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Regulatory oversight of nuclear safety in Finland

Annual report 2011

Erja Kainulainen (ed.)

Säteilyturvakeskus
Strålsäkerhetscentralen
Radiation and Nuclear Safety Authority

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STUK • SÄTEILYTURVAKESKUS
STRÅLSÄKERHETSCENTRALEN
RADIATION AND NUCLEAR SAFETY AUTHORITY

Osoite/Address • Laippatie 4, 00880 Helsinki
Postiosoite / Postal address • PL / P.O.Box 14, FIN-00881 Helsinki, FINLAND
Puh./Tel. (09) 759 881, +358 9 759 881 • Fax (09) 759 88 500, +358 9 759 88 500 • www.stuk.fi

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Management review

The Finnish nuclear power plants caused no danger to the plant environment or employees in 2011. No events with safety implications to the safety of the environment or people took place at the plants. The collective radiation doses of employees were low and the radioactive releases into the environment very small. 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 number of events reported to STUK was lower than in previous years. The underlying reasons for the events occurring during the year were mainly related to ageing of the plants. Ageing-induced faults were detected at both plants, among others in emergency diesel generators used for ensuring the power supply of safety systems in a situation where connection to other sources of electricity has been lost. Ageing-induced faults were also detected at the Olkiluoto NPP in the main valves of the reactor overpressure protection system. The detected faults have not prevented the operation of safety functions, but following the observations, STUK required both power companies to investigate and report on the sufficiency of condition monitoring, preventive maintenance and management of spare parts of the safety system equipment and structures. Furthermore, STUK inspected the spare parts management of plants, as well as their condition monitoring and licensee inspection activities during the annual maintenance outages. The inspections and operating experience show that the Loviisa and Olkiluoto plants have to pay more attention to the monitoring and management of ageing of safety systems.

At Loviisa and Olkiluoto, modifications required for improving safety continued regarding plant systems, equipment and structures and operating practices. At Loviisa 1, the suction strainers of the low-pressure emergency cooling system and containment spraying system, required in accident situations, were improved by installing smaller-mesh strainer elements. The modification will secure the cooling of fuel by preventing loose insulation materials, for example, from entering the reactor core through the emergency cooling system in an accident situation. A similar modification was carried out at Loviisa 2 the year before. The Olkiluoto plant continued the modernisation project spanning many years, aimed at extending the service life of the plant and improving its availability. Most of the modifications implemented at Olkiluoto 1 in 2011 were now implemented at Olkiluoto 2. TVO also started the work for expanding the spent nuclear fuel storage in Olkiluoto. At the same time, the structures of the storage facility will be modified to comply with the current safety requirements.

Following the Fukushima accident, national safety assessments were initiated and implemented at both pants. They involved assessing the safety of the plants and their safety margins against external threats, such as floods, earthquakes and extremely rare and severe weather conditions. The assessments also analysed emergency response activities in accident situations involving more than one plant unit, as well as cooling of the reactor and fuel pools in a situation where the plant has lost its power supplies or its normal residual heat removal systems. The assessments led to the conclusion that safety of the plants can be further improved in many ways. The safety of plants was also assessed independently of the Fukushima accident. The probabilistic risk analysis of the Olkiluoto plant units was further extended by supplementing it with the risk caused by an oil spill accident occurring at sea. Furthermore, the frequencies of fires and initiating events included in the analysis were updated. Following the changes, the expected core damage frequency of the plant increased by about 30%.

No essential changes affecting safety were made to the power companies' organisations. The organisations of both power companies have operated in a systematic and development-oriented way. STUK is of the opinion that both power companies should continue their development work. The Loviisa plant must ensure that information on the operations is collected and utilised for further development of operations and that the implementation of actions is systematically followed up. Sufficient resources must be allocated for development work. Teollisuuden Voima Oy must continue the development of its modification work process, taking into account the several simultaneous plant modification projects foreseen for the plant units currently in operation. Both power companies must invest resources in the evaluation, management and control of suppliers.

The problem areas in the Olkiluoto 3 project have not changed. The most important unsettled design issues still concern 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. Demonstration of the qualification of I&C equipment platforms for plant use will still require a lot of efforts from all parties concerned. In order to assess the supply chain management, STUK investigated the activities of the organisations related to the design and manufacture of emergency diesel generators. The investigation revealed deficiencies in the selection, instruction, guidance and control of subcontractors. The installation work of emergency diesel generators in Olkiluoto was suspended for about one year, during which time the conformity of design and manufacture of auxiliary equipment for the EDGs was investigated. Deficiencies were also discovered towards the end of the year in the manufacture of containment penetration pipes. The guidance and control of subcontractors participating in the design and manufacture of plant equipment still require constant monitoring and vigilance of TVO and the plant supplier. Although TVO and the plant supplier have continued the assessment of safety culture at the site and the creation of an atmosphere emphasising safety, ensuring and maintaining the highest priority for safety and quality will require continuous actions and exemplary conduct of the managements of project organisations.

STUK continued its work in preparation of the possible construction licence stages regarding the new NPP projects. As part of its preparations, STUK compiled experience from the oversight of the Olkiluoto 3 project, and this experience was discussed with the power companies, Posiva and the Advisory Committee on Nuclear Safety. STUK assessed the sections of TVO's and Fennovoima's tender documentation concerning safety requirements and provided the power companies with feedback regarding the comprehensiveness and unambiguity of the requirements. STUK studied Fennovoima's site related design basis criteria. Following the choice made regarding Fennovoima's plant site, STUK organised, at the invitation of the Municipality of Pyhäjoki, a briefing event and press conference for the inhabitants of Pyhäjoki and the media.

STUK's work input in the regulatory oversight of each of the operating nuclear power plants was equivalent to approximately 12 person-years. The working hours spent on regulatory oversight remained at the previous year's level. These objectives of oversight were attained. In all, 34 person-years were used for overseeing the design, component manufacturing and construction of the Olkiluoto 3 unit, which is about the same amount as in 2010. The amount of work will certainly not reduce during 2012–2013 when plenty of installation work will be performed and the operating licence application for the plant is reviewed. During the year, STUK issued its statement regarding the renewal of operating licence for the research reactor in Otaniemi and regarding the continuation of its operation.

As part of the continual improvement of safety and preparation for new NPP projects, STUK continued the work for revising its own YVL Guides and also participated in the preparatory work for reforming the Nuclear Energy Act. The reform will entail harmonising the requirements, as far as possible, with the national regulations of EU countries and the requirements of the IAEA. STUK had intended to complete the YVL Guides by the end of 2011. However, this was not achieved, partly because of the additional work caused by the Fukushima accident.

The storage of nuclear waste and spent nuclear fuel or the transfers of fuel did not encounter any problems at the Loviisa or Olkiluoto plants. Thanks to appropriate planning of operations, the plants accumulated clearly less nuclear waste than NPPs on average. At the Loviisa plant, STUK oversaw the commissioning of the liquid waste solidification plant that had among other things been delayed by the upgrade of ventilation systems, deemed necessary following an event in 2010. However, the delay in commissioning did not affect the safety of nuclear waste management at the Loviisa power plant. At the Olkiluoto plant, STUK oversaw the expansion work for expanding the spent fuel storage. The work continued throughout the year. The length of the storage building will be extended, and additional pools will be constructed there to also accommodate the fuel coming from the Olkiluoto 3 plant unit. At the same time, the storage facility will be protected against the crash of a large airplane.

Posiva Oy (Posiva) continued the construction of the underground research facility related to the final disposal of spent fuel under the oversight of STUK. The regulatory oversight was organised in the same manner as for the construction of a nuclear facility because the construction work will actually produce the first phase of the repository. The access tunnels and shafts leading to the research facility will become part of the repository, provided that the project progresses as planned. STUK issued its assessment of the planned contents of the construction licence application for the repository and also assessed the analyses related to the long-term safety of final disposal and the factors related to the reliability of technical release barriers. Careful preparations are necessary because a similar project has never been implemented elsewhere in the world. STUK was supported in its safety assessments by an international group of experts from different fields of science and technology.

STUK began producing a safety assessment of the amendment application regarding the operating licence of the low- and medium-level waste repository (VLJ repository) that has been in operation in Olkiluoto since 1993. The amendment concerns in particular the final disposal of low- and medium-level waste coming from the Olkiluoto 3 plant unit. The intention is also to solve at the same time the question of final disposal of radioactive waste from government-owned operations, stored temporarily in Olkiluoto. Small amounts of such waste has been accumulating from hospitals and industry for decades. A small part of this waste will have to be disposed of elsewhere due to its high activity. The possibility of placing them in Posiva's future repository is investigated as one alternative.

The implementation of nuclear safeguards based on the Non-Proliferation Treaty functioned without problems in Finland, and no cause for remarks was found in the inspections carried out by the IAEA and the European Commission. Development of the nuclear safeguards regarding spent nuclear fuel continued in cooperation with the IAEA and the European Commission.

The new four-year periods of the national nuclear research programmes (the SAFIR programme regarding the safety of nuclear facilities and the KYT programme regarding the safety of final disposal of nuclear waste) began. The purpose of the programmes is to develop, with a long-term perspective, high-class competence for ensuring the safe use of Finnish nuclear power. STUK has a major role in determining and guiding the contents of these programmes.

STUK participated actively in international nuclear safety cooperation. In particular, STUK participated in the harmonisation work of international nuclear safety requirements in the working groups of the International Atomic Energy Association, European safety authorities and the OECD Nuclear Energy Agency.

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 2011 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 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 work.

The section concerning the regulation of nuclear facilities contains an overall safety assessment of the nuclear facilities currently in operation or under construction. For the nuclear facilities currently in operation, the 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 and their safety, and nuclear waste management. The report also includes a description of the oversight of the operations and quality management of organisations, oversight of operational experience feedback activities, and the results of these oversight activities. The radiation safety of nuclear facilities is examined using employees' individual doses, 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 operations of the licensee and the organisations participating in the construction project. At the end of the chapter on the regulation of nuclear facilities, there is a summary of assessments initiated following the Fukushima accident, new plant projects and 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 specify further 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.

The chapter describing the oversight of security arrangements in the use of nuclear energy discusses oversight of the security arrangements in nuclear power plants and other plants, institutions and functions included within the scope of STUK's regulatory oversight. The chapter also discusses the national and international cooperation for developing the security arrangements and associated regulations.

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, and Appendix 3 describes exceptional operational events at the nuclear power plants.

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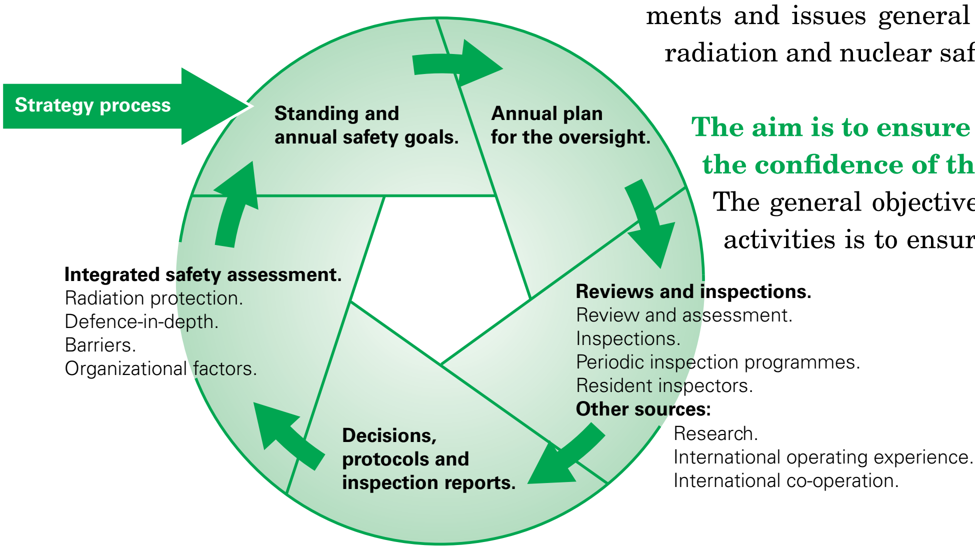
1 Fundamentals of nuclear safety regulation

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 facilities; from strategy to implementation.

Defence in depth

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

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

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

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

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

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 term of office ends on 30 September 2012.

During 2011, the Chairman of the Commission was key account manager Seppo Vuori (VTT, Technical Research Centre of Finland) and the Vice-Chairman was Professor Riitta Kyrki-Rajamäki (Lappeenranta University of Technology). The members are vice president Rauno Rintamaa (VTT), country manager 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, was a permanent expert to the Commission.

The commission has two committees, the Reactor Safety Committee and the Nuclear Waste Safety Committee. Foreign and Finnish experts have been invited to join the committees. English is the working language in the committees, and more extensive questions of principle will be brought to them for preparation. Nuclear industry experts from France, Germany, Hungary, Sweden, Switzerland, the UK and the USA have been invited to join the committees. The committees convene a couple of 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 requirements. 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

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 license holder, the country of location of the facility and the international liability community. In 2011, 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 2011, the value of the SDR was about EUR 1.15. 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. However, the entry into force of these international agreements has been repeatedly postponed. Consequently, the decision has been taken in Finland to legislate nationally regarding a higher amount of insurance and impose an unlimited liability on licensees. The amendment to the legislation entered into force at the beginning of 2012.

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

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

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 Operating Limits and Conditions, the Final Safety Analysis Report and the operating and maintenance procedures – have changed. STUK oversees the document revisions and generally follows the updating of plant documentation after the modifications.

Operability of the plant is overseen during operation and annual maintenance

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

Operational limits and conditions

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

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

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

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

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

The licensees submit event reports to STUK on operational events at nuclear facilities, comprising special reports, operational transient reports and scram reports. In addition to event reports, the facilities submit daily reports, quarterly reports, annual reports, outage reports, annual environmental safety reports, monthly individual radiation dose reports, annual experience operational feedback reports and safeguard reports to STUK.
Internal processing and reporting is also required for events or near-misses not subject to a special or operational transient report. Reports on such events are submitted to STUK for information if the event is or may be relevant to nuclear or radiation safety or STUK's communication activities.

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

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

Annual maintenance

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

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

Plant maintenance and ageing management

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

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

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

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

Radiation safety

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

Emergency preparedness

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

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.

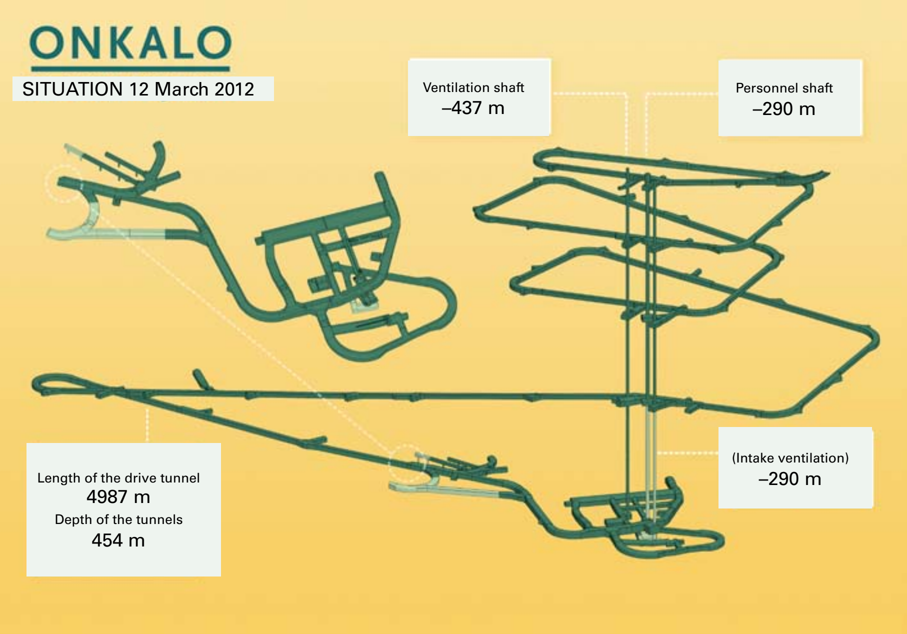


Figure 2. Plan of the underground rock characterisation facility (Onkalo) and status of the construction on 12 March 2012 (Posiva Oy).

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

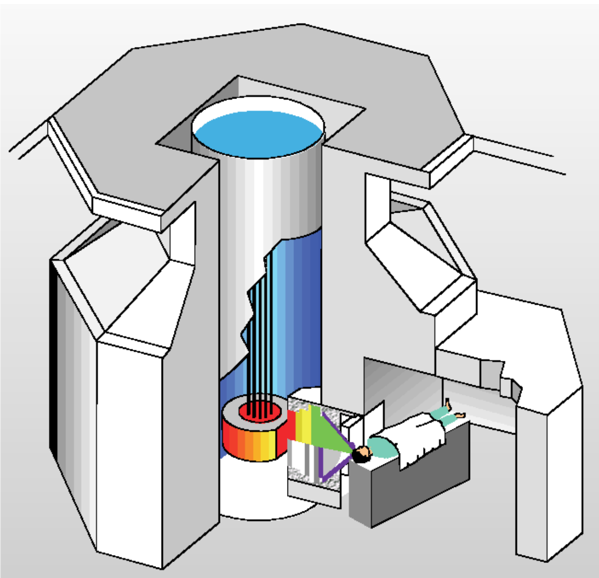


Figure 3. FiR 1 research reactor and the BNCT station.

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.

- 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 of regulations

Changes in upper-level regulations

An amendment to the Nuclear Power Act entered into force in 2011. STUK participated in its preparatory work in cooperation with the Ministry of Employment and the Economy. Among other things, the amendment took into account the changes to be made pursuant to the Nuclear Safety Directive as well as the changes derived from international recommendations concerning the development of security arrangements. STUK issued its statement of opinion regarding the amendment to the Nuclear Liability Act confirming the considerably higher limits for the licensees' compensation liabilities that were scheduled to enter into force at the beginning of 2012. The preparations for certain new amendments to nuclear energy legislation also began during the year. The most significant of these concerns the more extensive use of testing and inspection institutes that will release STUK's resources for tasks more important to safety.

Reform work of the YVL Guides continued

In 2011, STUK continued its project of many years for reforming the structure of YVL Guides. The purpose of the reform is to ensure the comprehensiveness and up-to-dateness of the Guides. The original target was to complete the new Guides during 2011, but this was not achieved. The main factors postponing the schedule were the larger-than-expected effort required for the project, the work carried out simultaneously due to the postponement of the Olkiluoto 3 project as well as the Fukushima accident that required STUK's expert to put in a considerable number of hours.

The current set containing over 70 separate YVL Guides will be replaced by approximately 40 new Guides. In addition to the comprehensive and demanding nature of the contents, attention will be paid in the reform work to a uniform and user-friendly manner in which the Guides are presented. Six final Guide drafts were completed in 2011, and a statement of opinion was sought from the Advisory Committee on Nuclear Safety for five Guide drafts. By the end of 2011, the preparatory work for all new Guides had began in the working groups appointed for the work.

Use of the Guide extranet now well established

Use of the Guide extranet (https://ohjeisto.stuk.fi) launched in 2010 increased during 2011, and the service established its position as an unofficial communication channel for the statements of opinion issued by the licensees on the YVL Guide drafts. A possibility for commenting on the drafts in English was added to the service.

Structure of the new YVL guides

A Safety management of a nuclear facility

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 Plant and system design

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

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 Nuclear materials and waste

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 Production of uranium and torium

E Structures and equipment of a nuclear facility

E.1 Inspection, testing and certifying organisations
E.2 Manufacture and use of nuclear fuel
E.3 Pressure vessels and pipings 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 Valve units of a nuclear facility
E.9 Pump units of a nuclear facility
E.10 Emergency power supply of a nuclear facility
E.11 Hoisting and transfer equipment of a nuclear facility

Figure 4. The structure of the new YVL guides by the end of 2011.

4 Regulatory oversight of nuclear facilities and its results in 2011

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 materials provided by the license holder, carrying out inspections in line with the periodic inspection programme and by overseeing operations at the plant. On the basis of this regulatory oversight, STUK can state that plant operations did not cause any radiation hazard to the employees, population or the environment. The 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 the requirements. The processing, storage and final disposal of low- and intermediate-level waste (so-called plant operating waste) at the power plant were carried out as planned.

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. No fuel leaks were observed at the Loviisa power plant in 2011.

STUK approved the licensee's application for increasing the average value fuel burn-up in fuel assemblies to 57 MWd/kgU. In 2011, STUK carried out a special inspection concerning ageing management where the sufficiency of spare parts and the functionality of spare parts management at the plant units were assessed. The inspection found that the licensee is aware of the challenges related to the availability of spare parts and has initiated in 2011 a task to determine spare parts needs.

Plant operation has been systematic and safe. No exceptional events with safety implications occurred at the plant. Two events occurred at the plant during which the plant was non-compliant with the Operating Limits and Conditions. One event at the plant was classified as an operational transient, resulting in a turbine trip. The events had no impact on the safety of employees or the plant surroundings. System and equipment failures had a minor safety implication for the plant. Annual maintenances were implemented as planned in terms of nuclear and radiation safety. An important observation, made through international operational feedback, related to a suspected fault in the connecting rod bearings of emergency diesels. Consequently, the connecting rod bearings of one emergency diesel engine at Loviisa 1 were replaced. The problems related to spare bearings were later found to apply to several EDGs in different countries, and STUK has reported the observations internationally.

During the year, the power company implemented several modifications for improving plant safety. At Loviisa 1, the suction strainers of the low-pressure emergency cooling system and containment spraying system (intended for use in accident situations) were improved by installing smaller mesh strainer elements for preventing, among other things, the thermal insulation materials from entering the reactor core in accident situations via the emergency cooling system. A similar modification was carried out at Loviisa 2 in 2010. The modifications succeeded well. In 2007, STUK issued its statement to the Ministry of Trade and Industry (currently the Ministry of Economy and the Employment) regarding the renewal of the Loviisa NPP's operating licence and the plant's periodic safety review. The actions for improving plant safety in compliance with the action plan produced by Fortum Power and Heat Oy at that time have mainly progressed according to plans.

Implementation of the second phase of the

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

Event	Non-compliances with the OLC	Special report and/ or root cause report	INES rating
Omission of primary coolant hydrogen concentration measurements	•	•	0
Initiation of annual maintenance of an emergency diesel generator at during power operation	•	•	0

I&C upgrade (LARA) at the Loviisa plant was postponed until 2014 for Loviisa 1 and until 2016 for Loviisa 2. The systems to be upgraded in the second phase include the reactor plant I&C systems most important to safety as well as the I&C systems of the main safety functions, such as that of emergency power supply. Postponement of the I&C upgrade requires the licensee to take action in order to ensure the sufficiency of maintenance operations on the existing I&C systems and equipment as well as the availability of spare parts.

In the main, Fortum Power and Heat Oy and its Loviisa power plant organisation have operated in a systematic and development-oriented way to ensure the safety of the plant. The observations made by STUK in the course of its oversight indicate that the organisation produces an abundance of information regarding its operations, but this information is not fully utilised for developing the management system and for improving operations. The work for improving the operational processes of the organisation must be continued in order to ensure the safe operation of the plant, particularly with regard to developing the management system, ensuring the quality of procurement operations and developing the safety culture assessment methods. The programme for developing project management at the Loviisa power plant has been successfully completed, but there is further scope for improvement in the quality management of project activities. STUK paid attention to the procedures in the power company's assessment and development activities and in the associated allocation of resources. STUK required the Loviisa power plant to ensure that the procedures are appropriate and comply with the requirements. STUK will assess the situation in the course of its oversight in 2012. STUK has found scope for improvement in the follow-up procedures of the Loviisa power plant regarding the implementation and success of corrective actions decided following plant's own operational events.

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

Compliance with the Operating Limits and Conditions

The Loviisa power plant has kept the power plant's Operating Limits and Conditions (OLC) up to date. STUK has assessed the OLC and their up-to-dateness in connection with inspecting the modifications and analyses carried out at the plant as well as in connection with on-site oversight.

During 2011, Fortum submitted to STUK for approval a proposed amendment to the Operating Limits and Conditions regarding a decrease in the limits for noble gas releases from Loviisa 1 and Loviisa 2. The need for the amendment was created by the fact that the doses resulting from the releases are currently estimated using a different calculation model and different weather data from those used at the time the release limits were originally calculated. STUK found the proposed amendment to be acceptable.

In 2011, the power company applied for permissions from STUK for four planned deviations from the Operating Limits and Conditions. Two of the applications were related to fault repairs, one to tests on the new emergency diesel generator and one to the periodic inspection of a chemical tank.

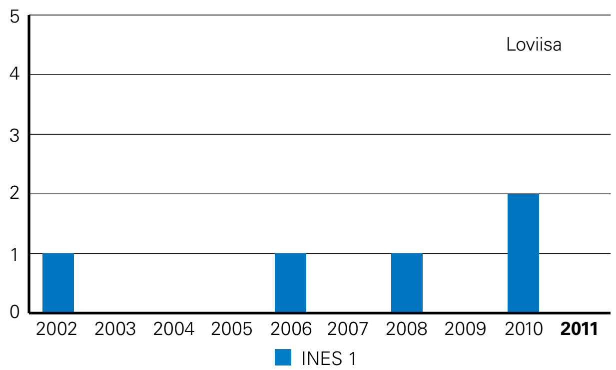


Figure 5. INES classified events at the Loviisa plant (INES Level 1 or higher).

STUK approved the applications because the assessments carried out indicated that deviations had no significant implications for the safety of the plant or the environment.

In 2011, two events occurred at the plant during which the plant was non-compliant with the Operating Limits and Conditions. One of the deviations was related to maintenance work carried out on an emergency diesel generator where a temporary power supply for the DC switchgear of the diesel generator was connected from the switchgear of

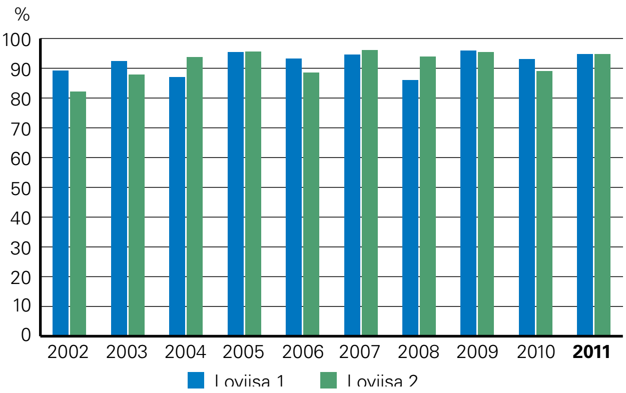


Figure 6. Load factors of the Loviisa plant units.

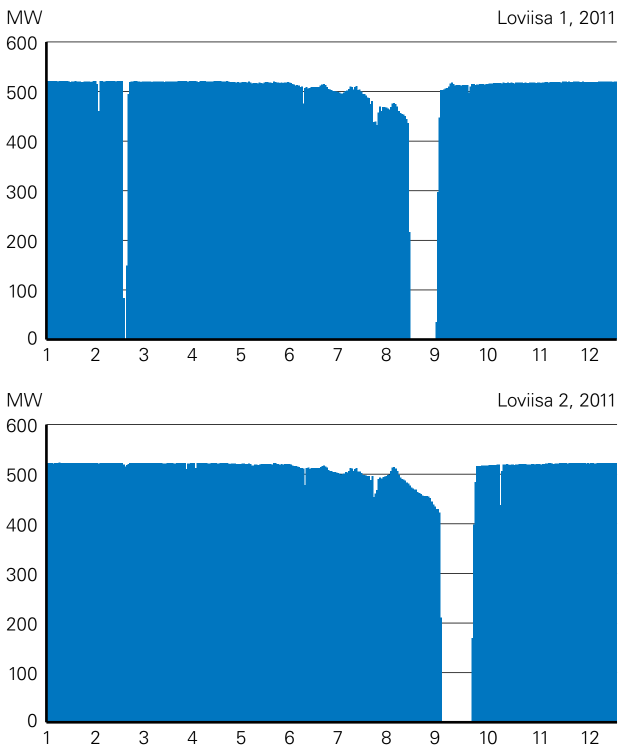


Figure 7. Daily average gross electrical power of the Loviisa plant in 2011.

Operation and operational events

The load factor of Loviisa 1 was 94.7%, while that of Loviisa 2 was 94.8%. Among other things, the load factor is affected by the duration of the unit's annual maintenance outage. Both plant units had short maintenance outages, approximately 17 days for Loviisa 1 and approximately 20 days for Loviisa 2. The load factor is also affected by the losses in gross energy output due to operational transients and component malfunctions. The losses in gross energy output were 0.8% at Loviisa 1 and 0.07% at Loviisa 2.

***A turbine trip occurred at Loviisa 1** in connection with a planned ramp-down carried out for maintenance operations. The erroneous controls of certain pieces of equipment, caused by a malfunction of a turbine control component that occurred during the change of power, had the result that the steam pressure downstream of the high-pressure turbine increased to the limit value, which triggers the turbine trip. In the event, the plant's I&C and other systems and equipment operated as planned, and the event did not affect the safety of the plant or its surroundings.*

***Loviisa 1 was shut down to repair a leaking flange seal in the steam generator.** In February, a steam leak was observed inside the containment. The steam leak was a minor one, and the steam contained no radioactivity as it came from the secondary circuit containing pure water. The leak did not put the safety of people or the surrounding environment at risk. In order to repair the leak, the plant had to be shut down and cooled down to a repair outage.*

***The connecting rod bearings of an emergency diesel engine had to be replaced in January 2011 due to a suspected fault.** In January, the Loviisa power plant learned through unofficial channels that the emergency diesels used in France had suffered serious connecting rod bearing failures. On the basis of this information and negotiations with the equipment manufacturer, the Loviisa power plant established that one emergency diesel at Loviisa 1 uses the same bearing type. These connection rod bearings had been installed in 2009 in connection with a complete overhaul. The power plant replaced the bearings without delay during the following week. In order to carry out the replacement work, an external power connection was made to replace the emergency diesel generator isolated for the replacement work. No defect could be found in the removed bearing in preliminary inspections, although there were some signs of excess wear.*

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 maintenance outage began on 21 August 2011 and ended on 7 September 2011 when one of the plant's two generators was synchronised with the national grid. The annual maintenance outage lasted for approximately 17 days, almost one day less than planned.

The main operations during the annual maintenance outage were refuelling, dismantling and re-assembly of the reactor as well as inspections and maintenance of equipment and structures. The operations important for safety included maintenance of the unit's four emergency diesel generators, replacement of the motors of three reactor coolant pumps to re-wound spare motors and dye penetration testing of the sealing grooves in the reactor pressure vessel flange face. The inspection indicated that the surface quality of the face conformed with the requirements.

A defect had already been detected in the pump motor of the plant's high-pressure emergency cooling system during the 2010 annual maintenance. Closer investigation revealed that the defect was a serious one. The power company decided to inspect all motors of similar type at the plant. All inspected motors were found to be in operating condition.

Alarms caused by the double seal of the primary collector had been observed in six steam generators of the reactor circuit during the previous operating cycle. Consequently, the collector covers were opened and the seals replaced with new ones with a denser texture.

The pump inlet strainers of the emergency cooling system located in the steam generator room of the containment were fitted with fine-mesh metal screens. The purpose of this modification was to prevent the fibres and other materials originating from the insulation materials of equipment and pipes from entering the reactor core. A similar modification was carried out at Loviisa 2 during the 2010 annual maintenance outage.

As part of the plant's ageing management, the power company continued the operation of replacing the 6kV switches of systems important for safety, initiated during the 2010 annual maintenance. The scheduled switch replacements were carried out during the annual maintenance outage, and the replacement project was completed.

The annual maintenance included periodic inspections of pressure vessels and pipelines in accordance with the inspection schedule. When overseeing the annual maintenance, STUK found that some pressure vessel inspections that were scheduled to be conducted during power operation had not been carried out. The power company submitted an application for postponing the delayed inspections, and STUK approved the application. Following the event, STUK required the power company to develop its inspections monitoring system.

It was observed in connection with the annual maintenance that there were problems in communications between Fingrid, the company monitoring and maintaining the national electric grid, and the power company, as well as in the way information supplied by Fingrid was processed in the plant's different organisational units. An example of the break in communications was an event during the annual maintenance outage in which Fingrid was carrying out operations at the plant's 400kV switchyard and the operating shift of the Loviisa plant was not aware of it. In its inspection during the annual maintenance outage, STUK demanded that the flow and management of information between Fingrid and the power company must be developed in order to ensure that similar events are not repeated.

another diesel generator and the battery array and rectifier of the diesel generator's control system were also disconnected for maintenance operations in breach of the OLC. In the second event, the continuous measurement of primary circuit hydrogen concentration was out of order, and the 24-hour time limit set in the OLC for hydrogen concentration measurements using a portable analyser was exceeded. The events are described in more detail in Appendix 3.

Operation and operational events

Operation of the Loviisa plant has been systematic and safe. No events with significant nuclear or radiation safety implications took place in plant operation. The one event classified as an operational transient at Loviisa 1 was a turbine trip. A leaking seal in the steam generator flange was a significant operational event at Loviisa 1. The plant unit was consequently shut down for a short repair outage. In addition, the exceptional events included the maintenance operations and investigations carried

Annual maintenance at Loviisa 2

Annual maintenance at Loviisa 2 was a short maintenance outage. The maintenance outage lasted for approximately 19 days, more than two days longer than planned. At the end of the outage, the power company had to carry out additional repairs due to equipment failures, and these delayed the start-up of the plant unit.

During the annual maintenance outage, the power company refuelled the reactor and carried out scheduled inspections, repairs and modifications. The inspections included periodic inspections of pressure vessels and pipelines. The operations important for safety included replacement of the 6kV electrical system switches and the periodic maintenance of one of the emergency diesel generators, which involved replacing the engine with a completely overhauled unit.

In the modernisation project regarding the plant's I&C systems, modifications were carried out in conjunction with the annual maintenance, the most important one being the installation of new level measurement pipelines for two steam generators. The pipelines will be connected to the process and commissioned at a later stage in the project.

The power company has replaced the gas turbine plant in the plant area with a diesel power plant during 2011. The power supply tests for Loviisa 2 were conducted in connection with the annual maintenance as part of the pilot operation programme of the diesel power plant.

During the annual maintenance outage, the power company carried out a measurement programme with the intention of verifying the functioning of the plant's internal earthing system. The purpose of the earthing system is to prevent the creation of harmful potential differences between the different components of the I&C system in case of an earth fault. The measurements were the first stage in the investigation aimed at assessing the potential differences caused by thunderstorms.

The replacement of cooling units in one emergency diesel generator room was planned for the annual maintenance outage. Of the three cooling units in the room, only two could be replaced due to certain design inconsistencies found during the operations. The third cooling unit will be replaced in the 2012 annual maintenance.

out due to the connecting rod bearing faults in the emergency diesel generators, as well as the spare part problems regarding the pump motors of the high-pressure safety injection system.

In 2011, the risks caused by the component malfunctions, preventive maintenance and other events causing unavailability of equipment were 5.3% and 8.6% of the expected value of the annual accident risk calculated using the plant's risk model for Loviisa 1 and Loviisa 2, respectively. The results are in line with long-term averages.

In 2011, two of STUK's resident inspectors worked at the Loviisa power plant. They were responsible for overseeing the plant operation, activities of the organisation and the overall situation at the plant. The inspection programme included one inspection regarding the oversight of operation during the power operation of plant units. The other inspection regarding the oversight of operation was related to the power company's activities for ensuring the safe and planned implementation of annual maintenance outages.

