was developed to include this special case. Therefore, the OLC deviation applications are no longer required in the future in similar situations.

A similar peak in the number of deviations could be seen in 2004 and 2005. At that time, the number of exemptions was increased by work and installations related to the modernisation of existing plant units and the construction of OL3.

Events non-compliant with the OLC

During the year, the Olkiluoto power plant did not report any situations where the Operational Limits and Conditions would have been breached.

A.I.3 Unavailability of safety systems

Definition

As the indicators, the unavailability of safety systems is monitored by the plant unit. The systems monitored at the Olkiluoto nuclear power plant are the containment vessel spray system (322), the auxiliary feed water system (327) and the emergency diesel generators (651–656). Those followed at 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 calculated as the indicator. Unavailability hours are the combined unavailability time of redundant sub-systems divided by the number of subsystems.

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

Subsystem unavailability hours include the time required for the planned maintenance of components and unavailability due to failures. The latter includes, in addition to the time spent on repairs, the estimated unavailability time prior to failure detection. If a failure is estimated to have occurred in a previous successful test, but to have escaped detection, the time between periodic tests is added to the unavailability time. If a failure has occurred between tests such that its date of occurrence is unknown, half of the time period between tests is added to the unavailability time. Whenever the occurrence of the failure can be identified as an operational, maintenance, testing or other event, the time between the event and the fault detection is added to the unavailability time.

Source of data

Data for the indicators is collected from the power companies. Licensee 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 condition and status of safety systems and their development can be monitored by means of the indicator.

Responsible units/persons

Operational Safety (KÄY), resident inspectors
Pauli Kopiloff (Loviisa nuclear power plant)
Jarmo Konsi (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 the LO1 plant unit had two faults causing system unavailability for a total of 31.8 hours. Similarly, LO2 had four faults, and they caused 65.6 hours of unavailability. The reasons for the faults in safety injection systems were not serious, and the repairs were completed within the permitted times.

The unavailability of high pressure safety injection systems was low in 2010, i.e. their condition and availability were good.

RL system

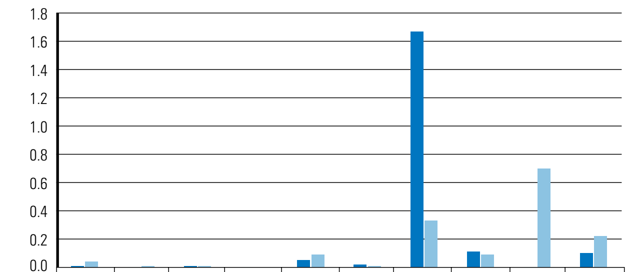
The total time of unavailability at LO1 was 514 hours. The unavailability of the RL system during power operation amounted to 53 hours, resulting in two repair operations. The duration of unavailability caused by annual maintenance of the RL94 system was 461 hours. The total time of unavailability at LO2 was 60 hours. One fault occurred during power operation, and its repairs took four hours. The duration of unavailability caused by annual maintenance of the RL97 system was 58 hours. The reasons for the faults in the RL system were not serious from the perspective of system operability, and the repairs were completed within the permitted times.

The unavailability of the auxiliary feed water systems was low in 2010, i.e. their condition and availability were good. In order to further improve the safety performance indicator, the maintenance organisation of the power plant must pay particular attention to the planning and efficient implementation of annual maintenance of the RL94 and RL97 systems so that no unnecessary unavailability is caused for the systems.

EY system

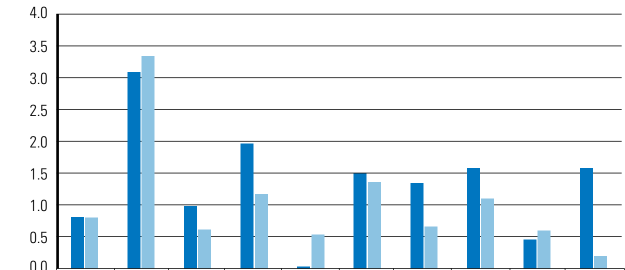
In 2010, the total unavailability for all eight diesel generators was 502 hours, where the estimated total duration of unavailability before detecting the faults was 61 hours. There were 23 faults in all, of which 15 caused immediate operation restrictions while eight caused operating restrictions from the beginning of the repair work. The failures detected were mainly caused by normal ageing of components and did not have any serious implications.

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



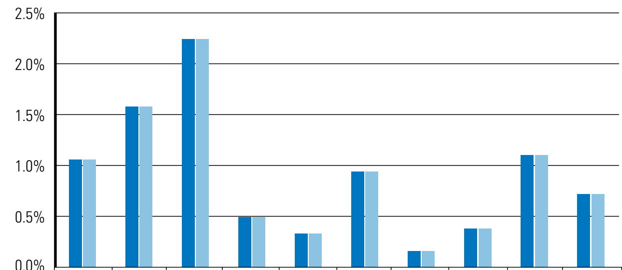
	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
LO1	0.01	0.00	0.01	0.00	0.05	0.02	1.67	0.11	0.00	0.10
LO2	0.04	0.01	0.01	0.00	0.09	0.01	0.33	0.09	0.70	0.22

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



	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
LO1	0.81	3.09	0.98	1.96	0.03	1.49	1.34	1.58	0.45	1.58
LO2	0.80	3.34	0.61	1.17	0.53	1.36	0.66	1.10	0.59	0.19

Unavailability of emergency diesel generators (EY), Loviisa NPP



	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
LO1	1.06	1.58	2.24	0.49	0.33	0.94	0.16	0.38	1.10	0.72
LO2	1.06	1.58	2.24	0.49	0.33	0.94	0.16	0.38	1.10	0.72

The unavailability of emergency diesels (EY) was lower than in the previous year, and the availability of the diesels can be considered acceptable on the basis of the safety performance indicator.

Interpretation of the indicator

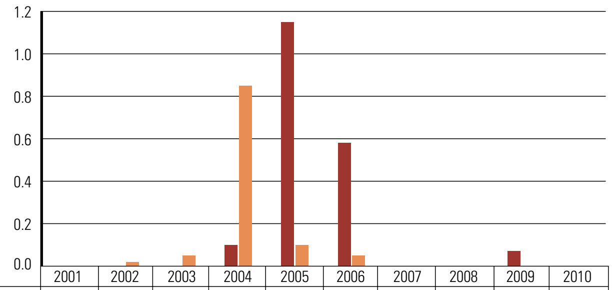
Olkiluoto

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

The unavailability of the auxiliary feed water system increased significantly after 2004 when the unavailability was practically at zero. The increased unavailability of Olkiluoto 1 in 2006 was due to faults in the recirculation and safety valves in system 327. As corrective measures, the torque settings of the recirculation line's valve actuator motors were adjusted, and a separate safety valve testing line was installed for one of the lines leading to the reactor core in 2008. Testing lines were installed in other similar lines at OL1 and OL2 during 2009 and 2010. No significant faults occurred in 2007, 2008 or 2009, and the unavailability of the auxiliary water system was reduced to zero in 2009 at both plant units. In 2010, unavailability was still zero at OL1 but increased somewhat at OL2 from the previous year, mainly as a result of new faults detected during the outage.

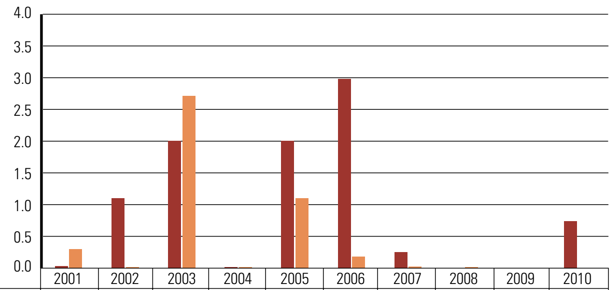
The unavailability of the diesel generators has decreased since 2004, and was very low in 2006 and 2007. In 2008, the value increased by nearly 95% compared to the previous year. The increase was due to latent faults in the compressed air motors of the diesels in both plant units. In 2009, the unavailability of diesel engines decreased considerably from the 2008 figures. In 2010, the unavailability increased slightly from the previous year as a result of faults occurring in connection with periodic testing. At OL1, the stator winding of the diesel generator failed in connection with periodic tests in August 2010, and the generator was replaced with an overhauled one. The other generators of the same type were inspected at both plant units, and visual inspection did not reveal any deviations in them. The failed generator was sent for repairs. No spare generator was available for either plant unit during the repairs that could not be completed in 2010 and therefore continued in 2011. Following the event, the power company has been planning a basic overhaul operation for the diesel generators of OL1 and OL2 that had their previous basic overhauls in 1992–1996. In November 2010, the switch of the diesel-backed 660 V network opened in connection with periodic maintenance. After checking the switch and replacing the voltage regulator, the test was repeated without problems.

Unavailability of containment spray system (322), Olkiluoto NPP



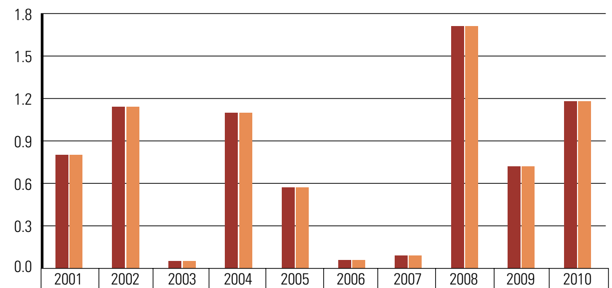
	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
OL1	0.00	0.00	0.00	0.10	1.15	0.58	0.00	0.00	0.07	0.00
OL2	0.00	0.02	0.05	0.85	0.10	0.05	0.00	0.00	0.00	0.00

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



	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
OL1	0.03	1.10	2.00	0.01	2.00	2.98	0.25	0.00	0.00	0.74
OL2	0.30	0.01	2.71	0.01	1.10	0.18	0.02	0.01	0.00	0.00

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



	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
OL1	0.80	1.14	0.05	1.10	0.57	0.06	0.09	1.71	0.72	1.18
OL2	0.80	1.14	0.05	1.10	0.57	0.06	0.09	1.71	0.72	1.18

A.I.4 Occupational radiation doses

Definition

As the indicators, collective radiation exposure by plant site and plant unit is monitored, as well as the average of the ten highest yearly radiation exposures.

Source of data

The data on collective radiation exposure is obtained from quarterly and annual reports. 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 1.22 manSv for one Loviisa plant unit and 2.15 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 are, at the same time indicating the effectiveness of the plant's radiation protection unit.

Responsible unit/person

Radiation protection (SÄT)
Antti Tynkkynen

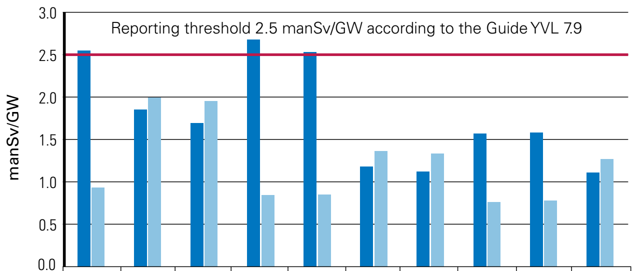
Interpretation of the indicator

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 yearly radiation doses. Both Loviisa plant units have had more extensive than normal annual outages every four and eight years (the four-year annual maintenance and the eight-year annual maintenance) so that both plant units never have a major annual maintenance outage in the same year. During the operating history of the Loviisa plant, 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 clearly seen in the *Collective radiation dose, Loviisa* graph. In 2010, the LO1 unit had a brief annual maintenance and the LO2 unit had an eight-year annual maintenance. The total time used for annual maintenance outages was long, and there was more work with significance for radiation protection than usual, which resulted in a total collective dose in Loviisa that was higher than that of the previous year. However, considering the extent of annual maintenance work carried out at the Loviisa power plant, the resulting collective dose can be considered smaller than average.

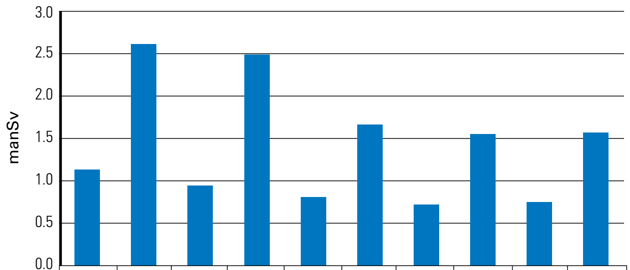
The radiation doses for nuclear power plant workers were below the individual dose limits. The trend regarding the average of the ten largest individual doses displayed a significant increase from the previous years in 2010. The increase was due to the extensive eight-year annual maintenance where some employees were exposed to more radiation due to the larger amount of work done. The Radiation Decree (1512/1991) stipulates that the effective dose for a worker from radiation work must not exceed the 20 manSv/year average over any period of five years, or 50 manSv in any one year.

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



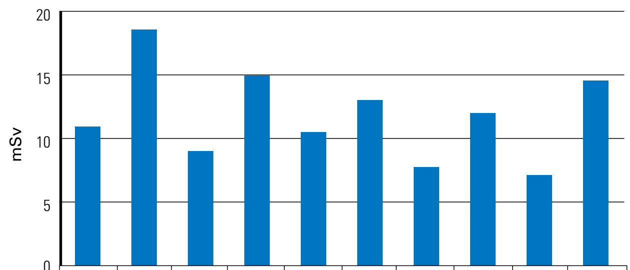
	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
LO1	2.55	1.85	1.69	2.68	2.53	1.18	1.12	1.57	1.58	1.11
LO2	0.93	1.99	1.95	0.84	0.85	1.36	1.33	0.76	0.78	1.27

Collective occupational radiation dose (manSv), Loviisa NPP



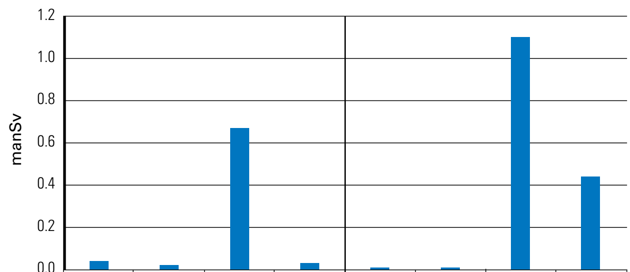
	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
LO	1.13	2.61	0.94	2.49	0.81	1.66	0.72	1.55	0.75	1.57

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



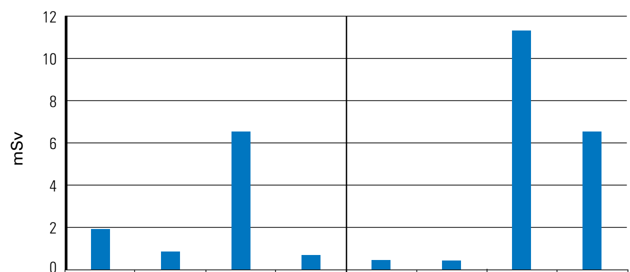
	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
LO	10.94	18.54	9.01	14.93	10.48	13.00	7.76	11.99	7.11	14.55

Collective occupational radiation dose (manSv) quarterly, Loviisa NPP



	I/09	II/09	III/09	IV/09	I/10	II/10	III/10	IV/10
LO	0.04	0.02	0.67	0.03	0.01	0.01	1.10	0.44

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



	I/09	II/09	III/09	IV/09	I/10	II/10	III/10	IV/10
LO	1.92	0.86	6.54	0.68	0.44	0.42	11.32	6.53

Furthermore, the threshold set for the collective occupational dose was not exceeded in 2010. 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 possibly required to improve radiation safety (Guide YVL 7.9).

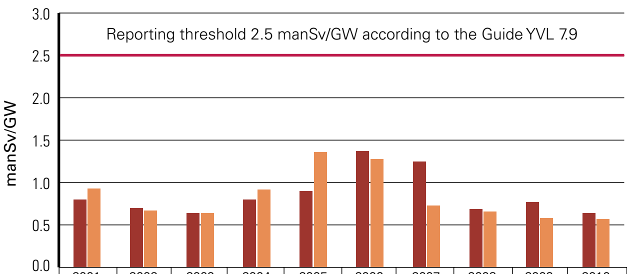
Interpretation of the indicator

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 yearly radiation doses. The annual outages for the Olkiluoto power plant units are divided into two groups: the refuelling outages and the maintenance outages. The refuelling outage is shorter in duration (approximately seven days). The length of the maintenance outage depends on the amount of work (two–three weeks). Annual outages are scheduled so that in the same year, one plant unit has a maintenance outage and the other a refuelling outage. In 2005 and 2006, the collective doses for the workers were high due to turbine work with considerable significance for radiation protection. In 2010, the collective dose at the Olkiluoto power plant was the smallest ever in the history of the plant in spite of the fact that a maintenance outage involving extensive personnel resources and a large amount of work was carried out at the Olkiluoto 1 plant unit. The new steam driers that were installed at the plant units in 2005–2006 have lowered the radiation levels in the turbine building and the collective dose.

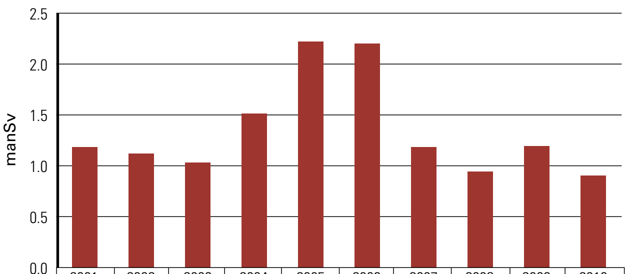
The average of the ten largest individual doses was of an average level in Olkiluoto during 2010. The prescribed dose limits (Radiation Decree 1512/1991) were not exceeded.

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



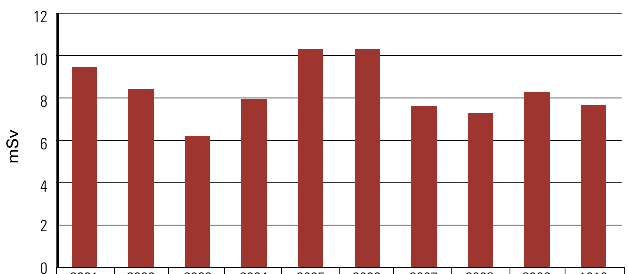
	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
OL1	0.80	0.70	0.64	0.80	0.90	1.37	1.25	0.69	0.77	0.64
OL2	0.93	0.67	0.64	0.92	1.36	1.28	0.73	0.66	0.58	0.57

Collective occupational radiation dose (manSv), Olkiluoto NPP



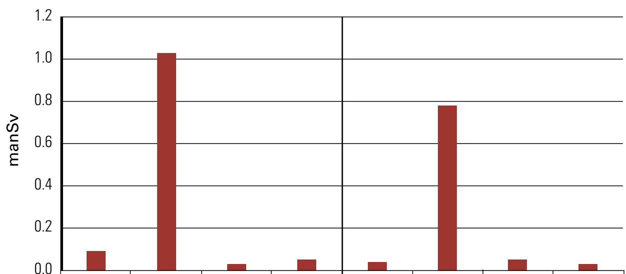
	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
OL	1.18	1.12	1.03	1.51	2.22	2.20	1.18	0.94	1.19	0.90

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



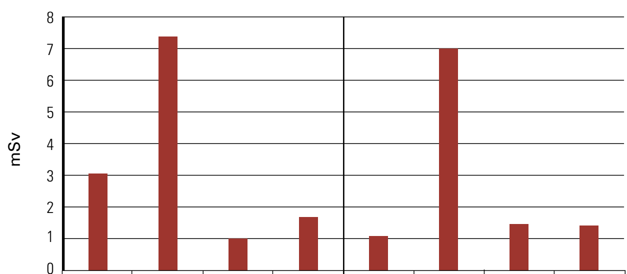
	2001	2002	2003	2004	2005	2006	2007	2008	2009	1010
OL	9.45	8.41	6.20	7.96	10.32	10.30	7.63	7.275	8.27	7.68

Collective occupational radiation dose (manSv) quarterly, Olkiluoto NPP



	I/09	II/09	III/09	IV/09	I/10	II/10	III/10	IV/10
OL	0.09	1.03	0.03	0.05	0.04	0.78	0.05	0.03

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



	I/09	II/09	III/09	IV/09	I/10	II/10	III/10	IV/10
OL	3.05	7.38	1.01	1.68	1.08	7.00	1.46	1.41

A.I.5 Radioactive releases

Definition

As the indicators, radioactive releases into the sea and the atmosphere (TBq) from the plant are monitored, as well as 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 utilities' 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 follow the amount and trend of radioactive releases and to assess factors having a bearing on any changes in them.