Following the observations made during the inspection of the plant's operation, STUK required the power company to assess the up-to-dateness of documentation in the main control room and to delete or update any outdated documents. Furthermore, some training bulletins included in the control room documents lacked some signatures which are required to indicate that the control room personnel are familiar with their contents.

Annual maintenance outages

Annual maintenance outages at the Loviisa plant were carried out safely, and the power company completed all maintenance work to its planned extent. During the annual maintenance outages, the power company paid particular attention to fire safety, tidiness and orderliness as well as to storage at the plant facilities. The oversight of annual maintenance outages by STUK comprised STUK's oversight and inspection functions set out in the YVL Guides, inspections complying with the periodic inspection programme and the activities of the oversight team composed for the annual maintenance.

During the annual maintenance outages,

STUK carried out an inspection of operation activities, which primarily focussed on the activities of the power company's operating and maintenance organisations and its quality assurance unit. Following the observations made in the course of oversight and inspections, STUK required the Loviisa power plant to develop further the flow of information between Fingrid, the company responsible for the monitoring and maintenance of the national electric grid, and the Loviisa power plant. Furthermore, the power plant must complete the instructions for kick-off meetings and implement the related induction training.

STUK composed a dedicated team for overseeing the annual maintenance outages. The team consisted of experts in different fields of technology as well as of resident inspectors from the department of nuclear reactor regulation. Following the oversight, it was found that the annual maintenance activities of the power plant had, in the main, been well organised and that the power company had clear objectives for developing them further. The oversight team made observations of varying degrees of importance, mainly related to the activities of the Loviisa NPP organisation and to irregularities in certain documents. STUK paid attention to the cleaning methods and equipment in work locations where employees could be exposed to significant amounts of radiation. Following the observations, STUK required the power company to improve further the cleaning methods in use.

STUK used a total of 234 man-days on on-site oversight during the annual maintenance outages; these days were made up of equipment and system inspections and oversight work in different areas of expertise. In addition, two resident inspectors worked regularly on site.

4.1.3 Ensuring plant safety functions

Because the plant's safety functions are secured with multiple parallel systems and equipment and in some cases also with systems and equipment that have different operating principles, the individual failures observed in the plant's equipment have not prevented the activation of safety functions in any situations.

In 2010, the power company made modifications to the operation of the pressure emergency water tanks of the low-pressure emergency cooling system on the basis of updated safety analyses (see the 2010 Annual Report). The problem has been the potentially poor leak tightness of the tank's original Russian-made isolation balls as there was a risk that they would release nitrogen into the cooling circuit when the system was required to operate. In 2011, the power company commissioned the Lappeenranta University of Technology to conduct a series of tests on new isolation balls from another manufacturer, where the results were compared with analyses and tests carried out in 2010 on the old balls. The results indicated that the new isolation balls of a different structure had clearly better leak-tightness than the original ones in a situation where the system is required to operate. Fortum intends to replace old balls with new ones starting from the 2012 annual maintenance. STUK will assess the power company's modification proposal in early 2012.

4.1.4 Integrity of structures and equipment

STUK monitored the integrity of structures and equipment on the basis of the periodic inspection programmes and repairs and modifications carried out. No significant deviations were observed in the monitoring and inspections of the primary circuit or other equipment and structures important to safety.

Fortum carried out periodic inspections of pressure equipment and pipeline condition inspections as part of the plant units' ageing management programs in connection with annual maintenance outages and during operation. No observations restricting the use of pressure equipment were reported following the inspections. However, STUK observed that some periodic inspections of pressure equipment had not been carried out by the due dates, and they had to be carried out later than planned. Following the observation, STUK required the Loviisa power plant to develop its inspections monitoring system and its inspection activities so that the set deadlines are kept.

In 2011, STUK carried out a special inspection related to ageing management where the sufficiency of spare parts and the functionality of spare parts management at the plant units were assessed. The inspection found that the licensee is aware of the challenges related to the availability of spare parts and has initiated in 2011 a task to determine spare parts needs. STUK will continue to follow the power company's spare parts management in 2012.

The operating licence of the reactor pressure vessel of Loviisa 1 is valid until the end of annual maintenance outage in 2012. In 2011, Fortum submitted to STUK a comprehensive set of thermal-hydraulic analyses regarding the loads exerted on the pressure vessel. STUK will assess the analyses during 2012 in connection with the review of the new operating licence application for the pressure vessel of Loviisa 1.

Primary circuit

The power company monitors the condition of the primary circuit, among other things, through periodic inspections. In addition, the power company records the loads exerted and STUK inspects the records in connection with its inspection programme concerning operation activities. Leak monitoring allows detecting, with a high probability, a crack in a pressure equipment wall before it results in a rupture. Good water chemistry in both the primary and secondary circuits is particularly important for the integrity of steam generator heat transfer tubes. The primary circuits of both Loviisa plant units are still in good condition. The validity of the operating licence of the reactor pressure vessel of Loviisa 2 was extended in 2010 until the end of validity of the plant unit's current operating licence. The safety of the reactor will in the future be assessed in connection with the plant's periodic safety review in 2016 and 2024. Similarly, STUK will assess the renewal of the reactor pressure vessel operating licence for Loviisa 1 in 2012.

Fuel

In the annual maintenance, a so-called dummy assembly of a new type, equipped with mixing spacers and containing no uranium, was put in the place of one protective element in the outer circle of the Loviisa 1 plant unit's reactor. It is mainly intended for verifying the mechanical durability of mixing spacers in reactor conditions. The purpose of mixing spacers is to improve the mixing of coolant inside the assembly, thus improving heat transfer from the fuel assemblies. The intention is to install 12 test assemblies fitted with the new type mixing spacers in the reactor of Loviisa 1 in 2012.

One of the conditions for increasing the highest permissible burn-up of fuel assemblies, approved in 2011, was that the amount of fission gases released inside the fuel rod remains small. During winter 2010, Fortum carried out measurements on a new type assembly that had been irradiated for four cycles, and the measurements were repeated in March 2011. The measurements indicated that this type of assembly releases very little fission gases, which is in line with the earlier measurement results obtained from first-generation assemblies.

Pressure equipment manufacturers and inspection and testing organisations

STUK approved, pursuant to the Nuclear Energy Act, one manufacturer of nuclear pressure vessels for the Loviisa 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, three testing organisations to carry out tests related to the manufacture of mechanical equipment and structures plus one inspection organisation to review the construction plans of mechanical components and structures and to carry out their structural and commissioning inspections. Testing operators from one testing organisation were approved for carrying out periodic tests of mechanical equipment and structures pursuant to YVL 3.8.

Jammed spring packs of the reactor pressure vessel protection elements

The fuel elements closest to the reactor pressure vessel wall had to be replaced with protective elements at both plant units of the Loviisa power plant in order to slow down the radiation embrittlement process of the wall. Each protective element contains six springs, designed to prevent the protective assemblies from rising up when drawn by the flow of primary coolant. Radiation, temperature and tension cause the springs to relax so that the force exerted by them decreases. To avoid replacing the complete protective elements every eight years or so, the power company has ordered protective elements with replaceable springs.

During the annual maintenance outages of 2010, jammed spring pins were observed in the protective elements in the outer circles of the reactors of Loviisa 1 and Loviisa 2. Consequently, the spring packs of all protective elements were inspected during the 2011 annual maintenance outages before fuel transfers. Two protective elements were replaced with eight-year-old protective elements that still had a sufficient spring force. Fortum has initiated investigations into the reasons for the jamming.

Reactor coolant pump seal

The purpose of the shaft seal of the reactor coolant pump is to prevent the primary circuit water from escaping into the room space. The shaft is sealed with two successive sealing systems, the so-called hydraulic and mechanical seals. The mechanical seal contains antimony as the packing material. Some antimony enters the sealing water by dissolving and abrasion, and it is activated when it ends up in the primary circuit when carried there by sealing water circulation. According to a survey carried out by Fortum, more than half of the radiation dose rate caused by the primary circuit comes from antimony. For this reason, Fortum has planned that it will replace the material of the mechanical seals of the reactor coolant pumps with another graphite-based material where resin is used as the packing material instead of antimony. The seal construction itself remains the same, but the new material will not be activated. During the annual maintenance outage of 2011, Fortum replaced the mechanical seal on the first reactor coolant pump at Loviisa 2. However, an installation error was detected in the hydraulic seal of the primary circuit during ramp-up. This resulted in the mechanical seal being damaged, and the old antimony-impregnated seal was re-installed. Fortum intends to test the use of a resin-impregnated mechanical seal in one of Loviisa's reactor coolant pumps in the 2012 annual maintenance.

Inspection of the material of valve bonnet stud bolts

A broken valve bonnet stud bolt was discovered during the 2010 annual maintenance outage at Loviisa 2. The bolt had broken because the manufacturer had used the wrong material and incorrect heat treatment. Following the discovery, Fortum inspected in 2011 the stud bolts of 58 valves at Loviisa 1 and 40 valves at Loviisa 2 using a material analyser. The above deviations were detected in a total of five bolts, which were replaced. The inspections will continue during the 2012 annual maintenance.

Periodic inspection programmes

In 2011, Loviisa 1 and Loviisa 2 had short refuelling outages, which means that the scope of periodic inspections was also limited. No significant faults with nuclear safety implications were observed in the inspections.

The dimensions of the indication earlier detected in one weld joint of the reactor pressure vessel cover head were measured using an improved ultrasonic inspection technique. The technique has been developed after the 2010 annual maintenance outage with the aim of being able to measure the dimensions of the fault more accurately. The size of the fault was determined to be larger than the 2010 results indicated, and it was found to start at the interface between the cladding and the base material. The power company submitted the updated strength calculations to STUK for approval. STUK has approved the indication. According to Fortum, the indication will be next inspected using the improved technique in 2014.

The deterministic periodic inspection programme of Loviisa 2 pipelines has been replaced by a risk-informed in-service inspection programme for the next 10-year inspection period of 2011–2020. At Loviisa 1, the change was already implemented for the 10-year inspection period of 2008–2017. Following the introduction of the risk-informed periodic inspection programme, new inspection subjects were added to the programme and subjected to basic inspections.

Delayed periodic inspections of registered pressure equipment

STUK observed in connection with the pressure equipment inspections made during the annual maintenance outage at Loviisa 1 that inspections of registered pressure equipment required to be carried out during power operation had been omitted and were several months overdue. STUK required Fortum to immediately investigate the root cause of the event and to assess the procedures related to the administration of pressure equipment inspections. In order to prevent similar occurrences, the Loviisa power plant must develop the system for monitoring the inspections of registered pressure equipment and the actual inspections so that they are carried out by the set deadlines.

Ageing management

Measurements of loads inducing fatigue to pipe material have been carried out at the Loviisa power plant in the system designed for blowing out secondary circuit impurities accumulating in the steam generator. STUK required the power company to verify further these observations by non-destructive tests on the subject pipeline sections. STUK also paid attention to the possibility of strains caused by fluctuating flow conditions when assessing the replacement of pressurizer spraying lines at the Loviisa power plant, and required that a report be submitted on the strain measurements carried out in connection with the replacement. In addition, the inspection revealed that the Loviisa power plant has not recorded the interrupted heat-ups of the primary circuit from the cold shutdown state to operating state as primary circuit loading situations. STUK required the power company to assess if the interrupted heat-ups might have caused significant additional strains on the primary circuit.

The Loviisa plant has had several development projects improving ageing management: the locations of faults in steam generator tubes and the spots where deposits from the secondary circuit will accumulate can now be visualised three-dimensionally, and their causal links can be shown. The material studies on parts decommissioned from the Greifswald plant were utilised for analysing the ageing mechanisms and realistic accident loads of inner parts of the reactor pressure vessel. Furthermore, the power company has studied ageing of cables, reactor support cage screws, diesel generators and concrete structures, and investigated the possibilities for increasing the pH of the secondary circuit. In deviation from the other main components of the primary circuit, no inner parts of the reactor pressure vessels are included in the most critical group of the ageing management programme of the Loviisa power plant, but the power company has allocated resources for studies concerning them.

The main focus of the ageing management programme at the Loviisa power plant is on the main components that are difficult to replace and determine the service life of the plant. When maintaining other components important to safety, the safety implications are taken into account through criticality classification based on the Operating Limits and Conditions. STUK required a further analysis to be carried out to establish whether the said method is sufficient for managing the ageing of these components. The power company must also analyse if the ageing management-related allocations of responsibility and resources at the Loviisa power plant are sufficient for all components important to safety.

In relation to ageing management, the periodic inspections of registered pressure equipment were carried out according to plans during the annual maintenance outages at both plant units. A total of 10 inspections were carried out at Loviisa 1; of these, two inspections were in STUK's inspection domain. A total of 17 inspections were carried out at Loviisa 2; of these, six inspections were in STUK's inspection domain. In addition, periodic inspections were carried out for 16 pieces of registered pressure equipment at both plant units. These pieces of pressure equipment are in the licensee's inspection domain. No observations restricting the use of pressure equipment were made during the inspections.

Condition monitoring

The condition monitoring inspections of pipelines at the Loviisa NPP were performed according to plans at both plant units, and no observations requiring repairs or restricting their use were made. No significant deviations were observed when monitoring the condition of the spent fuel storage and the fuel pools. The power company monitored the condition and leak tightness of the containment without observing any significant deviations. The monitoring of leak tightness requirements of NPP containments is discussed in greater detail in Section A.III.3 of Appendix 1.

On the basis of the analyses made following the Fukushima accident, STUK required Fortum to update the safety assessments of spent fuel storages and fuel pools with a view to earthquake situations. Fortum has announced that it will update its assessment after the supplementary analyses are completed on 30 April 2012.

Spare parts management at the Loviisa power plant

In 2011, STUK inspected the sufficiency of spare parts for systems and equipment important to safety and the functionality of spare parts management at the Loviisa power plant. The inspection focussed in particular on the spare parts inventory of systems and equipment important to safety as well as on the procedures used at the power plant for monitoring the spare parts needs and for procuring spare parts. The inspection found that the licensee is aware of the challenges related to the availability of spare parts and initiated in 2011 an investigation regarding spare parts requirements. STUK deems the investigation and its completion important. Furthermore, STUK found that the overall responsibilities, procedures and instructions regarding spare parts management must be further specified so that the spare parts requirements of systems and equipment important to safety are foreseen and that the procurement procedures ensure the timely availability of spare parts. Matters requiring immediate corrective actions were also observed in the storage conditions of spare parts for systems and equipment important to safety, such as further specification of procedures related to the ageing and maintenance of the stored spare parts as well as verification of the usefulness of aged items in the store or their removal from the store. The licensee must submit to STUK an account of the immediate corrective actions by the beginning of March 2012 and draw up, during the spring 2012, a development plan for spare parts management for the period 2012–2016. STUK considers a long-term development plan necessary in order to ensure the availability of spare parts for the systems and equipment important to safety throughout the entire planned service life of the plant unit.

Spare part problems regarding the pump motors of the high-pressure safety injection system

The spare part problems regarding the pump motors of the high-pressure safety injection system surfaced in 2010 when a spare motor was installed in place of a faulty motor. The replacement motor installed in the component location was the last spare motor in store for the safety injection system at the Loviisa power plant. Consequently, the power plant has initiated the process for procuring new motors. STUK has required the power company to submit a plan and time schedule for replacing the motors because the faults occurring in the pump motors of the high-pressure safety injection system indicate that the original Soviet-made motors should be replaced.

Management of EDG spare parts

In conjunction with its inspections and regulatory activities, STUK has paid attention to the poor spare parts situation of the emergency diesel generators at the Loviisa power plant and to the procurement and availability of critical parts. The goal must be to secure the long-term availability of good quality spare parts for the EDGs. In order to improve the situation, Fortum has concluded a framework agreement with the motor supplier for the spare parts required for basic maintenance and for other separately specified critical mechanical spares. The power company has also ordered more spare parts with long delivery times to be kept in store for the annual maintenance outages. Furthermore, Fortum intends to audit the spare parts suppliers among the motor supplier's subcontractors with whom quality problems have been encountered. STUK will assess the sufficiency of these actions in early 2012.

4.1.5 Development of the plant and its safety

In 2007, STUK issued its statement to the Ministry of Trade and Industry (currently the Ministry of Economy and the Employment) regarding the renewal of Loviisa NPP's operating licence and the plant's periodic safety review. Fortum Power and Heat Oy presented, in connection with the periodic safety assessment, an action plan for developing the plant's safety. It includes decreasing the risk of accidents and releases through various actions and supplementing the Probabilistic Risk Assessment. The actions have, in the main, progressed in line with the action plan. However, the intention is to implement certain actions aimed at improving safety in connection with the I&C upgrade of the Loviisa power plant. The intention is to reduce the risk associated with lifting heavy loads by modifications implemented in connection with modernising the fuel transfer machine. They will allow using lifting routes more beneficial to plant safety. Since the above projects have been delayed from their original schedule, the implementation of associated safety improvements has likewise been postponed.

The YVL Guides issued by STUK require that it must be possible after an accident to bring the reactor to a state that allows removing the fuel from it. In connection with renewing its operating licence, the Loviisa power plant announced that it is making investigations in order to meet this requirement and, in 2011, it submitted a report of the investigations carried out. The report presents, in a comprehensive manner, the procedures and systems that will be required for emptying the reactor of fuel in case of a primary circuit leak. The Loviisa power plant has produced the preliminary plans and reports that can be used as the basis for producing a detailed action plan when required.

Increasing the burn-up of fuel

STUK has earlier approved irradiating the nuclear fuel at the Loviisa power plant to a fuel assembly burn-up value of 45 MWd/kgU. In 2010, Fortum applied for permission to increase the fuel assembly burn-up value to 57 MWd/kgU for fuel of a new type, so-called second-generation fuel. This is a new fuel type to which burnable poison (Gd_2O_3) has been added to six fuel rods. The poison reduces the need to compensate for the reactivity by active boron control. Fortum submitted comprehensive empirical and computational material in support of its application for increasing the burn-up value. On the basis of the material, STUK assessed that the new fuel will meet STUK's requirements regarding the normal operation of the reactor and accident situations up to the burn-up value applied for.

Probabilistic risk analyses

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

The annual probability of a severe reactor accident calculated by the licensee for the Loviisa plant units was 4.3×10^{-5} in 2011. The value has decreased by about 17% from the previous year. Several minor plant modifications and the improvements to the PRA model have contributed to the reduction of the risk. The PRA modifications carried out in 2011 concerned, among other things, the modelling of replaced sump screen meshes in the recirculation lines of emergency cooling water, new procedures for recovering the 400 kV main transformer in cold shutdown states, replacement of the old gas turbines in Hästholmen with a new diesel emergency power plant and replacement of the EDG relays. For the backup system for residual heat removal, the introduction of own operating experience data and further specified assessment of human errors reduced the estimated unavailability of the system. In addition, the assessed seismic risk has decreased when the analysis has been updated and the susceptibility of components to seismic damage has been re-assessed using up-to-date computational methods.

The accident risk at the Loviisa power plant and its changes are discussed in closer detail in Section A.II.4 of Appendix 1 entitled "Accident risk of nuclear power plants".

I&C upgrade at the Loviisa power plant

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

No installation work took place in the I&C modernisation project at the Loviisa power plant in 2011. Warranty repairs and updates were made to earlier installed I&C systems during the annual maintenance outages. The most significant items of preparatory work related to phase 2 of the I&C upgrade included the preliminary installations of measurement pipelines for the reactor protection system at both plant units, as well as the earthing measurements conducted at Loviisa 2.

In 2011, the power company submitted to STUK for review requirement specifications and system descriptions as well as quality and qualification plans associated with phase 2 of the I&C upgrade. Their review will continue in early 2012.

One event occurred in 2011 in intermediate- and low-level waste management. *It was detected at the Loviisa power plant in early 2011 that the seepage water collection system of the low-level waste repository contained small amounts of radioactive tritium. Radioactivity had escaped into the system when the drain pipe for water dropping from the ceiling had become blocked and water had run on some waste barrels. The event had no impact on the safety of personnel or the environment. Following the event, Fortum replaced the drain pipes of the seepage water collection funnels on the ceiling of the repository. The activity of seepage water and condensation water in the ventilation system is closely monitored.*

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

The volume of spent nuclear fuel stored on-site at the Loviisa power plant at the end of 2011 was 4,339 assemblies (522 tU), an increase of 192 assemblies (23 tU). The volume of low- and intermediate-level waste finally disposed of was 1,774 m³. The total increase of volume from 2010 is 93 m³. Approximately 50% of the waste has been finally disposed of.*

** The assembly figures do not include the assemblies in the reactors. The average weight of spent fuel assemblies at the Loviisa power plant is 120.3 kgU.*

The project implementation schedule has now been further specified so that the installations of phase 2 will be made in 2014 for Loviisa 1. In deviation from the earlier schedule, the whole I&C upgrade of Loviisa 1 will be completed in 2015 before the installations at Loviisa 2 begin in 2016 and 2017.

Modernisation of refuelling machines

Fortum is in the process of modernising the refuelling machines at the Loviisa power plant. The modernisation project will include a basic upgrade of the electrical and I&C systems of the refuelling machine, now based on 1970s technology, as well as a possible increase in the height of the machine. The latter can be implemented either by modernising the existing machine or by replacing it. The main reason for increasing the height of the bridge is that it would allow installing permanent safety rails at the fuel pools. Provisions also exist for extending the rails of the refuelling machine. This would allow re-routing the heavy load lifts in the reactor hall, thus reducing the risk of core damage caused by falling loads. Fortum submitted a conceptual modernisation plan for the refuelling machine to STUK in June 2010. STUK reviewed the conceptual design plan and required additions to be made to it with respect to, among other things, quality management, systems classification and the I&C qualification plan. STUK approved the conceptual design plan with remarks in November 2011. Fortum submitted an updated I&C qualification plan to STUK at the end of the year.

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

STUK reviewed, 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 waste management focused on the situation of the project for developing the handling of low- and intermediate-level waste, the arrangements at the liquid waste solidification facility, waste accounting, organisation and instructions. Following the inspection observations, STUK required the Loviisa power plant to assess the rusting and corrosion mechanism of low-level waste barrels placed in the VLJ repository, as well as the impacts that the deteriorating condition of the barrels will have on nuclear waste management and its safety.

In October, STUK carried out an inspection of final disposal facilities for waste at the Loviisa power plant. It covered the maintenance procedures at the plant site, the repairs and modifications carried out and the results of inspections performed by the power company. The latter also included the results of groundwater chemistry measurements taken from the bedrock of the disposal facility, as well as the hydrological and rock-mechanical monitoring measurements. No requirements were imposed following the inspections.

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 2011, 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 solidification 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. STUK approved in 2008 the results of the pre-operational tests carried out using radioactive evaporation residues. Trial operation on the resin waste began in May 2009, but there have been delays due to various reasons, including the unreliable operation of the dosing tank level measurement.

In order to continue the commissioning of its liquid waste solidification facility, Fortum has designed improvements to the plant's process systems and instructions. The possibility of liquid waste spreading to the ventilation system from the degassing lines will be prevented by changes in process technology. Improvements will also be made to the tank level measurements.

The HARVALA sub-project of the LOKIT project, intended for increasing the resin storage capacity, has advanced in the liquid waste storage facility. In the sub-project, the storage capacity of intermediate-level resin will be expanded by modifying one low-level ion exchange resin storage tank to be suitable for intermediate-level resin. The radiation protection structures surrounding the tank will be reinforced, level measurements will be added and pipeline connections built. TVO submitted the conceptual design plan for the project to STUK for approval in late 2011.

Expansion of the repository for low- and intermediate-level waste

An expansion of the repository for low- and intermediate-level waste was initiated at the Loviisa power plant in 2010. The expansion will comprise Maintenance Waste Facility 3 and a connecting tunnel. The excavation work for the facilities was completed in the early spring of 2011, after which the construction work continued with equipment installations inside the facilities until the end of 2011. The new facility will be used for the sorting and temporary storage of maintenance waste.

According to the statement issued by the Ministry of Employment and the Economy, the expansion could be implemented subject to STUK's approval and oversight. Maintenance Waste Facility 3 will be commissioned during the first quarter of 2012. The commissioning will require an operating licence issued by STUK and a commissioning inspection.

Provisions for the costs of nuclear waste management

In compliance with section 88, subsection 2 of the Nuclear Energy Decree, Fortum provided the Ministry of Employment and the Economy with the revised and supplemented waste management scheme and information on the costs and prices of nuclear waste management measures at the end of June. The update of the waste management scheme includes an index adjustment to the cost and price information as well as an estimate of the amount of nuclear waste at the end of 2011.

STUK reviewed the documents submitted in compliance with the Nuclear Energy Decree and submitted a statement regarding them to the Ministry of Employment and the Economy. In its statement, STUK pointed out the incorrect estimate of the amount of spent fuel in the waste maintenance scheme of 2010, which Fortum will correct for the next waste maintenance scheme in 2013. In 2011, Fortum's liabilities amounted to EUR 968.3 million.

4.1.7 Organisational operations and quality management

The oversight of STUK did not reveal any significant deficiencies in the organisational operation of the Loviisa power plant in 2011. STUK continued the work for assessing the functionality of the management system at the Loviisa power plant and verified the compliance with the requirements of YVL Guide 1.4 that entered into force in 2008. Particular attention was paid to the power plant's procurement operations. STUK found that there were still deficiencies in the way the requirements on operations were applied and therefore required the Loviisa power plant to reduce the ambiguity in its procedures for procurement and supplier control as well as in the way auditing activities are reported. STUK also oversaw the development of the management system at the Loviisa power plant into a process-like system. The development work of the management system process at the Loviisa power plant is carried out by a working group. STUK will continue to assess the progress of this work in 2012. The project management development project was successfully completed at the Loviisa power plant, but there is still a need to develop further the quality management of project activities so that the need to ensure compliance with the nuclear safety requirements is taken into account in the activities throughout the entire life span of the projects.

The observations made by STUK in the course of its oversight indicate that the organisation produces an abundance of information regarding its operations, but this information is not necessarily utilised for developing the management system and for improving operations. STUK is of the opinion that the high-quality and timely fulfilment of the requirements regarding the management systems of nuclear facilities requires the management and entire organisation of the Loviisa power plant to be strongly committed. On the basis of the above, STUK requires the power plant to specify further certain matters, including the procedures for self-assessment and the associated assessment of safety culture.

STUK approved the updated description of the quality management system of the licensee, Fortum Power and Heat Oy. In its approval decision, STUK imposed the requirement that the licensee must supplement its quality management system with a management review compliant with YVL Guide 1.4. STUK assessed the procedures of the Loviisa power plant for processing the possible impacts of changes in the licensee's quality management system on the operations of the Loviisa power plant and found them to be deficient in parts. Consequently, the licensee was required to prepare an assessment of the manner in which the guiding documents are updated and the associated issues are assessed, as well as of the ways in which the sufficiently extensive processing and flow of information are ensured. The power company provided STUK with an assessment presenting the actions for ensuring that there is no conflict between the operations, procedures or other documents of the licensee and the power plant.

STUK found the human resources assessing the operation of the Loviisa power plant and running the related development processes to be somewhat scant and required the power plant to assess and describe its HR planning procedures so that the needs of development activities are also sufficiently taken into account in resource planning.

STUK approved, on the basis of an application and an interview, one new deputy to the responsible director in compliance with the Nuclear Energy Act. Following this approval, the responsible director of the power plant now has three deputies.

STUK oversaw the oral examinations of shift personnel where the shift managers, operators and trainee operators prove that they are conversant with all salient matters related to plant operation and safety. In 2011, STUK granted 25 licences to shift managers and operators on application by the power company and following a successful oral examination. STUK granted a trainee licence to four trainees in the basic operator training programme. The licence entitles the holder to supervised practical training in the main control room.

All participants passed their examinations in 2011. The new operators achieved good results in the examination, which indicates that the basic training programme is effective. The operators renewing their licences also achieved good results in the examination, which indicates that the power company's refresher and supplementary training is effective.

4.1.8 Fire safety

During 2011, STUK oversaw fire safety at the Loviisa nuclear power plant and nuclear facilities with inspections complying with the periodic inspection programme, visits made by fire safety experts during the annual maintenance outages and inspections rounds, in the course of the continuous presence of resident inspectors.

In the fire safety inspection made as part of the periodic inspection programme, STUK required the power plant to reduce the fire load during annual maintenance outages by reducing the use of wooden scaffolding planks. Fortum decided to stop using scaffolding planks inside the plant, and this practice began with the annual maintenance outages. Wooden scaffolding planks may only be used without the permission of the safety organisation in very limited locations according to advance instructions. Such locations include the spaces inside tanks and pressure vessels. Wooden scaffolding planks may only be used in rooms in exceptional cases when permitted by the safety organisation.

No significant deviations from the plant's procedures regarding the management of flammable materials during hot work or maintenance work were observed.

The plant's fire alarm and extinguishing systems had been managed in keeping with the condition monitoring programme. Demonstration of earthquake resistance was previously not required for the fire extinguishing systems, but following the analyses made after the Fukushima accident, STUK required Fortum to investigate the earthquake resistance of the fire extinguishing systems. The investigations will be completed during 2012.

The monitoring of fire safety at the NPPs is also discussed in section A.II.5 of Appendix 1, "Number of fire alarms".

4.1.9 Operating experience feedback

STUK assessed the operating experience feedback on the basis of reports, inspection visits and inspections within the periodic inspection programme. During the year, there were no events classified as INES 1 or higher.

Three root cause analyses were performed at the Loviisa power plant in 2011. Their subjects were the problems related to ventilation and cooling systems, management of component isolations and the modification process. The related events and observations are described in more detail in Appendix 3. The root cause analyses also considered several events with similar features of underlying factors. The analysis tool used was the AcciMap method, which the power company has used for seven root cause analyses since 2008.

The different steps of the root cause analyses brought up various observations concerning the technical solutions of systems or the operations of the organisation that can be deemed to be of particular importance. The analyses have been used as the basis for developing the procedures for nuclear fuel handling, risk assessment of work operations and the technical planning of projects. Factors leading to the events were identified in several areas, such as instructions, competence, observance of instructions or established practices, flow of information and lack of systems or tools supporting isolation management. The proposed actions related, among other things, to kick-off meeting practices, isolations carried out during daytime, qualification requirements regarding process chemistry and to recording observations.

The Loviisa power plant provided STUK with special reports regarding the omission of the hydrogen analysis required in the Operating Limits and Conditions and regarding the initiation of maintenance operations on the DC systems of a diesel generator while still in power operation. The events are described in closer detail in Appendix 3. STUK was provided with 12 event reports. A total of 52 unexpected operation-related events were recorded at the Loviisa power plant. The most significant events were processed at the Loviisa power plant, and the reports were completed on time. The reports related, for example, to water and other leaks, component isolation problems, modification works, component failures and methods of operation.

The follow-up procedures regarding the implementation and success of corrective actions decided following operational events at the Loviisa power plant are currently insufficient. The areas in need of improvement include the setting of priorities regarding action decisions and the timely implementation of actions. The Loviisa power plant has participated in the corporation-led development of a new follow-up system for observations, operational events and risk management. Organisation of the operating experience feedback activities as a separate group was being planned during the year.

The Loviisa power plant also intends to expand the group of people dealing with operating experience feedback.

The procedures for utilising international operating experience feedback function well at the Loviisa power plant. Foreign event reports are comprehensively analysed, and the corrective actions decided on their basis are justified and traceable. Fortum itself conducts pre-screening of the reports coming from various sources, mainly via WANO and the IRS system maintained by 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. The operating experience feedback activities and the monitoring of their impact could be further enhanced and improved using a uniform operating experience feedback database covering the company's internal and external operating experience. The fire that occurred in connection with the containment leak tightness test performed in connection with the 2011 maintenance outage of Ringhals 2, and the protective plastic sheet that burned, releasing a lot of corrosive chlorides, was also identified as an issue to be investigated at Loviisa. Fortum investigated the amount of plastic materials in the reactor hall in order to assess the fire load and risk. During the cleaning operations following the fire, a possible operational risk was discovered in the containment spraying system at Ringhals, caused by foreign material found in the pipelines. The foreign material possibly consisted of plugs and welding debris dating back to the modification work carried out in 1988, and it had not been detected in the periodic tests performed using air. No similar blockage of the containment spraying system has been identified as a problem at Loviisa.

The IRS reports dealing with the connecting rod bearing problems of EDGs in Germany and France had significant information for Finnish plants because the Loviisa power plant has emergency diesel generators of a similar size. The investigations performed by the power company revealed

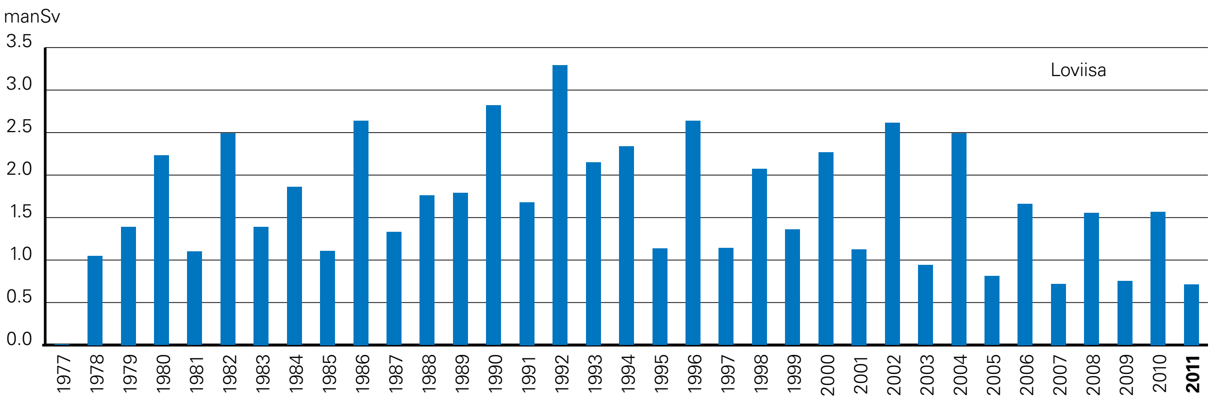


Figure 8. Collective occupational doses since the start of operation of the Loviisa nuclear power plant.

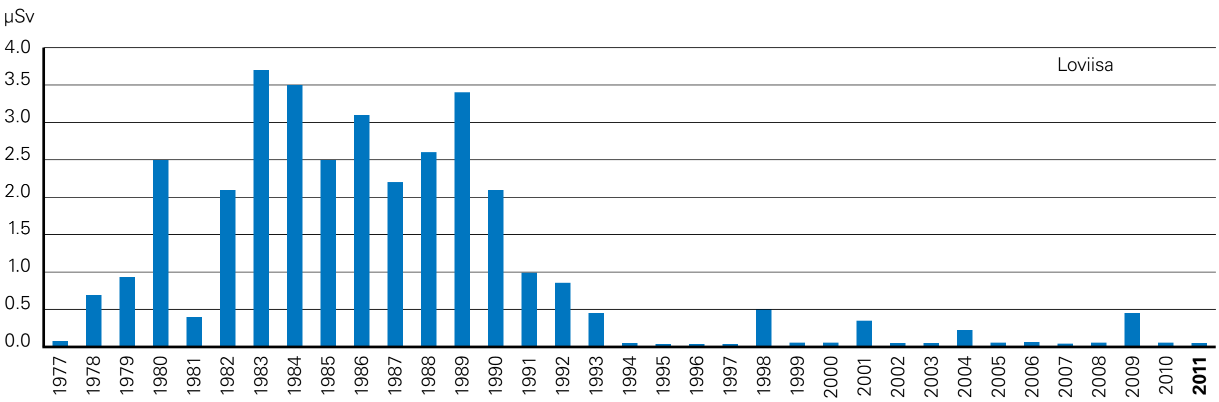


Figure 9. Annual radiation doses to the critical groups since the start of operation of the Loviisa nuclear power plant. Over the recent years, the doses to the critical groups have remained below one percent of the set limit, 0.1 milliSv.

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	Fe-59	Co-60	Zr-95	Ag-110m	Te-123m	Sb-124	Sb-125	Total
Air	–	1	–	1	2	–	–	–	–	–	4
Fallout	–	–	–	–	3	–	1	–	–	–	4
Seawater	5	–	–	–	–	–	–	–	–	–	5
Aquatic plants	–	6	6	–	9	2	9	1	5	1	39
Seabed fauna (Saduria Entomon)	–	–	–	–	–	–	1	–	–	–	1
Sedimenting materials	–	–	–	–	4	–	3	–	–	–	7
Total	5	7	6	1	18	2	14	1	5	1	60

that bearings of the subject type, proven to be susceptible to damage, had been installed in one of the EDGs at the Loviisa power plant in the summer 2009. The bearings were changed back to the original type in January 2011. It transpired during the basic overhaul of another EDG at Loviisa in the summer 2011 that the situation in spare bearings for the EDGs is worrying and an extensive problem because the supplier does not yet have a new, approved replacement bearing, and the old type bearings are no longer available. Fortum commissioned VTT to investigate the reasons behind the bearing damage. STUK reported the bearing problems internationally.

Following the results of the root cause analysis, STUK supplemented its report submitted in 2010 to the operating experience database maintained by the IAEA regarding an event at the Loviisa power plant where radioactive resin escaped into the ventilation channel from the mixing tank of a liquid waste solidification plant in trial operation.

4.1.10 Radiation safety of the plant, personnel and the environment

Occupational radiation safety

STUK carried out a radiation protection inspection as part of the periodic inspection programme at the Loviisa power plant, focusing on radiation measurements in particular. The scope of the inspection included the environmental radiation monitoring programme and the instruments intended for measuring radiation at the plant. Following the inspection, STUK requested a report regarding the impact of the dosimeter box and ambient conditions of the dosimeters kept in the plant surroundings on their response and wanted to know the person appointed responsible for the radiation measurements. STUK also required the power company to include the equipment used for collecting atmospheric samples from the environment within the scope of the periodic maintenance programme and to send the testing instructions of the three new radiation measuring instruments to STUK for information.

The dosimeters used for measuring the occupational radiation doses underwent annual tests. The tests comprise irradiating a sample of dosimeters at STUK's radiation metrology laboratory and reading the doses at the power plant. The test results were acceptable, although it was found that the test results for surface doses were systematically conservative. Closer investigation revealed that the surface doses reported to the dose register in 2011 were relatively higher in relation to deep doses when compared to previous years. As a corrective action, the Loviisa power plant intends to make technical and administrative changes to the radiation dose determination algorithms in 2012.

STUK carried out targeted radiation protection inspections during the annual maintenance outages. In the inspections, STUK assessed the radiation protection personnel's operations and resources as well as the training provided for personnel. At the same time, the activities of employees in radiation work were assessed. It was concluded that radiation protection at the plant units functions well throughout. In the inspections, it was found that the cleaning methods and equipment of the power plant in work locations where employees could be exposed to significant amounts of radiation should be developed. At the same time, it was noted that the cleaning operations have too few human resources for implementing the work efficiently, avoiding radiation doses. Follow-up of this issue will continue in 2012.

The Loviisa power plant intends to reduce the releases of antimony (Sb-122 and Sb-124) to the primary circuit and to reduce the activity of the primary circuit and the resulting radiation exposure. The power company intends to change the material of seals in the reactor coolant pumps to an antimony-free alternative (see Section 4.1.4, Reactor coolant pump seal).

Radiation doses

The collective occupational radiation dose was 0.43 manSv at Loviisa 1 and 0.29 manSv at Loviisa 1. According to the YVL Guide issued by STUK, the threshold for one plant unit's collective dose averaged over two successive years is 2.5 manSv per gigawatt of net electrical power. This means a collective dose value of 1.22 manSv per Loviisa plant unit. This limit value was not exceeded at either plant unit.

The total time used for annual maintenance outages in Loviisa was short, and there were few operations of significance for radiation protection, which resulted in the total collective dose being the lowest ever in the history of the Loviisa NPP. The collective occupational radiation doses of employees at the Loviisa NPP were smaller than the average doses of employees working in pressurized water reactors in the OECD countries.

The occupational radiation doses of NPP workers mostly accumulated in work carried out during annual maintenance outages. The collective occupational radiation dose caused by work carried out during the annual maintenance outages was 0.40 manSv at Loviisa 1, and 0.25 manSv at Loviisa 2. The highest individual radiation dose accumulated amounted to 4.9 mSv at Loviisa 1, and to 6.1 mSv at Loviisa 2. The highest individual dose incurred during the annual maintenance outages of both plant units was 7.4 mSv. The highest individual dose incurred during the year was 7.9 mSv.

The individual radiation dose distribution of workers at the Loviisa and Olkiluoto nuclear power plants in 2011 is given in Appendix 2.

Radioactive releases and environmental radiation monitoring

STUK inspected the operation of the weather measurement system and environmental radiation monitoring network at the Loviisa power plant site. The instruments of the weather measurement system were found to be operable. The environmental radiation monitoring network had operated well apart from a few isolated disturbances. Due to the ageing of both of these systems, the power plant initiated in 2011 the planning work for upgrading the weather measurement system and the environmental radiation monitoring network.

The radioactive releases into the environment from the Loviisa nuclear power plant were well below the authorised annual limits in 2011. The releases of radioactive noble gases into the air were approximately 6 TBq (as Kr-85-equivalent activity), which is approximately 0.03% of the authorised limit. The releases of radioactive noble gases were dominated by argon-41, i.e. the activation product of argon-40 present in the air space between the reactor pressure vessel and the main concrete shield. The releases of radioactive iodine isotopes into the air were about 1 MBq (as I-131-equivalent activity), i.e. approximately 0.0004% of the authorised limit. The emissions through the vent stack also included radioactive particulate matter amounting to 0.1 GBq, tritium amounting to 0.2 TBq and carbon-14 amounting to approximately 0.3 TBq.

The tritium content of liquid effluents released into the sea was 15 TBq, less than 10% of the release limit. The total activity of other nuclides released into the sea was about 0.2 GBq, which is

In early September 2011, an error was detected at the Loviisa power plant in the way in which radioactive emissions were determined. The power plant had introduced a new gamma activity measurement system on 11 June 2010, to be used, among other things, for determining the aerosols and iodine isotopes in the emissions released into the atmosphere. Due to an error discovered in the method used by the new measurement system to calculate the sampling air flow, the figures reported to STUK for gamma-active emissions into the atmosphere had been incorrect during the period 11 June 2010 to 2 September 2011. Having discovered the error, the licensee reported the matter to STUK. STUK required the Loviisa power plant to supply new, corrected figures for the incorrectly reported emissions.

The event is described in more detail in Appendix 3.

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 0.05 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 20 minutes.

A total of 300 samples were collected and analysed from the terrestrial and marine environment surrounding the Loviisa power plant during 2011. External background radiation measurement and the whole body counting of people in the surroundings were also carried out regularly. Very small amounts of radioactive substances originating from the nuclear power plant were observed in some of the analysed environmental samples. The amounts were so small that they are insignificant in terms of the radiation exposure of the environment or people.

4.1.11 Emergency preparedness

STUK oversees the capability of the emergency response organisations of nuclear power plants to act in abnormal situations. No situations requiring emergency response actions occurred at the Loviisa power plant in 2011.

Emergency preparedness at the Loviisa power plant complies with the main requirements. The emergency response organisation of the power plant consists of the organisation of the Loviisa power plant and of Fortum's technical support organisation in Keilaniemi. Both locations were included within the scope of periodic inspections in October 2011. The matters inspected included preparedness training, exercises, facilities and equipment, environmental radiation measurements and weather measurements at the plant site. The functions of the emergency information system were revised; the system is used to transfer the key information on events at the plant to the emergency response centres at STUK and Keilaniemi.

An unannounced emergency exercise was organised at the Loviisa power plant in May 2011. The exercise took place outside normal working hours, and the results indicated that the plant's emergency response organisation can be summoned quickly enough. The emergency response organisation of the power plant, STUK, the Regional Emergency Response Centre, the Eastern Uusimaa Fire and Rescue Services and the Eastern Uusimaa Police Department participated in the exercise. A personnel evacuation drill was organised at the power plant in December. In fire-fighting exercises, the fire brigade of the power plant works in close cooperation with the Eastern Uusimaa Fire and Rescue Services.

The assessments carried out following the Fukushima nuclear power plant accident did not yet affect the emergency response arrangements at the Loviisa power plant in 2011.

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 materials provided by the license holder, 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 employees, population or the 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 the YVL Guides. Emergency preparedness at the Olkiluoto power plant is in compliance with requirements. The processing, storage and final disposal of low- and intermediate-level waste (so-called plant operating waste) at the power plant were carried out as planned.

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 Olkiluoto 2 in 2010. It was located during annual maintenance in 2011, and the leaking fuel assembly was removed from the reactor. In August 2011, a new fuel leak was detected at Olkiluoto 2. The monitoring measurements indicate that it has remained small. The detected leakages are insignificant for the radiation safety of the environment, because the radioactivity is contained in the primary circuit and inside the containment.

STUK approved the licensee's application for increasing the average value fuel burn-up in fuel assemblies to 50 MWd/kgU. In 2011, STUK carried out a special inspection concerning ageing management where the sufficiency of spare parts and the functionality of spare parts management at the plant units were assessed. The licensee was found to have taken corrective actions regarding spare parts management. At the end of November, STUK received the report of these actions, which it had requested following the inspection.

Plant operation has been systematic and in compliance with the Operating Limits and Conditions (OLC) and guidelines. One event affecting safety was reported at the plant, rated as class 1 on the international INES scale. In the event, damage was discovered in the inner parts of the valves in the systems required for overpressure protection of and residual heat removal from the primary circuits of Olkiluoto 1 and Olkiluoto 2, which is why TVO replaced all damaged parts. A root cause analysis was also performed on the event. In 2010, STUK pointed out that there had been too few root cause analyses. Two were performed in 2011. They have concentrated on investigating the technical causes while the investigations on the activities of the organisation have scope for improvement. System and equipment failures had a minor safety implication for the plant. A significant observation received through international operating experience activities was related to a fire occurring in the containment of a Swedish NPP and the blockages discovered in the containment spraying system in that connection. Following the event, TVO decided to update its instructions for containment leak tightness tests and to extend the scope of tests and inspections on the spraying system.

The annual maintenance outages of plant units were implemented as planned in terms of nuclear and radiation safety. In 2010, STUK required TVO to develop its planning processes for annual maintenance and modification works. The situation regarding documentation to be submitted to STUK improved slightly in 2011. STUK will continue the assessment of corrective actions proposed by TVO in 2012.

During the year, several modifications were implemented for improving plant safety. The plant is in the middle of a modernisation project spanning many years, aimed at extending the service life of the plant and improving its availability. The modifications carried out at Olkiluoto 1 in 2010 were also implemented at Olkiluoto 2 in 2011. They included the replacement of inner isolation valves in the main steam system, replacement of low voltage distribution switchgears in one subsystem, replacement of the low-pressure turbine, modernisation of the main seawater pumps as well as replacement of the generator and its cooling water system. TVO is also in the process of expanding the spent fuel storage at Olkiluoto. At the same time, the structures of the storage facility will be modified to comply with the current safety requirements. In 2011, TVO provided STUK with the conceptual design plans for the construction of an emergency control room and for replacing the diesel generators. In 2009, STUK approved the periodic safety review regarding Olkiluoto 1 and 2 and TVO's action plan for developing plant safety. The agreed actions have mainly progressed in line with the plans.

TVO's organisation has acted in a systematic and development-oriented way to improve the plant's safety. In 2011, the modification work process was a subject of STUK's special oversight. TVO has developed its project management procedures, but management of the project portfolio still needs further attention. In its inspections performed as part of the periodic inspection programme, STUK pointed out several areas in need of development, and TVO is still in the process of improving the description of the modification work process. The modification work instructions will be developed in particular with respect to quality management and procurement.

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

Operating Limits and Conditions

STUK is responsible for verifying that TVO keeps the Operating Limits and Conditions (OLC) up to date and does not deviate from them without STUK's permission. TVO looks after the up-to-dateness of the OLC of the Olkiluoto plant among other things by assessing the need to update them in regular reviews and during the planning stages of modifications. In its inspections, STUK discovered individual points for improvement regarding the up-to-dateness of the OLC and the update procedures: the main control room did not have available the latest OLC updates regarding the spent fuel storage, and a few updates related to periodic tests had been made without STUK's approval. In 2011, TVO did not report any events during which the plant would not have been in a state compliant with the Operating Limits and Conditions.

STUK oversaw the observance of requirements and limits set out in the OLC in the course of its oversight of the licensee's activities at the plant site. Deficiencies were observed in keeping the fire doors shut during annual maintenance outages. The employees wedge self-closing fire doors open for easier passage. STUK requested TVO to look into the matter because, in case of fire, the doors left ajar may allow fire to spread from one compartment to the next. In its account on the matter, TVO presented the scheduled corrective actions with which it seeks to influence the matter from different angles, such as from that of the employees' attitudes and actions, control of the doors and assessment of the need to lock them.

During the year, TVO submitted to STUK for approval 10 amendment proposals for the Operating Limits and Conditions. The amendments were mainly due to modifications carried out at the plant, such as replacement of the inner isolation valves of the main steam lines at Olkiluoto 2 and upgrade of the plant's radiation measurement systems. In these cases, the operating and testing requirements of new equipment were different from those of the decommissioned equipment. STUK approved nine amendment proposals as they were and asked for further justification for the amendments in one case before approving them. One amendment proposal was only partly approved by STUK. That amendment concerned taking into account the Olkiluoto 3 plant unit, to be commissioned, in the release limits of radioactive substances. STUK wanted to keep some of the items as they were so that more lenient action limits than the current ones could not be applied in any situation.

TVO applied for permission from STUK for seven planned deviations from the Operating Limits and Conditions (Appendix 1, indicator A.I.2). Five of the applications were related to modifications and two to periodic tests. For example, the voltage had to be cut off from the power supply cables of the start-up transformers of Olkiluoto 1 and Olkiluoto 2 when the perimeter fence of the plant area was being refurbished and excavations were necessary at the location of the cables. This had to be done for occupational safety. STUK approved the applications but imposed restrictions in a few of its decisions concerning, for example, the validity of the permission and activities during the deviation. STUK also approved two applications for extending the validity period of two earlier approved deviations from OLC, when TVO was unable to start the work within the planned schedule.

Operation and operational events

No events leading to a reactor trip occurred at the Olkiluoto nuclear power plant. In addition to the annual maintenance outages, TVO shut plant units down for repairs to a so-called maintenance outage on three occasions: damaged inner parts in the valves of the systems required for overpressure protection of and residual heat removal from the primary circuit were replaced at both plant units, and the motor of one reactor coolant pump was replaced at Olkiluoto 1 due to a bearing fault. Other significant events included faults in the diesel generators forming part of the emergency power systems. The events are described in Appendix 3.

STUK oversaw the operation on a daily basis at the plant site, by inspecting the regular reports on operating activities as well as the event reports, and by making two inspections as part of the periodic inspection programme. One of the most significant observations regarding operation was to do with the activities of operating personnel during the annual maintenance outages. There have been several events in recent years where the operators have reacted slowly to the alarms coming to the control room during annual maintenance outages. Similarly, there have been several events related to component isolation during the annual maintenance outages. TVO has identified the individual events, analysed them and determined the corrective actions. The events have, for example, resulted in the pumps in safety systems starting unnecessarily as well as in radioactive systems being released inside the plant. Due to the recurring nature and common features of these events, STUK required TVO to analyse the events as one entity and determine the corrective actions and report the results to STUK in a root cause report and during an inspection to be conducted in the spring 2012.

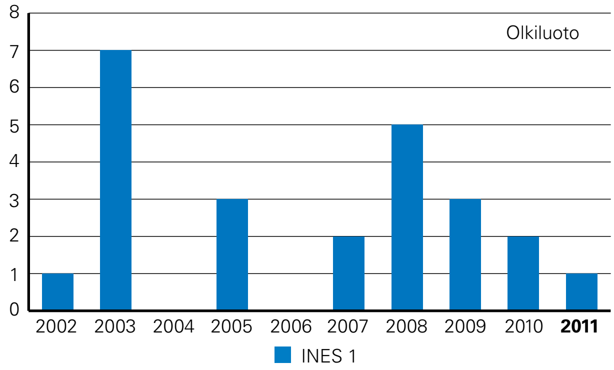


Figure 10. INES classified events at the Olkiluoto plant (INES Level 1 or higher).

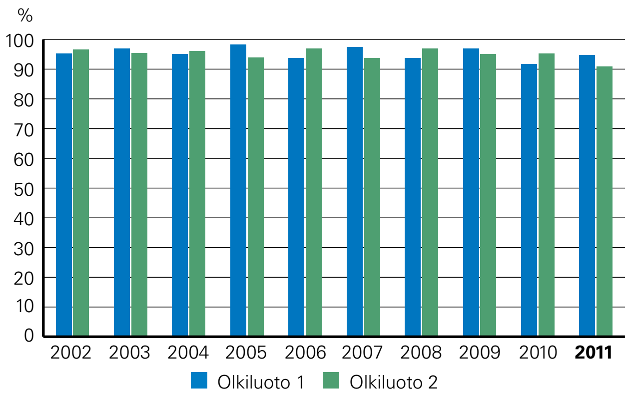


Figure 11. Load factors of the Olkiluoto plant units.

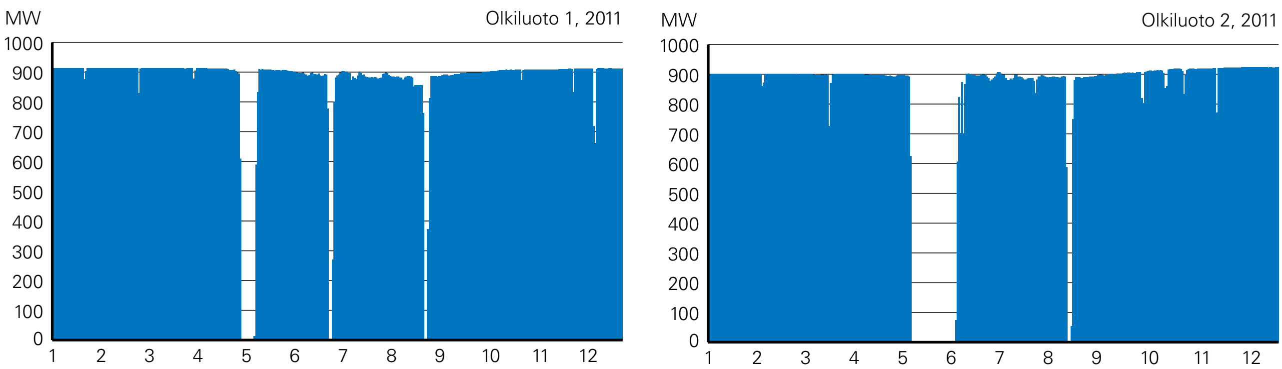


Figure 12. Daily average gross power of the Olkiluoto plant in 2011.

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

Event	Non-compliances with the OLC	Special report and/ or root cause report	INES rating
Incorrect operation of the emergency diesel generator at Olkiluoto 1		•	0
Defects in the internal parts of the valves of the system required for overpressure protection of and residual heat removal from the primary circuit at Olkiluoto 2 and Olkiluoto 1		•	1
Short between core windings discovered in the maintenance of a diesel generator		•	0

Operation and operational events

The load factor of Olkiluoto 1 was 94.8%, while that of Olkiluoto 2 was 90.9%. The annual maintenance outages have a major effect on the load factors. The outage at Olkiluoto 1 lasted for nine days, while that of Olkiluoto 2 lasted for 29 days. The losses in gross energy output due to operational transients and component malfunctions were 1.9% at Olkiluoto 1 and 1.4% at Olkiluoto 2.

***The emergency diesel generator at Olkiluoto 1 did not operate according to specifications** when the switch-over and re-switching automation of the 660 V emergency power supply was tested. During the test, the generator switch of the diesel generator opened. The opening was caused by overvoltage resulting from the incorrect operation of the generator exciter. Due to the fault, the generator would not have operated according to specifications in a real situation where it would have been required.*

***Damage,** such as cracks and coating flaws, was discovered **in the inner parts of the valves in the systems required for overpressure protection of and residual heat removal** from the primary circuits of Olkiluoto 1 and Olkiluoto 2 in inspections carried out during the annual maintenance outages. The damage had not affected the operation of the valves; they had operated correctly in regular tests. Nevertheless, STUK found, on the basis of the reports produced by TVO regarding the faults discovered, that the original pistons and pilot cylinders of the valves were approaching the end of their life span. TVO had replaced all damaged parts with new ones by the autumn 2011.*

*It was discovered in conjunction with maintenance performed at the equipment manufacturer's premises that **an earth fault occurs at a certain voltage level in a diesel generator** forming part of the emergency power systems of Olkiluoto 1 and Olkiluoto 2. A similar fault had been discovered during the maintenance of another diesel generator a year earlier. A fault like this can be latent for a long time without affecting the operability of the generator, but it can also rapidly escalate and damage the core winding and cause a risk of fire. Following the event, TVO has increased condition monitoring measurements and the frequency of maintenance operations on the diesel generators.*

The events are described in more detail in Appendix 3.

In 2011, the risks caused by component malfunctions, preventive maintenance and other events causing unavailability of equipment were 13.1% and 5.4% of the expected value of the annual accident risk calculated using the plant's risk model for Olkiluoto 1 and Olkiluoto 2, respectively. The result was in line with those of previous years.

Annual maintenance outages

Annual maintenance ensures the preconditions for operating the power plant safely during the following operating cycles. STUK oversees that the annual maintenance does not cause radiation hazards to the employees, the population or the environment and that the plant is safe. This is done by

Annual maintenance at Olkiluoto 1

Olkiluoto 1 had a refuelling outage from 1 to 10 May 2011. The outage lasted two days longer than planned due to the time taken to repair the faults discovered in the diesel generator and in the outer isolation valve of one of the main steam pipes.

Twenty-five per cent of the fuel in the reactor was replaced with fresh fuel. In other respects, the work carried out mainly consisted of inspections, maintenance, repairs and tests of systems, equipment and structures, such as fuel inspections and leak tests on the two hundred or so containment isolation valves.

During the outage, a fuel rack in the reactor hall fuel pool tilted slightly when spent fuel was moved to one side of the rack. The structure of the rack is such that a lop-sided load like this changes the centre of gravity, and the rack may tilt. The matter had not been taken into account when producing the transfer plan and when carrying out the actual transfers. TVO will develop its procedures and instructions so that a similar event can be prevented. The event did not put the integrity of fuel at risk.

inspecting the outage plans and modification work documentations and by carrying out site inspections during the annual maintenance.

STUK has found that TVO is capable of planning and implementing annual maintenance outages in a safe manner. However, STUK identified scope for development in spare parts management, planning and resource allocation of modifications implemented during the annual maintenance as well as in decision-making related to analysing events. Following its inspection performed before the annual maintenance, STUK required TVO to produce a report of spare parts maintenance regarding systems and components important to safety and submit it to STUK by the end of November 2011. The shortage of spare parts encountered during the annual maintenance outages further emphasised the importance and topicality of the issue. The observations made during the 2010 annual maintenance indicated that there is scope for improvement in the way TVO plans modifications and allocates resources for them. Following the 2010 annual maintenance, STUK required TVO to investigate the underlying problems that have led to delays in planning and to the deficiencies in the contents of documents submitted to

Annual maintenance at Olkiluoto 2

The annual maintenance outage at Olkiluoto 2 took place between 10 May and 8 June 2011 and lasted over three days longer than planned. The delay was caused in particular by investigations and repairs of the damage observed in the pistons and control cylinders of the valves in the system required for overpressure protection of and residual heat removal from the primary circuit.

Almost 25 per cent of the nuclear fuel in the reactor was replaced with fresh fuel during the annual maintenance outage. A fuel leak was detected at the plant unit soon after the start-up following the 2010 annual maintenance outage. TVO monitored the magnitude of the leak and its development by regular measurements during the operating cycle. During this annual maintenance outage, the leaking fuel assembly was identified and removed from the reactor.

Some major modifications were carried out during the annual maintenance outage. They included the replacement of the inner isolation valves of the main steam pipes (see the description in Section 4.2.5), the replacement of a low-voltage mechanism in one subsystem (see the description in Section 4.2.5), the modernisation of the main seawater pumps, the replacement of pipes in the seawater system, the replacement of low-pressure turbines, the replacement of the generator and the replacement of the generator's cooling system. In addition to the modifications, numerous inspections, maintenance operations, repairs and tests of systems, equipment and structures were carried out.

TVO tested the operation of the new generator and its voltage regulator on 11 and 13 June after the annual maintenance. An operational transient occurred during both tests resulting in the plant dropping off the national grid. The first transient was caused by an incorrect setting of the voltage regulator. The latter transient was due to an error in planning the tests. The voltage regulator setting was corrected before ramping up the reactor power. The events did not put the plant or its surrounding environment at risk. The events did not cause any disturbance to power supply to the plant's systems.

Maintenance outages

Olkiluoto 1 had a maintenance outage on 26–29 June 2011 for the purpose of inspecting the inner parts of the valves in the systems required for over-pressure protection of and residual heat removal from the primary circuit and for replacing any damaged parts (Section 4.2.4). The inspections were carried out following the observations made during the annual maintenance outage of Olkiluoto 2.

Olkiluoto 2 had a maintenance outage on 18–21 August 2011 for the purpose of replacing the inner parts of the valves in the systems required for over-pressure protection of and residual heat removal from the primary circuit. The damage was discovered during the annual maintenance outage in June–July, but TVO did not have enough spare parts available at that time for replacing all necessary parts (Section 4.2.4).

Olkiluoto 1 had a maintenance outage on 26–29 August 2011 for the purpose of replacing one main circulation pump motor. The pump's vibration readings had been increasing during the operating cycle. When the motor was inspected after removing it from its location, the reason for the vibration was found to be larger-than-normal wear on the bearing. The bearing material of the subject pump had been replaced during the 2010 annual maintenance outage, and the intention had been to open up the pump for inspection during the 2012 outage. The other main circulation pumps at Olkiluoto 1 and Olkiluoto 2 have bearings of the original type. During the outage, one pump in the cooling system of the shut-down reactor was replaced because its vibration level had increased.

STUK. The account submitted by TVO presented the corrective actions to be taken before the 2011 annual maintenance related, among other things, to the development of pre-planning and instructions. STUK will monitor the effectiveness of the corrective actions.

STUK used a total of 282 man-days on on-site oversight during the annual maintenance outages; these days were made up oversight work on different areas of expertise, such as equipment and system inspections at the plant site, and inspection rounds. In addition, two resident inspectors worked regularly on site, primarily responsible for overseeing the Olkiluoto 1 and Olkiluoto 2 plant units.

4.2.3 Ensuring plant safety functions

Because the plant's safety functions are secured with multiple parallel systems and equipment and, in some cases, also with systems and equipment that have different operating principles, the individual failures observed in the plant's equipment have not prevented the activation of safety functions in any situations. The safety of the plant was comprehensively assessed in the periodic safety review of 2009, after which TVO has further supplemented the transient and accident analyses performed for ensuring the safety functions – for example, with respect to an extension of a postulated accident in 2009 and with respect to loss-of-coolant accidents in 2010.

4.2.4 Integrity of structures and equipment

STUK monitored the integrity of structures and equipment on the basis of the periodic inspection programmes and repairs and modifications carried out. No observations restricting the use of pressure equipment or pipelines were made during the periodic inspections. The crack detected in 2003 in the nozzle weld of the reactor feedwater system of Olkiluoto 2 has not propagated. The leaking fuel rod detected at Olkiluoto 2 after the 2010 outage was replaced during the 2011 outage. Another leak was detected in the spring 2011; it must be located and the leaking fuel assembly replaced during the 2012 outage at the latest.

Faults were detected during the annual maintenance outages of both plant units in the pistons and hard-chrome plating of cylinders of the valves required for over-pressure protection of the primary circuit and for residual heat removal from the reactor. Consequently, STUK required the power company to replace all valves. Due to the limited availability of spare parts, the valve replacement operation caused an additional outage at both plant units in June and August 2011. Furthermore, signs of fatigue were detected in the exhaust manifolds of the EDGs of both plant units. However, the damage report produced by TVO indicates that the fatigue will not directly affect the operation of the diesel generators and does not therefore prevent the generation of emergency power. During 2011, STUK paid particular attention to ageing management of the plant units and to the availability of spare parts. In the spring 2011, STUK inspected the sufficiency of spare parts inventory for the most critical equipment and the functionality of spare parts procurement. The licensee was found to have taken corrective actions regarding spare parts management. At the end of November, STUK received the report of these actions, which it had requested following the inspection. STUK will continue to monitor closely the functionality of spare parts procurement during 2012.

Fuel

During the annual maintenance outages, TVO carried out visual inspections and measurement checks of the fuel as part of the periodic inspection programme. The purpose of these inspections is to investigate the behaviour of the last delivered fuel assemblies and their flow channels. An indication of a fuel leak had been observed at Olkiluoto 2 in the spring 2010. The leaking assembly was removed from the reactor during the annual maintenance. The initial visual inspection of the assembly indicated that the damage may have been caused by a foreign object. More specific results will be obtained from an inspection to be performed during the operating cycle.

Fuel leaks at Olkiluoto 2

A fuel leak was detected at the plant unit immediately after the 2010 annual maintenance outage. The leak remained very small the whole time. The maximum iodine-131 concentration measured in the coolant during 2011 was about one thousandth of the limit value specified in the Operating Limits and Conditions for operational restrictions. The highest activity concentration was measured during a reduction of power. Under reduced power, the gaseous fission products contained inside the fuel cladding, such as the iodine-131 isotope, are readily released to the reactor coolant. During power operation, the activity concentration usually stabilises at the level that prevailed before the reduction of power. The leaking fuel assembly was identified and removed from the reactor during the 2011 annual maintenance.

A new fuel leak was detected in the reactor of Olkiluoto 2 in early August 2011. The leak has remained small throughout the reported period. The maximum value of iodine-131 activity concentration in the reactor water was about 0.2%, or two thousandths, of the limit value set in the Operating Limits and Conditions. The highest activity concentration was measured during a reduction of power. The licensee will monitor the situation regarding the fuel leak both by continuous activity measurements and by laboratory measurements. The leaking fuel assembly will be removed from the reactor during the 2012 annual maintenance outage at the latest.

Primary circuit

The power company will monitor the condition of the primary circuit, among other things, by periodic inspections. The exerted loads are recorded, and STUK inspects these records in connection with the periodic inspection programme. Leak monitoring allows detecting, with a high probability, a crack in a pressure equipment wall before it results in a rupture. The primary circuit is still in good condition. The risk of stress-induced corrosion of stainless steel requires constant monitoring in boiling water reactors. Stress corrosion is caused by the combined effects of stresses, sensitisation caused by the carbon contained in the steel and unfavourable water chemistry. Oxygen is formed in the water of boiling water reactors, which is why it is so important to keep the concentrations of other impurities extremely small. Over the years, the pipelines at Olkiluoto have been gradually replaced with pipes made of stainless steel with lower carbon content.

Periodic inspection programmes

The inner parts of the reactor pressure vessel of Olkiluoto 1 were subjected to a visual video inspection during the 2011 refuelling outage. The Olkiluoto 1 faults being monitored have remained unchanged, and the inspections did not reveal any new faults with important safety implications. Periodic inspections were also performed on the reactor pressure vessel of Olkiluoto 2 using volumetric inspection methods.

There is a crack in a nozzle weld in the reactor feedwater system of Olkiluoto 2, which has been monitored during 2003–2009. The inspection made in 2011 indicated that the crack has remained unchanged. The testing organisation has developed its inspection techniques in order to verify the height of the fault. The current, qualified measuring technique has been optimised up to a fault height of 10 mm, but its accuracy quickly weakens with faults higher than that. The dimensioning of the crack have been further specified by making laboratory tests using fault geometries similar to that of the subject concerned. However, the techniques used in these tests have not been qualified in compliance with the national practice. The new probe type used in the tests gave 15.3 mm for the height of the fault. The testing organisation intends to use both the qualified procedure and the above new probe type in future annual maintenance outages so that the height of the fault can be determined more accurately.

The periodic inspections of registered pressure equipment were implemented during the annual maintenance outages according to plans for both plant units. At Olkiluoto 1, eight pieces of pressure equipment were inspected, all of them in the domain of TVO's inspection organisation. At Olkiluoto 2, a total of 44 registered pieces of pressure equipment were inspected. Of these, 18 were in STUK's inspection domain and the remaining 26 in the domain of TVO's inspection organisation. In addition, periodic inspections were carried out for 18 pieces of pressure equipment during the operation of plant units. No observations restricting the use of pressure equipment were made during the inspections.

Ageing management

The inspections carried out by STUK indicated that TVO had carried out the internal audits required for the service life management process and added in the organisational manual the previously missing descriptions of teams participating in ageing management. The internal auditing activities were found to function well, and the power company has initiated the corrective actions based on the audit findings.

TVO has also initiated improvement measures required by STUK so that more comprehensive documentation can be collected on the implementation of work carried out in component maintenance. Utilisation of the IT systems will be improved by user training. Furthermore, the list of items in the IT systems will be extended. This will benefit the monitoring of effectiveness and development of maintenance programmes, as well as the traceability of spare parts, materials and working methods that have proved incorrect.

Pressure equipment manufacturers and inspection and testing organisations

A total of 24 nuclear pressure equipment manufacturers were approved for the Olkiluoto plant (plant units Olkiluoto 1, 2 and 3). STUK approved five testing organisations to carry out tests related to the manufacture of mechanical equipment and structures, plus two inspection organisations to review the construction plans of mechanical components and structures and to carry out their structural and commissioning inspections. Testing operators from three different testing organisations were approved for carrying out periodic tests of mechanical equipment and structures pursuant to YVL 3.8.

The technical justification for structural solutions to be implemented at Olkiluoto 3 has given STUK cause to request an account of the possibility of thermal embrittlement in the dissimilar material joint of the primary feedwater fitting at Olkiluoto 1 and Olkiluoto 2. According to the report received by the power company from VTT, such a risk is not to be expected. TVO has continued its investigations regarding the accelerating effect of actual process conditions on the fatigue of the most important pipelines. With the help of these investigations and the supporting extensive development work regarding strength calculations, TVO intends to provide STUK with totally new fatigue analyses on these pipelines to serve as the basis for extending the service life of Olkiluoto 1 and Olkiluoto 2. In addition, the power company has investigated the technical prerequisites for increasing the output power. To this end, it conducted a trial programme in connection with the 2011 annual maintenance in which the vibrations in the main steam pipeline under increased flow of steam were measured.