Responsible unit/person

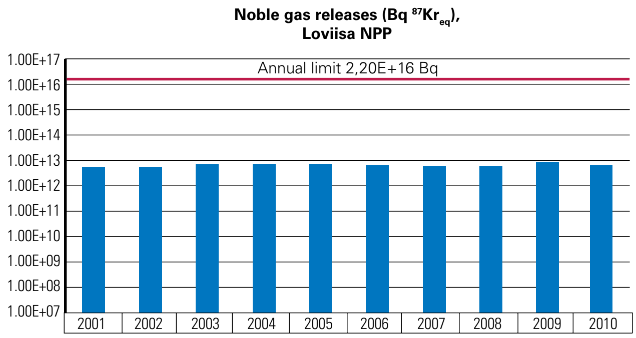
Radiation protection (SÄT), Antti Tynkkynen

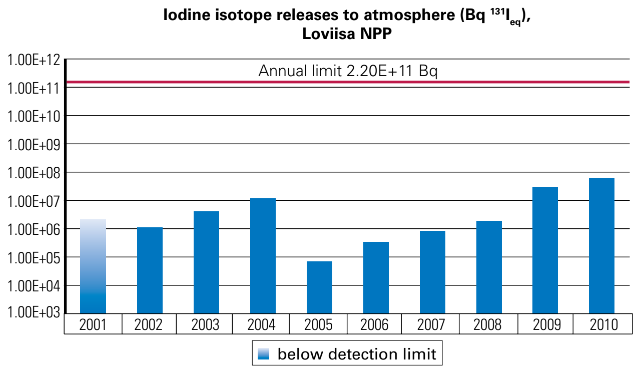
A.I.5a Releases into the atmosphere

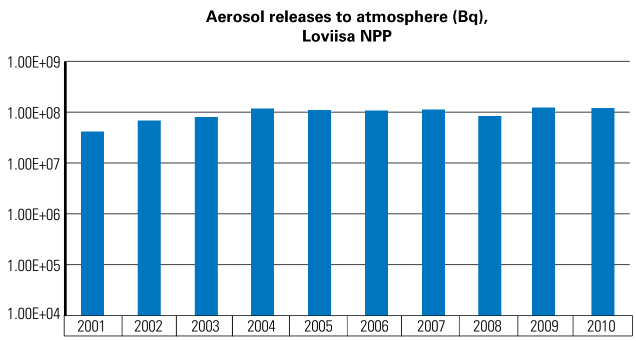
Interpretation of the indicator

Radioactive releases into the atmosphere from the Loviisa and Olkiluoto nuclear power plants in 2010 were of the same magnitude as in previous years. The emissions into the environment were minor and remained clearly below the set emission limits.

In Loviisa, only releases of iodine isotopes increased. This was now the sixth year in succession that iodine releases increased. The iodine releases were affected by a minor fuel leak occurring at the



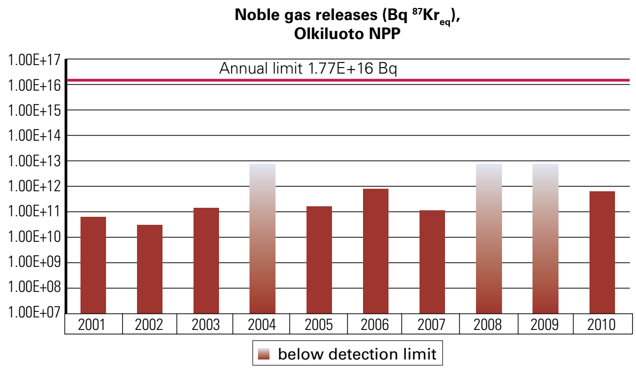


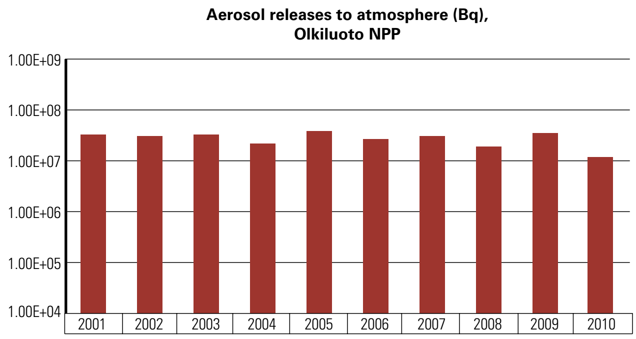


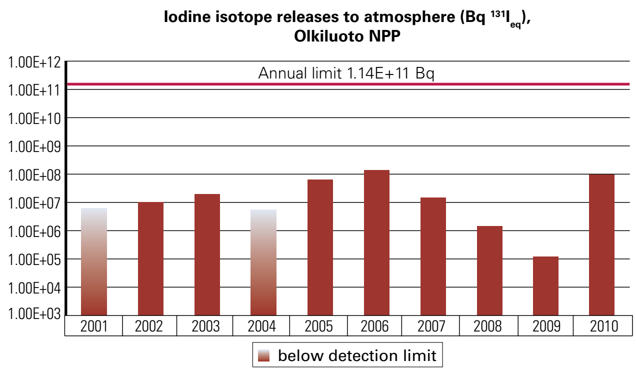
Loviisa 1 plant unit that released more iodine than usual into the environment. Loviisa 2 also experienced a fuel leak in 2009.

In Olkiluoto, the releases of noble gases and iodine increased and were clearly higher than in the previous years. The releases of noble gases and iodine were affected by the fuel leaks occurring at both Olkiluoto plant units in 2010. The releases of aerosols in particle form into the atmosphere were smaller than previously.

Gaseous fission products, noble gases and iodine isotopes originate in leaking fuel rods, in the minute amounts of uranium left on the outer surfaces of fuel cladding during fuel fabrication, and in reactor surface contamination from earlier fuel leaks. At both Loviisa and Olkiluoto, fuel leaks have been very small. However, a leak in one fuel rod was detected at the Loviisa 2 plant unit in November 2008. The fuel assembly was replaced with a fresh one during the 2009 refuelling outage. In addition, a minor fuel leak was detected at the Loviisa 1 plant unit after the 2009 annual maintenance, and the fuel assembly was replaced with a fresh one during the 2010 outage. One leaking fuel assembly was also detected at both Olkiluoto plant units before annual maintenance in 2010. Both leaking assemblies were removed from the reactors during the outages. In addition, a new fuel leak was detected at the Olkiluoto 2 plant unit immediately after the annual maintenance. The indicator A.III.1 describes fuel integrity. The noble gas releases from the Loviisa plant are dominated by argon-41, an activation product of argon-40, found in the airspace between the reactor pressure vessel and the main radiation shield. Aerosol nuclides (including activated corrosion products) are released during maintenance work.



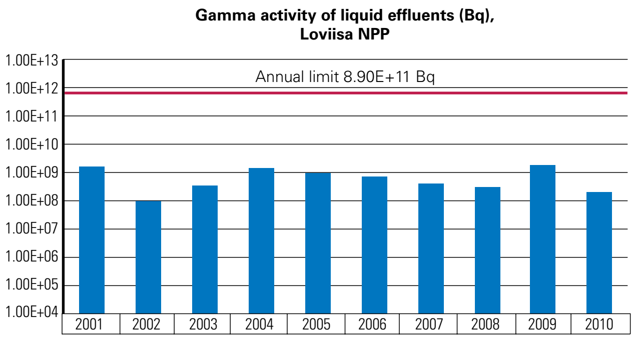


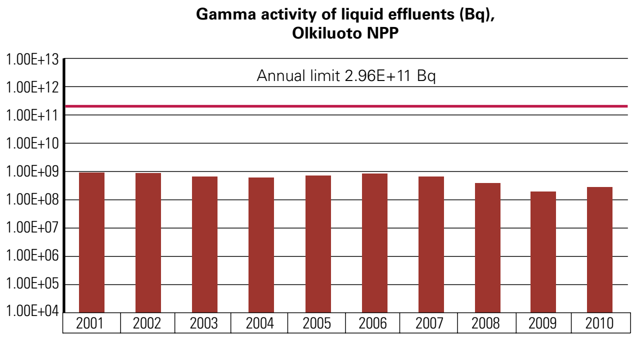


A.I.5b Releases into the sea

Interpretation of the indicator

Releases of radioactive substances emitting gamma radiation into the environment from the Loviisa and Olkiluoto nuclear power plants were clearly below the set limits. During 2001, 2004 and 2009, the Loviisa power plant discharged low-activity evaporation residues into the sea as planned. Consequently, the releases of substances with gamma activity were larger than average in those years. The releases of substances with gamma activity into the sea from Olkiluoto have been decreasing in recent years.



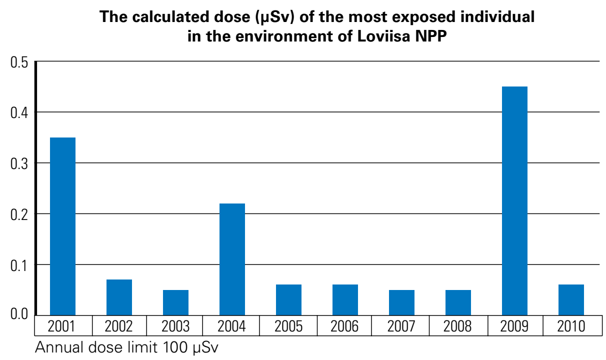


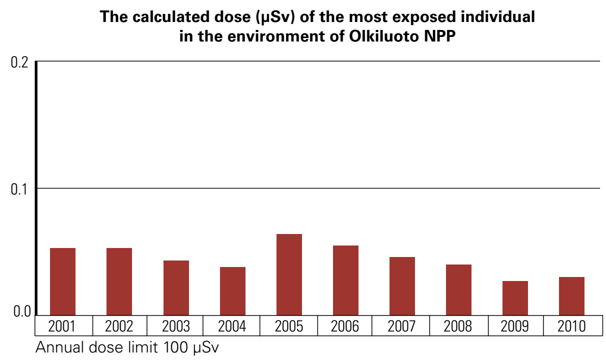
A.I.5c Population exposure

Interpretation of the indicator

The doses of the most exposed individual in the vicinity, calculated on the basis of releases from the plant, were below the set limit in Loviisa and Olkiluoto. In both plant localities, the doses of the most exposed individual in the vicinity were at the normal or even lower-than-normal level in 2010. As a result of the planned release of low-level evaporation waste into the sea in Loviisa, the dose of the most exposed individual in the vicinity of Loviisa was higher than usual in 2009.

For both plants, the calculated doses of the most exposed individual in the vicinity were less than 0.1% of the 100-microsievert limit set in Government Decree (733/2008).





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 euros are the confidential information of the utilities 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.

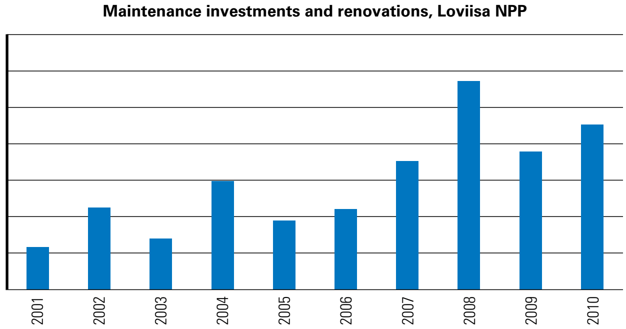
Purpose of the indicator
The indicator is used to follow the amount of investments in plant maintenance and their fluctuations.

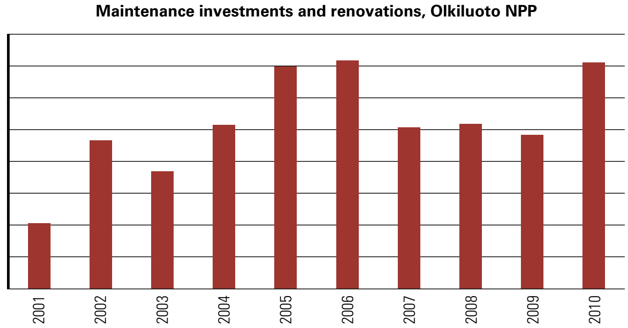
Responsible unit/person
Operational Safety (KÄY)
Suvi Ristonmaa

Interpretation of the indicator
The variation in the indicator distinctly shows the investments related to power upgrades and modernisation projects of the plants. Both plants have paid much attention to life-cycle management, which also shows as continuous long-term investment plans. The renewal of the operation permit of the Loviisa plant in 2007 and the intermediate assessment carried out at Olkiluoto in 2008 have also had an effect on the investment plans.

Loviisa
The increase in investments since 2007 is due to the I&C modernisation project in Loviisa. Other major investments in 2010 included alterations to the storage, waste and mechanical workshop facilities, replacement of the auxiliary sea water pipeline, improvement of the secondary circuit safety and construction of the new training simulator. Many modification projects last for several years, which means that their total costs are also divided over several years.

Olkiluoto
The investments in 2010 were higher than in previous years. This was due to major modifications that are scheduled to be mainly implemented during the annual maintenance of Olkiluoto 1 in 2010 and annual maintenance of Olkiluoto 2 in 2011. These include the replacement of inner isolation valves of the main steam lines, replacement of the LP turbines, replacement of the generator and replacement of the main seawater pumps.





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 (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.

Purpose of the indicator

The indicator is used to follow the number of safety-significant events.

Responsible unit/person

Organisations and Operations (KÄY)
Tomi Koskiniemi (Loviisa)
Suvi Ristonmaa (Olkiluoto)

Interpretation of the indicator

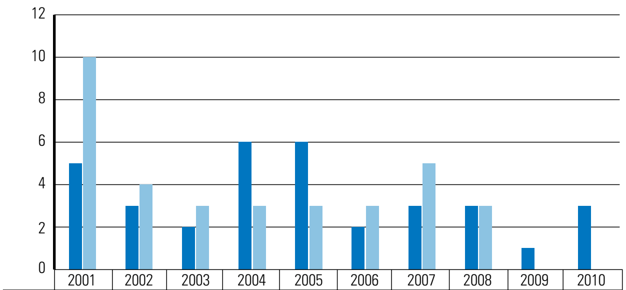
Loviisa

Loviisa 1 had one reactor trip. The operators of Loviisa 1 shut down the reactor by triggering a reactor trip as a result of a malfunction detected when testing the steam line isolation valve and the automatic turbine trip that followed. During the event, the plant operated as planned with regard to protective systems, and the event had no impact on the safety of the plant or its surroundings. Loviisa has had very few reactor trips. The previous ones occurred in 2004 and 2001.

Based on data from the last ten years, the average number of annual events warranting a special report is three while the average number of annual events warranting a transient report is seven. There were fewer of both in 2010 than in the previous years. The licence holder filed one special report. A quantity of mildly radioactive water-resin solution was transported to the venting line of the resin tank at the liquid waste solidification plant of Loviisa NPP and from there to the ventilation system of the auxiliary building as a result of overfilling the resin tank when it was being rinsed. As a consequence of the event, the liquid level measurement in the tanks will be improved and the operating instructions of the solidification plant will be further specified so that overfilling of the tank can no longer occur. Commissioning of the liquid waste solidification plant has not been continued yet after the event. There were three transient reports; they related to a turbine trip at Loviisa 1, a lightning strike on the 400 kV cable and to the reactor trip at Loviisa 1 discussed above.

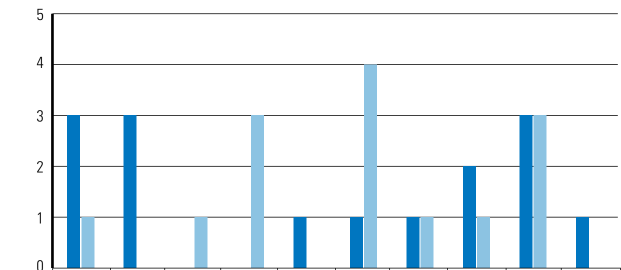
When considering the indicators, it must be noted that the number of reports does not give the correct idea of the division of events by plant unit since, for system technical reasons, the reports for both plant units have been entered for Loviisa 1. One event occurred in 2010 warranting a transient report and applying to both plant units.

Number of operational transient reports, Loviisa NPP



	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
LO1	5	3	2	6	6	2	3	3	1	3
LO2	10	4	3	3	3	3	5	3	0	0

Number of Special Reports, Loviisa NPP



	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
LO1	3	3	0	0	1	1	1	2	3	1
LO2	1	0	1	3	0	4	1	1	3	0

Number of reactor scrams, Loviisa NPP

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
LO1	1	0	0	1	0	0	0	0	0	1
LO2	0	0	0	0	0	0	0	0	0	0

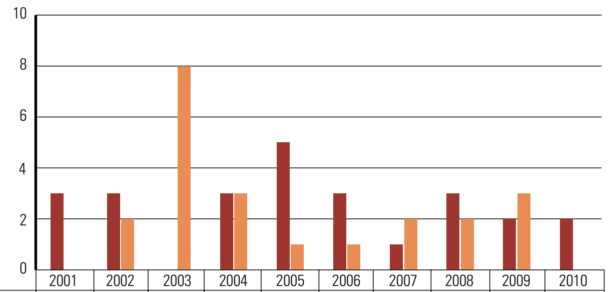
Olkiluoto

One reactor trip occurred at Olkiluoto 2, which is in line with previous years: the results for the last ten years indicate that the Olkiluoto NPP experiences an average of one reactor trip per year. During the previous decade, 1991–2000, an average of almost four reactor trips occurred per year. The figure is explained by the fact that it also includes reactor trips during annual maintenance—for example, those occurring while the reactor protection system was being tested.

Based on data from the last ten years, the average number of annual events warranting a special report or a transient report is five. Hence, the number of events warranting a special report (two) and the number of reported transients (also two) in 2010 were below the average level. The events warranting a special report included the failures of electrical pilot valves of the blowdown system of Olkiluoto 1 and the incorrect settings in the I&C systems of the reactor coolant pumps of both plant units. Both of these are discussed in more detail in Section 4.2.3 of the Annual Report. Transient reports were produced for the stoppage of one reactor coolant pump at Olkiluoto 1 on 5 February 2010 and of the opening of a generator switch at Olkiluoto 1 in conjunction with the commissioning of a new generator cooling system on 12 June 2010.

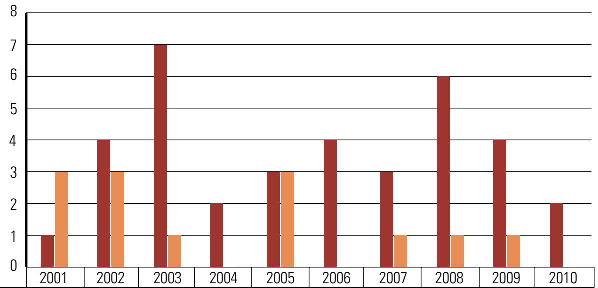
When considering the indicators, it must be noted that the number of reports does not give the correct conception of the division of events by plant unit since, for system technical reasons, the reports for both plant units have been entered for Olkiluoto 1. One event occurred in 2010 warranting a special report and applying to both plant units.

Number of operational transient reports, Olkiluoto NPP



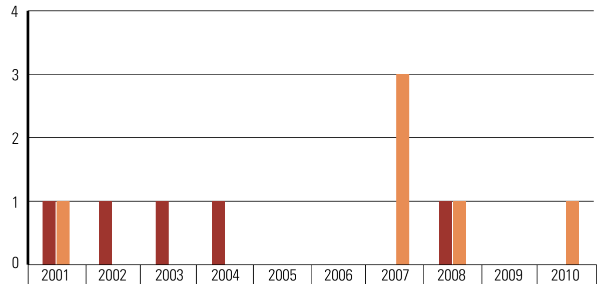
	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
OL1	3	3	0	3	5	3	1	3	2	2
OL2	0	2	8	3	1	1	2	2	3	0

Number of Special Reports, Olkiluoto NPP



	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
OL1	1	4	7	2	3	4	3	6	4	2
OL2	3	3	1	0	3	0	1	1	1	0

Number of reactor scrams, Olkiluoto NPP



	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
OL1	1	1	1	1	0	0	0	1	0	0
OL2	1	0	0	0	0	0	3	1	0	1

A.II.3 Risk-significance of events

Definition

As the indicators, the risk-significance of events caused by component unavailability is monitored. As the measure of risk, an increase in the Conditional Core Damage Probability (CCDP) associated with each event is employed. CCDP takes the duration of each event into consideration. Events are divided into three categories: 1) unavailability due to component failures, 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 is included in category 2. Possible non-compliances with the OLC are in category 1, if they can be utilised for this indicator. Non-compliances with the OLC are also dealt with under indicator A.I.2.

N.B.! The calculations regarding the Olkiluoto plants were carried out using FinPSA software and those for the Loviisa plants using RiskSpectrum software. Calculations for the Loviisa plant regarding simultaneous multiple failures are based solely on a power operation model, making them indicative only of a trend. The modelling of all states (17 states) would be possible, but the time taken for the calculations would be excessive in comparison with the benefits gained.

Source of data

Data for the calculation of the indicators is collected from utility 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, CCFs, simultaneously occurring failures and human errors. Another objective of the event analysis is to systematically identify signs of a deteriorating organisational and safety culture.

Responsible unit/person

Risk assessment (RIS), Jorma Rantakivi (PRA computation)
Operational Safety (KÄY) (failure data)

Interpretation of the indicator

Loviisa

A brief description of the significant events is given below:

Loviisa 1:

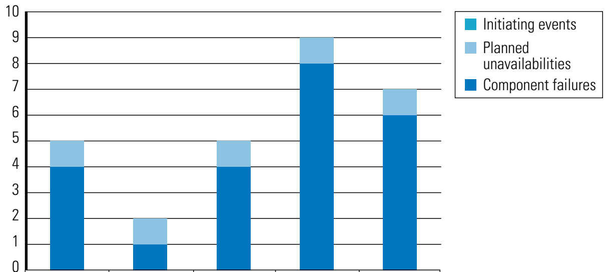
1) Component failure: The on-off switch of the instrumentation facilities cooling system blower (UV20D01) at the ventilation system control room faulty. Cannot always be turned to the start position. To be replaced. Fault duration 50 h. CCDP = 2.0E–7.
2) Component failure: After the start-up and synchronisation of diesel EY01, over-current alarms 325>A were received; problems in reactive power settings. Fault duration 278 h. CCDP = 4.4E–7.
3) Component failure: Testing of diesel EY02 interrupted. The generator cannot be excited. Alarm for I&C failure also given. Fault duration 359 h. CCDP = 5.1E–7.
4) Component failure: Boron pump TB22D001 tripped in periodic tests. At the same time, cooler UV25B002 of the instrumentation facilities cooling system was also faulty. Fault duration 177 h. CCDP = 5.2E–7.
5) Preventive maintenance: Preventive maintenance of the generator of diesel EY01, carried out every 17 years. Fault duration 178 h. CCDP = 2.1E–7.
6) Component failure: After half an hour of testing at 85% power, the power regulator of diesel generator EY01 started behaving erratically. The regenerative power relay was activated and dropped the power to zero, and was reset once. The equipment had also generated an oil pipe leak. Fault duration 387 h. CCDP = 4.7E–7.
7) Component failure cluster: During fault 6 (After half an hour of testing at 85% power, the power regulator of diesel generator EY01 started behaving erratically. The regenerative power relay was activated and dropped the power to zero, and was reset once. The equipment had

also generated an oil pipe leak.), diesel EY02 was leaking cooling water under cylinder cover 15. The cover was removed and the gaskets replaced. Fault duration 52 h. CCDP = 9.9E–7.

Loviisa 2:

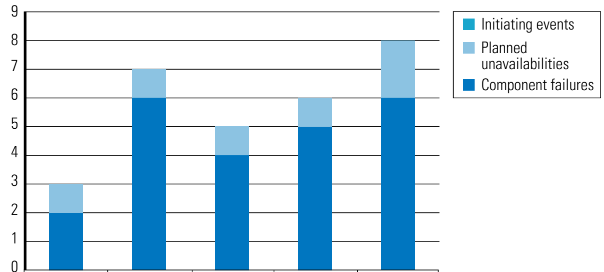
1) Preventive maintenance: Basic overhaul of fine screening unit 20VA12N0001 (LO2-K461-203-00003). Component RV09D02 underwent maintenance twice during the overhaul. Duration of the overhaul 393 h. CCDP = 1.3E–7.
2) Component failure: Circuit UV46 A keeps stopping with fault code 46 (high reheating temperature). Circuit B operates normally. Fault duration 120 h. CCDP = 1.6E–7.
3) Component failure: Machine UV45 in operation replaced with UV46 in connection with testing on 18 May. UV46 does not stay in operation. Had to be replaced again with UV45. Fault duration 120 h. CCDP = 1.6E–7.
4) Component failure: After the tests, the synchronisation of diesel EY01 after discrete operation went well, but diesel stop "remained on". The diesel stopped but did not reach the standby state. Fault duration 157 h. CCDP = 1.9E–7.
5) Component failure cluster: YZ81 CHANNEL 1. TJ11D01 and TQ11D01 were triggered during tests. The thermal relay triggering remained in force in TQ11D01. Fault duration 392 h. CCDP = 3.4E–7.

Most risk-significant events
CCDP ≥ 1E-7
Loviisa 1 (total number of events)



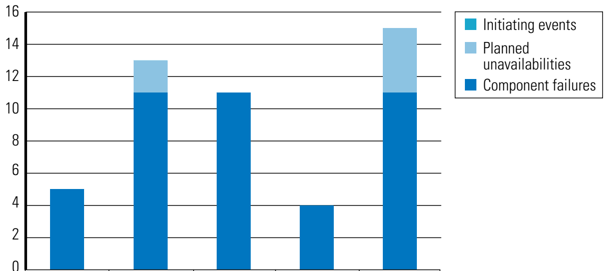
	2006	2007	2008	2009	2010
Initiating events	0	0	0	0	0
Planned unavailabilities	1	1	1	1	1
Component failures	4	1	4	8	6

Most risk-significant events
CCDP ≥ 1E-7
Loviisa 2 (total number of events)



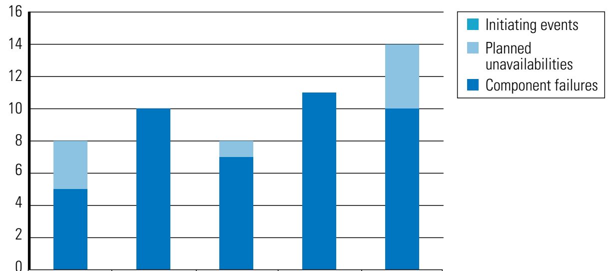
	2006	2007	2008	2009	2010
Initiating events	0	0	0	0	0
Planned unavailabilities	1	1	1	1	2
Component failures	2	6	4	5	6

Other significant events
1E-8 ≤ CCDP < 1E-7
Loviisa 1 (total number of events)



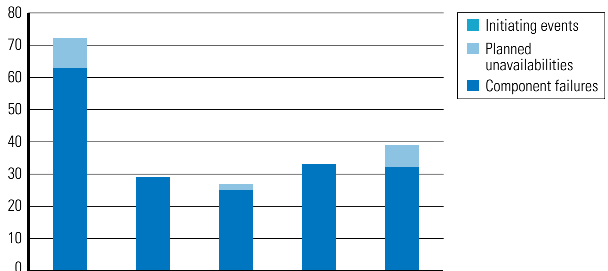
	2006	2007	2008	2009	2010
Initiating events	0	0	0	0	0
Planned unavailabilities	0	2	0	0	4
Component failures	5	11	11	4	11

Other significant events
1E-8 ≤ CCDP < 1E-7
Loviisa 2 (total number of events)



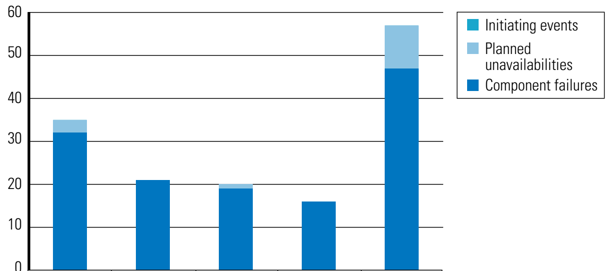
	2006	2007	2008	2009	2010
Initiating events	0	0	0	0	0
Planned unavailabilities	3	0	1	0	4
Component failures	5	10	7	11	10

Other events CCDP < 1E-8
Loviisa 1 (total number of events)



	2006	2007	2008	2009	2010
Initiating events	0	0	0	0	0
Planned unavailabilities	9	0	2	0	7
Component failures	63	29	25	33	32

Other events CCDP < 1E-8
Loviisa 2 (total number of events)



	2006	2007	2008	2009	2010
Initiating events	0	0	0	0	0
Planned unavailabilities	3	0	1	0	10
Component failures	32	21	19	16	47

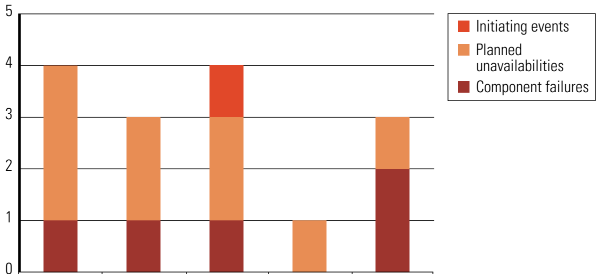
6) Component failure cluster: Simultaneously with fault 5 (YZ81 CHANNEL 1. TJ11D01 and TQ11D01 were triggered during tests. The thermal relay triggering remained in force in TQ11D01), oil in cooler UV45B002 was being changed, and the heat exchanger of cooler UV45B003 was leaking water at its end. Fault duration 168 h. CCDP = 6.7E–7.
7) Component failure cluster: Oil in cooler UV45B002 was being changed, and the heat exchanger of cooler UV45B003 was leaking water at its end. Fault duration 186 h.
CCDP = 3.8E–7.
8) Preventive maintenance: Maintenance during the revision of the auxiliary feed water system (RL94). Duration of maintenance 459 h.
CCDP = 3.2E–7.

Loviisa experienced six diesel failures of the highest category. There were five ventilation system failures of the highest category. Last year, there was a peak in the number of ventilation system failures; it now seems to have levelled to some degree. The analysed events are considered to be part of normal nuclear power plant operation, and no further measures were required from STUK.

Olkiluoto

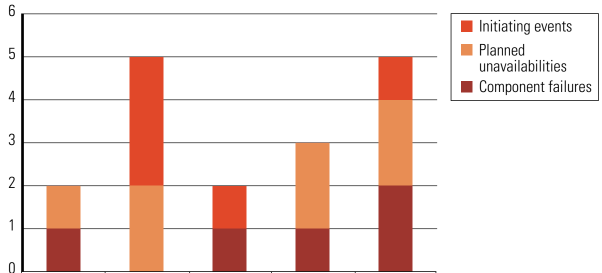
A brief description of the significant events is given below:

Most risk-significant events
CCDP ≥ 1E-7
Olkiluoto 1 (total number of events)



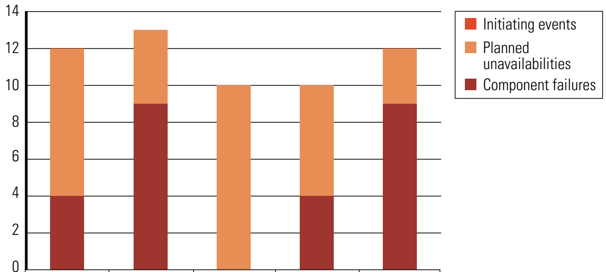
	2006	2007	2008	2009	2010
Initiating events	0	0	1	0	0
Planned unavailabilities	3	2	2	1	1
Component failures	1	1	1	0	2

Most risk-significant events
CCDP ≥ 1E-7
Olkiluoto 2 (total number of events)



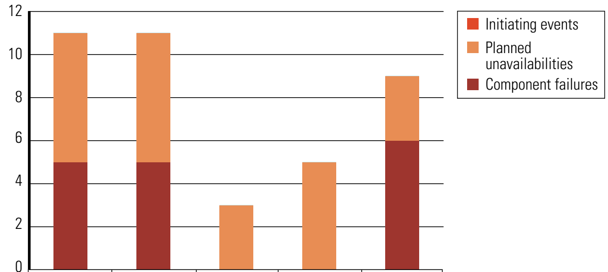
	2006	2007	2008	2009	2010
Initiating events	0	3	1	0	1
Planned unavailabilities	1	2	0	2	2
Component failures	1	0	1	1	2

Other significant events
1E-8 ≤ CCDP < 1E-7
Olkiluoto 1 (total number of events)



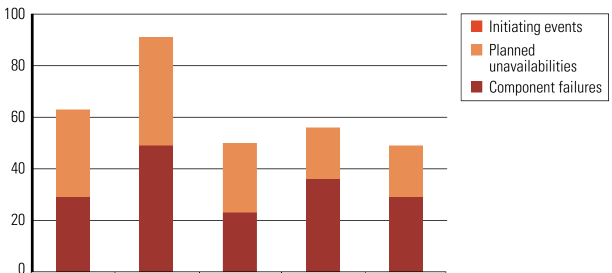
	2006	2007	2008	2009	2010
Initiating events	0	0	0	0	0
Planned unavailabilities	8	4	10	6	3
Component failures	4	9	0	4	9

Other significant events
1E-8 ≤ CCDP < 1E-7
Olkiluoto 2 (total number of events)



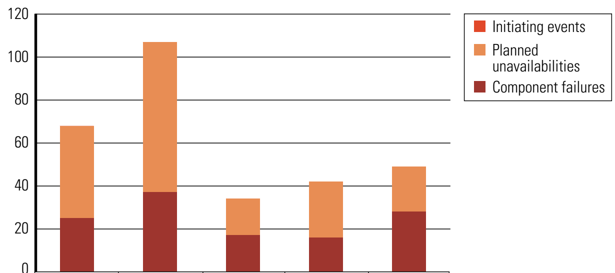
	2006	2007	2008	2009	2010
Initiating events	0	0	0	0	0
Planned unavailabilities	6	6	3	5	3
Component failures	5	5	0	0	6

Other events CCDP < 1E-8
Olkiluoto 1 (total number of events)



	2006	2007	2008	2009	2010
Initiating events	0	0	0	0	0
Planned unavailabilities	34	42	27	20	20
Component failures	29	49	23	36	29

Other events CCDP < 1E-8
Olkiluoto 2 (total number of events)



	2006	2007	2008	2009	2010
Initiating events	0	0	0	0	0
Planned unavailabilities	43	70	17	26	21
Component failures	25	37	17	16	28

Olkiluoto 1:

1) Component failure cluster: Pumps 712P04 and 721P04 had been isolated due to the washing of 721 E4 which also rendered diesel generator 653G401 inoperable due to lack of cooling. During this time, pump 721P02 failed to start in a restarting test because switchgear output 723P2 was on fire and the common control circuit breaker of the pumps tripped. The switchgear fire also eliminated the diesel-backed 660 V AC bus 662B201. Fault duration was 7.0 h, and the CCDP was calculated to be 6.9E–7.
2) Component failure: During periodic testing of diesel generator 653G401 on 18 August 2010, it was noted that the generator did not generate any voltage. The generator was replaced with an overhauled unit. The total time for repairs and latency was 390 h. The CCDP was calculated to be 1.33E–7. (The CCDP figure takes into account the fact that pumps 712P01, 351P01 and 712P04 were inoperable for some time during the latency period).
3) Preventive maintenance: The diesel package DIP-C took approximately 4.5 days. CCDP = 1.1E–7.

Olkiluoto 2:

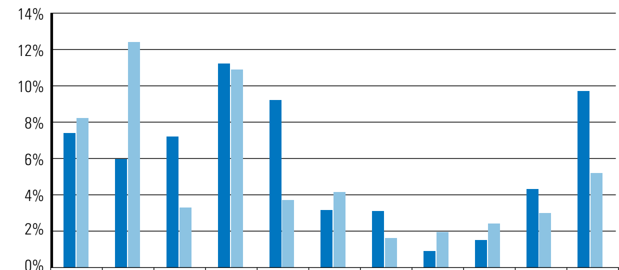
1) Component failure cluster: The performance of pump 712P4 was found to be deteriorated. The pump was isolated in order to repair the fault. Diesel generator 653G401 was isolated for the duration diagnostics on pump 712P4. The fault duration was 58 h. CCDP = 1.1E–7.
2) Initial event: Loss of control nitrogen pressure due to a pipe rupture caused the pilot valve of the inner isolation valve of main steam system 311 to open and the main valve to close. The increased flow of steam also closed the other inner isolation valves, and the trip was triggered by high pressure (SS6). The situation was modelled as a loss of condenser. CCDP = 2.7E–6.
3) Component failure: Switch 662T101-S opened during a diesel load test. When the load test was continued after restoring the switch and synchronisation, the reactive power could not be regulated. The diesel generator was isolated for replacing the voltage regulator. The total duration of repairs and latency was 343 h, and the CCDP was calculated to be 1.1E–7.
4) Preventive maintenance: The diesel package DIP-A took approximately 6.4 days. CCDP = 1.4E–7.
5) Preventive maintenance: The diesel package DIP-C took approximately 4.4 days. CCDP = 1.1E–7.

Occurrence 1 at OL1 led to further investigations because it was a case where the failure of a component of lower safety class (723) led to the failure of a component of higher safety class (721). Other events at Olkiluoto are considered to be part of normal nuclear power plant operation, and they did not give rise to any further measures by STUK.

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 level on average for several years, the annual fluctuation does not warrant particular attention.

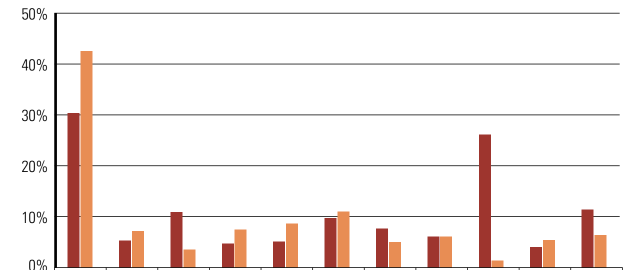
The risk due to operating activities at the Loviisa plants during 2010 has increased compared to the previous years. This year, the calculations for Loviisa were made using different software than before (migration from FinPSA calculations to

Risk contribution of the safety system unavailability at Loviisa NPP
Percentage of the average annual core damage risk



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
LO1	7.39	5.96	7.20	11.21	9.20	3.15	3.10	0.90	1.50	4.30	9.7
LO2	8.23	12.39	3.30	10.90	3.70	4.14	1.60	1.95	2.40	3.00	5.2

Risk contribution of the safety system unavailability at Olkiluoto NPP
Percentage of the average annual core damage risk



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
OL1	30.30	5.28	10.90	4.68	5.10	9.64	7.60	6.00	26.10	4.00	11.40
OL2	42.50	7.17	3.50	7.39	8.60	10.95	5.00	6.00	1.30	5.40	6.30

RiskSpectrum calculations). In addition, the faults were taken from the Lomax tables of Maintenance instead of monthly reports. Therefore, the results for Loviisa may have differences caused by the change of system. The figures for Olkiluoto have also increased although there were no changes in the method in principle. The simultaneous unavailability of several components occurring at Olkiluoto 1 (pumps 712P04 and 721P04, diesel generator 653G401, pumps 721P02 and 723P02 as well as diesel-backed 660 V AC bus 662B201) increase the resulting figure.