In spite of the research, development and modernisation projects, a growing trend can be seen in the failure frequency of safety-related components. The fault in the exhaust pipe of a diesel generator occurred unexpectedly in 2011 and was repeated in other units. Cracks and coating damage were discovered in the main valve of the system required for over-pressure protection of the primary circuit and residual heat removal from the reactor in inspections carried out in 2011. In its inspections, STUK called attention to the fact that the potential ageing phenomena are not sufficiently taken into account in the maintenance operations included within the scope of the equipment-specific responsibility system. The component classification used for the maintenance of equipment and structures does not particularly emphasise ageing or itemise the parts of even the most important equipment to allow their localised ageing phenomena to be taken into account.

Metal ageing phenomena in the valve pistons of the system required for over-pressure protection of the primary circuit and for residual heat removal

The purpose of the system required for over-pressure protection of the primary circuit and for residual heat removal is to restrict the pressure in the reactor by letting out steam generated in the reactor to the reactor containment building in cases where the normal route of the steam to the turbine plant is not available. TVO detected cracks in the valve piston of the said system in a visual inspection performed on 24 May 2011 during the annual maintenance outage of Olkiluoto 2. Following the observation, all 12 valves were disassembled and inspected.

The damage was analysed in investigations carried out by TVO and VTT. Stress corrosion and fatigue cracks were found in the welded piston coatings of several valves. In addition, parts of the chrome coating of the pilot cylinders had come off due to corrosion. The power company assessed that there was no immediate risk of the valves failing and becoming inoperative. Due to the extent of the discovered cracks and damage, STUK found that the components were due for replacement and required that this be done. Furthermore, STUK required TVO to inspect the valves of Olkiluoto 1, at that time in operation, during the maintenance outage in June. The rest of the valve parts suffering from ageing phenomena were replaced in August during an additional maintenance outage at Olkiluoto 2.

Cracks in the exhaust manifold of an emergency diesel generator

A leak was detected in the exhaust manifold of an emergency diesel generator at Olkiluoto 2 while the EDG was being tested. The exhaust manifold was disassembled and one of its parts was found to have cracks. Another broken part was discovered during a trial run after replacing the parts. The exhaust manifold parts are original and date back to the 1970s.

Because of the faults, TVO inspected all EDG engines and found similar faults in most of them. Following the trial runs and inspections, STUK required TVO to establish the root cause of the faults and the possibility of a common cause failure. Furthermore, STUK required TVO to establish the possible impact of loose parts on the availability of the engines and to have a damage report produced. In the damage report produced by TVO, the failure mechanism was found to be a fatigue crack that does not directly affect the operation of the diesel generator and, as a result, does not prevent the generation of emergency power.

Because of the event, TVO will inspect and repair the exhaust manifolds of all EDGs in the maintenance operations to be carried out in the autumn 2011 and the spring 2012.

Condition monitoring

The condition and leak tightness of the containment at the Olkiluoto NPP is monitored through periodic inspections. No significant deviations have been observed in them. The monitoring of leak tightness requirements of the containments at the Olkiluoto power plant is discussed in greater detail in Section A.III.3 of Appendix 1.

The condition of pipelines was inspected at both Olkiluoto plant units according to plans. At Olkiluoto 1, it was found that the erosion corrosion had not advanced in the spots being monitored. At Olkiluoto 2, several points in the pipelines were measured, for which no earlier results were available. Measurement results falling short of the approval limit were obtained from three of these pipelines. The weld of one valve was also found to be incomplete. Consequently, the power company made more detailed strength calculations, which indicated that the pipe wall thicknesses and the weld are still sufficient in spite of the measurement results.

No significant deviations were observed when monitoring the condition of the spent nuclear fuel storage and the fuel pools. The expansion of the spent nuclear fuel storage at the Olkiluoto plant is discussed in Section 4.2.6.

Spare parts management at the Olkiluoto power plant

In the spring 2011, STUK inspected the sufficiency of spare parts for systems and equipment important to safety and the functionality of spare parts management at the Olkiluoto power plant. The inspection focussed in particular on the spare parts inventory of systems and equipment important to safety as well as on the procedures used at the power plant for monitoring the spare parts needs and for procuring the spare parts.

The responsibilities and systematic procedures have been defined at the Olkiluoto power plant for monitoring the changes in the spare part inventory of systems and components important to safety. However, the observations made by STUK in its inspections indicate that these responsibilities and procedures need to be further defined so that they cover the monitoring and management of the spare parts requirements of all systems and components important to safety. It was also found that the licensee had taken action to ensure also the future availability of individual spare parts that are difficult to replace and are important to safety, such as electronic cards. In addition to further defining the responsibilities and procedures, STUK required that any products non-compliant with the requirements are removed from the goods reception area and that the storage practices are further specified so that the products accepted in the store do not become mixed with products that have not yet been inspected. In August 2011, STUK established jointly with the management of the power company that the corrective actions had been appropriately implemented at the goods reception area.

4.2.5 Development of the plant and its safety

Development actions based on the periodic safety review

In 2009, STUK approved the periodic safety review regarding Olkiluoto 1 and 2 and TVO's action plan for developing plant safety. Among other things, the power company is assessing and developing the application of the diversity principle at the plant, the Operating Limits and Conditions and the emergency operating procedures.

Development of the Operating Limits and Conditions

In its development plan for the Operating Limits and Conditions (OLC), TVO stated that it will improve the justification of requirements and reduce their ambiguity as required. In 2011, TVO had internal discussions regarding the needs to amend the OLC and produced amendment proposals. TVO will submit the first amendment proposals to STUK for approval at the beginning of 2012.

Further development of emergency operating procedures

Following the periodic safety review, STUK required TVO to draw up strategic and justification documents for the containment isolation procedures and to assess the need to re-validate the procedures. Furthermore, TVO has to assess the development needs of its entire set of emergency operating procedures (EOPs).

The procedures development has progressed as planned. The isolation procedures have now developed to be operator-specific, and justification documents have been produced for them. The procedures have been re-validated. STUK has monitored the work in follow-up meetings organised approximately once a year and by studying the submitted procedures and their justification memorandums and validation materials. STUK has not had any objections to the procedures or their validation. STUK considers compilation of information of old analysis carried out by Asea and observations made along the plant's operating history in the justification material as a good practice.

During 2011, TVO assessed the need to develop other EOPs and drafted on that basis a continuation plan for the development work. STUK has required that the generic procedures for emergencies and all related instructions, as well as all strategy/justification documents pertaining to the procedures to be followed during outages and the validation of the procedures, are completed by the end of 2012.

Probabilistic risk analyses

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

In 2011, the annual probability of a severe reactor accident calculated by the licensee for the Olkiluoto 1 and 2 plant units was 1.33×10^{-5}. The increase of approximately 30% from 2010 is caused by supplementing the model with the risks caused by an oil spill in the sea, as well as by an update of initiating event frequencies of fires and internal transients.

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

Increasing the burn-up of fuel

In 2010, Teollisuuden Voima applied for permission to increase the average discharge burn-up value of fuel to 50 MWd/kgU for the fuel types in use at Olkiluoto 1 and Olkiluoto 2. When these fuel types were first introduced, 45 MWd/kgU has been approved for their average discharge burn-up value. The behaviour of fuel assemblies has been studied by irradiating test assemblies up to a burn-up value of 50–53 MWd/kgU. In support of its application for increasing the burn-up, TVO presented a report with which it justified the acceptability of the proposed increase of discharge burn-up. On the basis of the material submitted, STUK assessed that the said fuel types will meet STUK's requirements regarding normal operation of the reactor and for accident situations up to the burn-up value applied for, and approved the application as submitted.

Construction of an emergency control room at Olkiluoto

Pursuant to a Government Decree, a nuclear power plant shall have an emergency control room independent of the main control room, and the necessary local control systems for shutting down and cooling the nuclear reactor, and for removing residual heat from the nuclear reactor and spent fuel stored at the plant in a situation where operations in the main control room are not possible.

TVO is in the process of constructing emergency control rooms for the Olkiluoto units currently in operation in compliance with the requirements set out in STUK's implementation decision regarding YVL Guide 5.5 and in the periodic safety review of Olkiluoto. The project is currently in its preplanning phase, and STUK reviewed the conceptual design plan of the emergency control rooms in 2011. STUK required TVO to asses, in a more comprehensive manner, the consequences of a loss of main control room as well as the sufficiency and comprehensiveness of the measurement data and controls to be brought to the emergency control room.

Replacement of diesel generators

TVO has investigated the possibilities for replacing all current emergency diesel generators (EDGs) of Olkiluoto 1 and Olkiluoto 2 with their auxiliary systems to correspond with the changed need for power, taking also into account any increases in the need for power due to possible future plant modifications as well as the lessons learnt from the Fukushima accident in relation to securing the power supply. The nuclear safety requirements dictate that a power margin of at least 10% is available in all load conditions. Furthermore, both main components of the EDGs (the diesel engine and the generator) are old models, whose development and manufacture has been discontinued, and the availability of spare parts and the supplier's technical support are declining.

The purpose of the emergency diesel generators and their associated auxiliary systems is to supply electrical power to the 660 V emergency power system in case of loss of supply from the 6.6 kV main bar. Both plants have four subsystems, and each subsystem has its own standby diesel generator. Replacement of the diesel generators will also mean that the main switchgear in the 660 V emergency power network has to be replaced; this will be done as part of the replacement of low-voltage switchgear as a modification project separate from the replacement of the EDGs.

The intention is to implement the EDG replacement project during the normal operation of the plant units as far as possible. According to the plan, the new EDGs will be installed and commissioned during power operation so that one new EDG is installed to both plant units during one power operation cycle. For this purpose, a ninth EDG unit has to be constructed to replace any one of the current EDGs of Olkiluoto 1 or Olkiluoto 2. In the future, the ninth EDG can be connected to replace an EDG undergoing periodic maintenance at Olkiluoto 1 or Olkiluoto 2, or it can replace a failed EDG. A new building will be constructed for the ninth EDG, while the replacement EDGs will be installed at the same premises where the current units are located.

In late autumn 2011, TVO submitted a conceptual design plan regarding the replacement of EDGs to STUK for approval. According to the preliminary schedule, the EDGs will be installed and commissioned during 2014–2018.

Replacement of the inner isolation valves of the main steam pipe at Olkiluoto 2

The inner containment isolation valves were replaced in the main steam lines of Olkiluoto 2 during the 2011 annual maintenance. The corresponding valves of Olkiluoto 1 were replaced during the 2010 annual maintenance. The purpose of the valves is to prevent the loss of coolant and the release of radioactive emissions outside the containment. The valves also serve as a back-up for the outer containment isolation valves.

One reason for replacing the valves was the fact that the old valves had a tendency to close when the flow of steam increased. In a situation where one valve closes, the flow of steam through the other valves increases, which may also cause them to close. The almost simultaneous closure of all steam line isolation valves will result in a larger increase in pressure and a larger load on the reactor pressure vessel and steam pipes than the closure of a single valve.

The new valves are of gate valve type, operating with media (steam) and the pressurizing principle. This valve type does not carry a similar risk of autonomous closure due to the increasing flow of steam.

STUK reviewed and assessed the valve design documentation before manufacture, oversaw the appropriateness of manufacture and the factory tests at the manufacturer's site, and also oversaw the installation and trial operation at the plant. The trial operation of the valves took place in June 2011 in compliance with the trial operation programme. The leak tightness tests, actuation tests in cold and hot states, as well as tests using a steam flow corresponding to 60% power of the plant were completed successfully.

Low-voltage switchgear replacement project

TVO has initiated a project (the SIMO project) for replacing the switchgears of the low-voltage distribution systems at Olkiluoto 1 and Olkiluoto 2. The primary reason for replacing the switchgears is the increase in maintenance costs due to the ageing of original equipment, as well as the need to modernise the switchgear to correspond to the current requirements regarding plant and personnel safety. The replacement mainly concerns the switchgears and associated transformers of electrical systems important to safety. TVO has already replaced the medium-voltage switchgear (6.6 kV) in 2005 and 2006. The voltages in the low-voltage networks of the units vary from 24 V DC to 660 V AC. The switchgears are used to supply the required electrical power to the I&C systems and components of the units.

TVO made the first switchgear installations of the project in the 2010 annual maintenance. They concerned an electrical system less important to safety. During the 2011 annual maintenance outage of Olkiluoto 2, TVO implemented the first switchgear replacement to systems important to safety so that the low-voltage switchgear in one of the plant's four subsystems was replaced with the associated transformers. TVO intends to continue the project at Olkiluoto 1 during the 2012 annual maintenance outage by replacing the switchgear of two subsystems.

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

In November, STUK conducted an inspection of nuclear waste management at the Olkiluoto NPP, focussing in particular on waste accounting and the foreseen waste management facilities and systems of the Olkiluoto 3 plant unit under construction. Following the inspection, STUK required TVO to update the mass limit set for the amount of waste cleared from control and received at its own landfill site. The waste volumes have increased as the plant has aged, and, in the future, Olkiluoto 3 will further increase the amount of waste. However, the activity limits important for nuclear and radiation safety have been appropriate, and the activity values of waste are well below the set limits.

The treatment, storage and final disposal of low- and intermediate-level waste ("operating 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 2011, maintenance waste below the activity limits taken to the local landfill for burial, waste oil was delivered to Ekokem Oy, and scrap metal 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.

On 21 September 2011, TVO submitted an application to the Government for an amendment, referred to in section 25 of the Nuclear Energy Act, to the current licence conditions of the low- and intermediate-level waste repository (VLJ repository) so that the nuclear waste from Olkiluoto 3 and the radioactive waste in the possession of the Radiation and Nuclear Safety Authority can be finally disposed of there. The licence conditions have also been revised with respect to nuclear materials. STUK will prepare its statement regarding the application for the Ministry of Employment and the Economy during the spring and attach to it its safety assessment and the statement of the Advisory Committee on Nuclear Safety.

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

The volume of spent nuclear fuel on-site at the Olkiluoto plant at the end of 2011 was 7,668 assemblies (1,292 tU, tonnes of original uranium) with an increase of 228 assemblies (39 tU) in 2011. The volume of low- and intermediate-level waste finally disposed of was 5,447 m³. The total increase of volume from 2010 is 132 m³. Approximately 81% of the waste has been finally disposed of.*

**The assembly figures do not include the assemblies in the reactors. The average weight of spent fuel assemblies at Olkiluoto 1 and Olkiluoto 2 is 170.8 kgU.*

Expansion of the spent fuel storage

TVO is also in the process of expanding the spent fuel storage (the so-called KPA storage) at Olkiluoto by three additional pools, and the storage structures will also be modified at the same time to comply with the current safety requirements. The current KPA storage capacity in Olkiluoto will be sufficient until 2014, and the expansion will increase the capacity for the spent fuel coming from the Olkiluoto plant units 1, 2 and 3. TVO submitted the documentation regarding expansion of the storage to STUK for approval at the end of 2009.

The extension of the storage is designed to fulfil the current safety requirements, the most significant of which are its ability to withstand the crash of a large airliner and its seismic resistance. At the same time, the structures of the existing part of the storage will be modified with a view to the current requirements. In conjunction with assessing the safety of the expansion, STUK inspected the needs to update the earlier design basis and safety analyses, the resources and operational methods of TVO's project organisation, the structural design basis of the storage, as well as the methods with which TVO will ensure the safety of the storage in operation. Following its inspections, STUK found that the storage expansion meets the safety requirements. During the construction work, STUK will inspect, among other things, the design basis with regard to aircraft crash resistance and the plans regarding annexation of the expansion to the storage currently in use.

The work carried out during 2011 at the KPA storage construction site included the construction of walls for the new pools and an upgrade of the wall structures of the existing building. STUK has reviewed the plans for the systems that will change with the expansion. The design and implementation of construction engineering structures are overseen by an inspection organisation approved by STUK. STUK has been overseeing and guiding the work of the inspection organisation.

Provisions for the costs of nuclear waste management

In compliance with section 88, subsection 2 of the Nuclear Energy Decree, Fortum provided the

Ministry of Employment and the Economy with the revised and supplemented waste management scheme and information on the costs and prices of nuclear waste management measures at the end of June. The update of the waste management scheme includes an index adjustment to the cost and price information as well as an estimate of the amount of nuclear waste at the end of 2011.

STUK reviewed the documents submitted in compliance with the Nuclear Energy Decree and submitted a statement regarding them to the Ministry of Employment and the Economy. In its statement, STUK assessed the technical plans and cost estimates on which the financial provision is based and considered them appropriate. At 2011 prices, the extent of TVO's liability is EUR 1,207.1 million.

4.2.7 Organisational operations and quality management

Based on STUK's oversight and the results of operating activities, it can be stated that, with a view to ensuring safety, TVO's organisation has operated in a systematic and development-oriented way. With regard to organisational operations, STUK oversaw the processes, resources and procedures of selected subjects during the year. In the summer, TVO was also required to assess the needs for developing the operations of the plants already in operation on the basis of the recommendations of the report following an investigation of Olkiluoto 3. TVO did not make any changes relevant to safety in its organisation during 2011.

The general description of TVO's management system complies, in the main, with the requirements of YVL Guide 1.4. One of the development actions spanning several years set out in the implementation decision of YVL Guide 1.4 is the development of a process-based management system. In 2011, TVO applied for more time to produce the process descriptions of the management system. TVO updated its operations manual towards the end of the year and submitted it to STUK for review. The verbal descriptions of updated and defined processes had been entered in the operations manual, but TVO is still continuing the process description work. The important processes include the modification work project and its closely associated procurement process.

The modification process was a particular subject of STUK's oversight in 2011, and it was reviewed in several inspections. TVO has introduced a process manual containing a compilation of modification work-related instructions, document templates and examples of good practices. TVO is looking for better ways to manage its project portfolio, and STUK found in the course of its periodic inspection programme that TVO might benefit from asking an external expert to assess TVO's project portfolio management procedures.

TVO is still developing the description of the modification work process. STUK required TVO to define the measurements for the modification work process and to develop further in particular the instructions for quality management and procurement. The power company must develop the planning of human resources for modification operations as well as the quality management competence related to the recruitment of persons participating in modification work. TVO must improve and further specify the conformity assessment of suppliers and subcontractors, the definition of requirements for the products to be procured, communication of the requirements to suppliers, as well as the exchange of information with suppliers and their subcontractors so that TVO can satisfy itself that it and the product supplier and its subcontractors share the same view of the product requirements and the quality management applicable to the products. STUK has already – for example, in 2010 – required a more robust management of the supply chain because that will make a major contribution to the safe and successful implementation of modification operations. The importance of conformity of procurement operations and good management of delivery control was also highlighted in the investigation conducted during 2011 regarding the Olkiluoto 3 plant unit.

In 2007 and 2008, STUK called attention to the situation regarding human resources and competence in the Reactor Physics and Reactor Monitoring Office. In 2011, STUK found that the situation has improved and that the office currently has sufficient human resources and competencies available. During the year, STUK reviewed the allocation of resources at TVO between projects and line organisation work and required TVO to develop its procedures for better compliance with the requirements of YVL Guide 1.4, also taking into account the risks related to the ageing of the plant. The risks related to the ageing of the plant require that the upgrade projects are given sufficient priorities, also with regard to resources.

Several changes took place in the personnel of TVO's training organisation during 2011. The power company has developed its definition of training requirements and classification of training courses during the year in order to develop the effectiveness of training and its assessment. On the basis of its supervision, STUK found that TVO has appropriate overall control of training activities, but there is scope for improvement in the competencies for quality, process and project management.

STUK oversaw the oral examinations of shift personnel where the shift managers, operators and trainee operators prove that they are conversant with all salient matters related to plant operation and safety. In 2011, STUK granted 21 licences to shift managers and operators on application by the power company and following a successful oral examination, four of them to new operators.

All participants passed their examinations in 2011. The new operators had good results in the examination, which is an indirect indication that the basic training programme is effective. The operators renewing their licences also had good results in the examination, which for its part indicates that the power company's refresher and supplementary training is effective.

4.2.8 Fire safety

During 2011, STUK oversaw fire safety at the Olkiluoto nuclear power plant and nuclear facilities with inspections complying with the periodic inspection programme, visits of fire safety experts during the annual maintenance outages and inspection rounds made in the course of the continuous presence of resident inspectors.

It has been found during oversight of the annual maintenance operations at the Olkiluoto plants that the employees wedge fire doors ajar for easier passage. STUK has required TVO to present an assessment of the extent of the problem, together with the actions already carried out and the planned actions with their schedules. The acceptable situation will be verified in the preparatory meetings for next year's annual maintenance operations.

No significant deviations were observed from the plant's instructions regarding the management of flammable materials during hot work or maintenance work.

The fire alarm and extinguishing systems of the plant had been managed in keeping with the condition monitoring programme. Demonstration of earthquake resistance was previously not required for the fire extinguishing systems, but following the analyses made after the Fukushima accident, STUK required TVO to investigate the earthquake resistance of the fire extinguishing systems. The investigations will be completed during 2012.

The monitoring of fire safety at the NPPs is also discussed in section A.II.5 of Appendix 1, "Number of fire alarms".

4.2.9 Operating experience feedback

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

The Olkiluoto plants had one INES class 1 event during the year when cracks were detected in the valve pistons of the primary circuit overpressure protection and residual heat removal system during the 2011 annual maintenance. The event is described in greater detail in Appendix 3. During the year, the power company performed two root cause analyses, one of them regarding the inspection procedures and ageing management problems of the above valves of the primary circuit over-pressure protection and residual heat removal system and the other regarding the erroneous disconnection of a sub-function of the reactor protection system. The root cause analyses were performed carefully, analysing the technical causes, but too little attention was paid to the operation of the organisation or to activities during the event. The root cause analyses do not indicate how they were made or what kind of expertise was used. Developing procedures, carrying out generic investigations and ensuring a sufficiently extensive pool of participants at the analysis phase would help develop the production of root cause analyses and to ensure the prerequisites of continual development in the organisation's operations.

Regarding the unexpected operational event occurring in 2011, TVO produced two special reports concerning EDGs. In addition, TVO produced

14 event reports and nine operational transient reports, of which two and six were submitted to STUK, respectively. The reporting instructions regarding TVO's own plant events have been updated, but the event reports have not been submitted to STUK in keeping with the instructions. The reports were only submitted when requested by STUK, although the instructions dictate that TVO must self-assess the importance of the event reports and the need to submit them to STUK.

TVO has been actively developing the procedures of its international operating experience activities. The new process includes preliminary screening and pre-processing of the reports obtained from different sources (WANO, IAEA/IRS, NRC, ERFATOM) before the meeting of the Operating Experience Group (KÄKRY). The KÄKRY meetings discuss, in turns, the plant's own events and those of other plants. For reports processed in KÄKRY meetings, the rationale for why the matter is considered to be in order at TVO is also recorded in the operating experience database (OPEX). If the reported event causes a change in procedures at TVO, the actions are recorded in the deviation processing and reporting system KELPO that is then used to follow up the implementation of approved actions. Action proposals are produced for technical modifications. There are plans to modify the OPEX database in order to improve its user-friendliness and the follow-up of implementation of actions. TVO has developed its operating experience activities to cater for the needs of Olkiluoto 3, and the members of the Operating Experience Group now also include representatives of operating activities at Olkiluoto 3.

Each office dealing with operating experience has appointed one person responsible for the activity (in all about 20 persons). The aim is to develop the collection of international operating experience available from many sources so that better information is obtained on the nature of information exchange between field of technology-specific offices and experts and so that the information can be made available to the whole organisation in a centralised manner. The information is conveyed by the persons responsible for operating experience activities in different offices.

The fire that occurred in the containment of Ringhals 2 in connection with a leak tightness test carried out during the 2011 annual maintenance outage and the consequently detected potential inoperability of the containment spraying system due to foreign material in the pipeline were identified as issues requiring investigations at the Olkiluoto plant units. Following the fire, TVO decided to update the leak tightness test instructions and enter the noteworthy issues to Olkiluoto 3 instructions. In addition, TVO has decided to carry out endoscopic inspections on the containment spraying system and to investigate whether a system test carried out using air is sufficient.

STUK made preparations for a new report to the operating experience database maintained by the IAEA regarding the cracks and damage detected in the inner parts of the valves in the systems required for over-pressure protection of the primary circuit and for residual heat removal at Olkiluoto 1 and Olkiluoto 2, as well as for a follow-up report on the repair and modification work carried out at the Olkiluoto plant on the pipeline penetrations of emergency cooling system pump rooms. STUK has reported the deficiencies detected in the leak tightness of the pipeline penetrations at the Olkiluoto plant in 2009.

4.2.10 Radiation safety of the plant, personnel and the environment

Occupational radiation safety

STUK carried out a radiation protection inspection as part of the periodic inspection programme at the Olkiluoto power plant, focusing on radiation measurements in particular. The scope of the inspection included the environmental radiation monitoring programme and the instruments intended for measuring radiation at the plant. Following the inspection, STUK requested a report regarding the impact of the dosimeter box and ambient conditions of the dosimeters kept in the plant surroundings on their reaponse. STUK also required the power company to assess the spare parts situation regarding the fixed radiation measurement instruments in the interim storage for spent fuel and to specify further the instructions for portable radiation measurement instruments.

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

STUK carried out targeted radiation protection inspections during the annual maintenance at the Olkiluoto plant units. In the inspections, STUK assessed the radiation protection personnel's instructions, training and resources. At the same time, the activities of employees in radiation work were assessed. The inspections indicated that radiation monitoring at the plant units functions well throughout. The resources of radiation protection were better than usual for the second year running because radiation protection was provided additional assistance by the power plant operator trainees of Olkiluoto 3. In addition, the power plant introduced new IT administration procedures that improved the internal communications of radiation protection personnel and the information administration. The inspections only revealed individual deficiencies regarding the activities of employees and the use of protective equipment in the radiation control area.

Radiation doses

In 2011, the collective occupational radiation dose was 0.21 manSv at Olkiluoto 1 and 0.76 manSv at Olkiluoto 2. According to the YVL Guide issued by STUK, the threshold for one plant unit's collective dose averaged over two successive years is 2.5 manSv per gigawatt of net electrical power. This means a dose value of 2.20 manSv per Olkiluoto plant unit. This limit value was not exceeded at either plant unit.

The collective radiation dose at the Olkiluoto power plant was small in spite of the maintenance outage of Olkiluoto 2 that was extensive, both in terms of personnel involved and the amount of work carried out. The collective occupational radiation doses of employees at the Olkiluoto NPP were smaller than the average doses of employees working in boiling water reactors in the OECD countries.

The occupational radiation doses of NPP work-

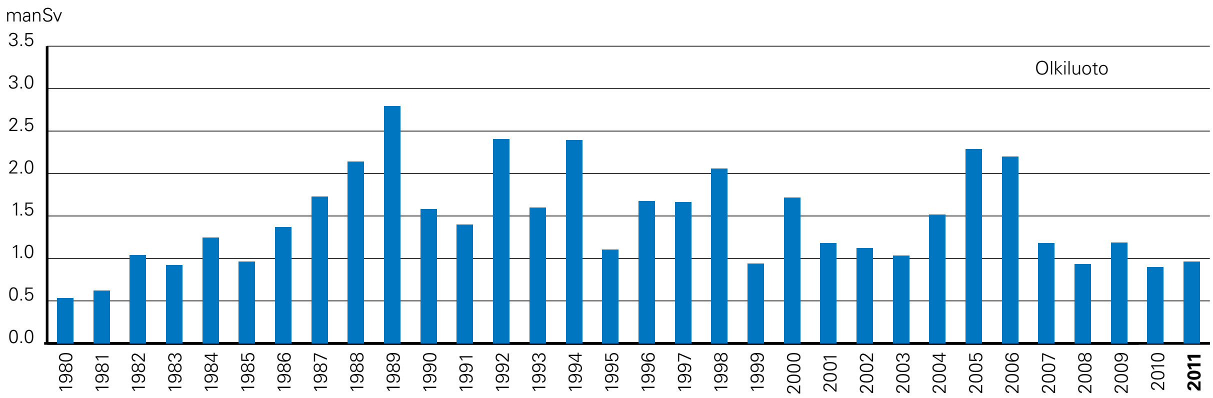


Figure 13. Collective occupational doses since the start of operation of the Olkiluoto units 1 and 2.

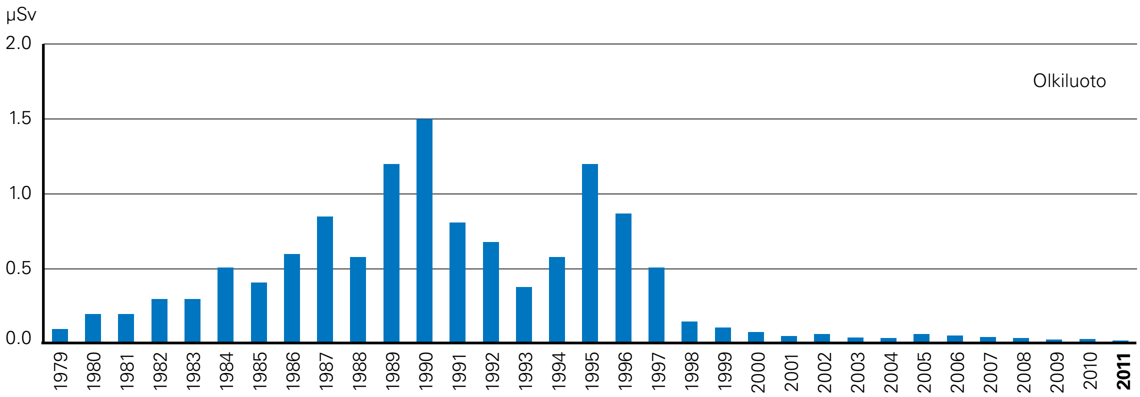


Figure 14. Annual radiation doses to the critical groups since the start of operation of the Olkiluoto units 1 and 2. Over the recent years, the doses to the critical groups has remained below one percent of the set limit, 0.1 milliSv.

ers mostly accumulate in work carried out during annual maintenance outages. The collective radiation dose of employees due to operations during the outage at Olkiluoto 1 was 0.12 manSv, and the collective radiation dose due to operations during the outage at Olkiluoto 2 was 0.67 manSv. The radiation levels at the turbine plants continued to decrease thanks to the new steam dryers that were installed in 2005 and 2006.

The highest individual radiation dose accumulated was 2.9 mSv at Olkiluoto 1 and 6.2 mSv at Olkiluoto 2. The highest individual dose incurred during the annual maintenance outages of both plant units was 7.5 mSv. The highest individual dose incurred during the year was 9.3 mSv. The highest individual radiation doses have been less than 10 mSv during the last five years. The individual radiation dose distribution of workers at the Olkiluoto and Loviisa nuclear power plants in 2011 is given in Appendix 2.

Radioactive releases and environmental radiation monitoring

STUK inspected the operation of the weather measurement system and environmental radiation monitoring network at the Olkiluoto power plant site. Both systems were upgraded in 2008. The weather measurement system and the environmental radiation monitoring network have functioned well, with the exception of individual device malfunctions. One of the fourteen stations in the radiation monitoring network was out of order for most of the year, but it was repaired in the autumn.

Radioactive releases into the environment from the Olkiluoto nuclear power plant were well below authorised annual limits in 2011. The releases of noble gases into the air were approximately 1.2 TBq (as Kr-87-equivalent activity), which is approximately 0.007% of the authorised limit. The releases of iodine into the air were approximately 1.7 MBq (as I-131-equivalent activity), which is approximately 0.002% of the authorised limit. The emissions through the vent stack also included radioactive particulate matter amounting to 11 MBq, tritium amounting to 0.2 TBq and carbon-14 amounting to approximately 0.8 TBq.

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	Mn-54	Co-60	Total
Air	–	1	1
Fallout	1	1	2
Dumping ground ditch water	–	1	1
Aquatic plants	1	14	15
Seabed fauna (clams)	–	1	1
Sedimenting materials	–	10	10
Total	2	28	30

The tritium content of liquid effluents released into the sea, 1.3 TBq, is approximately 7% of the annual release limit. The total activity of other radionuclides released into the sea was 0.1 GBq, which is less than 0.05% of the plant location-specific release limit.

The calculated radiation dose of the most exposed individual in the vicinity of the plant was about 0.02 microSv, i.e. less than 0.02% 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 10 minutes.

A total of 300 samples were collected and analysed from the terrestrial and aquatic environment surrounding the Olkiluoto power plant during 2011. External background radiation measurement and the whole body counting of people in the surroundings were also carried out regularly. Very small amounts of radioactive substances originating from the nuclear power plant were observed in some of the analysed environmental samples. The amounts were so small that they are insignificant in terms of people's radiation exposure.

4.2.11 Emergency preparedness

STUK oversees the capability of the emergency response organisations of nuclear power plants, formed of their operating personnel, to act in abnormal situations. No situations requiring emergency response actions occurred at the Olkiluoto power plant in 2011.

Emergency preparedness at the Olkiluoto power plant complies with the main requirements. The preparedness arrangements were inspected in June as part of the periodic inspection programme. The inspected subjects included preparedness training, exercises, facilities and equipment, alarm arrangements, environmental radiation measurements and weather measurements at the plant site, emergency preparedness at the Olkiluoto 3 site and the work for revising the emergency preparedness instructions. The data transfer system between the power plant and STUK is being upgraded; the new system is in trial operation, and it was used in the OLKI11 exercise. In the inspection, STUK required that the functional design of the emergency facilities of Olkiluoto 3 and the revision of preparedness plans shall be completed.

Two emergency response exercises were organised at the Olkiluoto power plant in 2011. An exercise related to the formation of a preparedness organisation and the initiation of activities was organised in April. Joint emergency response exercise OLKI11 was organised in August, with over 50 different organisations participating. The exercise combined for the first time a scenario initiated by illegal activities and a technical emergency situation at the plant.

At the time of the inspection, the assessments that began following the Fukushima NPP accident were still at their initial stage, and did not yet affect on the emergency response arrangements during 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, 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 2011. In the summer 2011, the licensee and the plant supplier announced that modifications will be made to the process and electrical systems of the plant unit; some of them will also require STUK's approval. Some of the modifications have been made as a result of the requirements STUK has imposed on systems design, but the majority of modifications have arisen from the licensee's and the plant supplier's own requirements. The modifications made to the systems design will also require the corresponding safety analyses to be updated so that the final conformity of the design with the requirements can be assessed. Several updates have also been submitted for the equipment plans. The plans submitted to STUK had not been sufficiently finalised or inspected by the licensee and the plant supplier. This conclusion is also supported by the observations made in connection with the inspections carried out as part of the inspection programme during construction that unfinished plans had been submitted to STUK for approval.

There are also open questions remaining regarding the overall architecture of I&C design, such as implementation of the defence-in-depth principle throughout the I&C system, the independence of different I&C systems from each other, compliance with the fault tolerance criteria and the suitability of equipment platforms for their intended purpose. STUK has emphasised to the licensee and the plant supplier how important it is to settle the open principal questions before starting the inspection of the detailed system design of the I&C system.

The construction work at the plant site was completed in 2011, apart from certain finishing work and the office building that TVO is having built. Concrete construction has continued to proceed almost without problems, and the procedures created for, among other things, determining the readiness for concreting have proven to function well. The installation of steel platform and support structures continued inside the building. The importance of the platforms has increased because pipelines and equipment important to safety will be supported on them unlike in the original plans. STUK has discovered numerous deficiencies in the plans for the steel platforms; some of them will also lead to structural modifications. The platforms must comply with the requirements of YVL Guides before they can be finally commissioned.

Installation of the mechanical and electrical equipment, pipelines and cables of the nuclear island continued at the plant site during 2011. The installations of the plant's primary circuit and its associated equipment were completed in the summer 2011, after which the work for inserting the internals of the reactor into the reactor pressure vessel commenced. Installation of the primary circuit and its equipment went well, apart from the grinding of butt welds made at the plant site where the appropriate quality requirements were not complied with. Many different deficiencies have been discovered in the construction inspections and pressure tests of the pipelines, which is why the inspections or tests have on many occasions been prevented from being performed. In its communications with the licensee, STUK has stressed the importance of ensuring the readiness for inspection in advance. STUK has earlier required the same procedure to be followed with inspections carried out at the place of manufacture.

Significant deviations were detected in 2010 in the design and manufacture of the auxiliary equipment for emergency diesel generators, and STUK initiated investigations into the matter, completed in the spring of 2011. TVO and the plant supplier assessed the conformity of the auxiliary equipment manufacturers' quality management, and most of the construction plans for the auxiliary equipment were submitted to STUK for processing. In its inspections, STUK has noticed further deficiencies in the plans. They require investigations and reports by TVO and the plant supplier. The problems related to the design and manufacture of auxiliary equipment have delayed the installations in diesel

Procurement of the emergency diesel generators (EDGs) for Olkiluoto 3 was investigated

During the inspections it carried out in 2010, STUK had in particular noted the poor quality of the design documents of the auxiliary systems and equipment of Olkiluoto 3's emergency diesel generators. On the basis of these observations, STUK suspected that there were deficiencies in the quality management of the licensee (TVO), the plant supplier (Areva) and the supplier of auxiliary equipment, and required TVO to carry out follow-up inspections (audits) at the main supplier of auxiliary equipment for the EDGs (Alstom) and its main subcontractors. The audits revealed that Areva had not provided Alstom with up-to-date design criteria that should have been used as the basis for designing and manufacturing the diesel generators, nor had it provided Alstom with the latest quality management policies to be followed in the Olkiluoto 3 project. There was no evidence on transferring the quality assurance requirements of the plant supplier to the equipment manufacturers, nor had the manufacturers been required to have project-specific quality plans. STUK considered the audit findings to be significant because they made it doubtful whether the EDGs and the quality management in their supply chain met the nuclear safety requirements concerning equipment important to safety.

On 26 November 2010, the Director General of STUK initiated an investigation regarding the supply of EDGs and associated auxiliary systems for Olkiluoto 3 with a view to assessing the actions of different parties in this procurement and to making recommendations for similar supply projects in the future. The investigation established the course of events in the procurement of EDGs as well as the control and monitoring procedures observed by the license holder and the plant supplier. The investigation also assessed STUK's own procedures and oversight activities.

The procurements for emergency diesel generators were mainly carried out during 2005–2006 following a brief pre-design phase. This was only the second subcontract procurement carried out by the plant supplier. The complex contractual arrangements hampered the supply management. The supplier of the EDGs was a consortium of SEMT Pielstick (nowadays MAN Diesel) and Alstom TPEG, the former supplying the diesel engines and Alstom the generators and their auxiliary equipment, parts for the auxiliary systems as well as electrical and I&C equipment. Alstom has almost 30 subcontractors, 10 of which further continue to the next supplier level who in turn rely on component-level supplies. Most of the organisations/subcontractors participating in the project had little or no experience at all of supplying the nuclear industry. The lack of experience seems to have contributed to the problems observed.

Basic design was initially guided by incomplete definition of requirements, their management in the course of the supply project and differing ideas of the standard of requirements. One reason for the problems was the fact that the design documentation progressed in parallel with the manufacturing process or lagged behind it, and the modification needs observed in it were not monitored at TVO or STUK using such a systematic approach that would have revealed the recurrence of these needs in time and allowed for addressing their causes.

The manufacturing process of parts for the auxiliary systems of EDGs had communication problems caused by the long subcontracting chains and defects in quality assurance due to the inaccurate definition of requirements. Control of the subcontracting chains and quality control of the parts was a demanding task for all parties concerned. Initially, TVO was not fully aware of the length of the supply chain, and its control did not reach the full extent of the supply chains. Initially, the EDG project was in the hands of electrical engineering experts at the designing organisation, the plant supplier, the licensee and the regulatory authority alike, and the flow of information between different engineering disciplines did not work flawlessly. The result was that the definition of requirements and quality management of mechanical equipment received less attention.

The event highlighted the issue of using serially produced parts in the safety-classified systems and installations of nuclear plants. The equipment and components intended for nuclear plant use have specific requirements related to their intended use; for example, regarding the inspections during manufacture and the traceability of materials. The investigation revealed that TVO had interpreted STUK's standpoint to be that it had approved the use of serially produced parts without supplementary quality assurance. This interpretation led to the construction plans for equipment and components used in the auxiliary systems of EDGs to be incomplete and contributed to a situation where the suppliers were not required to have project-specific quality plans. STUK required the quality of the diesel generators and their auxiliary equipment to be assessed and their compliance with the required level of safety to be demonstrated.

buildings; work was suspended for the whole year.

TVO and the plant supplier have begun preparations for starting the commissioning of the plant unit. In the summer 2011, STUK reviewed the capabilities of Siemens and TVO to start the commissioning of the turbine island and found them to be sufficient after a few document updates. Due to the unfinished state of I&C design, processing of the commissioning plans for the process and electrical systems of the nuclear island was suspended at STUK, because the operation of the controlling I&C system is to be in part tested in the same connection. Besides technical trial runs, commissioning also includes verification of the organisational capabilities to operate the plant in a safe manner. Safe operation requires, for example, the availability of a sufficient number of licensed operators and maintenance personnel familiar with the plant. The required operating manuals must also be available for the plant. The unfinished state of system design has prevented the training simulator at the plant from being finalised and the simulator training of operators from being started. The production of operating manuals has also been delayed due to the unfinished state of system design.

TVO and the plant supplier have jointly audited the contractors working at the plant site in order to ensure that their activities are appropriate. The operations of contractors working at the Olkiluoto 3 site were audited systematically up to the summer 2011, but after that, the audits were postponed until 2012 because the plant supplier did not have a sufficient number of qualified lead auditors at the Olkiluoto 3 site. Since then, the plant supplier has decided to increase the number of lead auditors at the plant site and has drawn up a comprehensive plan jointly with TVO for auditing the contractors in 2012.

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 areas of technology has become more detailed. Defects detected in manufacturing and installation 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. TVO has been systematically developing and introducing procedures related to the development and monitoring of safety culture at the Olkiluoto 3 site. The application of monitoring procedures is well-established, and the activities have been organised in an unambiguous manner. 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

Plant and system design

STUK continued to review the detailed design of process, support and electrical systems. The design of process, ventilation and electrical systems has for the most part been processed at STUK, apart from the approval of a few cooling units of the cooling water system; their method of implementation is yet to be decided. In addition, updates requested by STUK are still awaited for a few system descriptions. TVO also announced in the summer 2011 that the plant supplier is in the process of making modifications to plant systems that will require STUK's approval.

STUK continued to review the overall architecture of I&C systems. STUK has required that TVO and the plant vendor specify unambiguous requirements for the design of the overall architecture of I&C systems, and that the I&C architecture created on the basis of the requirements is described. The descriptions of architecture presented to STUK will still need to be supplemented with respect to the presentation regarding the defence-in-depth principle as well as with respect to the presentation and analysis of 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.

The third 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 device and other failures. STUK has required that the realisation of the requirements for independence and failure criteria must be demonstrated by means of analyses. In 2011, TVO submitted an analysis regarding the fulfilling of failure criteria in protection system to STUK for review. STUK reviewed the analysis and stated in its decision that it cannot be approved before the system description of the protection system with its associated documentation has been processed.

The work for qualifying the equipment platforms of the I&C systems is still in progress. During 2011, STUK reviewed the documentation regarding the equipment platform intended for discrete systems. Review of the equipment platform intended for Safety Class 2 I&C systems began. The documentation regarding the equipment platform intended for the plant operation I&C and certain Safety Class I&C systems was not submitted to STUK.

When inspecting the I&C systems for emergency diesel generator's load shedding, STUK found that a function of a lower safety class may in an unfavourable situation overload the EDGs. STUK has required TVO to investigate further and account for the impacts of the faults and malfunctions of I&C systems of lower safety classes on the electrical systems and other functions of higher safety classes. These accounts were not submitted to STUK by the end of 2011.

In 2011, STUK reviewed the updated common cause failure analysis concerning the independence of the plant's systems and their equipment of other systems and equipment. In its decision, STUK required that the analysis be further specified so that implementation of the diversity principle in the plant's safety functions can be verified.

Transient and accident analyses

In 2011, STUK received for inspection an updated analysis of overpressure protection during power operation and an updated analysis of the behaviour of the plant unit in a transient situation in normal connection with the national grid where power is supplied through an external auxiliary connection. Inspection of the analyses is still in progress.

Probabilistic risk analyses (PRA)

The review of Olkiluoto 3 probabilistic risk analyses in 2011 focused mainly on the assessment of the scope and traceability of documents submitted for information. New risk analyses were not submitted to STUK in line with the earlier presented time schedule. Furthermore, there will be changes to the PRA documentation submitted for information as the detailed design progresses.

In 2011, STUK continued the assessment of the fulfillment of the fundamental design principles in the detailed design documentation for systems and structures from the risk perspective. The key documentation has included pre-inspection documentation of systems, topical reports and construction plans for the fuel handling systems. In addition, the aim has been to ensure that adequate provisions have been made against area events (internal fires and flooding) and external events. For the PRA documents submitted for information, the contents and scope of the first phase of fire risk analysis have been assessed. Since the detailed design of I&C systems is not finalised, the reliability assessment of the overall implementation of I&C requested by STUK has not been submitted yet.

Radiation safety

During 2011, STUK continued the inspection of compliance with radiation safety requirements as part of the inspection of process systems and structural radiation protection. In connection with the suitability assessment of electrical and I&C equipment, STUK also inspected fulfilment of the requirements regarding the radiation resistance of equipment in normal use and during accident situations.

During 2011, STUK participated in the factory tests of the first instruments for the radiation measurement systems for Olkiluoto 3 as well as in the audit of the manufacturer of these systems.

STUK approved the limits for radioactive substance releases during normal operation of Olkiluoto 3. The release limits will be included in the Technical Specification that will be submitted to STUK for approval in connection with the operating licence application.

Fire safety at the plant

STUK reviewed the updated structural fire hazard analyses (FHA) of the plant, the purpose of which was to demonstrate that the plant structures will withstand the fire loads in fire compartments. In addition to the structural fire hazard analyses, STUK reviewed fire hazard functional analyses

(FHFA) showing the impact of fires on the safety functions of the plant. In the future, all analyses must still be updated for conformity with the final plant design and final cable routes. Furthermore, STUK requires that the plant's defence-in-depth is verified by sensitivity analyses where fire protection measures are assumed to be in a deteriorated state; for example, so that the fire dampers installed at the plant are inoperable.

VTT completed its fire safety investigations regarding the fire-retardant power and I&C cables to be installed at Olkiluoto 3 and produced a summary report in April 2011. The properties of the cable types presented by the plant supplier were assessed from the point of view of fire safety and found to be appropriate regarding the general-level fire protection arrangements of the plant. STUK is still waiting for the licensee's account regarding demonstration of the sufficiency of fire protection in certain cable rooms and routes. Further investigations and accounts are also required for those cable types that were not investigated by VTT. Following these additional investigations, STUK will make an overall assessment of the acceptability of the fire risk carried by FRNC cables.

The plant supplier and the power company found that flooding caused by a possible rupture in the fire water pipeline in the annulus space between the inner and outer containment walls could put safety functions at risk. Consequently, a bypass line and valve arrangement was designed for the fire water line so that the leaks can be limited to an acceptable level concerning the flooding risk while securing sufficient fire extinguishing capacity for the early stages of possible fires. STUK continued the inspection of the updated risk assessment regarding the risk of flooding in the annulus caused by the fire water system. STUK will perform an overall assessment of the acceptability of the annulus flooding risk on the basis of PRA level 1 and 2 risk assessments.

Design of components and structures

STUK continued the review of detailed plans for Safety Class 2 components and structures in 2011. The key objects of this review were the construction and work plans of concrete and steel structures, as well as the construction plans of mechanical equipment and their updates. STUK has reviewed and approved almost all construction plans concerning safety classified concrete structures. Approval will still be sought for minor concrete casting operations to be done during the installation of certain components. The plans for the steel cladding of fuel pools have, on the whole, been approved so that some plans related to the closer specified cleanliness requirements of surfaces set by STUK are still being reviewed by STUK. A major part of the planning documentation of steel platforms, originally only intended for use as maintenance platforms, is yet to be reviewed. The safety importance of the steel platforms has increased because process pipelines and equipment important to safety will be supported on them unlike in the original plans. This applies to about 150 different steel platforms. STUK has reviewed the design documentation of these steel platforms and discovered numerous deficiencies; some of them will also lead to structural modifications. STUK has approved a procedure whereby the steel platforms can be partially commissioned for equipment installations after construction inspections done in stages provided that the requirements are fulfilled before the final commissioning of the steel platforms. STUK has paid inspection visits to the site and verified that TVO's inspections have progressed in line with the approved procedure. STUK will review the final design documentation of steel platforms before starting its own commissioning inspections where fulfilment of the requirements will be finally verified.

During 2011, STUK continued the inspection of final strength analyses of the main components of the primary circuit. STUK was provided with supplementary and modification documentation on the strength analyses where the modifications made during manufacture had been taken into account. The basic inspection plans of periodic inspections, periodic inspection programmes and qualification documentation concerning inspection systems compliant with YVL Guide 3.8 regarding pressure vessels, heat exchangers, pumps, valves and pipelines continued in 2011.

The design work regarding the reactor plant pipelines continued in 2011. Calculations of pipeline support structures and pipeline stress analyses as well as construction plans and updates concerning Safety Class 1 and 2 components were submitted to STUK for review. The amount of inspection work carried out by STUK in 2011 remained high due to the large amount of design modification documentation.

The design work concerning the I&C systems of fuel handling systems and Safety Class 3 cranes continued in 2011, and no plans compliant with the requirements were submitted to STUK for assessment. Some of the subject cranes have been used for installation work at the Olkiluoto 3 site before the approval of design documentation regarding the I&C systems and the equipment tests required by the safety classification. However, approval of the design and tests is a prerequisite for the final commissioning transfer and of lifting equipment before fuel is loaded in the reactor. The design work and manufacture of auxiliary equipment for the emergency diesel generators continued in 2011. Several deficiencies had been detected in the construction plan for auxiliary equipment in 2010, and the acceptability of certain manufacturers' quality management had remained an open question. The results of STUK's investigations in the matter are shown in Section 4.3.1, "Overall safety assessment of Olkiluoto 3". TVO and the plant supplier assessed the conformity of the manufacturers' quality management, and most of the structural plans were updated and submitted to STUK for review. In its inspections, STUK has observed further deficiencies in the plans. They require investigations and reports by TVO and the plant supplier. The problems related to the design and manufacture of auxiliary equipment have delayed the installations in diesel buildings; work was suspended for the whole year.

Construction and commissioning of structures and buildings

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 concreting. The final massive concrete structures were the outer containment dome cast during January–February and the roof structures of the airplane crash shelter. Concrete casting has been successful from a technical point of view. Provisions were made at the site for power cuts during casting work, for example.

The procedures to determine readiness to start concrete casting, post-tensioning and grouting have proven to function well. These procedures have served to ensure that the plant vendor and TVO have reviewed and approved the plans for the structures and the work to be carried out before STUK is requested to give permission to start the work.

The steel cladding of the pools containing radioactive material during the operation of the plant was completed. STUK called attention to the cleanliness and appropriate corrosion protection of the steel cladding surfaces before an acceptable result was achieved.

STUK performed the first commissioning inspections when it inspected the acceptability of concrete and steel structures at the mouths of cooling water intake and discharge tunnels. Following the successful commissioning inspections, sea water could be let to the gates at the tunnel mouths.

4.3.3 Manufacture

Manufacture of main components

The installations of main components for the primary circuit were completed during 2011. The manufacture and testing of control rod mechanisms continued during the year, and the mechanisms were delivered to Olkiluoto at the end of 2011. STUK oversaw the manufacture and factory tests of the control rod mechanisms in France. It was found during the factory tests that the inner surfaces of the mechanism guide tubes were scratched. STUK required supplementary tests for two control rod mechanisms. The intention is to perform the tests in early 2012.

Manufacture of other equipment

During 2011, STUK also oversaw and inspected the manufacture of Safety Class 1 and 2 pipelines, tanks, heat exchangers, pumps, valves and steel structures. STUK maintained a permanent oversight at the German factory manufacturing pipeline prefabricates until September 2011. STUK also oversaw and inspected the manufacture of fuel handling equipment and Safety Class 1 and 2 valves.

In addition to the oversigtht of the manufacture of pressure equipment and steel structures, STUK oversaw 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 complies 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 inspection are in place. TVO and the plant vendor have changed their supervision and inspection procedures so that the aim is to ensure readiness for inspection prior to STUK's inspection.

4.3.4 Installation work

The welding operations on primary circuit pipelines continued in early 2011 with the pressurizer surge line welds. The connecting line welds were completed in the spring, and all the welds in the primary circuit were complete. STUK inspected the welds and saw no cause for remarks. However, appropriate quality requirements were not observed when grinding the weld, which means that the ground surface profile will make future periodic inspections more difficult. The suitability of the joints for periodic inspections will be verified during 2012. STUK also performed a cleanliness inspection inside the entire interior of the primary circuit, and did not find any deficiencies. Installation of the inner parts and motors of the reactor coolant pumps was completed. Installation of the reactor internals began in the summer and continued for the rest of the year, including the work for setting clearances and installing temporary vibration measurements. The work for fitting equipment on the reactor pressure vessel cover head began and will continue in early 2012 with installation of the control rod mechanisms.

In an inspection carried out in a storage room at Olkiluoto before the installation of Steam Generator 3, STUK observed that the exterior of the steam generator had damage caused by improper handling. There was surface damage in about 10 points on the same circumference. The damage was ground smooth after installation. The repairs were approved in an inspection by STUK.

Welding work on the cladding in the reactor building and fuel building pools continued throughout the year. Some of the pools were completed and filled with water for leak testing. The results of leak tests were acceptable. The installation of filters in the emergency cooling water pool began in the spring and continued for the rest of the year. Repairs of factory welds and inspections were also carried out on the filters.

The installation of pipelines and pipe supports at the reactor plant continued at an increasing rate. STUK has discovered many different deficiencies in the construction inspections and pressure tests of the installed pipelines. The repairs of these deficiencies have slowed down the inspections and, as a whole, STUK has spent a lot of oversight resources on the inspection when compared to the results achieved.

The diesel generators were hauled to their locations but were not yet finally fixed in their respective component locations because the installation work on EDG systems had been suspended.

During the year, STUK has pointed out deficiencies in the cleanliness of the site on many occasions. The installation of primary circuit components and electrical equipment, for example, requires a high standard of cleanliness. The level of cleanliness at the installation sites has improved, but STUK will continue its close monitoring.

Installation work on the electrical equipment and cabling continued at the reactor plant throughout 2011. Approximately 70% of the reactor plant cables had been installed by the end of 2011. Almost all low- and medium-voltage switchgears and distribution and control transformers had been installed. Most of the other electrical equipment (rectifiers, battery arrays, inverters and converters) have been installed. Cable connection work has also been in progress throughout 2011.

The low-voltage cable trays in the plant's main cable routes are rather full, which is why the trays have to be made wider or parallel trays have to be installed, and the dimensioning of certain cables may have to be reconsidered. TVO will present the modification needs to STUK in early 2012. Following a change in the cabling principles, TVO has provided STUK with a new cabling concept for approval. The essential change is that of covering the I&C cable trays in locations where cable routes cannot be kept sufficiently far apart from each other. By covering or otherwise protecting the trays, smaller distances can be used between safety classified and unclassified I&C and power cable trays. STUK will decide the matter in early 2012.

During 2011, STUK inspected TVO's installation supervision in several inspections carried out in accordance with the inspection programme for the construction stage in order to ensure the adequacy of TVO's supervision procedures. Adherence to the approved instructions and procedures was monitored during daily inspection rounds. STUK also participated in quality audits carried out by the plant supplier and TVO at the plant site. No significant deviations were observed.

4.3.5 Commissioning

STUK oversaw the activities of the licensee and the plant supplier in preparing for commissioning. The commissioning itself has been delayed and did not commence during 2011.

Inspection of trial operation plans is an important element of STUK's oversight work. The unfinished state of I&C design also affects the commissioning plans. Early in the year, the plant supplier announced that testing of the I&C systems will be included in the trial operation of process systems; this was a deviation from the earlier information. STUK required that the role of process system trial operation in the testing of I&C systems be announced. The comprehensiveness of test programmes cannot be assessed before such information is available. STUK continued the inspection of test programmes that were submitted before requesting the additional information, , but most of them could not be approved due to ambiguities regarding the I&C tests.

STUK continued the inspection of administrative procedures regarding commissioning. The administrative procedures are described in the commissioning manual that is submitted to STUK for information. STUK had no remarks to make concerning the administrative procedures, apart from procedures concerning the processing and approval of modifications where STUK required amendments to be made.

During the year, STUK preformed two inspections of commissioning activities. The first inspection concerned the procedures for processing modifications made during commissioning and the training of commissioning personnel. During the inspection, STUK noted deficiencies in the tools for managing open questions and in the training plans. The deficiencies were rectified after the inspection.

In June, STUK reviewed the readiness of TVO and Siemens to commence commissioning operations at the turbine plant. In the inspection it was found that the organisations have made sufficient preparations for starting the commissioning. The procedures have been created and instructions issued for them, the personnel have been trained and the required tools are available. Some of the procedural instructions required at the beginning of the commissioning process were not yet available at the time of the inspection. STUK required TVO to approve the instructions and submit them to STUK before commissioning of the turbine plant may begin. The instructions were submitted to STUK during the autumn.

Before the trial operation of the systems starts, the commissioning inspections of components and systems must be performed. STUK continued the planning of commissioning inspections, both internally and in cooperation with TVO and the plant supplier. During the year, STUK performed the first commissioning inspections of individual components.

Besides technical trial runs, commissioning also includes verification of the organisational capabilities to operate the plant in a safe manner. Safe operation requires, for example, the availability of a sufficient number of licensed operators. The required operating manuals must also be available for the plant. Two meetings were held during the year between STUK, TVO and the plant supplier to discuss the progress made in operator training and in the production and validation of instructions. The problems in I&C design work mean delays in all these areas.

The training simulator was brought to Olkiluoto in the summer, and the factory tests of the simulator were completed at the plant site. The trainee operators began practising the start-up and shutdown of the plant using the simulator. The simulator has not yet been approved for training use because it does not yet correspond to the final design of the plant. STUK has required TVO to approve the simulator for training use before starting the training and present the grounds for this approval to STUK.

In the autumn, STUK received for information the validation plan for operating instructions. The plan was of a very general nature and did not allow STUK to satisfy itself that the validation would be comprehensive and appropriate. STUK required the plan to be updated and detailed plans to be produced for certain parts of the validation process. The situation regarding the instructions was also discussed in an inspection of the preparations for the operating licence application, performed as part of the construction inspection programme. Following the inspection, STUK required TVO to provide STUK with a description of the structure of instructions and a time schedule of the instructions to be submitted to STUK in relation to the submission of the operating licence application.

4.3.6 Organisational operations and quality management

The total number of personnel working at the Olkiluoto 3 project site was about 3,200 at the end of 2011, of which about 2,800 were in the plant supplier's site organisation and about 350 were in TVO's project organisation. TVO's project organisation consists of in-house project personnel (about 60), TVO's line organisation personnel (about 80) and consultants (about 210).

In 2011, changes were made in the project organisation of Olkiluoto 3 in preparation for the commissioning and future operation of Olkiluoto 3. One essential change in the organisational structure was the combination of TVO's installation supervision function and the independent quality control into one unit. STUK saw no objection to the combination from the point of view of independent quality control because TVO's own installation supervision is also independent of the actual performance of work.

STUK inspected the sufficiency of resources in electrical and I&C quality control. The quality control resources were found to be sufficient for the work in progress in 2011, but the licensee must reassess the situation as the amount of electrical and I&C installation work increases. ,In 2011, TVO and the plant supplier increased the I&C design resources in particular. STUK's earlier observations indicate that the project organisation of Olkiluoto 3 and its structure are appropriate for supervising the construction of the new plant unit, but because of the organisational model, STUK considers it to be an important challenge to transfer and secure sufficient competence from the construction phase to the commissioning of Olkiluoto 3. In 2011, TVO also continued to plan the licensees' future or-

Safety culture at the Olkiluoto 3 construction site

TVO has been systematically developing and introducing procedures related to the development and monitoring of safety culture at the Olkiluoto 3 site since 2008. The application of monitoring procedures is well-established, and the activities have been organised in an unambiguous manner. In 2010, the license holder carried out a self-assessment of TVO's safety culture that also covered the personnel and consultants of the OL3 project. The assessment did not identify any differences between the safety cultures in TVO's plants already in operation and the Olkiluoto 3 project organisation; the results were similar in both organisations. The site interviews and observation visits made by STUK indicated that the overall state of safety culture at the Olkiluoto 3 site is good.

Thousands of deviations have been detected in different products during the Olkiluoto 3 project. The deviations have been processed in compliance with the guidelines observed in the project and rectified or approved as they were before commissioning the subject system. However, weaknesses in the operation or safety culture of organisations are not readily identified in connection with processing deviations. STUK is of the opinion that this is more affected by the practice observed in the project to see deviations as cases of technical problems and their rectification instead of seeking to identify systematically the underlying organisation-related factors behind the technical deviations. In its oversight work, STUK has observed deviations that should also be discussed when assessing the reasons for the deviations and the safety culture of the Olkiluoto 3 site as a whole. Such deviations include, for example, deficiencies in the cabling concept and observations regarding the quality of work of welding contractors. On the basis of observations made during inspections, STUK has recommended that TVO should assess the safety culture by utilising more extensively the available sources of information, such as deviation reports, site events, audit reports and other observations regarding the operations of subcontractors, the plant supplier and TVO. TVO has added the audit observations and processing of deviations to the safety culture monitoring procedures.

ganisation and prepared for the commissioning of Olkiluoto 3.

TVO's independent quality assurance unit monitors the quality of the Olkiluoto 3 project and its management by processing any critical deviations observed in the operations of the plant supplier and its subcontractors, product deviations and audit results, as well as by recording into statistics and analysing information pertaining to the reasons for deviations. In 2011, the quality assurance unit focussed its operation in particular on the management of open questions, I&C design and commissioning preparations. TVO and the plant supplier continued the development of procedures and tools required for the follow-up and management of open questions. One concern at Olkiluoto 3 is the large number of open issues and the postponement of their solutions to the operating licence phase. TVO's follow-up records indicate that there were over 6,000 open requirements by the regulatory authority in the Olkiluoto 3 project at the end of 2011.

TVO implemented the internal audits of the Olkiluoto 3 project in line with the plans. The actions of contractors working at the site were audited systematically up to the summer 2011, but after that, the audits were postponed until 2012. According to TVO, the audits were not carried out because the plant supplier did not have a sufficient number of qualified lead auditors at the Olkiluoto 3 site. On the basis of its inspection observations, STUK made an additional inspection of the activities and resources of Areva's OL3 Quality Management in January 2012. It was established during the inspection that AREVA has plans to increase the number of lead auditors at the plant site, and the company has drawn up a comprehensive plan jointly with TVO for auditing the contractors in 2012.

STUK's investigations regarding the procurement of emergency diesel generators (EDGs) were completed in the summer 2011. The results of the investigations are shown in Section 4.3.1, "Overall safety assessment of Olkiluoto 3". The results of the investigation show that the nuclear industry-specific requirements were not appropriately conveyed in the supply chain. During 2011, the plant supplier investigated the deficiencies in the quality management of its suppliers, their safety implications, as well as the corrective actions for demonstrating the conformity of auxiliary equipment. A significant part of STUK's resources available for the quality management of Olkiluoto 3 was used for reviewing the accounts submitted and for verifying the sufficiency of the suppliers' quality management.

In 2011, STUK performed one inspection of the licensee's procedures for monitoring the conformity of design documentation and the safety implications of requests for deadline extensions. The inspection indicated that the licensee has sufficient procedures and competencies in place for identifying the deficiencies in design documentation, but that the licensee's procedures allow submitting incomplete documentation for review by the authority. STUK required the licensee to specify further its procedures and independent quality assurance so that basically, incomplete documentation will not be submitted for the authority review. In addition, STUK required the licensee to develop its key indicators to allow the conformity of design documentation submitted to the authority being systematically monitored in the Olkiluoto 3 project organisation. In early 2012, STUK will subject the conformity of documents to special scrutiny.

The quality management system of the Olkiluoto 3 project was developed in a more risk-based direction. The systematic identification of risks related to nuclear safety, quality and organisational activities developed clearly from 2010. In its inspections, STUK has emphasised the importance of further developing the risk management of the Olkiluoto 3 project. STUK will oversee the implementation of planned development activities in 2012.

TVO had to implement an independent assessment of the Olkiluoto 3 project management system in compliance with the 2008 implementation decision of YVL Guide 1.4. TVO only started the assessment work in the autumn of 2011 so that completion of the assessment was postponed until 2012.

4.4 Actions required following the Fukushima accident

Actions after the Fukushima accident

Following the Fukushima accident, several investigations were initiated regarding how the lessons learned from the accident should be taken into account in improving the safety of nuclear power plants. In Finland, national investigations and the so-called EU stress tests are in progress. The International Atomic Energy Agency (IAEA) and the Organisation for Economic Cooperation and Development (OECD) have also initiated investigations following the Fukushima accident. The national investigations and the EU stress tests deal partly with the same issues, but they are separate and complementary to each other.

The national investigations began immediately following the Fukushima accident on 15 March 2011 at the initiative of the Ministry of Economy and the Employment. The accounts required of the licensees focussed on the issues most important to Finnish nuclear power plants. Particular attention was paid to how Finnish nuclear power stations have prepared for the effects of floods and other extreme weather phenomena on the operation of the plants and ensured the availability of electrical power in various different fault and transient situations and the success of emergency response activities even in an accident situation applying to several plant units when the external infrastructure has been destroyed. The investigations also looked at plant unit-specific possibilities to make changes for improving safety.

STUK submitted its report based on the licensees' assessments to the Ministry of Employment and the Economy on 16 May 2011. The national investigation did not reveal any such new threats or deficiencies that would have required immediate improvements to safety. However, STUK's decision associated with the national investigation deemed it necessary to continue more detailed plant unit-specific investigations regarding preparedness for certain exceptional environmental conditions. The purpose of these investigations was to assess the need for plant modifications to improve safety further. The assessment is particularly based on situations that simultaneously jeopardise the operation of several parallel safety systems or several levels of the in-depth defence. STUK received the power companies' responses to its requests for improving the safety of plant units on 15 December 2011. The need for plant modifications will be assessed on the basis of these responses.

The EU's stress tests for NPPs in operation and under construction were initiated in parallel with the national safety investigation. The purpose of these assessments is to establish how the plants would cope with exceptional external events and other situations associated with the simultaneous loss of operability of several safety systems. The investigation request associated with the stress tests was sent to the power companies on 1 June 2011, and they submitted their reports to STUK on 31 October 2011. The national report produced by STUK on the basis of these licensees' reports was sent to the European Commission on 30 December 2011. The stress tests will continue in early 2012 with an international peer assessment, whose final report is scheduled for completion by 30 April 2012.

4.5 Preparation for new projects

In 2008 and 2009, Teollisuuden Voima (TVO), Fortum and Fennovoima (FV) applied for the Government's decisions-in-principle regarding the construction of new nuclear power plant units in Finland. The decision-in-principle process includes STUK's preliminary safety assessment in compliance with the Nuclear Energy Act. STUK completed this assessment in October 2009 when the preliminary safety assessment concerning Fennovoima was submitted to the Ministry of Employment and the Economy. The Government rejected Fortum's application and made on 6 May 2010 positive decisions-in-principle regarding TVO's and Fennovoima's new plant units. In its decision regarding Fennovoima, the Government reduced the number of possible plant units from two to one. At the same time, the Government issued a positive decision-in-principle to Posiva regarding the final disposal of spent fuel from TVO's new NPP unit. Parliament ratified the Government's decisions-in-principle before its summer recess on 1 July 2010. Following the Government's decision-in-principle process, Fortum ended its Loviisa 3 project.

The next licensing phase prescribed in the Nuclear Energy Act for new NPP units will be the construction licence phase. In its decision-in-principle, the Government ordered that the power companies must apply for the licence prescribed in the Nuclear Energy Act for initiating the construction of the NPP unit (construction licence) within five years from Parliament's decision to uphold the decision-in-principle (2015).

STUK has established an oversight project (VALVE) in preparation for the construction licence application processing phase of Olkiluoto 4 and Fennovoima's Hanhikivi 1 NPP units. In its preparatory project, STUK has collected, classified and analysed experience from the Olkiluoto 3 oversight project. In addition to analysing written documentation, the managers of projects and sub-projects participating in the oversight project were interviewed. The experience gained will be utilised when preparing for new projects. In addition, an Olkiluoto 3 experience seminar was organised for all power companies, Posiva, the Advisory Committee on Nuclear Safety and STUK as part of the VALVE project. In addition to experience from the Olkiluoto 3 project, the seminar also discussed the impact of the Fukushima nuclear accident on new power plant projects.

STUK continued to work closely with the power companies regarding the design maturities, feasibility of plant alternatives and sites. In these meetings, STUK was presented with the preparations of power companies for the projects, and STUK presented observations regarding the organisational capabilities of the power companies. STUK also participated in the power companies' meetings assessing the feasibility of plant alternatives, where the impact of Finnish nuclear safety requirements on the design of plant alternatives was discussed. In compliance with Section 2.2 of YVL Guide 1.1, STUK assessed the safety-related sections of Teollisuuden Voima's and Fennovoima's invitations to tenders.

STUK studied the design basis regarding plant sites for Fennovoima and processed them as received for information. Following the choice made regarding Fennovoima's plant location, STUK organised, at the invitation of the Municipality of Pyhäjoki, a briefing event and press conference for the inhabitants of Pyhäjoki and the media.

4.6 Research reactor

The operating licence period of VTT's FiR 1 research reactor expired at the end of 2011. In November 2010, VTT submitted an application to the Government for renewing the operation licence. STUK reviewed and approved the submitted documents in compliance with the Nuclear Energy Decree, prepared its statement and issued a safety assessment for the Ministry of Employment and the Economy in October 2011. According to STUK's assessment, the nuclear safety of the FiR 1 reactor, the condition of its structures, systems and components, as well as its human resources are sufficient for continued safe operation. The Government granted the FiR 1 reactor an operating licence valid until 2023. The licence carries the conditions consistent with the statement of STUK regarding the planning of management of the uranium from the subcritical test equipment preceding the reactor and the spent nuclear fuel from the reactor in 2014 and regarding an interim safety assessment in 2020 if the reactor is still used at that time.

The issues in STUK's safety assessment requiring immediate follow-up will be reviewed in 2012. In addition to the safe operation of the reactor, STUK pays particular attention to safety management, more specific planning of decommissioning with respect to nuclear waste management, and to the development of physical protection.

During 2011, the research reactor was used, among other things, for radiation treatment of patients and for isotope irradiation operations ordered by external parties. In addition, the reactor is used in the basic courses in reactor physics organised annually for the students of universities in Espoo, Lappeenranta, Stockholm and Uppsala. The reactor had about 200 start-ups during the year.

During the year, STUK carried out inspections on the operational safety, physical protection, emergency preparedness, nuclear safeguards, nuclear waste management and radiation protection of the FiR 1 reactor.