A.II.4 Accident risk of 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/PSA) 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. As the basic data of the risk analyses, the globally collected reliability information of components and operator activities, as well as the operating experience from Finnish power plants, are used.

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 detect a need to make modifications to the plant or change operating methods.

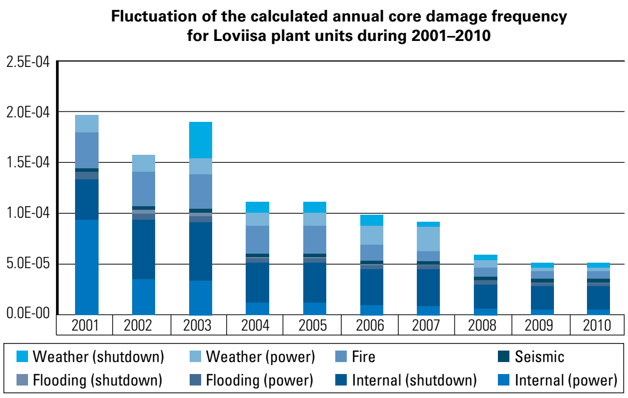
Responsible unit/person

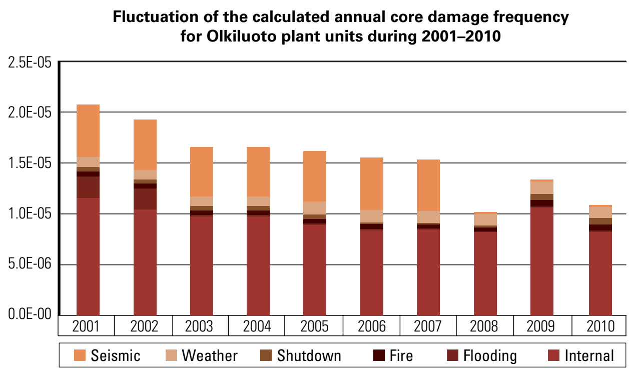
Risk assessment (RIS), Jorma Rantakivi (PRA computation)
Operational Safety (KÄY) (failure data)

Interpretation of the indicator

When assessing the indicator, it must be remembered 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. In addition, developing more detailed models or obtaining more detailed basic data may change risk estimates in either direction. For example, the 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 refuelling 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 seawater line completed during the period. The new line allows for the alternative intake of





seawater from the outlet channel to cool the plant in shutdown operation. The change will decrease risks in situations where algae, frazil ice, or an oil release endanger the availability of seawater through the conventional route. The decrease of the indicator in 2008 results from more detailed analyses performed in conjunction with the renewing of the operating licence, as well as changes at the plant planned to be carried out earlier or in connection with the licence renewal. Such changes include: the I&C renewal LARA; the decrease in the probability of a criticality accident using, for example, boron analysers; modernisation of the refuelling machine and the decrease in the probability of an external leak.

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 power operation and oil releases during a refuelling outage.

The indicator for the Olkiluoto plant decreased approximately 30% in 2008 compared to the relatively stable value of previous years. The decrease was mainly due to the more detailed modelling of earthquake events and the plant changes carried out to improve seismic qualification. The increase in 2009 was due to the fact that, contrary to earlier assessments, the heat exchanger of the purification system cannot be used for residual heat removal after all. 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).

A.II.5 Number of fire alarms

Definition

As the 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.

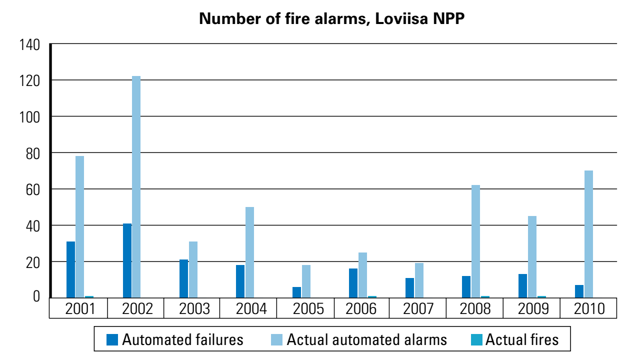
Responsible unit/person

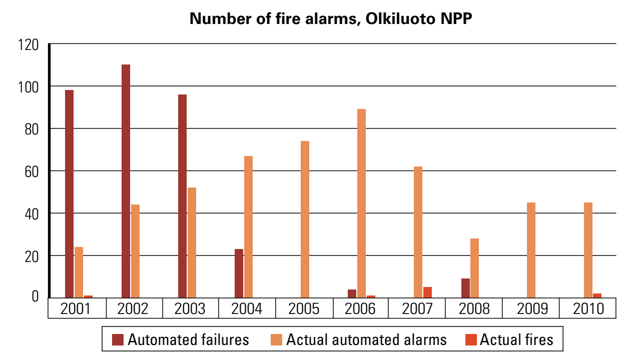
Civil Engineering and Fire Protection (RAK)
Pekka Välikangas

Interpretation of the indicator

There were no events classified as fires at the Loviisa power plant in 2010. In addition, there were no events classified as fires outside the plant perimeters either. The frequency of faults in the fire detector alarms of the Loviisa power plants slightly decreased in 2010 from 2009, but there were more genuine fire alarms during the year, partly because of the extensive annual maintenance outages at the plant during 2010.

Two events classified as fires occurred in the Olkiluoto plant area (OL1/2) in 2010. The transformer of the lift in the lift machine room of OL1 generated smoke. The other event classified as a fire at OL1 plant was one where an electrical cabinet inside the electrical facilities room of the right-hand auxiliary building was generating smoke. There were eight events classified as fire outside the plant perimeter: one in the entrance building of OL1 (food burned in a microwave oven), three





at the Olkiluoto 3 construction site, two in the accommodation village, one in Posiva Oy's research hall, and one case of a vehicle catching fire on the Olkiluodontie road. The fires were events of a minor nature. No fire detection system failures were observed at the Olkiluoto power plant in 2010. The situation was the same as in 2009. Genuine alarms generated by the fire alarm systems were at the same level in 2010 as in 2009.

The fire alarm system was revised in 2000 at the Loviisa power plant and in 2001 at the Olkiluoto power plant. After the revision of the fire alarm systems, the number of alarms increased at both plants due to more sensitive detectors. The distinct reduction in alarms at the Loviisa plant since 2003 and at the Olkiluoto plant since 2004 is due to pre-alarms no longer being included in the calculations.

On average, fire safety at Loviisa and Olkiluoto plants has remained at the earlier level, as no events classified as fires have occurred, with the exception of the two minor events classified as fires at the Olkiluoto power plant. Alarms from the fire alarm system have also been at a relatively low level. Most of the alarms were caused by dust, smoke or humidity. Fire alarm systems are not always disconnected in a wide enough area for maintenance work. The number of alarms from the fire alarm system is also affected by the amount of maintenance and repair work performed at the plants.

A.III Structural integrity

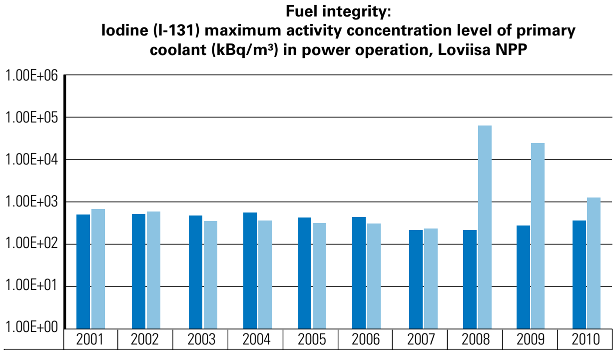
A.III.1 Fuel integrity

Definition

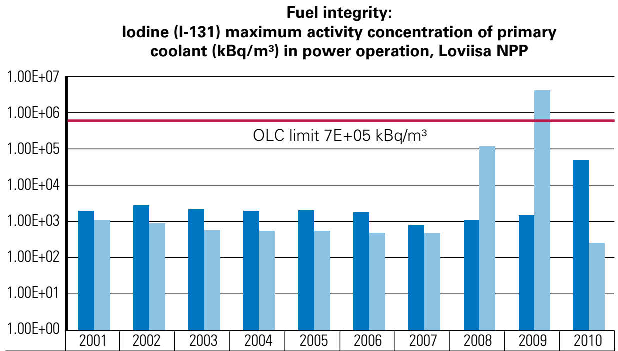
As the indicators, the plant unit-specific maximum level and the highest maximum activity value of the iodine-131 activity concentration (I-131 activity concentration) in the primary coolant in steady-state operation (start-up operation or power operation for Loviisa and power operation for Olkiluoto) are followed. The change in activity concentration of I-131 in primary coolant due to depressurisation while entering shutdown or in connection with a reactor trip, as well as the number of leaking fuel assemblies removed from the reactor, are also followed as indicators.

Source of data

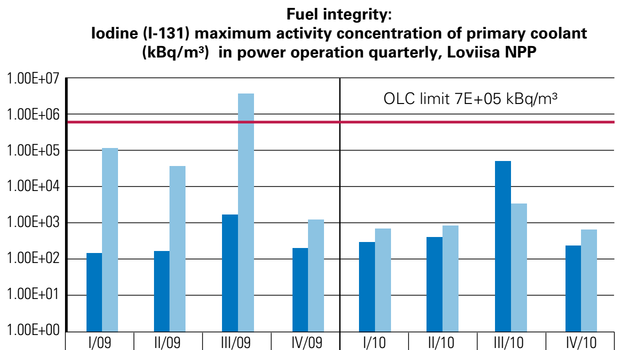
The licensees submit the indicator values directly to the person in charge of the indicator at STUK. The maximum activity levels are also available in the quarterly reports submitted by the utilities.



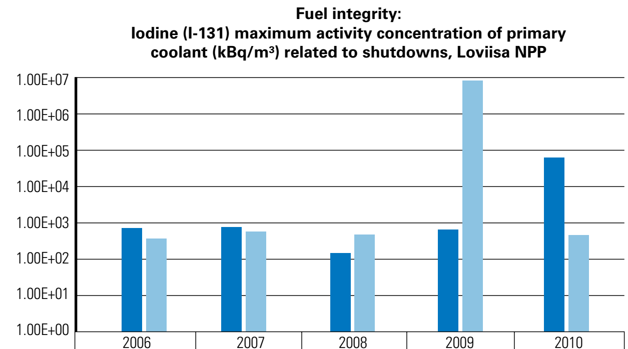
	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
LO1	4.45E+02	4.71E+02	4.32E+02	5.01E+02	3.89E+02	3.91E+02	1.90E+02	2.00E+02	2.60E+02	3.80+02
LO2	6.40E+02	5.74E+02	3.22E+02	3.39E+02	2.91E+02	2.72E+02	2.10E+02	4.90E+04	2.40E+04	1.20E+03



	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
LO1	2.10E+03	3.00E+03	2.30E+03	2.10E+03	2.20E+03	1.90E+03	8.10E+02	1.20E+03	1.54E+03	4.97E+04
LO2	1.20E+03	9.30E+02	6.00E+02	5.80E+02	5.90E+02	5.20E+02	5.00E+02	1.30E+05	3.85+06	3.20E+03



	I/09	II/09	III/09	IV/09	I/10	II/10	III/10	IV/10
LO1	1.40E+02	1.61E+02	1.54E+03	1.89E+02	3.03E+02	4.18E+02	4.97E+04	2.43E+02
LO2	1.20E+05	3.75E+04	3.85E+06	1.16E+03	7.02E+02	8.07E+02	3.20E+03	6.66E+02



	2006	2007	2008	2009	2010
LO1	5.48E+02	5.70E+02	1.40E+02	4.80E+02	5.60E+04
LO2	2.93E+02	4.40E+02	4.30E+02	6.40E+06	4.10E+02

Purpose of the indicator

The indicators describe fuel integrity and the fuel leakage volume during the operating cycle. The indicators for shutdown situations also describe the success of the shutdown concerning radiation protection.

Responsible unit/person

Reactor and Safety Systems (REA),
Kirsti Tossavainen

A.III.1a Primary coolant activity

Interpretation of indicators (Loviisa)

A minor fuel leak was observed at Loviisa 1 on 20 October 2009. There were no significant changes in the I-131 activity concentration of primary coolant in spite of the fuel leak. One leaking fuel assembly was found in the investigation carried out during the annual maintenance outage of 2010, and it was removed from the reactor. The leak was so small that no change could be observed in the I-131 activity concentration of primary coolant when compared to the concentrations before the annual maintenance outage. The maximum values of I-131 activity concentrations during shutdowns were measured during the shutdown for the annual maintenance outage. In 2009, Loviisa 2 briefly exceeded the OLC limit value for I-131 activity concentration of primary coolant (see STUK-B 115).

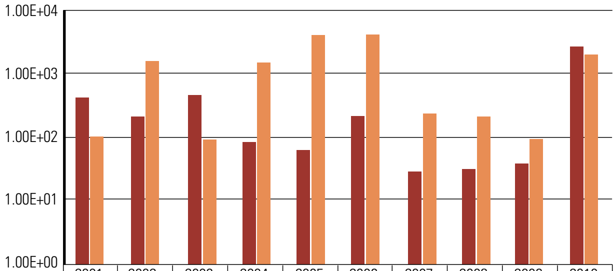
At Loviisa 1, fuel integrity was decreased by a minor fuel leak. At Loviisa 2, fuel integrity was good.

Interpretation of indicators (Olkiluoto)

A fuel leak was observed at Olkiluoto 1 on 7 May 2010, about one week before the annual maintenance outage. The leak remained small, and the leaking fuel assembly was removed from the reactor during the annual maintenance outage. The maximum value of I-131 activity concentration during shutdowns was measured during the shutdown for the annual maintenance outage.

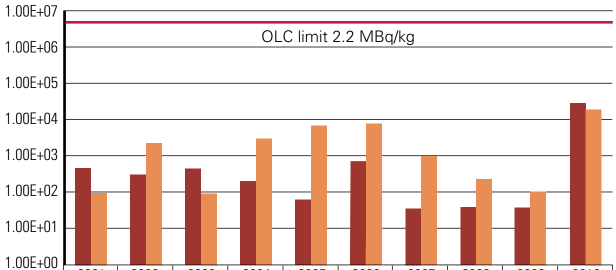
Olkiluoto 2 had two fuel leaks, the first of which was detected on 20 January 2010. The I-131 activity concentration of primary coolant remained small, and the leaking fuel assembly was removed from the reactor during the annual maintenance outage. The other fuel leak was detected after the end of the annual maintenance outage on 31 May 2010. The leak could really only be observed by

Fuel integrity:
Iodine (I-131) maximum activity concentration level of primary coolant (kBq/m³) in power operation, Olkiluoto NPP



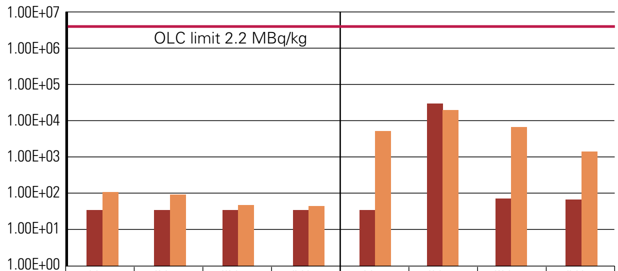
	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
OL1	4.00E+02	2.00E+02	4.30E+02	8.20E+01	5.80E+01	2.00E+02	2.70E+01	3.00E+01	3.50E+01	2.45E+03
OL2	1.00E+02	1.50E+03	9.00E+01	1.49E+03	4.00E+03	4.00E+03	2.30E+02	2.10E+02	9.10E+01	1.87E+03

Fuel integrity:
Iodine (I-131) maximum activity concentration of primary coolant (kBq/m³) in power operation, Olkiluoto NPP



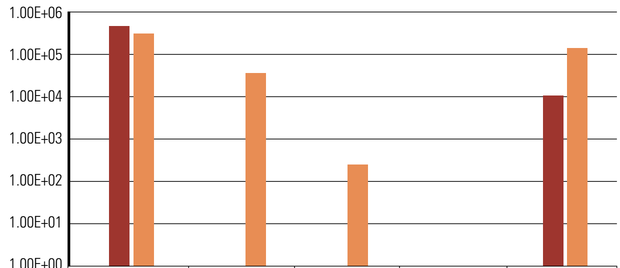
	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
OL1	4.42E+02	2.90E+02	4.30E+02	1.90E+02	5.90E+01	6.90E+02	3.50E+01	3.70E+01	3.60E+01	3.12E+04
OL2	9.88E+01	2.37E+03	9.10E+01	3.12E+03	6.52E+03	7.03E+03	9.99E+02	2.30E+02	1.00E+02	2.01E+04

Fuel integrity:
Iodine (I-131) maximum activity concentration level of primary coolant (kBq/m³) in power operation quarterly, Olkiluoto NPP



	I/09	II/09	III/09	IV/09	I/10	II/10	III/10	IV/10
OL1	3.60E+01	3.50E+01	3.50E+01	3.50E+01	3.44E+01	3.12E+04	7.55E+01	7.07E+01
OL2	1.00E+02	9.30E+01	4.10E+01	4.50E+01	5.71E+03	2.01E+04	7.01E+03	1.45E+03

Fuel integrity:
Iodine (I-131) maximum activity concentration of primary coolant (kBq/m³) related to shutdowns, Olkiluoto NPP



	2006	2007	2008	2009	2010
OL1	3.60E+05	0.00E+00	0.00E+00	0.00E+00	1.03E+04
OL2	3.08E+05	3.70E+04	2.52E+02	0.00E+00	1.61E+05

activity measurements of exhaust gases. The I-131 activity concentration of primary coolant remained small throughout the period being reported. The maximum value of I-131 activity concentrations measured during shutdowns is from a situation where the plant unit was brought to a cold shutdown state for Midsummer. The leaking fuel bundle will be removed from the reactor in the 2011 annual maintenance outage at the latest.

The fuel integrity of Olkiluoto plant units was decreased by minor fuel leaks. Several fuel leaks have occurred at the Olkiluoto plant units during the 2000s. The main reasons for these leaks have been small loose articles entering the reactor during annual maintenance—for example, metal chippings that may get caught in the fuel assembly structures. The coolant flow may make the loose articles vibrate and break the fuel cladding. Administrative procedures have been developed at the plant for eliminating the problem, and the screens filtering foreign articles have been improved, among other things.

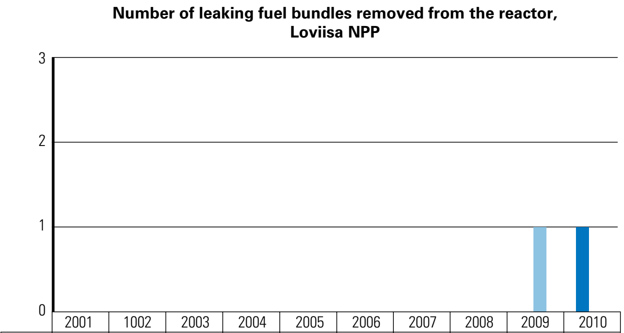
A.III.1b Number of leaking fuel bundles

Interpretation of indicators (Loviisa)

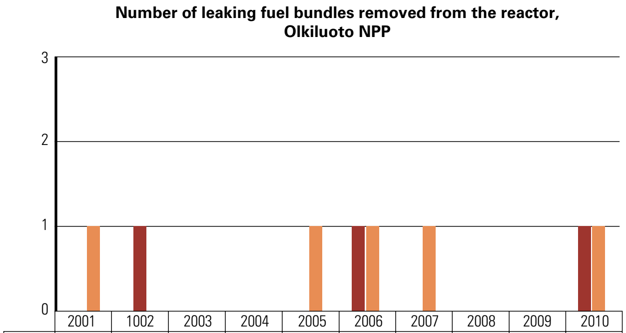
A minor fuel leak was observed at Loviisa 1 in October after the annual maintenance outage. The leaking fuel was removed from the reactor during the annual maintenance outage. The reactor of Loviisa 2 had no leaking fuel.

Interpretation of indicators (Olkiluoto)

The reactors of both Olkiluoto plant units had leaking fuel. A fuel leak was detected at Olkiluoto 1 just before the annual maintenance, and the leaking fuel assembly was removed from the reactor during the annual maintenance outage. A fuel leak was detected at Olkiluoto 2 in January, and the leaking fuel assembly was removed from the reactor during the annual maintenance. A new fuel leak was detected at Olkiluoto 2 following the annual maintenance. The leaking fuel bundle will be removed from the reactor in the 2011 annual maintenance outage at the latest.



	2001	1002	2003	2004	2005	2006	2007	2008	2009	2010
LO1	0	0	0	0	0	0	0	0	0	1
LO2	0	0	0	0	0	0	0	0	1	0



	2001	1002	2003	2004	2005	2006	2007	2008	2009	2010
OL1	0	0	1	0	0	1	0	0	0	1
OL2	0	1	0	0	1	1	1	0	0	1

A.III.2 Primary circuit integrity

A.III.2a Water chemistry conditions

Definition

As the indicators, the water chemistry conditions for each plant unit are followed.
The water chemistry indicators are:

- Chemistry performance indices used by the licence holders, illustrating 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 pressurised water plant affect the integrity of the interface between the primary and secondary circuits. 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 feed water. For steam generator blowdown, the calculation includes the chloride, sulphate and sodium concentrations and acid conductivity. For feed water, 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 feed water. The indices for both plants only cover the aforementioned parameter values during power operation.
- The maximum chloride concentration of the steam generator blowdown (Loviisa plant units) and the reactor water (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 on even, steady-state operation is followed as well.
- Corrosion products released from the surfaces of the reactor circuit and the secondary circuit into the coolant. For the Loviisa plant, the iron concentration of the primary coolant and the secondary circuit feed water (maximum value for the monitoring period) are followed. For the Olkiluoto plant, the iron concentration of feed water (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 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 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 water chemistry indices combine a number of water chemistry parameters and thus give a good overview of the water chemistry conditions. STUK 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, the success of the water chemistry control, and the shutdown procedures. In addition to the parameters described here, the licence holders use several other parameters to monitor the plant units' water chemistry conditions.

Responsible units/persons

Reactor and Safety Systems (REA)
Kirsti Tossavainen

Interpretation of indicators (Loviisa)

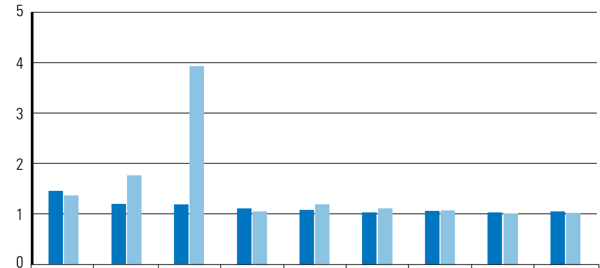
The iron content in the primary coolant and the chloride content in the steam generator blowdown flow have complied with the license holder's guidelines at both plant units. There were two brief periods when the guide value (< 10 µg/l) set by the power company for the iron content of secondary circuit feed water was exceeded at Loviisa 1. At Loviisa 2, the iron content of feed water has complied with the guide value set by the power company.

The iron and chloride concentrations monitored in STUK's indicator system refer to values measured during operation. The concentrations of cobalt-60 activity are monitored during shutdown. They did not deviate from previous years' values.

The chemistry index of both Loviisa plant units has remained at almost the best possible value.

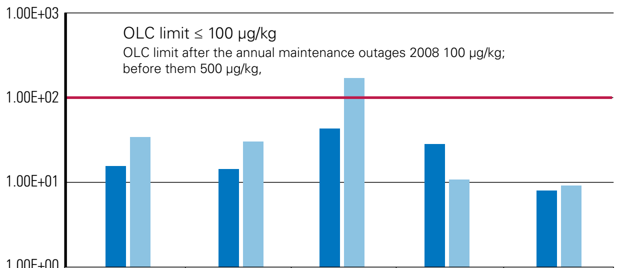
Based on the water chemistry indicators, the primary circuit integrity of Loviisa plant units has remained good.

Integrity of the secondary circuit: Chemistry index, Loviisa NPP



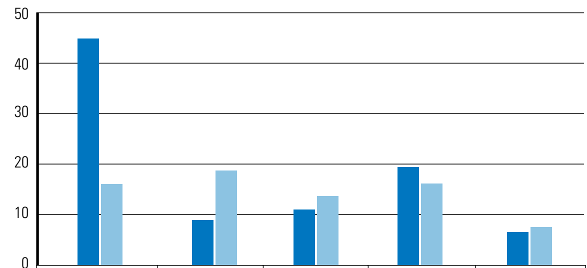
	2002	2003	2004	2005	2006	2007	2008	2009	2010
LO1	1.45	1.19	1.18	1.11	1.08	1.03	1.06	1.03	1.05
LO2	1.36	1.76	3.93	1.05	1.18	1.11	1.07	1.01	1.02

Integrity of primary circuit: Corrosive impurities; Maximum chloride concentration of a steam generator blow-down (µg/kg) during power operation, Loviisa NPP



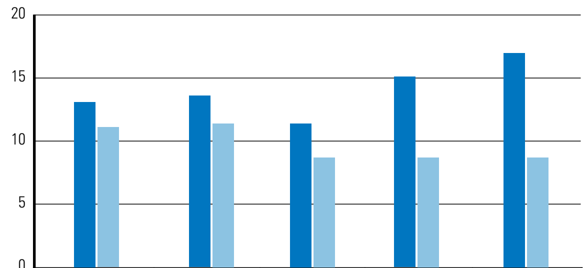
	2006	2007	2008	2009	2010
LO1	1.84E+01	1.43E+01	3.64E+01	2.90E+01	7.80E+00
LO2	3.73E+01	3.19E+01	2.10E+02	1.14E+01	9.10E+00

Integrity of primary circuit: Corrosion products; Maximum iron concentration in primary coolant (Fe-tot µg/l) during power operation, Loviisa NPP



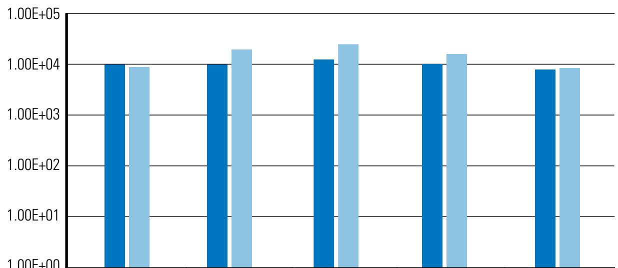
	2006	2007	2008	2009	2010
LO1	44.9	8.9	11.0	19.4	6.5
LO2	16.0	18.7	13.6	16.1	7.5

Integrity of primary circuit: Corrosion products; Maximum iron concentration in the feed water (µg/l) (RL30 / RL70) in power operation, Loviisa NPP



	2006	2007	2008	2009	2010
LO1	13.1	13.6	11.4	15.1	17.0
LO2	11.1	11.4	8.7	8.7	8.7

Integrity of primary circuit: Maximum cobalt-60 activity concentration (kBq/m³) in primary coolant related to shutdowns, Loviisa NPP



	2006	2007	2008	2009	2010
LO1	9.60E+03	1.09E+04	1.29E+04	1.03E+04	8.21E+03
LO2	9.00E+03	2.30E+04	2.40E+04	1.71E+04	8.60E+03

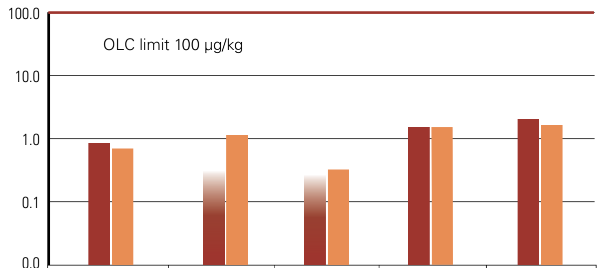
Interpretation of indicators (Olkiluoto)

The sulphate and chloride concentrations in reactor water have complied with the license holder's target values apart from one brief incident where the target value for sulphate concentration (< 5 µg/l) was exceeded at Olkiluoto 1. The iron concentration in the feed water for Olkiluoto 1 reactor circuits has been increasing, which is thought to be caused by erosion in the feed water pipelines and corrosion in the condensate system heat exchangers. The licence holder has planned an extended inspection of these objects during the 2011 annual maintenance. During the year, the iron concentration exceeded the target value set by the licence holder (< 1 µg/l) in a total of four samplings. The iron concentration in the feed water for Olkiluoto 2 has decreased. In spite of the increase in feed water iron concentration at Olkiluoto 1, the chemistry index of both plant units has remained at the best possible value.

There were no significant changes in the maximum concentrations of Co-60 activity measured during shutdown.

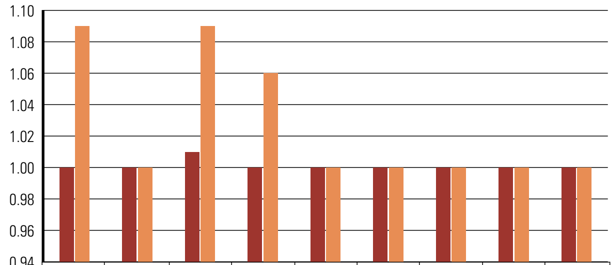
Based on the water chemistry indicators, the primary circuit leak tightness of Olkiluoto plant units has remained good.

Integrity of primary circuit: Corrosive impurities; Maximum chloride concentration in primary coolant (µg/kg) in power operation, Olkiluoto NPP



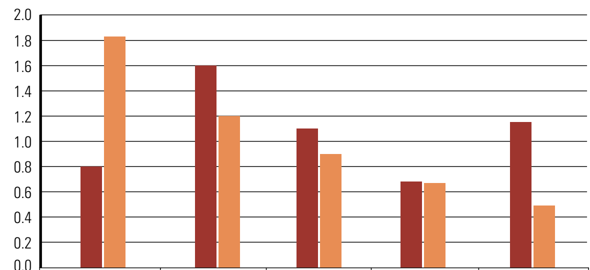
	2006	2007	2008	2009	2010
OL1	0.9	0.5	0.5	2.1	3.0
OL2	0.8	1.2	0.6	2.0	2.1

Integrity of primary circuit: Chemistry index, Olkiluoto NPP



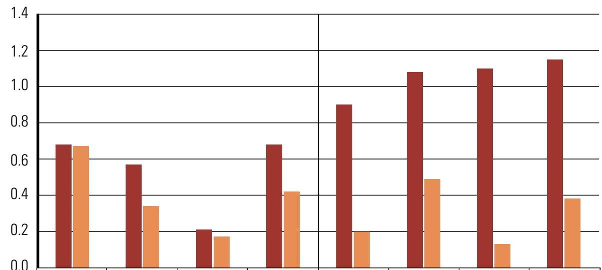
	2002	2003	2004	2005	2006	2007	2008	2009	2010
OL1	1.00	1.00	1.01	1.00	1.00	1.00	1.00	1.00	1.00
OL2	1.09	1.00	1.09	1.06	1.00	1.00	1.00	1.00	1.00

Integrity of primary circuit: Corrosion products; Maximum iron concentration in reactor feed water (µg/l) in power operation, Olkiluoto NPP



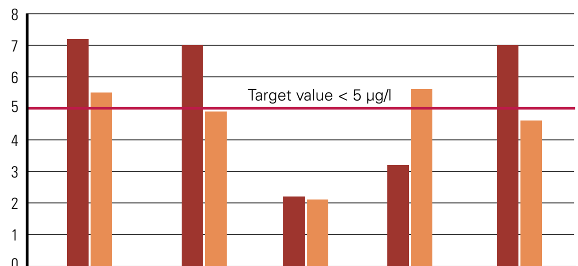
	2006	2007	2008	2009	2010
OL1	0.80	1.60	1.10	0.68	1.15
OL2	1.83	1.20	0.90	0.67	0.49

Integrity of primary circuit: Corrosion products; Maximum iron concentration in reactor feed water (µg/l) in power operation quarterly, Olkiluoto NPP



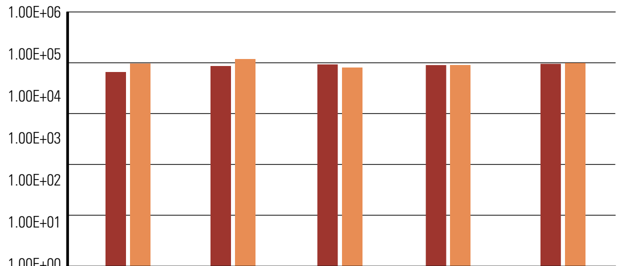
	I/09	II/09	III/09	IV/09	I/10	II/10	III/10	IV/10
OL	0.68	0.57	0.21	0.68	0.90	1.08	1.10	1.15
OL	0.67	0.34	0.17	0.42	0.20	0.49	0.13	0.38

Integrity of primary circuit: Corrosive impurties; Maximum sulphate concentration in primary coolant (µg/l) in power operation, Olkiluoto NPP



	2006	2007	2008	2009	2010
OL1	7.2	7.0	2.2	3.2	7.0
OL2	5.5	4.9	2.1	5.6	4.6

Integrity of primary circuit: Corrosion products; Maximum cobalt-60 activity concentration (kBq/m³) in primary coolant related to shutdowns, Olkiluoto NPP



	2006	2007	2008	2009	2010
OL1	5.70E+04	7.08E+04	8.34E+04	7.83E+04	8.59E+04
OL2	9.67E+04	1.46E+05	7.01E+04	7.54E+04	1.01E+05

A.III.2b Primary circuit leakages (Olkiluoto)

Definition

The indicators below are used to follow identified and unidentified primary circuit 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) containment internal leakages during the operating cycle.
- Highest daily containment internal leakage volume during the operating cycle in relation to the allowed leakage volume 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 primary circuit leakages at the Olkiluoto power plant to the responsible person at STUK.

Purpose of the indicator

The indicators describing primary circuit leakages are used to follow and monitor the leak rate of the primary circuit within the containment.

Responsible units/persons

Operational Safety (KÄY), Jarmo Konsi

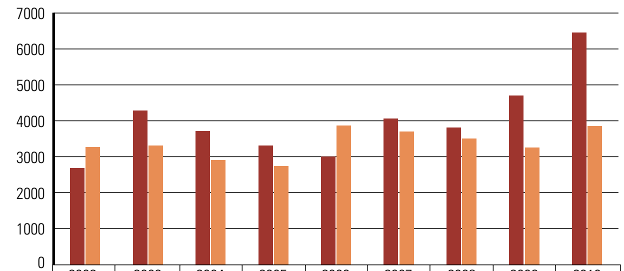
Interpretation of the indicator, operating cycle 2009–2010

One of the purposes of controlled leakage drain system 352 is to collect seal box 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 on the drains above the main lines will detect any leakage in the specific line. Other methods must then be used to locate the actual leaking object. During the operating cycle of 2009–2010, the number of leaks identified in the containment was a continuation of the increasing trend observed during the last three operating cycles at OL1. The trend at OL2 has been a decreasing one before the operating cycle now being reported when a small increase compared to the previous cycle took place. The numbers of leak occurrences do not include the cases where the process systems were drained during annual maintenance and other outages. The identified leaks include some 1,000–1,500 m³ of sampling flows in 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 number of unidentified primary circuit leaks occurring during the operating cycle of 2009–2010 increased somewhat at both plant units, having been small during four successive operating cycles before that. One reason for the number of leaks increasing was due to small valve seal leaks inside both plant unit containments.

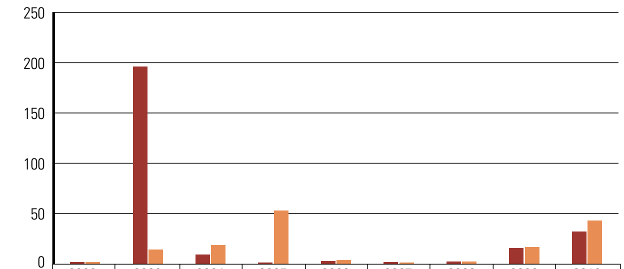
One of the purposes of containment gas cooling system 725 is to remove moisture from the containment atmosphere. Moisture may originate from

Identified leakages of primary circuit (352T1, m³), Olkiluoto NPP



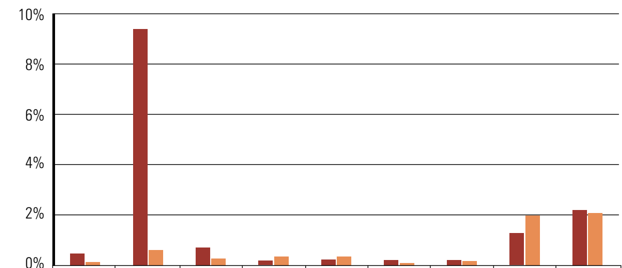
	2002	2003	2004	2005	2006	2007	2008	2009	2010
OL1	2678	2481	3716	3300	3004	4058	3805	4697	6448
OL2	3262	3307	2908	2741	3862	3696	3502	3252	3847

Unidentified leakages of primary circuit (345T33, m³), Olkiluoto NPP



	2002	2003	2004	2005	2006	2007	2008	2009	2010
OL1	1.8	196.0	9.2	1.1	2.5	1.6	2.2	15.5	32.3
OL2	1.8	14.0	18.6	53.0	3.8	1.3	2.0	16.5	43.1

The maximum unidentified leakage in ratio to the OLC limit, Olkiluoto NPP



	2002	2003	2004	2005	2006	2007	2008	2009	2010
OL1	0.46	9.40	0.70	0.18	0.23	0.21	0.21	1.27	2.20
OL2	0.12	0.60	0.27	0.35	0.35	0.09	0.1	1.97	2.08

steam leaking from the primary circuit. In the operating cycle of 2009–2010, the containment's largest internal daily leak volume's ratio to the maximum allowable volume, as specified in the Operational Limits and Conditions, continued to be low for both plant units although there was some increase from the previous cycle's figures. This was the sixth consequent operating cycle with very few leaks from the primary circuit to the containment atmosphere.

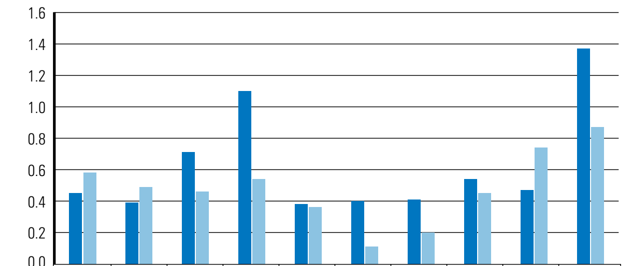
The primary circuit has been relatively leak-proof in the 2009–2010 operating cycle.