The licences of the two managers and two operators of the reactor were renewed at the beginning of 2011. In November, an oral examination of managers and operators was organised at the FiR 1 reactor. STUK issued its approval decision for 2012–2015 on the basis of the results of the examination.

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 permit; comprises the on-going construction of an underground research facility, Onkalo.
3. Construction stage: from the construction permit 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 the year before to the effect that the final disposal of spent nuclear fuel from the Loviisa and Olkiluoto NPPs 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 indicates 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. The decision-in-principle regarding final disposal of spent fuel was later extended to cater for the Olkiluoto 3 and 4 plant units.

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

5.1 Spent nuclear fuel disposal project

In 2011, during the "research construction stage", the preparations for the disposal project progressed both with respect to the construction of Onkalo and with respect to producing the construction licence documentation. Posiva achieved the depth of 437 metres in the excavation work for Onkalo, and most of the underground technical rooms were completed. In addition, Posiva excavated the underground demonstration tunnels to be used for demonstrating the functionality of the disposal system. During 2011, STUK reviewed and approved an amendment to the overall plan of Onkalo, aimed at increasing the underground research work on the bedrock. In addition, STUK approved the tunnel section-specific design documentation important to safety, according to which Posiva implemented the Onkalo excavation operations.

Posiva is making preparations for the construction licence application to be submitted at the end of 2012, and STUK made preparations for reviewing the licence application as part of its oversight activities in 2011. Finalising the review of the draft documentation for a construction licence, submitted by Posiva at the end of 2009, and communicating the review observations related to the demonstration of safety to Posiva constituted the key elements of oversight.

5.1.1 Oversight of Posiva's management system

STUK completed its review and assessment of the change in Posiva's management system and approved the management system coming into force. Since STUK's previous review, Posiva has significantly changed its method of operations by changing from a line organisation to a matrix organisation and by starting to operate more clearly in a process-oriented manner. STUK required changes be made in the operations management system regarding, among other things, clarification of the responsibilities of individual employees and groups guiding the activities, as well as description of the nuclear non-proliferation process. In connection with Posiva's organisational change, STUK approved the Posiva person responsible for the construction of Onkalo with remarks related to the training programme to be created for familiarising the person and to the way the deputy to the person responsible for construction is determined according to the description of Posiva's operations management system.

5.1.2 Oversight of the construction of research facility (Onkalo oversight)

The construction of Onkalo is divided into five excavation stages. In 2011, excavation stage five was being implemented, together with additional excavation work associated with the stage. The excavation work concentrated on the access tunnel, pumping station area and technical rooms. In addition, the test, or demonstration, tunnels were excavated. Posiva intends to use them for demonstrating its capabilities for the rock engineering construction of disposal tunnels and for carrying out tests related to disposal. During the year, construction of the access tunnel progressed from 4,560 metres to 4,913 metres (to a depth of 455 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 safety documents.

Site inspections

STUK paid regular inspection visits to the construction site, about twice a month depending on the situation of 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 described below.

There was no need to seal the excavated access tunnel due to seepage water by injecting concrete into the bedrock. Sealing work was done in the other demonstration tunnel where silica grouting material was injected for the purpose of demonstrating the method. The systematic, final reinforcement of the bedrock by rock bolting followed the progress of excavation work. The bedrock surrounding the intake air, exhaust air and personnel shafts was sealed by injection in the depth range of 290–437 metres. Posiva had problems in achieving sufficient leak tightness in the bedrock surrounding the shafts with the previous injection operations. The matter was discussed, *inter alia*, in the inspection forming part of the inspection programme during the construction of Onkalo.

In 2011, STUK paid particular attention to occupational safety. A fatal accident occurred in Onkalo in January 2011 when a block of rock fell off the tunnel ceiling in connection with removal of loose rock materials. STUK required Posiva to produce a report of the incident. In addition, STUK required Posiva to submit reports of any similar accidents and near misses in the future. Following the occurrences of rocks falling and near misses in the autumn of 2011, Posiva changed its bedrock reinforcement practices in order to improve occupational safety in Onkalo. STUK approved Posiva's proposal for changing the reporting practice but required investigations related to the organisation of work and ensuring the availability of sufficient bedrock characterisation data.

STUK inspected the readiness to start construction work of the demonstration tunnels planned in Onkalo and granted permission to start the construction work with remarks concerning, among other things, missing system descriptions.

STUK carried out eight inspections in order to give permission for shotcreting excavated rock surfaces. The excavated tunnel sections will be shotcreted, apart from the demonstration tunnel, which will be reinforced with metal network. 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.

In the follow-up meetings regarding the construction of Onkalo, the situation in the design and construction of Onkalo was regularly discussed along with the research work carried out in Onkalo related to, among other things, the stability of the bedrock on the surface of the disposal hole. Furthermore, the development work of the Rock Suitability Criteria (RSC) system, carried out in the demonstration tunnels of Onkalo, was discussed in the follow-up meetings. The status of repository design work was also monitored in the meetings.

Posiva's construction organisation and its operating methods were the focus of the Onkalo construction inspection programme. STUK carried out nine inspections according to the inspection programme. The inspections concerned:

- Posiva's management system;
- Processing of safety issues;
- Quality management of the Onkalo project;
- Development of excavation methods used for Onkalo;
- Limitation of the amount of groundwater seeping into Onkalo by injecting concrete grouting material into the bedrock (excessive injection may disturb the favourable chemical conditions of the bedrock);
- Use and amount of foreign materials which could disturb the bedrock's chemical conditions (e.g. explosives, concrete, fuels); and
- Impacts of the construction work of Onkalo on the hydro-geochemical conditions in Olkiluoto, including research into the salinity of groundwater inside the bedrock.

The inspections in the construction inspection programme of Onkalo concentrated on, among other things, the instructions and procedures concerning the construction of the research facility. The following actions were required on the basis of the inspections:

- Update of the instructions for quality control activities;
- Delivery of test results related to hardening of the grouting material to STUK;
- Update of the outdated shaft injection plan;
- Ensuring adherence to the instructions regarding the use of foreign materials and further specification of the location of the safety data sheets of foreign materials.

STUK's regulatory oversight of Posiva's subcontractors was based on the safety significance of the work they perform. STUK participated, in the capacity of an observer, in Posiva's supplier audit concerning Destia Oy, the excavation contractor for Onkalo.

Construction document reviews

STUK approved the amendment of Onkalo's general design and the amendment of Onkalo's implementation extent intended for increasing the volume of underground bedrock research and thus helping the later migration to implementing the disposal facilities. The tunnel section leading to the second exhaust air shaft at the depth of 437 metres and the first part of the vehicle access route later leading to the technical rooms at the depth of 420 metres were approved as new Onkalo parts. Implementation of the new premises required, among other things, that an additional testing plan regarding the rock classification system developed by Posiva as well as the plans regarding rock engineering plans for the areas were submitted to STUK.

STUK reviewed Onkalo's design documents and their updates that were sent to STUK in compliance with the construction documents delivery plan and the construction communication plan produced by Posiva. STUK approved the rock engineering implementation and type plans and the update of construction communication plan with remarks concerning, among others, the following issues: Informing STUK of serious hazard situations. The key subjects for review and assessment also included the rock engineering type and implementation plans regarding additional excavation work during stage 5 of the Onkalo tunnel contract as well as their associated construction engineering drawings, reinforcement calculations, as well as forecasts of bedrock status and stress-induced damage. The additional excavation work concerned the technical rooms, pumping station area and extension to the access tunnel. 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 reviewed the updates of Onkalo's rock engineering and construction engineering plans as well as Onkalo's research plans, including Onkalo's research plan for the depth range of 420–460 metres and the survey plan for the eastern areas of Olkiluoto. In addition, STUK reviewed HPAC design documents for the classified systems of the ventilation and lifting equipment building to be constructed above ground. Onkalo will later be ventilated through the ventilation and lifting equipment building.

Furthermore, Posiva gave STUK the following sets of documentation for processing:

- Updates of Posiva's operations management system
- Posiva Oy's crisis communication plan
- Quality plan and safety plan for the Onkalo site.

5.1.3 Overseeing the research, development and design work for further specification of the Safety Case

The Ministry of Employment and the Economy required in 2003 that the parties under the nuclear waste management obligation shall, either separately, jointly or through Posiva submit a status report on the preparation of the construction licence application for the encapsulation and final disposal facility during 2009. STUK issued a statement of the report to the Ministry of Employment and the Economy in late 2010. In addition to the statement, STUK sent the observations made during review of the draft application and its opinion regarding fulfilment of the safety requirements to Posiva in June 2011. In this safety evaluation report regarding the preliminary application documents, STUK has gone through the safety requirements regarding final disposal (Government Decree 736/2008) and assessed, as its conclusion, the situation regarding fulfilment of the requirements. STUK is of the opinion that the plant can be implemented so that it meets the safety requirements, but achieving the required standard of design following the suggested time schedule will be challenging. The following is a summary of the issues STUK considers most critical for the construction licence application:

- Formation of scenarios meeting STUK's requirements and describing the entire final disposal system, analysis of the release and migration of radionuclides in these scenarios, as well as a comprehensive analysis of uncertainty factors.
- In its documentation, Posiva has not explained how the parts of the final disposal system will reach the target status and how they will meet the set performance requirements (performance analyses). Deficiencies are obvious, particularly with regard to the buffer, in understanding the processes affecting performance and in demonstrating the planned performance of the buffer.
- Demonstration of the development work and functionality of the bedrock classification system as well as demonstration of the final disposal tunnels and holes in Onkalo.
- The documentation submitted by Posiva does not shed any light on how the defence-in-depth principle and single failure tolerance of systems, for example, have been taken into account in plant design work.

In 2011, STUK monitored in particular the progress made in the above issues in Posiva's work, and safety issues were discussed in many subject-specific meetings between STUK and Posiva. One of STUK's key tasks in 2011 was to start preparations for processing Posiva's construction licence application for the disposal facility of spent nuclear fuel to be submitted in 2012. In the first stage of the preparatory work, the first version of the review plan was compiled on the basis of safety requirements and areas and subjects of review composed of them. External international experts also assisted in producing the review plan, and the work was observed by representatives of the Swedish Radiation Safety Authority (SSM).

During 2011, STUK actively monitored Posiva's design work for the encapsulation plant and disposal facility, particularly the situation in system design. Posiva is developing its process and system descriptions to the standard required for the construction licence application. This requires developing Posiva's organisation and operations to meet the safety requirements of nuclear facilities, and STUK is of the opinion that Posiva should, for example, pay attention to ensuring the availability of sufficient resources as well as to the guidance and quality assurance of design work.

During 2011, STUK has monitored the research and development work on the final disposal system, and that on the canister and bentonite buffer in particular. Posiva has several projects in progress aimed at demonstrating the performance of the buffer. STUK's oversight focussed on the definition of functions and goals set for the buffer and on the associated open questions regarding safety. In 2011, STUK began the review of the detailed buffer plan and the freezing-thawing analysis related to the penetration of permafrost. These reviews will be completed in early 2012.

STUK has assessed the documentation on Posiva's disposal canister manufacturing, welding and inspection techniques and sent to Posiva, in June, the resulting statement on the status of development work regarding the manufacturing, welding and inspection techniques of disposal canisters. It can be stated as a conclusion on the assessment work that the descriptions, quality requirements and acceptance criteria regarding the manufacturing, welding and inspection techniques of disposal canisters have become more specific compared to what was presented earlier. In the opinion of STUK, the descriptions, quality requirements and acceptance criteria must be further developed and specified for the construction licence application documents so that the impacts of different stages of the manufacturing, welding and inspection techniques on the operational and long term safety of the disposal canisters are shown comprehensively enough. In addition, STUK began the review of documents concerning the design and corrosion resistance of canisters; this review will be completed in early 2012.

Regarding disposal scenarios, STUK analysed Posiva's safety analysis methodology for scenario analysis. The focus of STUK's oversight in this area was on assessing the international situation and knowledge regarding the formation of scenarios and on assessing the safety requirements. Furthermore, STUK began its own comparable scenario analysis work that can be used as support when analysing the scenarios presented by Posiva in the construction licence application.

STUK has monitored Posiva's development work on the bedrock classification system by assessing the results of the project and the efforts to demonstrate its functionality, by overseeing the research work carried out in Onkalo and by analysing development subjects with Posiva. Testing of the bedrock classification system was an important part of the implementation of Onkalo's demonstration facilities, and Posiva produced detailed descriptions of the bedrock in the area for the purpose of indicating in advance the suitability of the subject rock volume for final disposal. In its oversight work, STUK paid particular attention to the reliability of descriptions and the bedrock criteria set in the classification system.

As a summary, it can be stated that STUK presented in 2011 its views to Posiva regarding the open safety questions raised in the preliminary application documentation and monitored in particular the research, development and design/planning work related to these areas. At this stage, Posiva is concentrating its efforts in preparing the construction licence documentation to be submitted at the end of 2012, and it has therefore submitted less preliminary documentation to STUK. Consequently, STUK's regulatory activities mainly consisted of plan assessments, inspection visits and analysis of observations jointly with Posiva.

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 constitutes a requirement for the peaceful use of nuclear energy. In Finland, the national system for nuclear material control is 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 of international 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 participation is required in inspections performed by the IAEA and the European Commission in Finland.

The IAEA must be able to satisfy itself that the member country has no undisclosed activities related to the nuclear fuel cycle, and that the member country honours its obligations under the Nuclear Non-Proliferation Treaty. In addition to the nuclear material records, states must notify the IAEA of nuclear facility sites, research and development projects related to the nuclear fuel cycle, as well as of the manufacture of certain, separately defined, components in the nuclear field and their export. The operators in the industry report nuclear materials to the Commission and STUK in compliance with the Commission Regulation. STUK submits to the IAEA and the Commission the declarations concerning Finland and Finnish facilities 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 also allows the IAEA more extensive access rights to inspect activities related to the nuclear fuel cycle in the whole country.

In the IAEA's integrated safeguards, the control under the Safeguards Agreement and that under the Additional Protocol have been matched together so that the IAEA carries out fewer routine inspections, but it has the possibility to make inspections unannounced or at very short notice on plants or activities related to the nuclear fuel cycle. The IAEA's integrated control began in Finland on 15 October 2008. The implementation of the IAEA's Integrated Safeguards in Finland is made possible by the national control system maintained by STUK. STUK has enhanced its inspectors' capabilities for participating in the IAEA's Unannounced Inspections (UI) or Short Notice Random Inspections (SNRI).

In parallel with the expansion of the IAEA's regulatory control, the Commission also developed its inspection activities. The number of inspections carried out by the IAEA and the Commission has been decreasing since 2009. The number of inspections carried out by STUK has increased. The new subjects of control, Posiva's Onkalo, TVO's Olkiluoto 3 and 4, Fennovoima and Talvivaara, have increased the number of inspections. STUK reports all nuclear material inspections to the Commission.

Plants and operators within the nuclear fuel cycle under control

STUK's nuclear safeguards apply to all nuclear fuel cycle activities in Finland as well as to nuclear commodity accounting and control systems, import, use, transport, storage, transfers, removal from use and final disposal. Nuclear items include nuclear materials (uranium, plutonium and thorium), 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 in the country annually.

STUK inspects the holders of nuclear items and stakeholders in the nuclear industry through facility and transport inspections and document reviews. At the facilities, STUK verifies that the quantity of nuclear items and their physical location comply with the accounting records. STUK reviews the documents on the facilities' nuclear items management: reports, notifications and nuclear safeguards manuals, and grants licences required by legislation. In addition, STUK is responsible for the approval process of international inspectors.

The technical analysis methods applied to nuclear items ensure that nuclear materials and operations are in accordance with the notifications and that all operations are notified. 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 plant and material category are shown in Figures 15 and 16, as well as in Table 5.

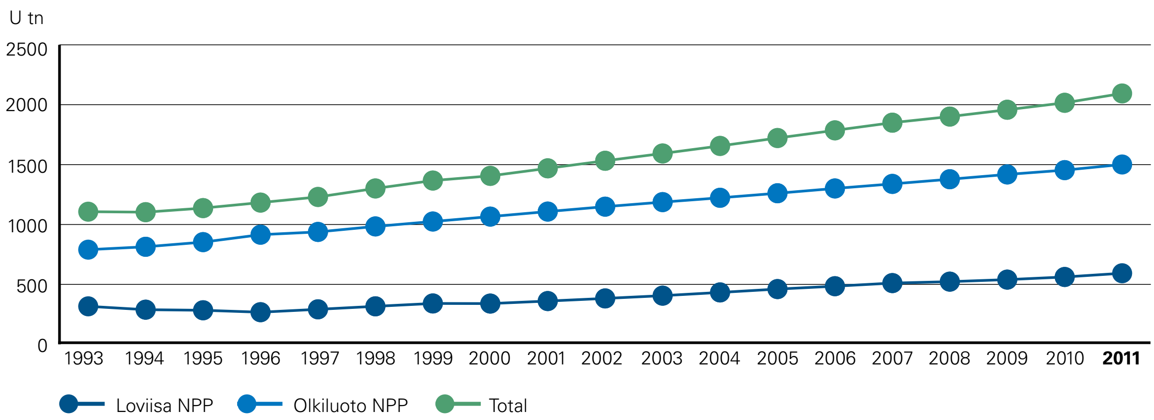


Figure 15. Amount of uranium in Finland.

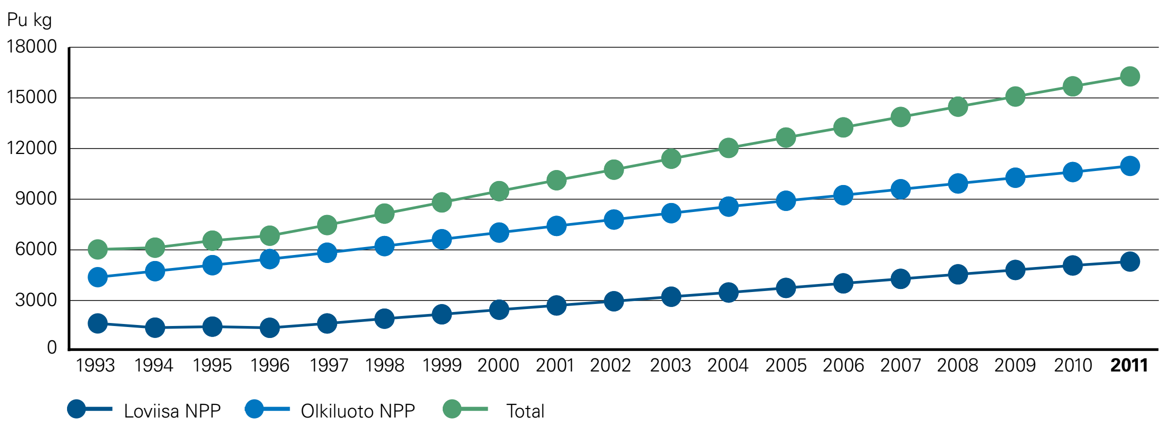


Figure 16. Amount of plutonium in Finland.

Table 5. Amounts of nuclear materials in Finland 31 December 2011.

Location	Natural uranium kg	Enriched uranium kg	Depleted uranium kg	Plutonium kg	Torium kg
Loviisa plant	–	593 001	–	5 304	–
Olkiluoto plant	–	1 491 233	–	10 971	–
VTT / FiR 1 research reactor	1 511	60	~0	~0	~0
Other facililties	4 402	< 1	1 353	~ 0	~ 3

Control of transfers of nuclear products

In order to prevent the proliferation of nuclear weapons and sensitive nuclear technology, STUK controls the transfer of nuclear products and co-operates with Finnish 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 products. Licence from STUK, as well as a transport plan and transport security plan approved by STUK, are required for the transport of nuclear materials. Customs and STUK co-operate in preventing illegal imports and exports at Finnish borders.

Nuclear security and cooperation between authorities

Another objective 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 'Nuclear Security'. In addition, the security arrangements of the oversight of non-proliferation include acting as a liaison authority for Customs in actions required by irregularities observed in radiation monitoring at the borders, and also as an expert when developing these radiation monitoring operations.

Oversight of non-proliferation in final disposal of nuclear fuel

Final disposal of nuclear fuel in inaccessible underground facilities sets 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 in 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 so that international regulatory organisations can take care of their regulation obligations in an appropriate way: the IAEA must be able to satisfy itself that there are no undisclosed nuclear activities in Finland during the construction or use of the final disposal facility or after its closure. The Commission will verify that the operator's actions are sufficient for implementing nuclear safeguards at the final disposal facility. The development of nuclear safeguards for the final disposal facility is a demanding task because there is no experience of controlling a similar facility anywhere in the world. Both the IAEA and the Commission plan and implement their own regulation and inspection procedures on the basis of declarations made by the operator and the Government.

The IAEA finalised the control criteria for the final disposal facility and encapsulation plant in 2009 and 2010. On their basis and on the basis of experience from overseeing Onkalo, STUK has participated in the development of international requirements for nuclear safeguards in the IAEA's ASTOR support group for control activities. The practical control requirements were prepared in October in a joint seminar organised with the IAEA, the EC and Posiva in Vuojoki. In addition, STUK established an R&D project for nuclear safeguards at the final disposal facility, concentrating on developing verification equipment and the management of continuity of control information. Late in the year, the project was presented to the SSM of Sweden, an important partner in safeguards development.

6.2 Nuclear safeguards, activities and results in 2011

Licences and approvals

During 2011, STUK received 31 licence applications concerning nuclear items and 358 nuclear safeguards reports, notifications or other applications. All licence applications were approved. No significant deviations were detected in document reviews. In 2011, STUK granted five import licences for nuclear materials and eight import licences for nuclear equipment or components, as well as three licences for the possession of equipment. STUK also granted a total of 17 licences for the import, possession or assignment of nuclear technology. The licences according to the Nuclear Energy Act are listed in Appendix 4. Furthermore, STUK issued a statement on the uranium extraction project in Talvivaara. VTT's FiR1 reactor organisation and Posiva submitted the updates of nuclear safeguards manuals, compliant with YVL Guide 6.9, for approval. STUK approved VTT's manual, but the approval of Posiva's manual was postponed to 2012.

During 2011, STUK approved three transport plans for fresh fuel, one transport security plan for the transport of fresh fuel and one update to a transport security plan. STUK also granted approvals for design of a transport package, a transport with special arrangements and an additional report regarding transport. In addition, STUK issued a certificate for non-objection related to transports.

There were considerably more applications for the approval of responsible directors and persons responsible for nuclear safeguards referred to in the Nuclear Energy Act than in previous years. The following responsible persons were approved in 2011, nine approvals in all:

- Fortum: Deputy to the responsible director, deputy to the person responsible for nuclear safeguards and person attending to the duties of the person responsible for nuclear safeguards in matters pertaining to the control of other nuclear items in the nuclear safeguards support organisation.
- Posiva: Person responsible for the construction of Onkalo (see responsible director) and person responsible for nuclear safeguards.
- STUK / Research and Environmental Surveillance: Responsible director and deputy to the responsible director.
- TVO: Deputy to the person responsible for nuclear safeguards (international transportation of uranium).
- VTT: Deputy to the responsible director.

The qualification requirements of the responsible persons include sufficient knowledge of the legislation and other regulations governing nuclear safeguards. STUK is responsible for assessing the fulfilment of these qualification requirements before approval. Competence was assessed by written questions and an oral examination. This provided a good indication of the person's competence. When required, additional familiarisation may be required of the person in connection with the approval. In such a case, fulfilment of the requirement is also monitored and the person's level of competence is later re-assessed.

During 2011, the IAEA and the European Commission sent a total of 12 applications regarding the appointment of new inspectors. STUK asked the major holders of nuclear materials and the Finnish Security Intelligence Service to provide statements regarding the inspectors and approved all the proposed inspectors, 67 IAEA inspectors and 10 European Commission inspectors.

Declarations and inspection visits pursuant to the Additional Protocol to the Safeguards Agreement

STUK submitted all declarations pursuant to the Additional Protocol to the Nuclear Safeguards Agreement within the set time limits. STUK was also able to verify that the Commission had submitted the declarations regarding Finland under its responsibility within the time limits. The IAEA did not request any additional accounts on the basis of the declarations sent from Finland, and it has been able to verify on the basis of the declarations sent that activities in Finland have been in line with the notifications. In 2011, one supplementary inspection visit was paid by the IAEA in

Finland to the Loviisa power plant, and two inspections were made at short notice: one at the spent fuel storage in Loviisa and the other at Olkiluoto 1. No cause for remarks was discovered in the inspections and the supplementary inspection visit. STUK delivered protocols of all inspections to the IAEA and the Commission for information within three days of the inspection, even in cases where the IAEA or the Commission did not participate in the inspection.

Inspections as part of nuclear safeguards

In 2011, STUK carried out a total of 44 nuclear safeguards inspections; four planned inspections were postponed to 2012 due to reasons attributable to plant operation. All items of minor holders of nuclear material were inspected apart from the Tornio plant of Outokumpu, where the items will be inspected during 2012. No deficiencies were detected in the inspections. The inspection reports by the IAEA and the European Commission (Statement 90a) indicate that the Finnish nuclear operators have met the obligations of international control. No significant deviations were detected in document reviews. In December 2011, STUK submitted a preliminary safeguards inspection plan for 2012 to the IAEA and the Commission for information.

During 2011, STUK has paid particular attention to the security arrangements of minor holders of nuclear items. The inspections of nuclear items also included inspections of the security arrangements of five minor holders of nuclear items: Inspecta Oy, AEL Oy, the Department of Physics at the University of Jyväskylä, MAP Medical Technologies Oy and Rautaruukki Oyj. No deficiencies were found. The update of YVL Guides by STUK takes the security arrangements of nuclear items into account more specifically than before.

STUK carried out nuclear fuel verification measurement campaigns: two at the Olkiluoto plant units and one at the Loviisa plant. STUK took environmental samples at the Olkiluoto power plant and acquired new environmental sampling equipment. VTT provided STUK with an analysis report of the samples.

Inspections as part of nuclear safeguards regarding the disposal facility

STUK has carried out nuclear safeguards control at the Onkalo facility constructed by Posiva, intended as part of the disposal facility. STUK's control activities were implemented in line with the national nuclear safeguards plan. Finland is the first country in the world to implement nuclear safeguards regarding disposal facilities, which is why STUK holds a key position in the development and implementation of international (by the IAEA and the Commission) nuclear safeguards regarding disposal facilities. The biggest challenge in implementing international safeguards is the fact that Posiva is not a licensee referred to in the Nuclear Energy Act. International safeguards do not recognise the licensee; instead, the need for safeguards is initiated by a nuclear facility under construction. The IAEA and the Commission have carried out the inspections under their inspection programme at the Onkalo construction site and at the plant area referred to in the Additional Protocol.

Control meetings with licensees

Control meetings between STUK and the responsible directors of plants and the persons responsible for nuclear safeguards have been found to be a good and necessary forum for regular discussions on topical issues every six months or so. In 2011, control meetings were held with TVO and Fortum; next year, control meetings will also be held with Fennovoima, Posiva, VTT and Talvivaara.

Conclusions and results of inspection activities

STUK delivered protocols of all nuclear material inspections to the IAEA and the Commission for information within three days of the inspection, even in cases where the IAEA or the EC did not participate in the inspection.

The IAEA and the Commission sent 20 reports to STUK on the results and conclusions of inspection activities. The reports did not contain inconclusive results. STUK compared the inspection results in the IAEA's and the Commission's reports to the results of its own inspections and found the information to be very coherent. STUK sent the inspection results to the inspected plants for information.

Safeguards by Design

It is important that nuclear safeguards are included in the design and construction of new plants. This saves costs and additional work required for,

for example, installation of surveillance cameras in the reactor hall when the plant is otherwise ready. In June 2011, STUK organised a training event entitled “Safeguards by Design” at Sannäs Manor in cooperation with the IAEA and the European Commission. The training event provided the nuclear operators with an overall picture of the basis of nuclear safeguards, as well as of their principles applied to the design and construction of new plants. The training event also included an exercise on how the safeguards could be taken into account at the participants’ own plants. After the training event in September 2011, STUK organised jointly with the IAEA and the Commission events for both TVO and Fennovoima, where taking the safeguards into account in TVO’s OL4 and Fennovoima’s FV-1 projects was discussed in practical terms. STUK has informed TVO, Fortum and Fennovoima of the updated IAEA instruction: Nuclear Safety Series, NPP Design (into force on 10 August 2011), which now takes nuclear safeguards and security arrangements into account for the first time.

Remote surveillance and data transfer at nuclear facilities

The IAEA and European Commission use surveillance cameras for control. The cameras are located in the reactor halls and spent fuel storage facilities at the Olkiluoto and Loviisa plants. The camera surveillance of the IAEA and the Commission has been in use at both plant units for about twenty years. The IAEA and the Commission have changed the video tapes / hard disks in connection of their inspections. Now technology allows sending real-time surveillance video directly to the IAEA and Commission headquarters. Remote Data Transmission has advanced to a stage where the plants have been asked to investigate the impacts of its introduction on safety and security arrangements. It is expected that Remote Data Transmission will be introduced to Finnish NPPs during 2012. Remote Data Transmission will, for its part, allow reducing the number of inspection visits by the IAEA and the Commission.

Regulatory control of transport of nuclear material

STUK inspected transports in line with the inspection plan for 2011. Experts from the Nuclear Waste and Material Regulation and Nuclear Security Unit participated in the inspections. Two of the inspections concerned TVO’s transports and one of Fortum’s.

Cooperation between STUK and the police was seamless and functioned well in the transport inspections. The police has allocated ample resources to the transport events and contributed to the success of STUK’s inspection activities. In addition to individual transports, the requirements of YVL Guide D.2 and preparations for Posiva’s spent fuel transports have been discussed with the police, among other things. In addition, STUK discussed the uranium transports associated with the operations of the Talvivaara mine with the Kajaani Police Department in September.

Enhancement of radiation control at borders

Finnish Customs and STUK launched a joint project for revising radiation control at 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.

In 2011, new items of equipment were procured for new border crossing points in Vaalimaa and the harbours of Helsinki. Procurement of the radiation control system for Helsinki Airport has advanced to its final stage. Trial operation of the system will begin at the beginning of 2012 and production operation three months later.

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 ratify the Treaty. Finland ratified the Treaty in 1999, and a total of 182 countries had signed and 155 counties had ratified the Treaty by the end of 2011. Adherence to the Treaty is monitored by a global network of 321 observation 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.

A special Preparatory Commission, convening 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, also operates in Vienna.

The National Data Centre, based on the CTBT and operating by STUK, contributed to the work of the Preparatory Commission for the Comprehensive Nuclear-Test-Ban Treaty Organisation (CTBTO) in establishing a cost-effective international organisation that is functional from the Finnish perspective. The automatic analysis software used for the NDC's own routine monitoring analysed on average more than 800 spectra per day towards the end of 2011. Routine monitoring is facilitated by an alarm system transmitting data on unusual observations to NDC personnel. Following the Fukushima accident, the results of the CTBT's global radionuclide measurement network provided by the National Data Centre from these analyses improved the picture of the situation maintained by STUK's emergency preparedness organisation.

Activities of the National Data Centre in 2011

The data systems of the National Data Centre have for the first time in their history operated without interruptions for the whole year, apart from a few maintenance breaks lasting a few minutes. The external vulnerability scan of the data systems performed in November (TIH/Nixu Oy) detected vulnerabilities in the systems of the Data Centre, most of which could be eliminated immediately after discovering them.

During 2011, the National Data Centre created several new connections to the international data centre. They allow following the status of the international monitoring system more accurately and easily.

Health Canada has provided the first new development version of the Xenon analysis software for testing. New modifications and corrections were decided upon on the basis of the tests and discussions. The project is making good progress, and it will continue in 2012.

STUK has participated in WGB meetings and chaired its radionuclide expert group.

Finland's national CTBT cooperation meeting was held in June at the Institute of Seismology. In addition, a national meeting was held at the initiative of the Institute of Seismology, where the proposal of nominating the Rovajärvi exercise area as a candidate for OSI IFE2014 exercise area was discussed.

STUK's representative was a co-author of the publication "Biegalski, S.R., et al., Analysis of data from sensitive U.S. monitoring stations for the Fukushima Daiichi nuclear reactor accident, Journal of Environmental Radioactivity (2011), doi:10.1016/j.jenvrad.2011.11.007".

7 Nuclear security

Regulatory oversight of security in the use of nuclear energy is a versatile task

Oversight of nuclear security is the responsibility of the Nuclear Security Unit YTS, a part of the Nuclear Reactor Regulation Department YTO. YTS reports to the director responsible for preparedness, security and regulations. YTS also oversees the security of the final disposal project for spent nuclear fuel and the recovery project for the uranium in the Talvivaara mine, as well as the security of transportation of nuclear materials, even if these matters, as a whole, are the responsibility of the Department for Nuclear Waste and Material Regulation YMO.

Oversight of the nuclear facilities' security is also performed by using experts in the Nuclear Reactor Regulation Department representing various areas of technology, such as construction and electrical engineering. The organisation of the Nuclear Security Unit was strengthened by recruiting a new expert to deal with inspections of administrative information security from 1 September 2011 onwards. Thus, at the end of 2011, the staff of the Nuclear Security Unit YTS comprised four employees.

In matters related to the oversight of nuclear security, STUK also co-operates with other authorities.

Loviisa nuclear power plant

The licensee has revised its instructions concerning security in the Loviisa power plant and renamed it as the Security Plan. The new guidelines consist of four parts:

A. General (principles and issues that have not been dealt with in other guidelines)
B. Security Standing Order, SSO (document required under the Nuclear Energy Act and the Government decree 734/2008)
C. Security Operating Procedures, SOP (set of procedures for carrying out practical security measures by the nuclear security officers)
D. System description of security surveillance systems.

These documents and certain other documents concerning security are handled as confidential documents. This is due to the fact that should they come into the possession of anyone planning unlawful actions, it would undoubtedly compromise the achievement of the objective of the security arrangements (Act on the Openness of Government Activities 621/1999, section 24, subsection 7). The SSO (part B) was approved with a separate decision by STUK in 2010, and the General section (part A) of the Security Plan was approved in January 2011. STUK handled the SOP (part C) and system description (part D) as documents received for information. The security organisation's identifiers, which are associated with the uniforms and which indicate nuclear security officer's rank and powers related to legislation, were adopted in June 2011.

The Security Plan is based on Guide YVL 6.11 valid at the time of drawing up the plan (YVL 6.11 is still valid). The Guide will eventually be replaced by Guide YVL A.11, which, once completed, requires also the Security Plan to be updated and revised. The same is true for the Design Basis Threat (DBT). The Security Plan took into account the 2009 recommendation by the international IPPAS expert team (described later separately) on increasing the level of detail in the Plan. This is illustrated by, among other things, the addition of a completely new part D (system description of security surveillance systems).

STUK inspected the plant's security arrangements during both annual maintenance (13 September 2011) and plant operation (inspection of the periodic inspection programme, 2 November 2011). No significant deviations were detected in the inspections. Measures resulting from remarks made in the course of inspections that preceded these inspections were also considered appropriate.

Information security was also inspected between 1 and 2 February 2011 as part of the periodic inspection programme. The inspection concentrated on the information security practices in the power plant and had two priorities:

- providing instructions for operations related to information security, and maintaining those instructions
- reviewing the information security lessons learned during the first phase of the I&C modernisation project (LARA) and taking them into account when operations are developed.