A.III.3 Containment leak tightness

Definition

As the indicators, the parameters below are followed: the total as-found leakage of outer isolation valves following the first leak tightness tests, compared with the highest allowed total leakage from the outer isolation valves; the percentage of isolation valves tested during the year in question at each plant unit that passed the leakage test on the first attempt (i.e. as-found leakage smaller than the acceptance criteria of a valve and no exceeding of the so-called attention criteria of a valve without repair in consecutive years) and the 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. In Loviisa, the combined leakage rate is comprised of the leakage test results of personnel airlocks, the material airlock, the cable penetrations of inspection equipment, the containment maintenance ventilation systems (TL23), the main steam piping (RA) and the feed water system (RL) penetrations, as well as the seals of the blind-flanged penetrations of ice-filling pipes.

The overall as-found leakage of outer isolation valves compared with the highest allowed overall leakage of outer isolation valves, Loviisa NPP



	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
LO1	0.45	0.39	0.71	1.10	0.38	0.40	0.41	0.54	0.47	1.37
LO2	0.58	0.49	0.46	0.54	0.36	0.11	0.20	0.45	0.74	0.87

Source of data

Data is extracted from the utilities' leak-tightness test reports submitted by the licensee to STUK for information within three months of the completion of annual maintenance. STUK calculates the total as-found leakages, since the reports give total leakages as they are at the end of the annual maintenance outage (i.e. after the completion of repairs and re-testing).

Purpose of the indicator

This indicator is used to follow the leak tightness of the containment isolation valves, penetrations and airlocks.

Responsible unit/person

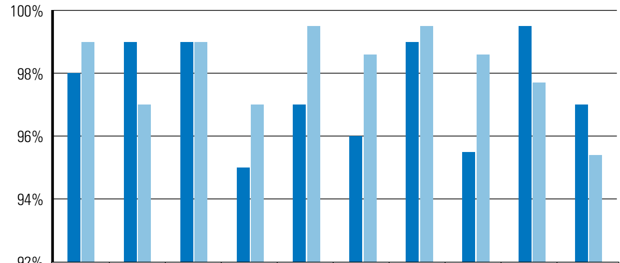
Reactor and Safety Systems (REA)
Päivi Salo

Interpretation of the indicator

Loviisa

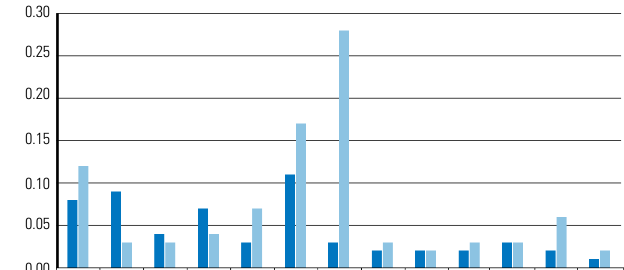
The overall as-found leakages of the outer isolation valves have increased for both plant units. At the Loviisa 1 plant unit, the overall as-found leakages observed in the first leakage tests exceeded the limit set in the OLC. The largest leakage, about 40%, occurred through the isolation valve of one

Isolation valves passing the leakage test at the first attempt, Olkiluoto NPP



	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
LO1	98.0	99.0	99.0	95.0	97.0	96.0	99.0	95.5	99.5	97.0
LO2	99.0	97.0	99.0	97.0	99.5	98.6	99.5	98.6	97.7	95.4

Combined leak rate of containment penetrations and air locks compared to the leak limit, Loviisa NPP



	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
LO1	0.08	0.09	0.04	0.07	0.03	0.11	0.03	0.02	0.02	0.02	0.03	0.02	0.01
LO2	0.12	0.03	0.03	0.04	0.07	0.17	0.28	0.03	0.02	0.03	0.03	0.06	0.02

normal makeup water system. After repairs, the overall as-found leakage was below the limits set in the OLC.

At Loviisa 2, the largest leak came via a valve in one fuel pool cooling system (approximately 63%).

The percentage of isolation valves which passed the leakage test at the first attempt has remained high.

The overall as-found leakage of containment penetrations, which at Loviisa includes the leakage 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 small at both plant units.

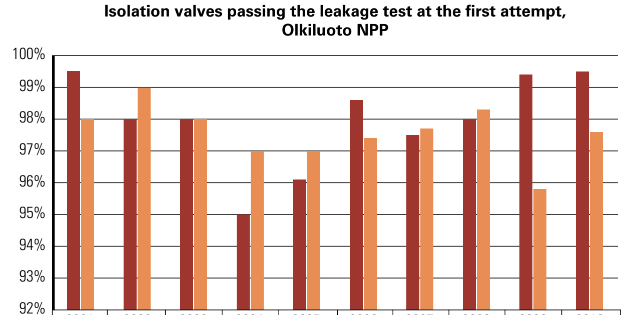
Olkiluoto

The total as-found leakages of outer isolation valves at the Olkiluoto 1 plant unit was very small, and clearly below the limit set in the OLC. About 20% of the leakage was caused by a leaking isolation valve in the main steam line.

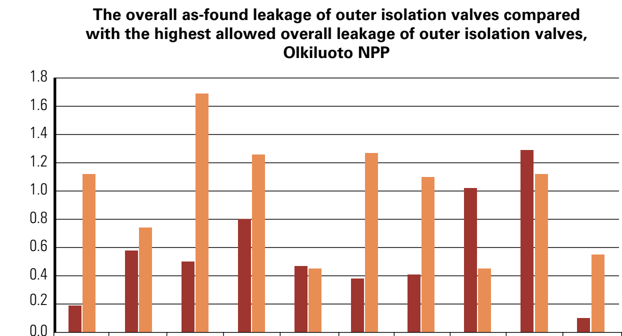
The total as-found leakages of outer isolation valves at the Olkiluoto 2 plant unit were below the limit set in OLC and also smaller than in 2009. Most (about 58%) of the total is caused by a single leaking valve in the controlled leakage drain system.

The percentage of isolation valves that passed the leak tightness test at first attempt has remained high for both plant units.

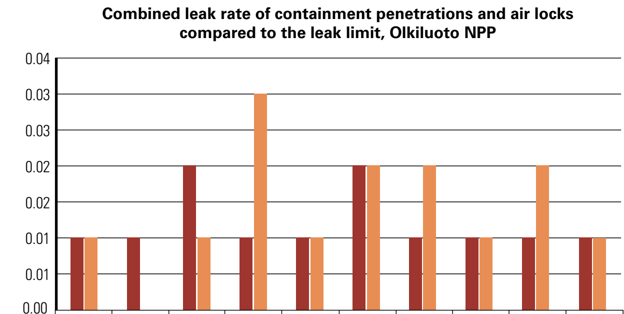
The total as-found leakage rate of containment penetrations, in which TVO includes leakages in the upper and lower personnel airlocks, the maintenance dome and the containment dome, has remained small for both plant units.



	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
OL1	99.51	98.00	98.00	95.00	96.10	98.60	97.50	98.00	99.40	99.50
OL2	98.00	99.00	98.00	97.00	97.00	97.40	97.70	98.30	95.80	97.60



	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
OL1	0.19	0.58	0.50	0.80	0.47	0.38	0.41	1.02	1.29	0.10
OL2	1.12	0.74	1.69	1.26	0.45	1.27	1.10	0.45	1.12	0.55



	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
OL1	0.01	0.01	0.02	0.01	0.01	0.02	0.01	0.01	0.01	0.01
OL2	0.01	0.00	0.01	0.03	0.01	0.02	0.02	0.01	0.02	0.01

APPENDIX 2 Occupational radiation dose distribution at Loviisa and Olkiluoto nuclear power plants in 2010

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 13.5 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 2006 to 2010 was 50.8 mSv. The dose was accumulated at Loviisa and Olkiluoto, as well as at Swedish nuclear power plants.

dose range (mSv)	number of persons by dose		
	Loviisa	Olkiluoto	total*
< 0,1	812	1545	2263
0.1–0.49	188	753	908
0.5–0.99	125	242	355
1.00–1.99	131	154	262
2.00–2.99	68	62	116
3.00–3.99	55	24	74
4.00–4.99	37	6	44
5.00–5.99	26	4	34
6.00–6.99	16	3	29
7.00–7.99	10	4	22
8.00–8.99	5	3	11
9.00–9.99	1	1	3
10.00–10.99	6	0	6
11.00–11.99	3	0	4
12.00–14.99	16	0	17
15.00–20	2	0	3
> 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 Significant operational events

Loviisa NPP

Entry of low-activity rinsing water to the auxiliary building ventilation system

Resin tanks and their overflow lines were being rinsed with pure water at the radioactive liquid waste solidification plant of the Loviisa power plant on 30 March 2010. The tanks and overflow lines had minor resin residues from previous use. Resin is used, among other things, for purifying the primary circuit coolant water. This makes the resin radioactive. The level measurement of one of the tanks was unreliable, which is why the tank was overfilled as a result of human error and slightly radioactive water-resin mixture entered the gas exhaust line of the tank and from there to the auxiliary building ventilation system. The entry of water in the ventilation system was quickly discovered because maintenance work was in progress in the corridor along which the ventilation channel runs. A temporary bypass line had been made in the ventilation channel for the maintenance operation. The maintenance workers noticed that water was seeping from the joint between the regular and temporary channels and reported this to the control room.

The corridor in the auxiliary building was cordoned off and actions were initiated in the area for limiting the spread of radioactivity. The ventilation system was set in filtering mode, the area was cleaned and the resin-containing water was collected.

The power company performed radiation measurements on the ventilation lines, even further away from the location of the event. Small quantities of radioactive resin were found in the ventilation system in places unaffected by the migration of resin and water that had now taken place. This led to the conclusion that radioactive resin had already entered the auxiliary building ventilation system on some previous occasion. The scope of cleaning operations at the power plant was extended and all dry resin was also collected from the ventilation systems. The last inspections of the ventilation system were carried out on 20 April 2010.

The total activity of the mildly radioactive resin and water entering the ventilation channel was estimated to be less than 100 MBq. The total volume of water collected from the system was about 100 litres, and about 5 litres of wet resin and 8 litres of dry resin were also collected. The employees accumulated a collective radiation dose of 0.2 mmanSv in the course of the cleaning operation, which means that the operation did not cause a risk to personnel safety.

Because the auxiliary building ventilation system leads the exhaust air to the vent stack, the filters in the vent stack sampling lines were measured. No radioactive particles were found in them, nor were there any indications that radioactive particles would have spread into the environment.

The power company performed comprehensive measurements outside the plant buildings in order to verify that particulate resin had not escaped into the environment through the vent stack. The measurements concentrated on the natural drainage routes of melting waters and rain water. The measurements did not reveal any radioactive particles. However, the power company did find minute amounts of radioactivity (Co-60) from the samples of grit used for sanding the parking lot. The quantity was 0.2 Bq/kg. The quantity allows for the conclusion that the quantity of activity possibly released into the environment in connection with the event is so small that it is insignificant for the vicinity of the plant and the people living in it.

The event showed that liquid substances may escape through the venting lines as a result of various process measures and erroneous actions and end up in places where they do not belong. The operation of the liquid waste solidification plant has not been continued after the event. Fortum performed a root cause analysis of the event. Fortum will investigate the process planning and instructions at the plant. The entry of liquids into the ventilation system through the venting lines will be prevented by modifications to process technology. The liquid level measurement in the tanks will be improved so that overfilling of the tank can no longer occur. The operating instructions for the solidification plant will also be further specified.

The event was classified at INES Level 1.

Spread of contamination in conjunction with transfers of spent fuel

Radioactive particles fell on the security-fenced yard of the Loviisa NPP from an inadequately cleaned transport vessel for spent nuclear fuel during the period 10 May to 9 June 2010 when spent fuel was being moved to the spent fuel interim storage from Loviisa 1. The storage is located at the Loviisa 2 plant unit. The power plant discovered the event on the evening of 9 June 2010 when measuring radioactivity on the transfer route. The power plant notified STUK of the event the following morning.

Spent fuel is moved from the reactor hall to the fuel storage using a purpose-built transfer container. The radioactive particles found on the transfer route were small metal particles that are present in the fuel storage pool water in the reactor hall. The particles had been deposited on the surface of the transfer container while it was in the pool, and because the container was not properly cleaned, they fell to the ground when the container was being transported.

About 50 radioactive particles were found in the vicinity of the transfer route on the plant yard when the power plant carried out measurements on 9–10 June 2010. The measurements were continued on the yard area using a more accurate method on 4–7 August 2010, and 35 particles more were found around the transfer route. The particles mainly contained Co-60, Mn-54, Co-57 and Co-58 nuclides. The total activity of the particles was determined and found to be about 10 MBq. This is a small amount of activity, but it should not be present outside the controlled area at all.

The transfer route of spent nuclear fuel had been cleaned, and the sand vacuumed from the area had been moved to the landfill site of the plant area on 1 June 2010. The sand and soil taken to the landfill site was brought back to a separate storage hall for investigations after radioactive particles had been discovered in the yard area. The sand and soil were investigated, and a total of four radioactive particles were found among the material brought back from the landfill site.

The storage and transfer route of spent nuclear fuel are in the controlled area of the power plant where radioactivity is regularly monitored. Particles were only found near the transfer route and at the landfill site. The yard was cleaned of any radioactive particles in connection with the radioactivity measurements. The event did not cause any hazard to people or the environment.

The Loviisa power plant took corrective action in order to prevent similar events. The methods and instructions for the transfers will be revised, and advanced radiation protection training will be organised for the fuel team. In addition, improvements will be made to the container transfer trolley in order to prevent the spread of contamination. STUK will follow the implementation of these actions. The event was classified at INES Level 1.

Turbine trip triggered by high level in one steam generator and the consequent manually activated reactor trip at Loviisa 1

The operators of Loviisa 1 shut down the reactor by triggering a reactor trip on 12 July 2010 as a result of malfunction detected when testing the steam line isolation valve and the turbine trip that followed. The protection systems of the plant functioned as planned during the event. The event had no significance for the safety of the plant or its surroundings, and it was rated at level 0 on the INES scale.

Loviisa 1 has six steam generators that generate steam using the thermal energy produced by the reactor core. The steam if further led via steam lines to the turbines. All steam lines of the steam generators have isolation valves that allow stopping the flow of steam from an individual steam generator to the turbine. The isolation valve of one steam line was subjected to a weekly test to verify its operability when the isolation valve of another steam line erroneously closed. The selection switch used for selecting the isolation valve to be tested had been left in an intermediate position, and the close command was sent to two isolation valves instead of just the one. The operators followed the instructions and stopped the corresponding primary coolant pump that maintains the flow of coolant from the reactor to the steam generator. Stopping the primary coolant pump also limited the reactor power.

A malfunction occurred in the test valve controlling the isolation valve with the result that the closed isolation valve re-opened. The water level in the steam generator rose, causing an automatic turbine trip after which the operators conducted a reactor trip.

The test selection switch as well as the control relays and I&C card of the faulty test valve were replaced as corrective actions. After that, the repaired equipment and all steam isolation valves were successfully tested.

Olkiluoto NPP

Blowdown system failure at Olkiluoto 1 and repair outage at Olkiluoto 2 on 24–25 June 2010

The purpose of the blowdown system is to limit the pressure in the reactor by letting out steam from the reactor to the containment building if the normal route of the steam to the turbine is not available. The system consists of a total of 14 pipelines. Each pipeline has a valve, controlled by the I&C system of the reactor, that opens when the reactor pressure must be reduced. The valves can be opened either by an electric pilot valve or a pressure-operated pilot valve.

On Sunday, 16 May 2010, in a test carried out just before the shutdown of Olkiluoto 1 for the annual maintenance outage, two blowdown valves did not function as planned, so TVO decided to inspect their electrical pilot valves during the annual maintenance outage. The inspections revealed that three electrical pilot valves were jammed. All jammed pilot valves were of a new type. Five of these valves had been installed at Olkiluoto 1 a year before. The five other electrical pilot valves were of the old type that has operated well for several years. Originally the decision to replace the valves was taken for the purpose of making their maintenance easier.

The jamming was caused by oxidation of the plating material inside the guide bushes that reduced the clearance between the valve piston and the guide bush and jammed the valve. TVO removed the electrical pilot valves of a new type during the annual maintenance outage of Olkiluoto 1 and reinstalled the old-type valves. Operation of the blowdown system (overpressure protection of the reactor) was not at risk due to the faults detected, because the pressure-operated pilot valves were in operating condition.

Ten electrical pilot valves of a new type were installed at Olkiluoto 2 in the annual maintenance in early May before the faults at Olkiluoto 1 were discovered. TVO verified the operability of the installed valves by tests carried out during the start-up of Olkiluoto 2. As the valves installed at Olkiluoto 2 were similar to the ones at Olkiluoto 1, the experience from Olkiluoto 1 suggested that there was a risk of the valves failing during the 2010–2011 operating cycle. TVO decided to replace eight valves with old-type valves. Two valves were replaced with new-type valves that had been modified after the fault was discovered. These two valves have a different coating on the guide bush, and the piston has a bigger clearance. The valves operated during start-up of the plant unit as well as in the tests performed in November.

The fault did not endanger the safety of the plant or its surrounding environment. On the INES scale, the event is rated at level 1.

Reactor trip at Olkiluoto 2

The inner isolation valve of one main steam line closed when the reactor power was being increased after the annual maintenance outage at Olkiluoto 2. When one steam line was closed, the steam flow rate in other main steam lines increased so much that the other lines were automatically isolated. When all steam lines were closed, the steam had no route available out of the reactor, and pressure in the reactor increased. The pressure increase triggered a reactor trip. The protection system initiated the safety functions as designed, and all systems also operated as designed.

The isolation valve closed because its control valve opened. This, in turn, was caused by loss or control nitrogen pressure. The pilot valve is kept closed by nitrogen pressure. The pressure keeping the valve closed was lost when a joint in the nitrogen line unexpectedly opened. The investigations carried out led to the conclusion that the connection had apparently been originally made incorrectly. This was a compressing ring joint, and the pipe had not been inserted deep enough when the joint was tightened. The joint was repaired by replacing the pipe and the connections at both ends. The integrity of the joint was verified after the repair. Following the event, all other similar joints in the containment building were inspected.

To prevent similar events from recurring, TVO will organise related training for the maintenance organisation in March 2011. The purpose of this training is to create an understanding of how the joints function and to teach the correct methods for installing them. In addition, TVO has produced new instructions for installing connections.

The replacement of the inner isolation valves of main steam lines at Olkiluoto 2 is scheduled for the 2011 annual maintenance outage because the old isolation valves may close by themselves when the flow rate in steam lines increases. This modification was made at Olkiluoto 1 during the 2010 annual maintenance.

The safety significance of the event is minor. If the steam line isolation valve closes, the safety systems and the plant function as designed. On the INES scale, the event is rated at level 0.

Incorrect settings in the I&C of main coolant pumps at Olkiluoto 1 and 2

Incorrect settings were detected in the I&C of main coolant pumps at Olkiluoto 1 and Olkiluoto 2 during the annual maintenance outage in the spring. This could have resulted in the main coolant pumps stopping quicker than planned in certain rare transient situations.

During normal operation, the power of a boiling water reactor is controlled by changing the flow rate of cooling water inside the reactor. The reactor power control system monitors the electrical power generated by the plant and adjusts on this basis the speed of the main coolant pumps (6 pumps per plant unit) by controlling the frequency controllers that supply the pump motors. In addition to the power control system that is part of the regular operation automation of the plant, certain functions deemed as safety functions have been implemented in the frequency converters, such as the quick shutdown of the main coolant pumps in connection with a reactor trip.