Progress made with respect to findings in the previous information security review in 2006 was also followed. A positive observation was the licensee's representative's constructive approach. It was also reassuring to see the attitude of representatives at the Group level towards finding solutions to the challenges in the Loviisa power plant. Development needs, on the other hand, were identified in risk assessment in the organisation, and the ICS systems had a number of different development targets. Attention was also paid to improving training.

On 29 July 2011, STUK followed the security organisation's annual refresher training on the use of force, which was arranged in the accommodation village of the power plant. Trainers were officers from the Helsinki Police Department who are authorised under the provisions of the Decree 1121/2010 of the Ministry of the Interior to provide use-of-force training to security guards. The training was arranged in line with the curriculum approved by the National Police Board, and it included both theory and practical exercises.

In 2011, STUK also reviewed documentation on training and training programmes of the licensee's security organisation. Similarly, issues related to security engineering, such as the construction of a new Central Alarm Station (CAS) and plans related to modifications of the plant area double fence, have also been reviewed.

Olkiluoto nuclear power plant

At Olkiluoto nuclear power plant, inspections conducted in 2011 included a security inspection according to the periodic inspection programme (16 November 2011) and an outage inspection made during annual maintenance (19 May 2011). These inspections concentrated on improvements made on the security of the facility as follows:

- on the basis of the periodic safety review (OLMATA) carried out in 2009, the licensee TVO assessed how well the requirements of Government Decree 734/2008 concerning biological, chemical and electromagnetic threats were met
- in 2010, an extensive external review of security issues was conducted in Olkiluoto, and on the basis of the review, TVO improved the security arrangements at the Olkiluoto NPP in the course of 2011
- the extension of the spent fuel storage (KPA) was reviewed from the perspective of security, and TVO carried out some related reforms
- following a decision in 2011 by STUK, security officers started using new identifiers, which are associated with the uniforms and which indicate rank and powers related to legislation
- as the construction of Olkiluoto 3 progressed, security arrangements were developed accordingly.

An information security inspection according to the periodic inspection programme was conducted between 17 and 18 November 2011. The inspection concentrated on the licensee's information security practices in the operating plants. The audit had two priorities:

- managing information security risks, with the emphasis on ICS equipment and software
- managing information security values/targets that need to be secured, with the emphasis on ICS equipment and software.

Progress made with respect to findings in the previous Surveillance Programme inspection in 2010 was also followed up. A positive observation was that TVO has significantly improved its information security practices related to laptop computers and memory devices. The inspection touched on the positive experiences in the previous annual maintenance, when the new practices were already in use. Development needs were identified in risk assessment in the organisation. The ICS systems had a number of different development targets as well. Attention was also paid to training and its improvement.

Hanhikivi nuclear power plant project

In October 2011, Fennovoima Oy decided to concentrate its efforts on the preparation of the construction permit application solely on the Hanhikivi plant site, located in the Pyhäjoki municipality in North Ostrobothnia. Fennovoima asked STUK to review certain plans and documents it had prepared and to provide preliminary instructions concerning, among other issues, security of the plant and the plant site. STUK responded to the request with respect to the design basis requirements necessary for nuclear security and other issues.

Otaniemi research reactor

STUK requested a statement from the Ministry of the Interior concerning the updated Security Plan of the FiR 1 research reactor, after which STUK approved the corrected Security Plan to be used in carrying out security measures. In addition, the SSO (Security Standing Order) of the reactor was approved by STUK to be implemented in 2011. Comments provided by the Ministry of the Interior and the Advisory Commission on Nuclear Security have been taken into account in the approved SSO.

An external review on the structural and organisational security of the research reactor was conducted on 29 and 30 August 2011. The review team pointed out several targets for improvement in security management, security culture, guidelines, orientation and training provided to the personnel as well as response and structural protection.

Following Section 37 of the Nuclear Energy Decree, STUK asked the Ministry of the Interior to provide a statement, related to the operating licence application, on nuclear security and emergency preparedness arrangements of the FiR 1 research reactor. The Ministry of the Interior, for its part, requested the National Police Board provide a statement on the security of the plant. In its statement, the National Police Board was of the opinion that there are shortcomings in the security arrangements that need to be corrected immediately. In its statement issued on 13 October 2011, the Ministry of the Interior agreed with the statement of the National Police Board. The statements by the Ministry of the Interior and the National Police Board take into account the afore-mentioned external review on the structural and organisational security measures at the plant.

On 25 October 2011, VTT – Technical Research Centre of Finland prepared an action programme to resolve the shortcomings identified by the review team and to improve security. Urgent measures following from the action programme were taken during 2011, and a majority of the corrective measures will be carried out in 2012. Evaluation of the requirements concerning DBT will be conducted once the DBT is completed, which is also estimated to take place in 2012. Urgent measures following the action programme were reviewed on 28 December 2011. At that occasion, STUK conducted an inspection on the security of the research reactor, as provided for in Section 20 of the Nuclear Energy Act, and did not find any obstacles to continue operating the plant in the operating licence period beginning on 1 January 2012.

Spent nuclear fuel disposal project

Posiva Oy presented STUK with a number of layout plans on the construction and use of the disposal facility for spent nuclear fuel and the related security aspects. In its safety assessment concerning documentation contained in Posiva's preliminary construction permit application, STUK also provided Posiva with its comments as regards to ia. security of the disposal facility.

Talvivaara uranium recovery project

Planning and construction of a uranium recovery plant in Talvivaara began in 2011. STUK discussed matters related to security with the applicant, Talvivaara Sotkamo Oy, and the local police (Kainuu police department). Requirements concerning security of the uranium recovery plant were defined, employing the requirements set for nuclear facilities but bearing in mind that the plant in question is not actually a nuclear facility. The security arrangements at the Talvivaara site was inspected on-site and the necessary memorandums were drawn up to facilitate its improvement.

Transport of nuclear material and nuclear waste

STUK ensured that transport of nuclear fuel took place according to approved Security Plans. STUK inspected an updated Security Plan for nuclear fuel transports by TVO; the update concerned the procedure of submitting information related to the

Security Plan to STUK. STUK inspected on-site the implementation of the security measures on one transport by Fortum and two by TVO.

Posiva informed STUK of an on-going study concerning the security of disposal-related transports of spent nuclear fuel. STUK discussed with Posiva the assessment of Security Plans of the transports at different phases of the disposal project, and heard Posiva in the preparation of Design Basis Threat related to the transports. In its safety assessment concerning documentation contained in Posiva's preliminary construction permit application, STUK also provided Posiva with transport-related comments.

STUK discussed the security requirements of transports of natural uranium oxide (yellow cake) with Talvivaara Sotkamo Oy and Cameco Corporation. In its statement on the permit application by Talvivaara submitted to the Ministry of Employment and the Economy, STUK also presented its assessment on the transports of uranium products.

Security regulations, their development and the Design Basis Threat

On 22 December 2011, the Government presented Parliament with a proposal concerning the amendment of the Nuclear Energy Act. Finalisation of a proposal concerning the amendment of the Government Decree 734/2008 on Security in the Use of Nuclear Energy was, on the other hand, postponed until 2012.

Version L4 (Draft 4) of Guide YVL A.11 concerning security at nuclear facilities was completed and submitted for statements to both the Advisory Commission on Nuclear Security and the Advisory Commission on Nuclear Safety. The Ministry of the Interior and the National Police Board provided their statements concerning version L3 of the Guide. Version L4 of the Guide was translated into English.

Version L1 (Draft 1) of Guide YVL D.2 was completed. STUK had a meeting with representatives of the police on matters related to security of transports of nuclear material and nuclear waste, including the requirements contained in the upcoming Guide YVL D.2.

Design Basis Threat (DBT) is one of the tools for setting official requirements on nuclear security. It defines the threat employed as the basis for planning and evaluating security. The DBT is based on the threat scenario of unlawful action related to use of nuclear energy and radiation, and the potential consequences of such unlawful action. The threat scenario has been drawn up under the management of the Finnish Security Intelligence Service (SUPO) and is maintained in cooperation with relevant authorities. In 2009-2011, STUK prepared a draft DBT. During the preparation, STUK consulted the operators of nuclear facilities and requested statements from the Ministry of the Interior and the Advisory Commission on Nuclear Security. The DBT will be approved once the assessment concerning its implementation is completed.

Emergency preparedness instructions, emergency response training and exercises

STUK's emergency preparedness (or contingency) instructions for threat situations related to unlawful action were updated with the experiences gained from, for example, the emergency response training arranged in 2011 in mind. STUK discussed the contents of the emergency preparedness instructions, particularly those related to cooperation with the police, with police representatives.

STUK arranged emergency response training related to security. Topics covered included the threat scenario of unlawful action related to the use of nuclear energy and radiation as well as the roles, responsibilities and actions of various stakeholders in a threat situation.

In Loviisa, a cross-authority exercise called Moni11 took place. In the course of the exercise, special units from a variety of authorities practised the counteraction of an unlawful threat in cooperation with the licensee's security organisation. The exercise also contained elements related to an insider threat. STUK participated in planning, organising and monitoring the exercise.

In Olkiluoto, the Olki11 rescue service exercise took place. It is an extensive exercise arranged every three years, and this time it was based around a scenario where an accident at the plant was combined with unlawful action concerning security. In addition, one unannounced exercise on security was arranged outside the daily working hours.

The Nuclear Security Unit YTS participated in the planning and implementation of the INEX4 (International Nuclear Emergency Exercise).

Internal cooperation in STUK concerning nuclear security

STUK has a cross-department cooperation team on security, responsible for ensuring that in STUK, tasks related to nuclear security are carried out in close cooperation, employing the resources of different departments and units. In 2011, the team met regularly, followed the implementation of STUK's security tasks and conducted internal, national and international collaborational communication. The team participated in STUK's strategic work by drawing up an assessment and a plan for the operating programme of the next strategic period and launched the preparation of the operating programme.

National and international cooperation for developing nuclear security

The Advisory Commission on Nuclear Security, appointed by the Government and functioning in conjunction with STUK, met three times in 2011. The Commission discussed, among other topics, the operation of the research reactor and it's SSO (Security Standing Order), the draft Guide YVL A.11, and matters related to the DBT (Design Basis Threat).

A working group on competencies in the nuclear sector and a working group on the nuclear sector of the so-called NSA cooperation group, established by the National Security Authority (NSA), met under the auspices of the Ministry of Employment and the Economy in 2011. STUK has participated in both working groups and acted as a secretary in the latter group. The NSA subgroup met seven times during the year, and it has contributed to the preparation of a cooperation agreement (MoU) for exchanging confidential information on new nuclear power plant projects between Finland and Japan and Finland and South Korea.

STUK participated in the national cooperation group for the prevention of terrorism, operating under the auspices of the National Police Board, and in the CBRNE cooperation forum of the police. STUK also participated in Satakunta Police Department's OL3 project steering group in 2011.

In 2011, STUK launched tests on structural endurance of nuclear facilities in cooperation with the Defence Forces Technical Research Centre.

STUK was the Finnish representative of the Ad Hoc Group on Nuclear Security (AHGNS) of the Council of the European Union.

In addition, STUK participated in international cooperation on nuclear security in 2011 as follows:

- participation in ENSRA (European Nuclear Security Regulators Association)
- preparation of international security recommendations and guides belonging to the IAEA Nuclear Security Series
- communication via IAEA's Illicit Trafficking Database (ITDB) on irregularities related to nuclear material and other radioactive material
- participation, at IAEA's request, of STUK's experts in peer reviews of security and training events arranged by IAEA in other countries: in 2011, one IPPAS mission and one DBT workshop
- preparation of a framework agreement on cooperation in nuclear security issues between IAEA and STUK
- preparation of the nuclear security summit to be arranged in Korea in 2012.

Reporting related to international assessments of nuclear security

In 2009, Finland completed the International Physical Protection Advisory Service (IPPAS) mission under the management of IAEA. The objectives of the mission was to obtain an independent evaluation of the nuclear security planning, implementation and regulatory control by comparing those with the Finnish requirements, international conventions, IAEA recommendations and guidelines, and internationally recognized best practices. STUK's final IPPAS report, based on the recommendations and suggestions of the assessment, was completed on 28 February 2011, and it has been published on the STUK website. The recommendations and suggestions of the assessment team have mostly been completed. Measures taken as part of the updating process of STUK's YVL Guides will be completed according to the YVL Guide schedule. The Ministry for Employment and the Economy has invited IAEA to conduct a similar IPPAS follow-up assessment, which will be carried out between 16 and 27 April 2012.

8 Safety research

The purpose of publicly funded safety research is to ascertain that the authorities have adequate expertise available, including a concern for unforeseeable issues affecting the safety of nuclear facilities. Safety research is divided into two research programmes, of which SAFIR2014 focuses on nuclear power plant safety and KYT2014 on the comparison of different ways of implementation and methods of nuclear waste management. The projects under the research programmes are selected annually on the basis of a public call for projects. The projects selected for the programmes must be of a high scientific standard and their results must be available for publication. The results must have a broader scope of applicability than the nuclear facility of a particular licensee. Funding is not granted for research which is directly connected with projects 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

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 safety.

The public research programmes related to nuclear safety operational in Finland until 2010 were 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, which started at the beginning of 2011, are SAFIR2014 and KYT2014.

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/, http://www.ydinjatetutkimus.fi and http://kyt2014.vtt.fi/.

Pursuant to Finnish legislation, the parties with nuclear waste management obligations are unambiguously responsible for the design, implementation and 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.

and STUK's research needs related to nuclear safety. STUK issued its statement on the projects under the SAFIR2014 research programme in January 2011, and a corresponding statement on the KYT2014 programme in February 2011.

In 2011, a new four-year safety research programme, SAFIR2014, was initiated as a continuation of the previous SAFIR2010 programme. The new programme is more extensive than the previous one due to the decisions-in-principle issued in the summer 2010 regarding new plant units. Following the decisions, funds for the research programme were also collected according to the maximum thermal power defined in the licence conditions for the new plant units (funding from the National Nuclear Waste Management Fund). The annual volume of the SAFIR2014 programme was EUR 9.6 million, of which the share of the National Nuclear Waste Management Fund was EUR 5.3 million. The project programme initiated at the beginning of the year provided funding for 38 projects. The organisation providing the largest amount of funding was VTT whose share was EUR 2.9 million.

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

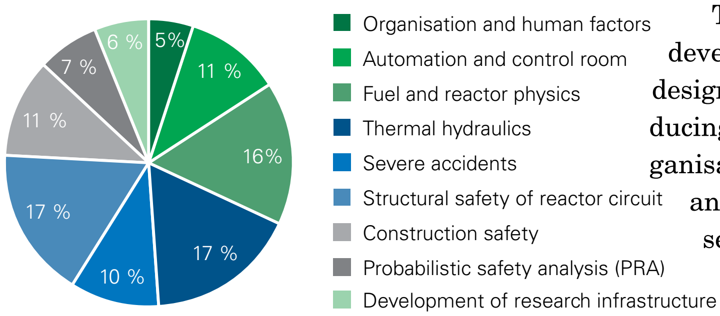


Figure 17. Research areas of SAFIR2014 programme and their shares of the total funding in 2011.

Two new appendices to the body plan of the SAFIR2014 programme were prepared in the autumn 2011 for the 2012 application round for projects. One appendix concerned the needs for research on social and crisis communications, and the other the needs to supplement the body plan of the programme following the experience from the nuclear power plant accident at the Fukushima Dai-ichi plant units in March 2011. The 2011 round of applications for projects received research proposals complying with the latter appendix, but no project proposals qualifying for funding were received for research on social and crisis communications.

The concluding seminar of the SAFIR2010 research programme was held in March 2011. The SAFIR2010 programme has been the largest publicly funded research programme: EUR 27.5 million, 197 person-years, 866 publications and 40 academic degrees.

The research programme involved extensive development of Finnish expertise for defining the design basis of nuclear power plants and for producing safety analyses, as well as for managing organisations with a high standard of safety culture and expert work. One topical detail is the research on external threats where the potential impacts of climate change on the extreme weather conditions and sea water levels occurring in Finland were studied, along with the seismic requirements for nuclear facilities.

The new four-year research programme KYT2014 covering the period 2011–2014 was also initiated in 2011. The programme has a revised framework programme consisting of research subjects important to national competence. The aim is to establish coordinated projects for the most salient subjects. The programme guidelines were updated to correspond with the new framework programme and practices. Furthermore, the criteria for the project proposals for the research programme were revised, following, among other things, feedback from the support groups.

The KYT steering group gave its funding recommendations to the Ministry of Employment and the Economy, relying on the assessments of support groups. In 2011, the research programme provided funding for 30 research projects representing new and alternative technologies for nuclear waste management (3 projects) and safety research on nuclear waste management (27 projects). The latter category had two extensive, coordinated projects: Safety Case and the performance of buffer and backfill materials. The other safety studies represented about 40% of the total volume of the programme. In 2011, the total funding of the KYT2014 programme was about EUR 2.8 million, of which funding from the National Nuclear Waste Management Fund makes up about EUR 1.7 million. Figure 18 shows the relative shares of these areas of the total funding.

A total of 34 research project proposals were submitted for 2012 for the KYT2014 programme, and the work of evaluating them is in progress. The topical research subjects in line with the guidance of the management group included the lessons learned from the Fukushima accident regarding water pool storage of spent nuclear fuel, and crisis communications. The project proposals will be evaluated by applying specific criteria.

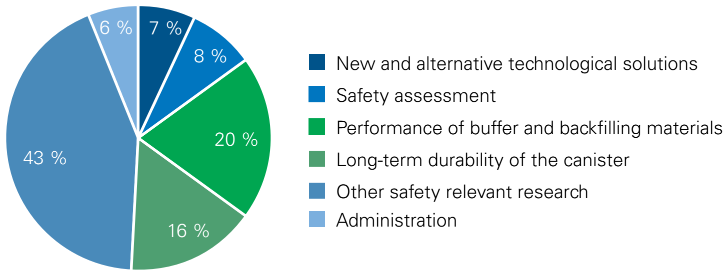


Figure 18. Research areas of KYT2014 programme and their shares of the total funding in 2011.

9 Oversight of nuclear facilities in numbers

9.1 Review of documents

In all, 3,706 documents were submitted to STUK for review in 2011. Of these, 1,593 concerned the nuclear power plant under construction, and 268 were related to the final disposal facility for spent nuclear fuel. 3,745 document reviews were completed, including documents submitted in 2011, 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 138 days. The number of documents and their average review times in 2007–2011 are shown in Figure 19. Figures 20, 21 and 22 present the distribution of document review times for the different plant units.

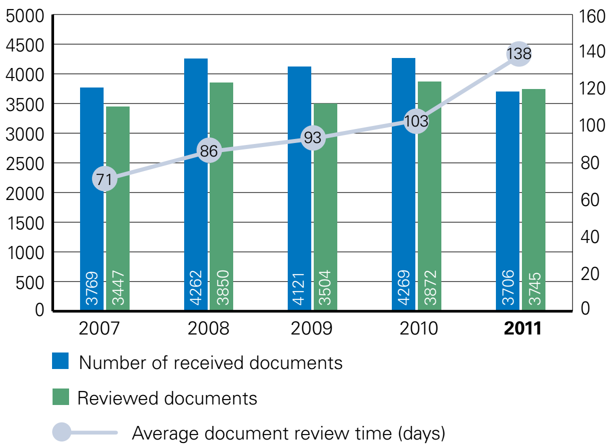


Figure 19. Number of documents received and reviewed as well as average document review time.

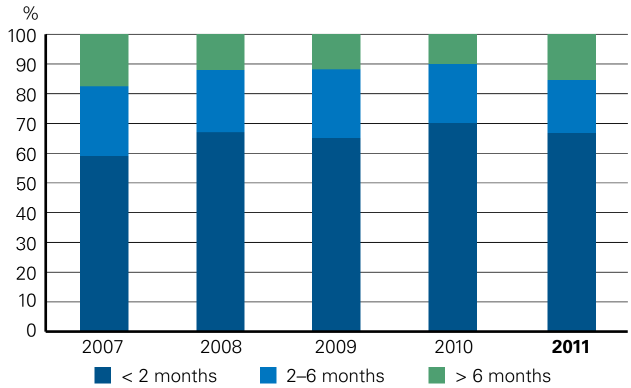


Figure 20. Distribution of time spent on preparing decisions on the Loviisa plant.

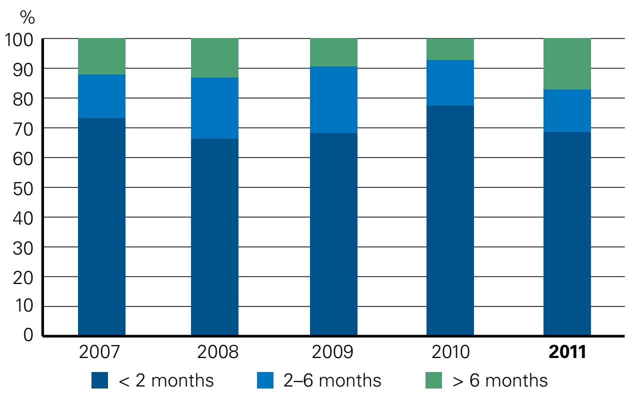


Figure 21. Distribution of time spent on preparing decisions on Olkiluoto plant units 1 and 2.

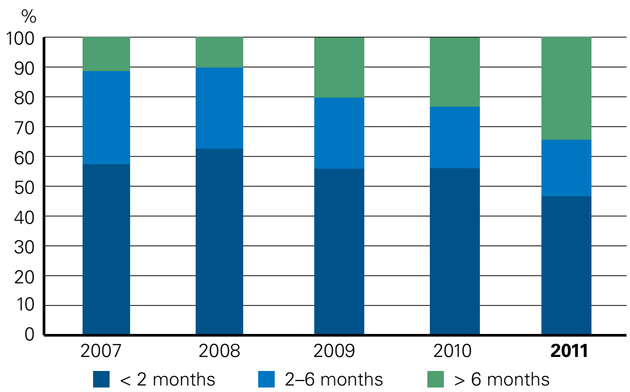


Figure 22. Distribution of time spent on preparing decisions on Olkiluoto plant unit 3.

9.2 Inspections on site and at suppliers' premises

Inspection programmes

A total of 24 inspections at the Loviisa plant and 21 at the Olkiluoto plant were carried out under the 2011 periodic inspection programme. Appendix 5 contains a summary of the contents and results of the periodic inspection programme. STUK carried out 15 inspections within the Olkiluoto 3 construction inspection programme (Appendix 6) and nine inspections within the Onkalo construction inspection programme (Appendix 7). The main findings of the inspections are presented in the chapters on regulatory oversight.

Other inspections at plant sites

A total of 753 inspections on site or at suppliers' premises were carried out in 2011 (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, 254 were related to the regulatory oversight of the plant under construction and 499 to that of the plants in operation.

The number of inspection days on site and at component manufacturers' premises totalled 3,820. 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 251 inspection days outside normal working hours were spent at operating nuclear power plants, mostly during annual maintenance outages, as well as 120 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 numbers of on-site inspection days during 2007–2011 are 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 rule-making 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 2011, the total cost of the regulatory over-

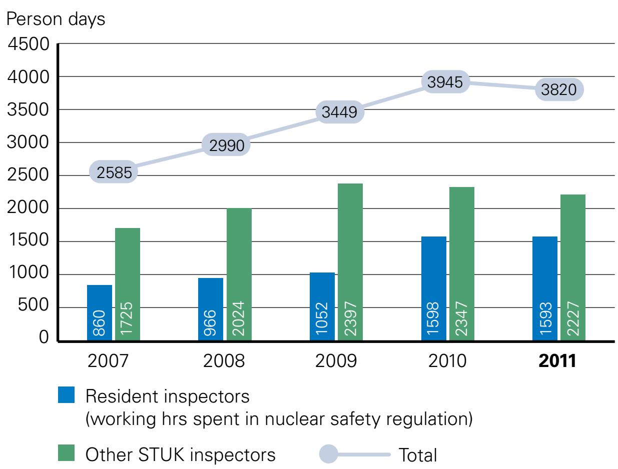


Figure 23. Number of inspection days onsite and at component manufacturers' premises.

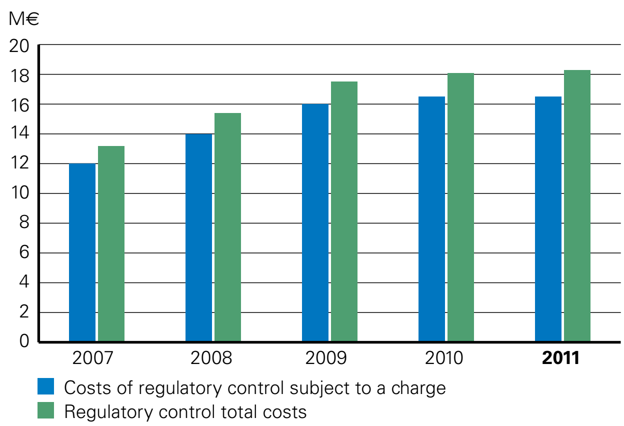


Figure 24. Income and costs of nuclear safety regulation.

sight of nuclear safety subject to a charge was EUR 16.5 million. The total cost of nuclear safety regulation was EUR 18.3 million. The share of activities subject to a charge was 90.3%.

The income from nuclear safety regulation in 2011 was EUR 16.5 million. Of this, EUR 2.7 million and EUR 10.9 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 Olkiluoto nuclear power plant also includes the costs invoiced for the work done in preparation to the regulatory oversight of the new nuclear power plant project. The income from the inspection and review of Posiva Oy's operations was EUR 2.2 million, while that from preparations for the regulatory oversight of Fennovoima's NPP project was EUR 0.3 million. Figure 24 shows the annual income and costs relating to nuclear safety regulation during 2007–2011.

The time spent on the inspection and review of the Loviisa nuclear power plant was 12.2 person-years, i.e. 8.3% of the total working time of the nuclear regulatory personnel. For the Olkiluoto nuclear power plant's operating units it was 11.8 person-years, which accounts for 7.9% of the total working time. In addition to the oversight of the operation of nuclear power plants, the figure includes nuclear material control. The time spent on the inspection and review of Olkiluoto 3 was 33.5 person-years, i.e. 22.6% of the total working time. Work related to the new power plant projects amounted to 1.4 person-years, i.e. 1.0% 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 5.8 person-years, and that spent on the FiR 1 research reactor was 0.4 person-years. The working time spent on small-scale users of nuclear material was 0.07 person-years. The working time spent on follow-up and assessing the Fukushima accident at the Nuclear Reactor Regulation Department was about 1.1 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 during 2001–2011.

Where necessary, STUK commissions independent safety analyses and research in support of regulatory decision making. Figures 26 and 27 show the costs incurred for orders during 2007–2011. The costs in 2011 were mainly related to assessment and inspection work concerning the plant unit under construction, carried out by external consultants, as well as to assessment work concerning the safety documentation for final disposal of nuclear waste. Appendix 8 shows the assignments financed by STUK in 2011 regarding the safety of nuclear power plants and final disposal of nuclear waste. Assessment of the safety documentation for final disposal of nuclear waste is 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.

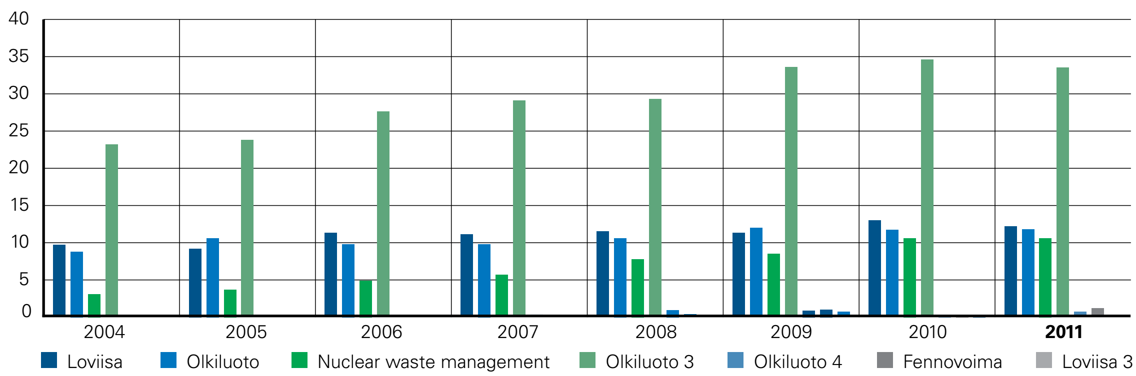


Figure 25. Distribution of working hours (person-years) of the regulatory personnel by subject of oversight in 2004–2011.

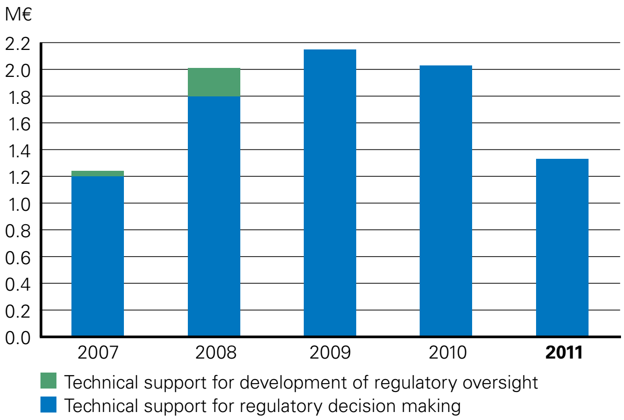


Figure 26. The costs of research and commissioned work pertaining to the safety of nuclear power plants.

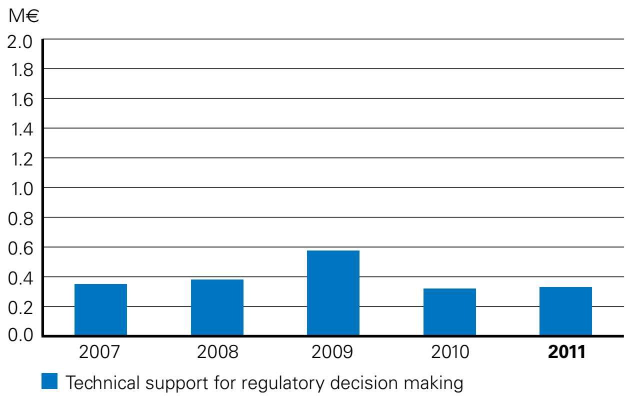


Figure 27. The costs of research and commissioned work pertaining to nuclear waste management and nuclear non-proliferation.

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

Duty area	2007	2008	2009	2010	2011
Basic operations subject to a charge	55.7	60.7	68.0	70.5	70.2
Basic operations not subject to a charge	6.1	6.3	6.6	7.8	8.8
Contracted services	2.2	2.2	1.7	1.9	1.7
Rule-making and support functions	30.3	31.5	33.6	38.2	43.0
Holidays and absences	19.1	21.1	23.5	24.3	24.7
Total	113.4	121.8	133.5	142.9	148.4

10 Development of regulatory oversight

10.1 STUK's own development projects

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

A total of 22 guides were updated in the quality manual for nuclear safety regulation, and 32 appendices to the guides were updated. Four new guides were completed, together with a total of five appendices to different guides. The new guides concerned the regulatory oversight of chemistry at the NPPs, use of the IT system intended for producing electronic inspection protocols, audits of the providers of technical support, as well as the induction training for new employees. The guides were updated following changes in procedures as well as changes in the personnel of the Nuclear Reactor Regulation Department and the Nuclear Waste and Material Regulation Department.

Development project for the periodic inspection programme

An procedure that allows a more illustrative and systematic assessment of the operation of nuclear power plants in relation to the requirements set out in the YVL Guides was developed in the Periodic Inspection Programme Development Project (KOTKA). For this purpose, the regulatory oversight subjects describing the operation of organisations as well as the criteria for assessing their status were defined on the basis of YVL Guides. The amendments to the inspection programme were updated in the internal quality manual guides, and training sessions were organised for inspectors in order to familiarise them with the new procedure. In 2012, the inspections will be conducted following the new procedure.

Development of the records management system

The records management system introduced in 2009 was improved further during 2011. The workflow associated with the records management system, intended for improving the follow-up of uncompleted matters, did not meet STUK's requirements, which is why its introduction was further delayed. A further development project was initiated during the year for developing the records management of several state departments as a joint project on the basis of the system now in use.

Electronic inspection protocols were introduced

Over 10 different inspection protocol forms are used in nuclear safety regulation. The so-called TARKKA project was initiated at the beginning of 2009 for introducing electronic inspection protocols. The electronic inspection protocols were introduced in June 2011. Their launch was delayed by approximately one year, as more additional work was required than anticipated. On the basis of feedback collected during the commissioning phase, a further TARKKA development project was initiated. It will be implemented during 2012 and it will improve the functionality and ease of use of the system.

10.2 Renewal and human resources

Training for inspectors was organised, for example, concerning systems of nuclear power plants and regulatory activities. 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 eighth YK course was 19 days in six periods. Three periods took place in spring 2011. Ten STUK employees attended the YK8 course. In the autumn 2011, the YK9 course began with eight STUK inspectors participating. The total number of participants in the YK9 course was 70.

The two-day pilot course in nuclear waste management organised in 2010 was followed in 2011 by a national nuclear waste management course of more than one week's duration, organised by actors in the field of nuclear waste. The course had 23 participants. The lecturers were experts from the Ministry of Employment and the Economy, STUK, Posiva, Fortum, Fennovoima, TVO, Aalto University, the Laboratory of Radiochemistry at the University of Helsinki, and Saanio & Riekkola. The course concentrated on the main themes of nuclear waste management, covering the entire nuclear fuel cycle.

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

Two Master's theses were completed at the Nuclear Reactor Regulation Department in 2011: 'Studying Failure Tolerance with Probabilistic Risk Assessment' and 'Prevention of Common Cause Failures in Nuclear Power Plant Electrical Systems in Case of Electrical Network Disturbances'. In addition to these, two Master's theses were prepared for completion in 2012.

On average, 9.5 days per inspector in the field of nuclear waste and materials regulation and 7.3 days per inspector in the field of nuclear reactor regulation were spent on developing the expertise of STUK's nuclear safety experts in 2011.

Four new inspectors were hired for nuclear reactor regulation in 2011. Their positions are in the regulatory oversight of nuclear fuel, radiation protection, information safety and operations. One new inspector was recruited for the regulatory oversight of nuclear waste management to be responsible for the performance analyses of the buffer and tunnel backfill materials used in the final disposal of spent nuclear fuel.

11 Emergency preparedness

In 2011, the Finnish nuclear power plants reported 16 events of 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 power plant 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.

An emergency exercise was conducted at the Olkiluoto power plant on 28 April 2011 without any advance notice. It began before office hours and lasted for about two hours. In conjunction with the exercise, new members of personnel were trained to operate as part of STUK's on-site response team. In addition to STUK and the Olkiluoto power plant, the Satakunta Fire and Rescue Service at Rauma also participated in the exercise. Only a part of STUK's emergency response organisation, a total of 24 persons, participated.

The actual weather conditions were used in the exercise. STUK practised the initiation of activities and the organisation of a status assessment group. In addition, the persons in charge of calculating dispersion of radioactive releases and the management of the group assessing radiological consequences participated in the exercise.

An emergency exercise was conducted at the Loviisa power plant on 26 May 2011 without any advance notice. It began before office hours and lasted for about three hours. The tests carried out in connection with the exercise revealed scope for improvement in the emergency preparedness of Fortum's Support Team based in Keilaniemi. In addition to STUK and the Loviisa power plant, the Eastern Uusimaa Fire and Rescue Services, the police and the Emergency Response Centre of the region participated in the exercise. Only a part of STUK's emergency response organisation, a total of 22 persons, participated.