In order to prevent the operational I&C systems of the plant from stopping the pumps too quickly as a result of a possible malfunction, the safety classified part of the frequency converter has a so-called ramp monitoring system that takes over the control of the frequency converter from the power control system if it detects a too rapid decrease in pump speed. The fault now detected had to do with the time delay in the monitoring system: had the operational I&C systems started, for whatever reason, to run the pumps down quicker than intended, the monitoring system would only have detected this deviation after 0.7 seconds when the design basis of the system dictates that the deviation should be detected in 0.1 seconds. If the reactor had been operating at full power and the pumps had slowed down at their maximum deceleration rate for 0.7 seconds as a result of the fault in the power control system, the fuel in the reactor would have had insufficient cooling for a brief moment, and some fuel rods might have overheated and possibly ruptured. However, there was no significant danger because the period of insufficient cooling would have been limited to a maximum of a few seconds.

The fault was repaired by replacing certain components on the I&C card controlling the rate of slowing down the pumps with components of correct values, and the monitoring system was tested after the repairs and found to function as designed.

The event was rated at level 0 on the international INES scale, i.e. it was not deemed to have any significance for nuclear or radiation safety.

Erroneous bypass connection in the reactor protection system at Olkiluoto 2

At Olkiluoto 2, one of the neutron flux measurements in the reactor protection system was inoperable for about two weeks in August–September. The measurement was disabled by a bypass connection for the duration of the periodic test carried out on 25 August 2010 so that the false alarms and functions caused by the test could be avoided. Contrary to the instructions, the bypass links were not removed after the test in spite of the fact that they were signed off on the work records as having been removed. The bypass was detected in conjunction with another periodic test on 7 September 2010, and the measurement was restored to operable condition.

This neutron flux measurement is one of the many measurements included in the reactor protection system. The purpose of the protection system is, among other things, to initiate the protective functions required for the safe shutdown of the reactor and to initiate interlocks critical to plant safety. There are four of these neutron flux measurements used at power levels below 8%, and they are required during reactor start-up. The measurement was not required during the time it was inoperable, as the power of the plant was higher than 8% during the whole period. The protection function would have been activated if required because the three other measurements were operable and two measurements are enough to trigger the protection.

TVO identified several causes for the event that related to inspections and sign-offs of actions completed, as well as to working methods. Following the event, TVO will develop its methods and procedures; for example, by having employees work as pairs more often. On the INES scale, the event is rated at level 0.

APPENDIX 4 Licences and approvals in accordance with the Nuclear Energy Act in 2010

Teollisuuden Voima Oy

- 1/C42214/2010, 22 February 2010. Import of control rods from Sweden. Six control rods of type CR99. Last date of validity 30 April 2010.
- 1/G42214/2010, 23 February 2010. Import of software related to reactivity measurement and analysis equipment from Germany. Last date of validity 31 December 2010.
- 3/C46201/2010, 19 March 2010. Transport of decommissioned reheaters to Sweden. Four reheaters, total activity about 44 GBq. Last date of validity 31 December 2010.
- 3/C42214/2010, 13 April 2010. Import of control rods from Sweden. 12 control rods of the Marathon type. Last date of validity 31 December 2010.
- 2/C42214/2010, 19 April 2010. Export of decommissioned reheaters to Sweden. Four reheaters, total activity about 44 GBq. Last date of validity 31 December 2010.
- 7/C42214/2010, 5 August 2010. Import of radioactive waste produced in scrapping decommissioned reheaters from Sweden. A total of 250 tonnes of waste, total activity about 44 GBq. Last date of validity 31 December 2012.
- 6/C42214/2010, 10 September 2010. Transport of radioactive waste produced in scrapping decommissioned reheaters from Sweden. A maximum total of 250 tonnes of waste, total activity about 44 GBq. Last date of validity 31 December 2012.
- 8/C42214/2010, 24 August 2010. Import of nuclear fuel with Euratom obligation code “S”, from Spain. 116 assemblies, a total of 20,600 kg (maximum) of low-enriched uranium. Last date of validity 31 December 2011.
- 10/C42214/2010, 24 August 2010. Import of nuclear fuel with Euratom obligation code “S”, from Spain. Four GNF2 test assemblies, a total of 750 kg (maximum) of low-enriched uranium. Last date of validity 31 December 2011.
- 11/C42214/2010, 3 September 2010. Import of nuclear fuel with Euratom obligation code “P”, from Sweden. 70 assemblies, total of 12,200 kg (maximum) of low-enriched uranium.
- 2/G42214/2010, 3 September 2010. Amendment to import licence G214/2 for dual-use items required in the construction and operation of a nuclear power plant. The reactor internals will be imported from the Czech Republic instead of France. The licence supersedes licence G214/2 granted on 1 November 2007, and its last date of validity is 31 December 2010.
- 12/C42214/2010, 29 July 2010. Import of control rods made of zirconium alloy from Sweden. Four rods, a maximum total of 9 kg zirconium. Last date of validity 31 March 2011.
- 13/C42214/2010, 27 September 2010. Import of nuclear fuel with Euratom obligation code “S”, from Sweden. 36 assemblies, a total of 6,300 kg (maximum) of low-enriched uranium. Last date of validity 31 December 2011.
- 3/G42214/2010, 28 October 2010. Import of spent fuel mast bridge and fuel handling tools from France. Last date of validity 31 December 2013.
- 4/G42214/2010, 28 October 2010. Amendment to import licence 2/G42214/2 for dual-use items required in the construction and operation of a nuclear power plant. Part of the equipment will be imported from Germany instead of France; the equipment list was further specified and validity of the licence extended. The licence supersedes licence 2/G42214/2010 granted on 3 September 2010, and its last date of validity is 31 March 2013.

Fortum Power and Heat Oy

- 2/A42214/2010, 29 January 2010. Import of intermediate shafts from the Czech Republic. Five intermediate shafts of the control rod system. Last date of validity 31 December 2010.

Other

- 7/Y42214/2010, 1 March 2010. Norilsk Nickel Harjavalta Oy. Production, possession and storage of nuclear material at the company's production plant in Harjavalta. Uranium compounds as solutions and precipitates, used in the nickel refining process. The total quantity of uranium produced during any calendar year may not exceed 10,000 kg, and the company may not be in possession of more than 10,000 kg at any one time. Last date of validity 31 December 2019.

APPENDIX 5 Periodic inspection programme

Inspections contained in the periodic inspection programme focus on safety management, operational main processes and procedures, as well as the technical acceptability of systems. The compliance of safety assessments, operations, maintenance and protection activities (radiation protection, fire protection and security) with the requirements of nuclear safety regulations are verified by the inspections. The annual inspection programme is brought to the attention of the licensee at the beginning of each year, and inspection dates are agreed upon with the licensee's representatives.

		Inspections in 2010	
Basic programme		**Loviisa 1 and 2**	**Olkiluoto 1 and 2**
Management, management system and personnel			
A1	Management and safety culture	13.–14.4.2010	26.–27.1.2010
A2	Personnel resources and competence	7.–8.6.2010	9.–10.9.2010
A3	Functionality of the management system	27.10.2010	4.–5.11.2010
Plant safety and its improvement			
B1	Assessment and improvement of safety	11.6.2010	23.–24.11.2010
B2	Plant safety functions	10.6.2010	24.11.2010
B3	PSA and safety management	23.11.2010	14.10.2010
B4	International operating experience feedback	9.12.2010	17.11.2010
Operational safety			
C1	Operation	2.3.2010 21.6.2010 annual maintenance 26.11.2010	4.2.2010 annual maintenance 30.–31.8.2010 17.–18.11.2010
C2	Plant maintenance	14.12.2010	11.–12.10.2010
C3	Electrical and I&C systems	16.–17.12.2010	3.–4.32010
C4	Mechanical engineering	17.11.2010	8.–9.4.2010
C5	Structures and buildings	26.11.2010	18.11.
C6	Information management and security		26.10.2010
C7	Chemistry	2.–3.2.2010	28.–29.9.2010
Personal and plant protection			
D1	Radiation protection	4.–5.11.2010	23.–25.3.2010
D2	Fire protection	2.3.2010	17.11.2010
D3	Emergency response	26.10.2010	8.–9.6.2010
D4	Security	2.6.2010	17.12.2010
Nuclear waste and its storage			
E1	Reactor waste	7.–8.6.2010	1.–2.11.2010
E2	Final disposal facilities		21.4.2010
Special items			
F1	LARA (renewal project for the I&C systems of Loviisa NPP)	18.5.2010	

APPENDIX 6 Periodic inspection programme during construction

The objective of the Olkiluoto 3 construction-time inspection programme is to verify that the operations required by the construction of the plant ensure a high quality implementation according to the approved plans and compliant with official regulations, without endangering the plant units operational within the plant site. The inspection programme assesses and oversees the licensee's operations in building the plant unit, implementation procedures in various technical areas, the licensee's expertise and use of that expertise, the handling of safety issues and the quality management and control. STUK prepares an inspection plan for Olkiluoto 3 every six months.

Subject of inspection	Time of inspection
Main functions	
Project management and the management of safety	22–23 April 2010
Project quality management	2–3 February 2010
Development of safety culture on the site, follow-up inspection	17 June 2010, 22 June 2010 and 29–30 June 2010
Organisations, resources and development of competence	25–26 October 2010
Work processes	
Equipment installation steering process	15–16 March 2010
Quality assurance	24–25 May 2010
Inspection of the licence holder's layout plans	10 June 2010
Pipeline installations in the reactor building	11 June 2010
Equipment installation steering process, electrical engineering	23–24 September 2010
Utilisation of PRA	1 December 2010
Functions of TVO's Nuclear Safety Department	15 December 2010

APPENDIX 7 Inspection programme during the construction phase of Onkalo

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	10 May 2010
Planning and management		
ONP-B1	Project management and control	26–27 October 2010
ONP-B2	Safety management	Not in 2010.
ONP-B3	Project quality management	Not in 2010.
ONP-B4	Planning and management of the research and monitoring programme	14–15 April 2010
ONP-B5	Design of Onkalo	7–8 December 2010
Implementation		
ONP-C1	Site inspection and monitoring procedures	Not in 2010.
ONP-C2	Drilling and modelling	15 June 2010
ONP-C3	Foreign substances	14–15 December 2010
ONP-C4	Excavation and EDZ	13–14 October 2010
ONP-C5	Onkalo in-flows	13–14 October 2010
ONP-C6	Monitoring and research methods	23–24 November 2010

APPENDIX 8 Assignments funded by STUK in 2010

Safety of nuclear power plants

The subjects of assignments presented in the 2010 plan for technical support assignments were mainly 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, part of the assignments proposed for 2010 were postponed to 2011.

Of the assignment proposals for 2010, 32 were related to the project of overseeing the construction of Olkiluoto 3 (FIN5/OL3), six to the Olkiluoto plant units already in operation, 10 to Loviisa plant units and one to new NPP projects. The most significant framework agreements related to overseeing the construction of Olkiluoto 3 in 2010 were

- FIN5/OL3, Consultancy agreement related to the manufacture of pipelines (Quality Factory Oy, EUR 300,000)
- FIN5/OL3, Consultancy agreement related to the inspections of strength analyses included in the structural plans of mechanical devices (Lamprotek Oy, EUR 124,000)
- Expert studies related to non-destructive testing (TÜV Nord Finland Oy, EUR 135,000
- FIN5/OL3, Inspection of the stress and resilience analyses of Safety Class 1 and 2 piping (VTT, EUR 100,000)
- FIN5/OL3, Strength analyses of nuclear pressure vessels, (VTT, EUR 125,000)
- FIN5/OL3, Strength analyses of structural plans (Inspecta Nuclear AB, EUR 300,000)
- FIN5/OL3, Buildings and structures: inspection of detailed structural plans (Pontek Oy, EUR 60,000)

Safety of nuclear waste disposal

The volume of the technical support programme for the oversight of nuclear waste management was about EUR 437,000 in 2010. The programme included assignments related to both overseeing the construction of the underground research facility and to the preliminary inspection of the construction licence for the final disposal facility. They included:

Overseeing the construction of the underground research facility (about EUR 27,000)

- External specialist work related to the construction of ONKALO, Ortogeo

Preliminary inspection of the construction licence for the final disposal facility (about EUR 410,000)

- Inspection of the operational safety of the encapsulation plant and repository
  - Plant design, VTT Ortogeo Oy
    - Evaluation of the Preliminary Safety Assessment Report, Ortogeo Oy
  - Operational safety analyses, VTT
  - Evaluation of the ventilation solution, Oy Kalottkonsult Ab
- Safety Case
  - Technical release barriers
    - EBS Design Reports; Hannu Hänninen
    - Buffer Design Reports; Intera
    - Buffer Design Reports; Intera
    - Update of the copper corrosion State of the art report; Hannu Hänninen, VTT
    - Supplement to the erosion study and a study on the factors affecting the buffer swelling pressure; Intera

  - Disintegration and solubility of fuel, HYRL
- Plant site – natural release barriers
  - Olkiluoto Site Description 2008; Martin Mazurek, Intellisci, Auli Niemi, STC AB, Geosigma
  - Olkiluoto Biosphere Description 2009; Kirsti-Liisa Sjöblom.
  - Rock Suitability Criteria; Geosigma, Martin Mazurek, Intellisci
- Assessment of overall safety
  - Models and Data; VTT, Intera, Intellisci, Hardrock Consulting
  - Radionuclide Release and Transport – RNT-2008; VTT, Intera, Intellisci
  - Biosphere Assessment Report -BSA 2009; Aleksandria Sciences
  - Impact of climate change and glacial formation on final disposal
    —Expert views on climate and glacier issues, the Geological Survey of Finland
    — Freezing-thawing behaviour of buffer and backfill materials, VTT
  - Assessment of the significance of open safety issues and methods of safety analysis; VTT, Intera, & Chapman & Co Consulting
  - Development of independent capabilities for producing safety analyses – Ecolego Safety Analysis Tool, Intera, Facilia

APPENDIX 9 International co-operation in 2010

IAEA

IAEA working groups

- IAEA/Regulatory Co-ordination Forum Meeting, Petteri Tiippana (1 day) (A)
- CSS, Commission of Safety Standards – a body steering the preparatory work for IAEA's safety standards, Jukka Laaksonen, Lasse Reiman (6 days, 2 meetings) (A).
- INSAG, Jukka Laaksonen (6 days, 2 meetings) (A)
- IAEA, SG Infrastructure, Jukka Laaksonen, 18–22 January 2010 (B3)
- Expert groups preparing IAEA safety standards:
  - IAEA DS 441 Construction of Nuclear Installation, Janne Nevalainen (2 days) (A)
  - IAEA Safety Guide, Construction Activities at Nuclear Installations, Jouko Mononen (4 days) (A)
  - NUSSC, Nuclear Safety Standards Committee, DS 414 Meeting, Marja-Leena Järvinen, Keijo Valtonen (4 days, 2 meetings) (A)
- NUSSC, Nuclear Safety Standards Committee, Marja-Leena Järvinen (9 days, 2 meetings), Keijo Valtonen (3 days, 2 meetings) (A)
- WASSC, Waste Safety Standards Committee, Kaisa-Leena Hutri (8 days, 2 meetings) (A)
- TRANSSC, Transport Safety Standards Committee, Anna Lahkola (5 days) (A)
- IAEA Steering Committee on Competence of Human Resources for Regulatory Bodies in Member States with Nuclear Power Plants, Bureau Meeting, Kaisa Koskinen (2 days) (A).
- IAEA Steering Committee Meeting on Competence of Human Resources for Regulatory Bodies in Member States with Nuclear Power Plants, Kaisa Koskinen (3 days) (A).
- CEG, Contact Expert Group for International Radwaste Projects in the Russian Federation, Henri Niittymäki, Risto Paltemaa (8 days, 2 meetings) (A)
- ASTOR, Application of Safeguards to Geological Repositories, Elina Martikka, Olli Okko (6 days, 2 meetings) (A)
- GEOSAF, International Project on Demonstrating the Safety of Geological Disposal, Jussi Heinonen (5 days) (A)
- EMRAS II, Environmental Modeling for Radiation Safety, Kai Hämäläinen (5 days) (A)
- PRISM, Practical Illustration and Use of the Safety Case Concept in the Management of Near-Surface Disposal, Arto Isolankila (5 days) (A).

IAEA's expert duties

- IRRS, International Regulatory Review Service, IAEA expert group to assess national nuclear safety regulation
  - Assessment of public authorities in China 19–30 July 2010, Lasse Reiman, Mika Markkanen (B3)
  - NRC – IRRS, Washington DC, 18–29 October 2010, Jukka Laaksonen, Petteri Tiippana (B3)
- IAEA workshop on Regulatory requirements concerning Management Systems, Jouko Mononen, Romania, (5 days) (C)

Each item on the list bears a marking that shows how the participation was financed:

A All travelling costs were borne by STUK.
B1 The airfare was paid by the inviting party while the other travelling costs were borne by STUK.
B2 The airfare and accommodation were paid by the inviting party while the other travelling costs were borne by STUK.
B3 All travelling costs were borne by the inviting party while STUK paid the participant's salary.
C All travelling costs and the participant's salary were borne by the inviting party.
The trip was made on the participant's own leisure time.

- IAEA Foratom workshop on Management System, Jouko Mononen, (3 days) (C)
- IAEA International Conference on Human Resource Development for Introducing and Expanding Power Programmes, Kaisa Koskinen (5 days) (A)
- Consultancy on the Revision of the Safety Report on Competence Management Systems, Kaisa Koskinen (4 days) (B3)
- IAEA Regional Meeting on Exploring Possibilities for Regulatory Harmonisation: Strengthening Nuclear Regulatory Authorities in the Asia and the Pacific Region, Kaisa Koskinen (5 days) (C)
- IAEA Regional Workshop Development and Implementation of Regulatory Requirements for the Oversight of Licensees' Management: Strengthening the Effectiveness of Regulatory Authorities and Advanced Training in Nuclear Safety, Kaisa Koskinen (5 days) (C).

IAEA's expert meetings

- IAEA General Conference, Jukka Laaksonen (5 days) (A)
- IAEA/ISSC International Seismic Safety Centre ISSC-Meeting, Jorma Sandberg (4 days) (A)
- IAEA Technical Meeting on Safety Culture during Pre-Operational Phases of New NPPs, Anna Aspelund, (4 days) (A)
- IAEA Technical Meeting on the Considerations of Human Factors in New NPP Projects, Anna Aspelund, (4 days) (A)
- IAEA meeting of INES coordinators, Tomi Koskiniemi, (5 days) (A)
- IAEA Technical Meeting on Safety Culture during Pre-Operational Phases of New NPPs, Kirsi Levä, (4 days) (A)
- IAEA Technical Meeting on Nuclear Security Recommendations on Physical Protection of Nuclear Material and Nuclear Facilities (INFCIRC-225/ Rev. 5), Paula Karhu (4 days) (A)
- IAEA Technical Meeting on three Nuclear Security Recommendations, Paula Karhu (5 days) (A)
- IAEA Technical Meeting on Fundamentals of a State's Nuclear Security Regime: Objective and Essential Elements. Paula Karhu (4 days) (A).
- IAEA's Technical Meeting on Irradiation Embrittlement and Life Management of RPVs in NPPs, Mika Bäckström (5 days) (A)
- IAEA IGALL (International Generic Ageing Lessons Learned) scoping meeting, Petri Vuorio (3 days) (A)
- IAEA/NEA: Joint Technical Meeting to Exchange Experience on Recent Events in Nuclear Power Plants and the Technical Committee Meeting of the IRS National Coordinators , Erja Kainulainen, Seija Suksi (5 days, 2 meetings) (A).
- IAEA: Improvements in International Operating Experience (consultancy meeting regarding implementation of the recommendations in the INSAG-23 report), Advisory Committee on the International Reporting system, Erja Kainulainen (5 days, 2 meetings) (A).
- IDN, International Decommissioning Network, Annual Forum for Regulators and Operators in the field of Decommissioning IDN Activities and Other Major Initiatives, Henri Niittymäki (3 days) (A)
- Safeguards Analytical Services and Safeguards by Design, Elina Martikka (2 days) (A)
- Accountancy and control of nuclear material for nuclear security purposes, Elina Martikka (3 days) (A)
- New technologies symposium, Tapani Honkamaa (2 days) (A)
- Spent Fuel Treatment Options, Antero Kuusi (2 days) (A)

CTBTO

- CTBT WGB, Mikael Moring (13 days, 2 meetings) (A)
- CTBT Xe & Laboratory WS, Mikael Moring (5 days) (A)

OECD/NEA

- **CNRA**, Committee on Nuclear Regulatory Activities, Petteri Tiippana, (4 days, 2 meetings), (A)
  - CNRA, Jouko Mononen, (2 days) (A)
  - CNRA/WGRNR, Tapani Virolainen, (5 days) (A)
  - CNRA Task Group on Long Term Operation. 1st meeting of the Green booklet working group, Martti Vilpas, (3 days) (A)
  - OECD/NEA/CNRA Workshop on "New Reactor Siting, Licensing and Construction Experience", Seija Suksi (3 days) (A)
  - OECD/NEA/CNRA/WGOE pre-meeting, Spe-

cial Topic (KM on OE) Extended Meeting and the actual 7th meeting, Seija Suksi (4 days, 3 meetings) (A).
  - OECD/NEA EHPG meeting of the Halden project, Harri Heimbürger (5 days) (A).
  - WGIP, Working Group on Inspection Practices Workshop, Milka Holopainen, Ann-Mari Sunabacka-Starck, Jukka Kupila (4 days) (A)
  - WGIP meeting, Jukka Kupila, (4 days) (A)
  - OECD/NEA/WGOE meeting, Seija Suksi, (5 days) (A)

CSNI

- CSNI 47th Committee Meeting On the Safety of Nuclear Installations, Keijo Valtonen (2 days) (A)
- CSNI 48th Halden project Board Meeting, Keijo Valtonen (3 days, 2 meetings) (A)
- CSNI/WGRisk Annual Group Meeting and Bureau Meeting, Reino Virolainen (5 days, 2 meetings) (A)
  - WGRisk Group Meeting, Jorma Sandberg (3 days) (A)
- CSNI 9th COMPSIS SG-Meeting, Heimo Takala (4 days) (A)
- HALDEN Management Board Meeting, Keijo Valtonen (2 days) (A)
- FUEL Working Group Meeting On Fuel Safety, Risto Sairanen (2 days) (A)
- WGAMA Programme Project Meeting, Nina Lahtinen (4 days) (A)
  - SETH 7th Meeting of the Management Board of the SETH-2 Project, Eero Virtanen (1 day) (A)
  - SETH 8th Meeting Programme Group and Management Board SETH-2 project, Eero Virtanen (2 days) (A)
  - 6th Meeting of the Programme Group and Management Board PKL2 Project, Eero Virtanen (2 days) (A)
  - ROSA 2 Project Meeting Group, Eero Virtanen (2 days) (A)
  - ROSA 4th Meetings of the Programme Group and Management Board ROSA-2 project, Eero Virtanen (5 days, 3 meetings) (A)
  - SERENA Project 6th MB Meeting of Serena project, Tomi Routamo (5 days, 2 meetings) (A)
- HALDEN Enlarged Halden Programme Group Meeting 2010, Päivi Maaranen (5 days) (A)
- DIDELSYS2 Meeting, Kim Wahlström (2 days) (A)
- WGHOF meeting, Kirsi Levä, (2 days) (A)
- SCAP Management Board Meeting, Rauli Keskinen (1 day) (A)
- SCAP Workshop "Commendable Practices for the Safe Long-Term Operation of Nuclear Reactors – Stress Corrosion Cracking and Cable Ageing Project", Rauli Keskinen, (2 days) (A)
- OECD/NEA/OPDE-SCAP project meeting, Rauli Keskinen (1 day) (A)
- OECD/NEA Expert Group on Education, Training and Knowledge Management, 3rd meeting, Kaisa Koskinen (2 days) (A).
- OECD/NEA Expert Group on Education, Training and Knowledge Management, 2nd meeting, Kaisa Koskinen (2 days) (A).

CRPPH

- OECD/NEA CRPPH annual meeting, Olli Vilkamo (3 days) (A).
- NEA: Participation in a MDEP/CSWG meeting, Yrjö Hytönen, (3 days) (A)

RWMC, Radioactive Waste Management Committee

- IGSC-12, Integration Group for the Safety Case, Petri Jussila, (3 days, 1 meeting) (A)
- WPDD, Working Party of Decommissioning and Dismantling, Henri Niittymäki (5 days, 1 meeting) (A)

EU

- **ENSREG**, European Nuclear Safety Regulator's Group, Jukka Laaksonen (3 days, 3 meetings) (B1)
  - WG2, Tero Varjoranta, Risto Paltemaa (5 days, 3 meetings) (A)
- Meeting regarding the EC article 37 report, Petteri Tiippana, Kirsi Alm-Lytz (1 day), (A)
- Meeting of the Article 37 expert group, Lauri Pöllänen (3 days) (A)
- Meetings of the EURATOM Article 37 expert group, Lauri Pöllänen (3 days, 2 meetings) (A)

- Euratom – Group of Experts referred to in Article 31 of the Euratom Treaty, expert meeting on radiation protection, Olli Vilkamo (4 days, 2 meetings) (A)
- EURATOM ASAMPSA2 Project Meeting, Tomi Routamo (3 days) (A)
- EU CBRN Action Plan: Advisory Group, 1st Meeting, Paula Karhu (1 day) (B2)
- 5th Europol Seminar on Illicit Trafficking on Nuclear and other Radioactive Material, Paula Karhu (2 days) (A).
- Euratom – Meeting of the advisory committee on Directive 2006/117/Euratom, Arja Tanninen (1 day) (B1)
- Joint Research Centre (JRC) Decommissioning and Waste Management Expert Group, Risto Paltemaa (4 days, 2 meetings) (B3)
- The European Security Strategy, Elina Martikka (2 days) (A)
- EU-JRC, Radar project, training event for customs officials, Tapani Honkamaa, Timo Ansaranta (4 days) (A)
- ESARDA RG, European Safeguards Research and Development Association Reflection Group, Elina Martikka, Tapani Honkamaa (5 days, 4 meetings) (A)
- ESARDA NDA, Techniques and Standards for Non Destructive Analysis, Tapani Honkamaa (1 days) (A)
- ESARDA C/S, Containment and Surveillance, Tapani Honkamaa (1 day) (A)
- ESARDA VTM, Verification Technologies and Methodologies, Tapani Honkamaa (1 day) (A)
- ESARDA IS, Implementation of Safeguards, Elina Martikka (2 days) (A)
- ESARDA Executive and WG Chairs, Instrument of Stability, Elina Martikka (6 days, 2 meetings) (A)
- ESARDA Steering Committee, Elina Martikka (2 days, 2 meetings) (A)
- ESARDA Annual Meeting, Elina Martikka, Tapani Honkamaa (3 days) (A)
- Euratom Safeguards Implementation, Elina Martikka (2 days) (B1)

Nordic cooperation

- SSM – Human Factors Oversight meetings, Anna Aspelund, (2 days) (A)
- SSM Seminar, Risto Sairanen (1 days) (A)
- Annual meeting of persons in charge of Swedish NPPs, and SM meeting, Olli Vilkamo (1 day) (A).
- Meeting of Nordic public authorities Int BBS & meeting SSM Int Dept, Olli Vilkamo (1 day) (A).
- SSM, Swedish Radiation Safety Authority, Workshop, Jussi Heinonen, Jaakko Leino (3 days) (A)
- Nordic Society seminar on non-proliferation issues, Tero Varjoranta, Elina Martikka, Olli Okko, Marko Hämäläinen, Anna Lahkola, Timo Ansaranta, Antero Kuusi (2 days) (A)
- Cooperation between authorities in inspection activities SSM, Veli Riihiluoma, Antti Tynkkynen (2 days) (A)
- Nordic meeting on dose monitoring, Olli Vilkamo, Veli Riihiluoma (2 days) (A)
- Managerial meeting 14 June 2010, Helsinki, Jukka Laaksonen.

Other multinational working groups

- **WENRA**, Western European Nuclear Regulators' Association, Jukka Laaksonen (Chairman), Kirsi Alm-Lytz, Lasse Reiman (2 days, 1 meeting), (A)
    - WENRA/RHWG, Reactor Harmonization Working Group, Lasse Reiman (16 days, 6 meetings) (A)
    - WENRA/RHWG, Reactor Harmonization Working Group, Kirsi Alm-Lytz, (13 days, 4 meetings) (A)
    - WENRA/RHWG Reactor Harmonization Working Group, Keijo Valtonen (2 days) (A)
    - WENRA/WGWD, Working Group for Waste and Decommissioning, Esko Ruokola (10 days, 3 meetings) (A)
- **MDEP**, Multinational Design Evaluation Programme – Cooperation project of 10 countries aimed at achieving global harmonization in the construction of new nuclear power plants,
    - MDEP STC, Meeting of the Technical Management Group, Lasse Reiman (5 days, 2 meetings) (A)

- MDEP/Multinational Design Evaluation Programme / Notification of the 12th Meeting of MDEP STC, Petteri Tiippana (2 days) (A)
- MDEP Safety Goals Expert Group, Lasse Reiman (5 days, 2 meetings) (A)
- MDEP/EPRWG, Multinational Design Evaluation Programme, Petteri Tiippana, Tapani Virolainen (2 days) (A)
- MDEP/EPRWG, Kirsi Alm-Lytz, (2 days) (A)
- MDEP/EPRWG, Multinational Design Evaluation Programme, Petteri Tiippana, Keijo Valtonen, Tapani Virolainen, Kim Wahlström, Ari Julin (5 days) (A)
- MDEP/EPR Technical Expert Subgroup on Accidents and Transients Working Group Meeting, Keijo Valtonen (4 days, 2 meetings) (A)
- MDEP EPR meeting of the Serious Accidents WG, Risto Sairanen (3 days, 2 meetings) (A)
- MDEP/IRSN Group Meeting, Ilkka Niemelä (2 days) (A)
- MDEP/EPR Working Group Meeting, Ari Julin (2 days) (A)
- MDEP/EPR Working Group PRA Meeting, Matti Lehto (2 days) (A)
- MDEP/DI & CWG Meetings, Kim Wahlström (3 days) (A)
- MDEP/ I & C Working Group Meeting, Kim Wahlström, (2 days) (A)
- MDEP/EPR I & C Working Group Meeting, Mika Johansson (2 days) (A)
- MDEP/EPRWG Topical Meeting on Radiation Protection, Lauri Pöllänen (2 days) (A)
- MDEP Codes and Standards Working Group, Yrjö Hytönen, (3 days) (A)
- MDEP/Vendor Inspection Cooperation – Westinghouse and Flowserve, Petri Vuorio (6 days) (A)
- MDEP VICWG, Jouko Mononen, (9 days) (A)
  - NRC Audit Group, participation in the audit of Sandvik Materials Technology in Sandvik, Mark Cederberg, (5 days) (A)
- **VVER Forum**, Jukka Laaksonen, VVER Forum meeting, Tomi Koskiniemi, (3 days) (A)
- European Pilot Study Group, Risto Paltemaa, Jussi Heinonen (2 days, 2 meetings) (A)
- AECA, Association of the European Competent Authorities for the Safe Transport of Radioactive Materials, Anna Lahkola (1 day) (A)
- International Advisory Board of Emirates, Abu Dhabi, Jukka Laaksonen (2 days, 2 meetings) (C)
- Code of Conduct Meetings, Pariisi, Seoul, Toronto, Jukka Laaksonen (6 days, 3 meetings) (B3).

Lectures given at training events

- Elforsk Seminar – Ersätta och bygga nya reaktorer 21 January 2010, Stockholm, Petteri Tiippana, (A)
- EUROSAFE 2010 Seminar Marja-Leena Järvinen, Olli Vilkamo (2 days) (A)
- MIT Safety Course Boston 21–22 June 2010, Jukka Laaksonen (B2).

Participation in international meetings in the capacity of a lecturer, panel member or session chairperson

- Regulatory Information Conference, Jukka Laaksonen, Petteri Tiippana, Keijo Valtonen, (3 days) (A)
- IRSN/DPAM European Review Meeting on Severe Accident Research/ERMSAR Meeting, Risto Sairanen (2 days) (A)
- IRSN/ASAMPSA2 Group Meeting, Ilkka Niemelä (2 days) (A)
- Third European IRPA Congress, Regional, Helsinki 14.–18.6.2010 Jukka Laaksonen, Olli Vilkamo, Veli Riihiluoma (5 days) (A)
- OECD/NEA/IAGE – IAEA/ISSC (ISSC = International Seismic Safety Center), OECD/SSI seminar on the interaction of buildings and bedrock/soil 6–8 October 2010, Ottawa, Pekka Välikangas, (3 days) (A)
- ESREL 2010 Annual Conference, Reino Virolainen (6 days) (A)
- Symposium “Ageing & Maintenance of Nuclear Power Plants ISaG2010”, Rauli Keskinen, (2 days) (A)
- OECD, Reversibility and Retrievability Conference, Risto Paltemaa (3 days)
- Rosatom Forum, Risto Paltemaa (2 days) (A)
- ICDP, International Continental Drilling Programme, Postglacial faulting in Northern Europe, Ari Luukkonen (3 days) (A)

- Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management, Establishment of a Radioactive Waste Management Organization, Kaisa-Leena Hutri (4 days) (A)
- European Nuclear Conference ENC2010, Elina Martikka (2 days) (A)
- IAEA Safeguards symposium, Elina Martikka, Marko Hämäläinen, Olli Okko, Tapani Honkamaa (5 days) (A)
- INMM, Institute of Nuclear Materials Management, Illicit Trafficking Panel, Tapani Honkamaa (5 days) (A)
- Pacific Northwest International Conference on Global Nuclear Security, Antero Kuusi (5 days) (A)
- Council of Europe, Debate Conference, Strasbourg 25–26 November 2010, Jukka Laaksonen, (C)
- Nuclear Power Europe Conference, Amsterdam 8 June 2010, Jukka Laaksonen (B2)
- Lecture given to MEPs, Paris 24 February 2010, Jukka Laaksonen (B3)
- SNRCU, Annual Topical Meeting on Nuclear and Radiation Safety, Kiova, Jukka Laaksonen (1 day) (A).

Standardisation working groups

- Meetings of the IEC TC45/SC45A WG A3 and WG A8 expert working group as well as meetings of the sub-committee SC 45A, Harri Heimbürger (7 days) (A).

Participation in foreign committees

- Advisory committee on nuclear safety to support the Swedish nuclear authority (SSM, Strålsäkerhetsmyndigheten), Lasse Reiman (4 days, 3 meetings) (B3)

Bilateral cooperation between authorities

- Meeting of authorities in SSM with management of the Nuclear Safety Department, Petteri Tiippana, Marja-Leena Järvinen (1 day) (A)
- SSM's research seminar, Lasse Reiman (3 days) (B2)
- Meeting at SSM, Olli Vilkamo (1 day) (A).
- Discussion of authorities between CNSC and STUK regarding topical issues in construction and fire technology, Pekka Välikangas (2 days) (A)
- STUK-ROSATOM, Early Notification and Information Exchange, Practical Arrangements, Bilateral Talks, Hannu Koponen, Heikki Reponen, Olli Vilkamo (2 days)
- Joint Inspection in Kuola NPP with Russian Regulatory Authorities, 14.–20.11.2010, Jukka Laaksonen, Ilari Aro, Heikki Reponen, Kim Söderling, (B3).

Others

- Halden Enlarged Programme Group Meeting, Anna Aspelund, (5 days) (A)
- Technical meeting on Development on Safety Report on Low Events and Near Misses, Hanna Kuivalainen, (4 days) (A)
- NRC Course E-301, Quality Assurance, Jouko Mononen, (7 days) (A)
- Nuclear Supply Chain Conference, Janne Nevalainen, (2 days) (A)
- International Conference on Optional Safety Experience and Performance of Nuclear Power Plants and Fuel Cycle Facilities, Seija Suksi, (3 days) (A)
- Nuclear Security Summit, Washington, USA, Lasse Reiman (3 days) (B2)
- Eurosafe: Innovation in Nuclear Safety and Security, Marja-Leena Järvinen, Olli Vilkamo, (2 days) (A)
- Finnish Consortium and Technical Meetings, Marja-Leena Järvinen (3 days) (A)
- European Conference on Individual Monitoring of Ionizing Radiation, Veli Riihiluoma (3 days) (A).
- "Loss of Safety Classified Electrical Equipment due to Generator High Voltage Peak" – Kick-off meeting of the Topical Study assignment with the representatives of EU Clearinghouse and Swedish Nuclear Safety Authority at SSM, Seija Suksi, Kim Wahlström, Erja Kainulainen, (1 day) (A).
- European Clearinghouse for Operational Experience Kick-off Meeting, Jukka Laaksonen, Seija Suksi (2 days) (A).

- 19th Annual PLIM/PLEX Conference, Martti Vilpas,(4 days) (A)
- Meeting of the EDEX Working Group, Martti Vilpas, (1 day) (A)
- "The 8th International Conference on NDE in Relation to Structural Integrity for Nuclear and Pressurised Components, Olavi Valkeajärvi, Jukka Härkölä (3 days) (A)
- ICG-EAC Annual Seminar (International Collaborative Group on Environmentally Assisted Cracking), Jukka Mononen, (4 days) (A)
- Program of III Estonian Nuclear Power Conference, Petteri Suikkanen (1 day) (A)
- PSAM 10th International Probabilistic Safety Assessment & Management Conference Seattle, Board Meetings, Reino Virolainen (6 days, 4 meetings) (B3)
- PSAM 10th International Probabilistic Safety Assessment & Management Conference Seattle Ari Julin (5 days), Matti Lehto (4 days) (A)
- 13th Technical Meeting on Risk-based Precursor, Jorma Rantakivi, Janne Laitonen (3 days) (A)
- Castle Meeting PSA 2010, Matti Lehto (2 days) (A)
- ISO/IEC JTC1 SC7 Plenary Meetings, Mika Johansson (5 days) (A)
- SAFECOMP 2010 Conference, Mika Johansson (3 days) (A)
- ISO/JTC1 SC7 2010 Meeting, Mika Johansson (6 days) (A)
- ASN-IRSN-SSM-STUK cooperation (French Safety Authority, French Institute for Radiological Protection and Nuclear Safety, Swedish Radiation Safety Authority), Risto Paltemaa, Arto Isolankila, Katriina Labbas, Paula Ruotsalainen, Ari Luukkonen, Rainer Laaksonen, Kai Hämäläinen (6 days, 2 meetings) (A)
- ITC Assembly of Members, International Training Center, School of Underground Waste Storage and Disposal, Tero Varjoranta (3 days) (A)
- Spent Fuel Workshop, Jaakko Leino (2 days) (A)
- Six Party (Posiva (+TVO, Fortum), SSM (Swedish Radiation Safety Authority), SKB (Swedish Nuclear Fuel and Waste Management Company), IAEA, EC, STUK) meeting on final disposal safeguards monitoring Elina Martikka, Tapani Honkamaa, Marko Hämäläinen, Antero Kuusi, Mikael Moring (1 day) (A).

APPENDIX 10 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
Incident Reporting System; nuclear power plant operating experience reporting system maintained by the IAEA and 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
OECD Nuclear Energy Association

OLC
Operational Limits and Conditions (previously Technical Specifications)

Onkalo
underground research facility for the final disposal of spent nuclear fuel

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

STUK-YVL Guides
Working title for the new restructured regulatory guides on nuclear safety during the renewing process in 2006–2009

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. There's a large restructuring project going on, the new YVL Guides should replace old ones by the end of 2011. The last old style YVL Guides with number-only id's were issued in 2008.