The actual weather conditions were used in the exercise. STUK practised the initiation of activities and the organisation of a status evaluation team. In addition, the persons in charge of calculating dispersion of radioactive releases and the management of the group assessing radiological consequences participated in the exercise.

A full-scale rescue exercise for the Olkiluoto power plant was conducted on 31 August 2011. It was a cooperation exercise for the nuclear power plant and the authorities, conducted every three years. The advance preparations for the exercise include double checking the action plans and training the personnel. The purpose of the exercise was to test and enhance cooperation between different authorities. This exercise also had the further purpose of testing the management conditions when moving from a police-controlled situation to a situation controlled by rescue services. More than 30 organisations of central, regional and local levels participated in the exercise, which was also attended by reporters from the local media. A total of 87 persons from STUK participated.

The other specific goals of the exercise included the use of the revised USVA website for conveying simulated measurement results of external radiation dose rates. The conveyance of status reports and other information using VIRVE call group was also tested between the head of STUK's emergency management group, the head of rescue operations at Rauma and the on-site emergency manager of the Olkiluoto plant.

The actual weather conditions were used in the exercise. STUK produced the status assessments, recommendations for the protection activities required by the hypothetical situation as well as the press releases published in Finnish. Information was conveyed to relevant authorities and other actors via the protected Finri website.

On the basis of the assessment on the exercise, scope for improvement was identified in the maintenance of status information and operational responsibilities in case of a nuclear security scenario at the plant.

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

12 Communication

Fukushima news dominated nuclear safety communications

In 2011, STUK's nuclear safety communications were dominated by news of the Fukushima NPP accident. The largest recorded earthquake in the history of Japan on 11 March 2011 and the resulting tsunami inflicted severe damage on the nuclear power plant in Fukushima, on the eastern coast of Japan.

For the first few weeks after the accident, STUK's media service operated non-stop, around the clock. STUK and its radiation and nuclear safety experts had an important role as a source of information for the Finnish media. Hundreds of interviews were given to various parts of the mass media. STUK's experts appeared in dozens of live news broadcasts and current affairs programmes.

STUK first broadcast the news about the accident on 11 March at 3:40 p.m. Finnish time in the *Ajankohtaista ydinturvallisuudesta* (Topical issues in nuclear safety) column of its website. In all, 55 news items were published regarding Fukushima. STUK organised two Fukushima-related press conferences, which were broadcast live through the Internet. In addition, a representative of the Radiation and Nuclear Safety Authority participated in a press conference organised by the Ministry for Foreign Affairs.

STUK kept a close eye on the events in Fukushima even after the situation at the plant had been stabilised. STUK established a dedicated Fukushima page on its website. The page was regularly updated for eight months. A total of 21 status reports were published on the page.

In addition to reports directly related to the events in Fukushima, STUK published four news bulletins on nuclear safety issues, plus a total of 29 news items in its topical issues column *Ajankohtaista ydinturvallisuudesta*. Throughout the year, the news releases monitored the progress made in the assessments regarding the safety of Finnish nuclear facilities. The assessments were initiated after the Fukushima accident, and STUK's national final report on the so-called stress tests required by the EU was completed at the end of the year. The report was released in a press conference on 30 December. In the press conference, reporters were particularly interested in hearing what provisions Finnish NPPs have made for a loss of offsite power.

In March, STUK announced that WENRA had elected director Lasse Reiman of STUK to chair a working group established for the purpose of developing uniform safety requirements for European NPPs.

The topical issues column contained information on faults, transients and other irregular events observed at the nuclear power plants. At the beginning of March, STUK announced in the column that it is in favour of granting a new operating licence for VTT's FiR 1 research reactor in Otaniemi, Espoo.

As the YVL Guide revision progress progressed, the Guides in the process of being revised were published in the Guide Extranet service, where they can be commented on while they are being prepared. The link to the service can be found on STUK's website.

Immediately following the Fukushima accident, STUK organised the sixth *Säteilyn salat* (Secrets of Radiation) course aimed at the media. Twenty reporters attended the course. During the course, STUK's experts discussed topical nuclear safety issues, such as new NPP projects, nuclear waste and oversight of the Olkiluoto 3 construction work. The course included visits to the Loviisa NPP and the Sosnovyi Bor NPP in Russia.

Nuclear safety issues were also discussed in four events organised at the NPP localities. In May, STUK's experts discussed the operation and safety at the Loviisa and Olkiluoto power plants in 2010 in public events organised in Loviisa and Eurajoki.

In October, STUK invited the local media around the Olkiluoto region to a morning coffee meeting in Rauma. Six reporters attended the meeting and asked questions about various subjects, including the I&C system of Olkiluoto 3, the progress of the final disposal project and the sufficiency of STUK's regulatory oversight resources.

In December, STUK's experts also met municipal decision-makers, local reporters and inhabitants in Pyhäjoki to discuss the role of the Radiation and Nuclear Safety Authority as an overseer of nuclear safety in Pyhäjoki when Fennovoima starts to build a nuclear power plant in the locality.

During the year, STUK's Alara magazine dealt with nuclear safety issues from many different angles. Among other things, the magazine evaluated the nuclear safety work done with Russia, reported on the progress made in revising the YVL Guides, described the important characteristics of a nuclear waste disposal site and the relevance of the Nuclear Waste Directive, and explained the course of events in Fukushima. The last issue of the year focussed on the theme of nuclear safety and reported on the qualifications and training of employees working at NPPs, and took a look at the plant world from the resident inspector's perspective.

13 International cooperation

International conventions

STUK's experts presented Finland's national report at the statutory review meeting of the International Nuclear Safety Convention in the spring of 2011. The report was well received by the meeting. The participants were particularly interested in Finland's plans to build new nuclear power plants, in the flow of the licencing process and in the experience gained from the Olkiluoto 3 project. The meeting found that the good practices observed in Finland include the provisions made for serious accidents, the practice of systematic improvements at the plants and the advanced public authority infrastructure. The challenges for future years were found to include ensuring the availability of Finnish competence, the allocation of resources for the new plant projects and the revision of regulations.

The Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management requires that a report is presented every three years on how the obligations stated in the Convention are met. 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 October 2011. Corresponding reports have previously been submitted in 2003, 2005 and 2008. The reports will be reviewed by the Contracting Parties at an extensive international conference in Vienna in the spring of 2012.

Cooperation within international organisations and with other countries

MDEP

The Multinational Design Evaluation Programme (MDEP) was established on the initiative of the United States nuclear safety authority (Nuclear Regulatory Commission, NRC). It involves 10 countries with the objective of improving cooperation in the field of the assessment of new nuclear power plants and developing convergent regulatory practices. In addition to the USA, the following countries participate in the programme: South Africa, Japan, Canada, China, Korea, France, Finland, the United Kingdom and Russia. Participants in the programme include only those countries with new nuclear power plants at some stage of assessment by the regulatory authorities. The OECD Nuclear Energy Agency functions as the secretariat for the programme.

The MDEP's work is organised in Design-Specific and Issue-Specific Working Groups. In addition, the MDEP has a Management Group and a Steering Group. STUK is represented in both groups. There are two Design-Specific Working Groups: the EPR Working Group and the AP 1000 Working Group. Of these, Finland only participates in the EPR Working Group because a plant of that type is being built in Olkiluoto. The other countries in the EPR group include France, the USA, the United Kingdom, Canada and China. STUK's representative chairs the EPR Working Group. The Working Group has four Subgroups dealing with plant automation, accidents and transients, severe accidents and probabilistic risk analyses (PRAs). STUK's representative chairs the PRA Subgroup. The EPR group's work was originally a continuation of cooperation between the Finnish and French authorities concerning safety assessment of EPR power plants.

The MDEP Programme Working Groups independent of plant design dealt with the following three subjects:

- Inspections of plant and equipment suppliers
- Pressure equipment standards
- Programmable I&C.

STUK participates in the activities of all three Issue-Specific Working Groups. The objective of the Working Group dealing with plant and equipment supplier inspections is to establish the procedures and requirements applied to inspections by the participating countries and to create the procedures and goals for joint inspections. The objective of the Working Group dealing with pressure equipment is the harmonisation of requirements in different standards. The Digital Instrumentation and Controls Working Group aims to promote co-ordinated development of the IEC and IEEE standards. In addition, some individual issues have been chosen, on which common positions have been drafted.

Co-operation within the IAEA

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

The International Nuclear Safety Group (INSAG) is convened 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 Director General acts as the deputy chairperson of the group.

STUK's representatives participated in expert groups summoned by the IAEA for the purpose of reviewing the regulatory authorities' operations in Korea, Germany and Switzerland.

The IAEA's International Seismic Safety Center (ISSC) coordinates the research into safety against the threats posed by earthquakes, floods, tsunamis, volcanoes and illegal human activities. The ISSC also coordinates the work for preparing the IAEA's related instructions. In addition, the ISSC provides international expert assistance for controlling the consequences of threatening situations. STUK's representatives participated in the cooperation and expert meetings of the IAEA/ISSC.

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

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

Cooperation within the EU

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 nuclear waste management and coordinates the implementation of directives in the Member States.

STUK participated in the nuclear safety, nuclear waste and decommissioning work carried out by WENRA (Western European Regulators' Association) and its Working Groups. The groups have developed common safety reference levels on the basis of the IAEA standards, and an agreement regarding their implementation in all member countries has been concluded between the members of WENRA. WENRA continued the earlier initiated work for defining the safety objectives of new plants and for establishing the differences and common features of inspection operations in different countries. STUK's Director General chaired WENRA until November 2011. STUK's representative was appointed chairperson of the Nuclear Safety Group in March 2011.

Cooperation within the OECD/NEA

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

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

STUK participated in a meeting of the Network of Regulators of Small Nuclear Programs (NERS). The aim of the NERS cooperation is to promote cooperation between the authorities of small nuclear power countries in issues typical of these countries. In addition to Finland, the following countries participate in NERS: Argentina, Belgium, South Africa, Holland, Pakistan, Slovakia, Switzerland and the Czech Republic. Finland was elected as the next country to chair the NERS forum.

STUK participated in the co-operation between the regulatory authorities of countries with VVER power plants (such as the Loviisa NPP) via the VVER Forum. STUK's representative chairs the Working Group considering the ways of overseeing the operations of organisations. The working group's theme was the assessment and oversight of management systems.

STUK's representative participated in the Swedish supporting committee and in the Reactor Safety Working Group of the French nuclear safety authority.

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

APPENDIX 1 STUK's safety performance indicators for NPPs in 2011

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Summary of the safety performance indicators for nuclear power plants

Background and objectives of the indicator system

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

The objective of the indicator system is to recognise changes in plant safety as early as possible. If the indicators weaken, the factors behind the development are investigated 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. STUK began the development of its own indicator system in 1995. Since 2006, indicator information has been managed in STUK's INDI (INdicator DIsplay) information system. Nominated STUK representatives are responsible for the maintenance and analysis of the indicators. Individual indicators, their maintenance procedures and the interpretation of results are presented at the end of this summary. A brief summary of the safety situation in each plant in 2011 is presented below, followed by the detailed results by indicator.

<table>
<tr><th colspan="3">Nuclear safety</th></tr>
<tr><th>A.I Safety and quality culture</th><th>A.II Operational events</th><th>A.III Structural integrity</th></tr>
<tr><td>1. Failures and their repairs</td><td>1. Number of events</td><td>1. Fuel integrity</td></tr>
<tr><td>2. Exemptions and deviations from the Operational Limits and Conditions</td><td>3. Risk-significance of events</td><td>2. Primary and secondary circuits integrity</td></tr>
<tr><td>3. Unavailability of safety systems</td><td>4. Accident risk of nuclear facilities</td><td rowspan="4">3. Containment integrity</td></tr>
<tr><td>4. Occupational radiation doses</td><td rowspan="3">5. Number of fire alarms</td></tr>
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</table>

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

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

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

Results of the safety performance indicators for the nuclear power plants in 2011

Summary of indicator results for the Loviisa power plant

Structural integrity

In 2011, neither plant unit reactor in Loviisa had any leaking fuel, meaning that fuel integrity was good. The low activity values of primary coolant during shutdown of the plant units for annual maintenance outages indicated the success of the shutdowns from the perspective of radiation protection.

The indicator system values show that both plant units have enjoyed good primary circuit integrity during 2011.

The indicators show that the leak-tightness of outer containment isolation valves has improved from the previous year at both Loviisa plant units. The indicator describing the overall as-found leakage of the personnel airlock, material airlock, emergency personnel airlock, reactor pit, inward relief valves, cable penetrations and bellows seals (RA, RL, TL23), is good at both plant units.

Radiation doses and releases

The radiation doses received by employees and the releases into the environment remained small and clearly below the limits set in official regulations. The total time spent on annual maintenance outages was short, and there were few operations of significance for radiation protection. Consequently, the total collective dose of the Loviisa power plant was the lowest ever in the history of the Loviisa NPP. The releases into the environment were small, well below the set limits.

Operational events at the plant

No reactor trips occurred at the Loviisa plant units during 2011. The one event classified as an operational transient at Loviisa 1 was a turbine trip. The leaking seal in the steam generator flange was a significant operational event at Loviisa 1. The plant unit was shut down for a short outage to repair the seal. The operational events had no safety significance. The annual maintenance outages were so-called refuelling outages. For the

Loviisa power plant, the most significant factors affecting the overall accident risk include internal plant events during outages (such as falling heavy loads in the reactor hall), fire, a high level of seawater during power operation and oil spills during a refuelling outage. The annual probability of a severe reactor accident calculated for the Loviisa plant units has decreased by about 17% from the previous year. Several minor plant modifications and the improvements of computational modelling have contributed to the reduction of the risk. Loviisa power plant's accident risk has continued to decrease over the last 10 years, and new risk factors discovered as the scope of the risk analysis has been extended, have been systematically removed.

The functionality of safety systems is monitored at the Loviisa power plant on the basis of the unavailability of the high-pressure safety injection system, the emergency feedwater system and the emergency diesel generators. The unavailability of the emergency make-up water system at Loviisa 2 increased somewhat from the previous year due to pump motor failures and the poor availability of spare parts. The indicators show that the maintenance of and fault repairs to components important to safety was otherwise appropriate.

There were no events classified as fires at the Loviisa power plant or in its immediate vicinity in 2011. The power plant's fire detection system had a similar number of faults as in the previous year. The average fire safety of the Loviisa plant has remained at the same level.

Summary of indicator results for the Olkiluoto power plant

Structural integrity

The impurity and corrosion product levels in reactor water and feedwater, followed in STUK's indicator scheme, were in keeping with the guide values set by the license holder at both plant units almost throughout the year. The indicators show that reactor circuit integrity has been good at the Olkiluoto plant units in 2011.

In 2011, fuel integrity was good at Olkiluoto 1. Two fuel leaks were observed at Olkiluoto 2. A fuel leak was detected immediately after the 2010 annual maintenance outage, and the leaking fuel assembly was removed from the reactor during the 2011 annual maintenance outage. The leak remained very small throughout this time. A new fuel leak was detected at Olkiluoto 2 on 5 August 2011. The leak has remained small throughout the monitored period, and the leaking fuel assembly will be removed from the reactor during the 2012 annual maintenance at the latest. Several fuel leaks have occurred in the 2000s at the Olkiluoto plant units, particularly at Olkiluoto 2. The main reason for the leaks has been small loose objects entering the reactor during maintenance operations. Among other things, foreign object sieves of a new type have been designed for the fuel assemblies in order to prevent loose objects from entering the assemblies. Fuel assemblies fitted with these are to be introduced in 2012.

The total as-found leakages of outer isolation valves at the Olkiluoto 1 plant unit was extremely small, clearly below the limit set in Tech Specs. At Olkiluoto 2, the as-found leakage of the outer isolation valves was also below the limit set in the Tech Specs and has remained approximately the same as before. 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.

Radiation doses and releases

The radiation doses received by employees and the releases into the environment remained small and clearly below the limits set in official regulations. At Olkiluoto, the radiation dose of employees was the lowest in the power plant's operational history. The releases of substances with gamma activity into the sea from the Olkiluoto power plant have been decreasing in recent years. In 2011, the atmospheric releases of radioactive substances were of the same magnitude as in previous years.

Operational events at the plant

For the Olkiluoto power plant, the most important factors affecting the overall accident risk include internal events during power operation (component failures and pipe ruptures leading to an operational transient). In 2011, the annual probability of a severe reactor accident calculated for the Olkiluoto plant increased by approximately 30%

from 2010. The change was caused by supplementing the model with the risks caused by an oil spill into the sea, as well as by an update of initiating event frequencies of fires and internal transients.

No reactor trips occurred at the Olkiluoto nuclear power plant during 2011. Based on the data from the last 10 years, an average of one reactor trip per year occurs at the Olkiluoto nuclear power plant.

The production losses due to failures were higher than in previous years. This is particularly due to the fact that there were three maintenance outages during which inspections and repairs were carried out. The production losses due to failures at Olkiluoto 1 during 2011 were mainly (>80%) caused by the maintenance outages in June and August. In June, inner parts of the primary circuit overpressure protection and residual heat removal system valves were inspected and damaged parts were replaced. The inspections were made following the observations made during the annual maintenance outage at Olkiluoto 2. In August, the motor of one main circulation pump was replaced by an overhauled pump because the motor's vibration levels had been increasing during the operating cycle. The inspections revealed that this was caused by a damaged bearing. The production losses due to failures at Olkiluoto 2 were mainly (>70%) caused by the maintenance outages in August, in which inner parts of the primary circuit overpressure protection and residual heat removal system valves were replaced. The damage was discovered during the annual maintenance outage in May–June. Not all parts could be replaced at that time due to an insufficient inventory of spare parts. A root cause report was produced for this event.

Based on data from the last 10 years, the average number of annual events warranting a special report or a transient report is five. The number of events warranting a special report in 2011 (2) was below the average. In contrast, the number of events warranting a transient report (9) was above the average. Both special reports concerned faults in the emergency diesel generators. The events are described in greater detail in Appendix 3 to the report. The majority of transient reports (6 out of 9) concern the main circulation pumps. As a rule, operational transients do not warrant any actions on STUK's part.

A latent fault was discovered in 2011 at Olkiluoto 1 in an emergency diesel generator, making the addition or risks due to faults in 2011 larger than in previous years. In 2011, the unavailability of EDGs was over four times higher than in 2010 because of faults detected in exhaust manifolds and exhaust pipes, the highest figure ever recorded while the parameter has been monitored. However, the risk significance of events at the Olkiluoto plant in 2011 remained, on average, at the level of previous years. The number of failures occurring and preventive maintenance operations carried out during power operation and causing the unavailability of components subject to Technical Specifications increased somewhat from 2010.

Fire safety has remained at the 2010 level, i.e. no events classified as fires occurred in the Olkiluoto plant area (OL1/2) in 2011.

Safety performance indicators

A.I Safety and quality culture

A.I.1 Failures and their repairs

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

Definition

The number of failures causing the 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)

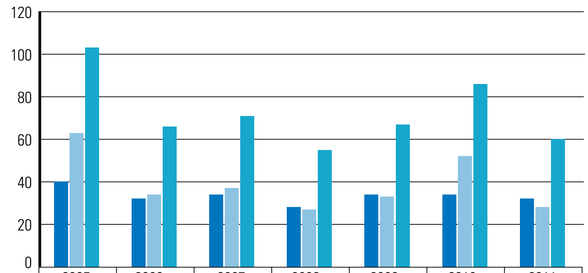
Interpretation of the indicator

Loviisa

In 2011, the number of failures in OLC components causing an operating restriction was 164, while in 2010 it was 204. The number of failures was lower than the average of the four preceding years (190). No single significant reason can be identified for the decrease.

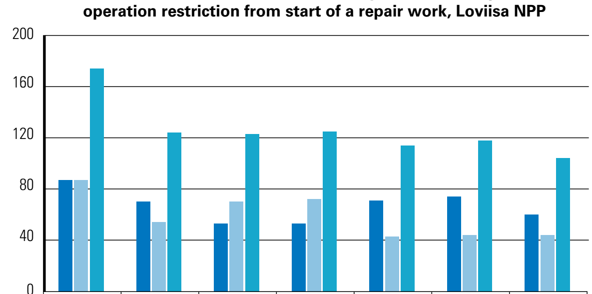
The number of failures per year has remained stable. Any variation therein has been caused by the random occurrences of failures that occur in any large number of components. Failure detection and anticipation have been continuously improved in plant maintenance operations at Loviisa, and components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

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



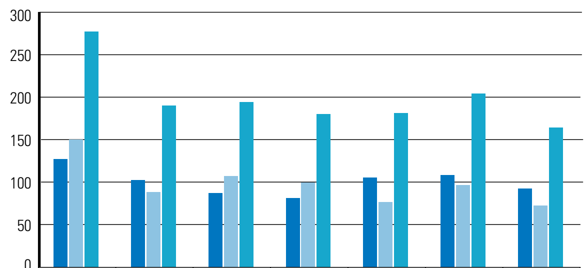
	2005	2006	2007	2008	2009	2010	2011
LO1	40	32	34	28	34	34	32
LO2	63	34	37	27	33	52	28
LO1,2	103	66	71	55	67	86	60

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



	2005	2006	2007	2008	2009	2010	2011
LO1	87	70	53	53	71	74	60
LO2	87	54	70	72	43	44	44
LO1,2	174	124	123	125	114	118	104

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



	2005	2006	2007	2008	2009	2010	2011
LO1	127	102	87	81	105	108	92
LO2	150	88	107	99	76	96	72
LO1,2	277	190	194	180	181	204	164

measures, the operability of components significantly affecting the safe operation of the plant has remained well under the NPP's control.

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

Interpretation of the indicator

Olkiluoto

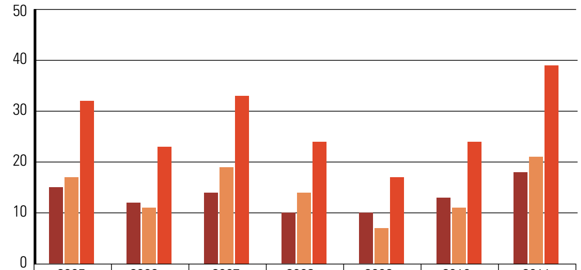
The number of failures occurring during power operation and causing the unavailability of components subject to Operational Limits and Conditions has been increasing since 2009. The number of failures occurring in 2011 was almost double compared to the failures in 2009. The number of failures had decreased during the period 2007–2009. The number of failures indicates that maintenance work has been successful.

The unavailability times of OLC components at OL1 were short during all quarters of 2011 except for the failure of a valve in the containment building gas treatment system that occurred during the first quarter. The failures occurring during the third quarter mainly concerned the seawater system of a shut-down reactor.

At OL2, the failures during the first quarter of 2011 mainly consisted of cases of unavailability of the diesel generator. The unavailability times of OLC components were in the main short.

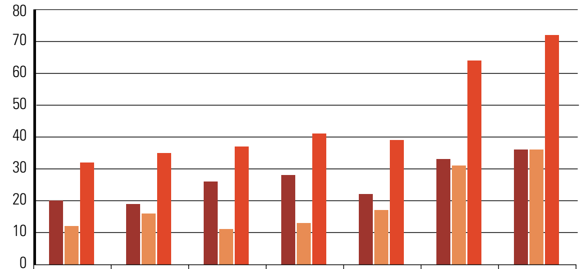
Heat exchanger washing operations increased the number of operation restrictions at both plant units.

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



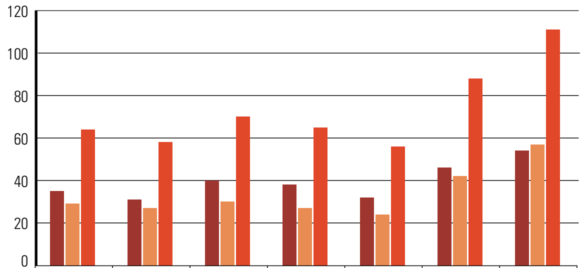
	2005	2006	2007	2008	2009	2010	2011
OL1	15	12	14	10	10	13	18
OL2	17	11	19	14	7	11	21
OL1,2	32	23	33	24	17	24	39

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



	2005	2006	2007	2008	2009	2010	2011
OL1	20	19	26	28	22	33	36
OL2	12	16	11	13	17	31	36
OL1,2	32	35	37	41	39	64	72

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



	2005	2006	2007	2008	2009	2010	2011
OL1	35	31	40	38	32	46	54
OL2	29	27	30	27	24	42	57
OL1,2	64	58	70	65	56	88	111

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

Definition

As the indicator, the number of fault repairs and preventive maintenance work orders for components defined in the OLCs 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 fault repairs are retrieved.

Purpose of the indicator

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

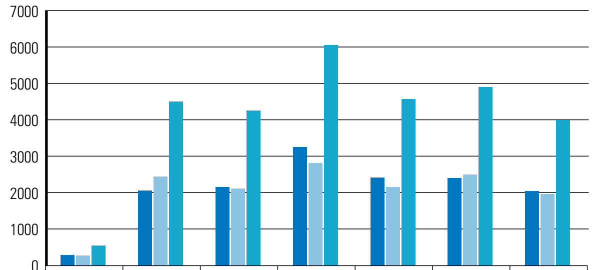
Loviisa

A new IT system was commissioned at the power plant in 2006. The scope of the indicator was changed in conjunction with the IT system revision. The annual maintenance operations also included the work for such components covered by OLCs 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 six years.

When considering the variation in the volume of fault repairs and particularly in the number of preventive maintenance works, the scheduling of various annual maintenance works (fuel replacement 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. The Loviisa plant units had short refuelling outages in 2011.

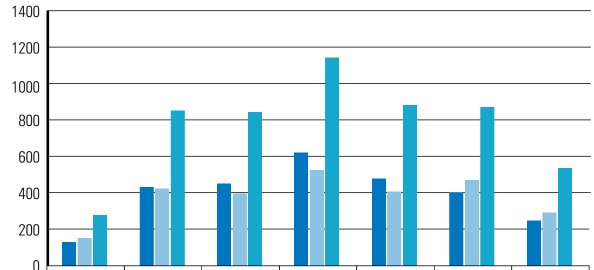
Judging by the data behind the indicator, 2011

Volume of annual maintenance works of OLC components, Loviisa NPP



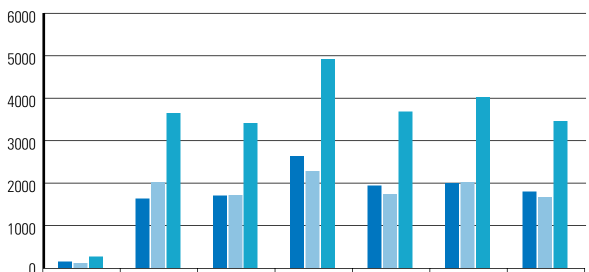
	2005	2006	2007	2008	2009	2010	2011
LO1	277	2057	2148	3250	2416	2403	2040
LO2	269	2444	2105	2807	2148	2495	1952
LO1,2	546	4501	4253	6057	4564	4898	3992

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



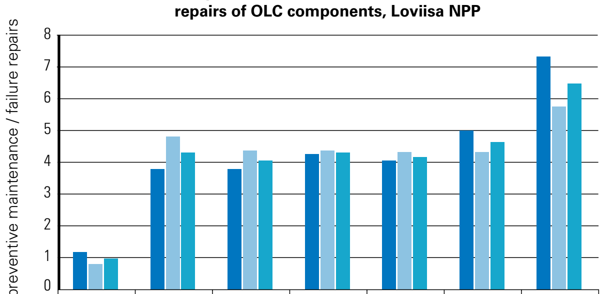
	2005	2006	2007	2008	2009	2010	2011
LO1	127	429	448	619	478	401	245
LO2	150	421	393	524	404	469	289
LO1,2	277	850	841	1143	882	870	534

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



	2005	2006	2007	2008	2009	2010	2011
LO1	150	1628	1700	2631	1938	2002	1795
LO2	119	2023	1712	2283	1744	2026	1663
LO1,2	269	3651	3412	4914	3682	4028	3458

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



	2005	2006	2007	2008	2009	2010	2011
LO1	1.18	3.79	3.79	4.25	4.05	4.99	7.32
LO2	0.79	4.81	4.36	4.36	4.32	4.32	5.75
LO1,2	0.97	4.30	4.06	4.30	4.17	4.63	6.48

was markedly different from the previous years as concerns the number of fault repairs and amount of preventive maintenance. The number of maintenance operations on OLC equipment reduced from the previous year by 19%, so that the reduction in preventive maintenance operations was 14%, while the reduction in fault repairs was 39%. Due to the fact that the reduction was different in the different types of work, their ratio changed significantly from 4.6 in 2010 to 6.5 in 2011.

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

The decrease in the fault repairs included in the indicator and the ratio of preventive maintenance operations to fault repairs may be regarded as an indication of a functional maintenance strategy.

Interpretation of the indicator

Olkiluoto

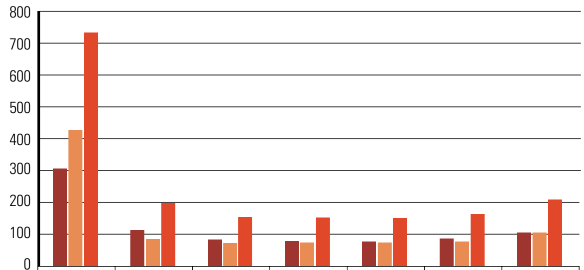
The data for the indicator is obtained from the plant work order system and operating documentation. Due to changes in the work order system implemented by the power company from 1 January 2006, the data is not comparable with the figures for earlier years. Class 3 data (systems subject to the Operational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

The number of maintenance works causing the 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.

In 2011, the number of fault repairs causing unavailability increased at both plant units from 2010. At the same time, the number of preventive maintenance operations increased by 30% with the result that the ratio of preventive maintenance operations to fault repairs is better than in 2010.

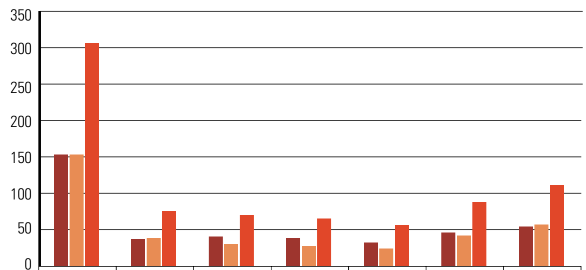
Based on the development of the ratio of preventive maintenance work to fault repairs and the assessment of the work behind the figures, the maintenance strategy can be considered functional.

Volume of annual maintenance works of OLC components, Olkiluoto NPP



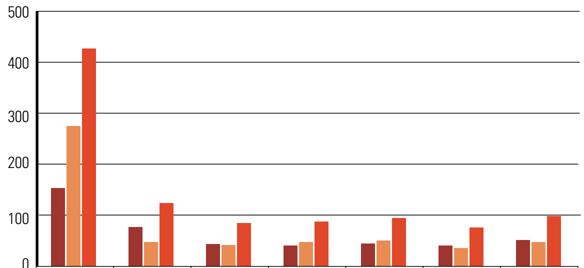
	2005	2006	2007	2008	2009	2010	2011
OL1	306	113	83	78	76	86	105
OL2	427	85	71	74	74	77	104
OL1,2	733	198	154	152	150	163	209

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



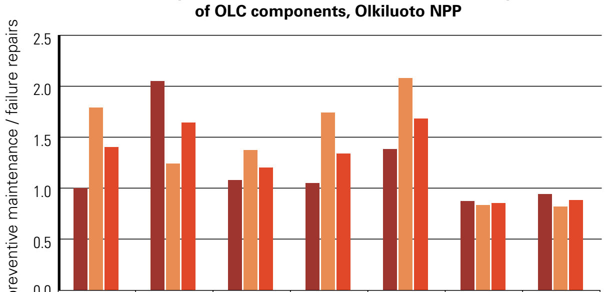
	2005	2006	2007	2008	2009	2010	2011
OL1	153	37	40	38	32	46	54
OL2	153	38	30	27	24	42	57
OL1,2	306	75	70	65	56	88	111

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



	2005	2006	2007	2008	2009	2010	2011
OL1	153	76	43	40	44	40	51
OL2	274	47	41	47	50	35	47
OL1,2	427	123	84	87	94	75	98

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



	2005	2006	2007	2008	2009	2010	2011
OL1	1.00	2.05	1.08	1.05	1.38	0.87	0.94
OL2	1.79	1.24	1.37	1.74	2.08	0.83	0.82
OL1,2	1.40	1.64	1.20	1.34	1.68	0.85	0.88

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

Definition

As the indicator, the average repair time of failures causing the unavailability of components defined in the OLCs 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 the 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 OLCs. 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

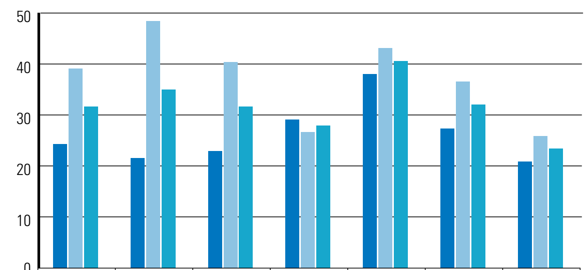
The Operational Limits and Conditions define the maximum allowed repair times for components based on the components' safety significance. The times vary between four hours and 21 days. Failures in OLC components are to be repaired within the allotted time without undue delay.

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 for failures causing the unavailability of components have remained stable at the Loviisa plant for several years. However, a decreasing trend can be seen over the last three years in these times. In 2011, the average repair time at the plant units was 23.4 hours while the average for the four preceding years was 33.0 hours. The average repair time of OLC component failures that had an allowed repair time of 72 hours or less was 11.1 hours at LO1 and 14.3 hours at LO2 in 2011.

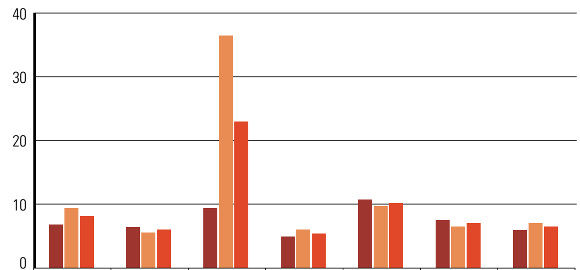
Based on the 2011 indicators and the data behind them, the plant's maintenance operations can be considered appropriate. In spite of the positive development in repair times, attention needs to be paid to the power plant's maintenance on having the necessary resources available for fault repairs and on carrying out the repairs without unnecessary delays.

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



	2005	2006	2007	2008	2009	2010	2011
LO1	24.3	21.5	22.9	29.1	38.0	27.3	20.9
LO2	39.1	48.4	40.4	26.6	43.1	36.6	25.9
LO1,2	31.7	35.0	31.7	27.9	40.6	32.0	23.4

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



	2005	2006	2007	2008	2009	2010	2011
OL1	6.8	6.4	9.4	4.9	10.7	7.5	5.9
OL2	9.4	5.5	36.5	6.0	9.7	6.5	7.0
OL1,2	8.1	6.0	23.0	5.4	10.2	7.0	6.5

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 from six to 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 2011, the average repair time of failures causing the unavailability of components defined in the Operational Limits and Conditions was about six hours at OL1 and about seven hours at OL2. At both plant units, the average repair time of failures causing the unavailability of components defined in the Operational Limits and Conditions was of the same order of magnitude as in 2010.

On the basis of the 2011 indicators and the data behind them, the plant's maintenance operations met 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 OLCs is followed.

Source of data
Data for the indicators is collected from the reports by the utilities of works causing an operation restriction.

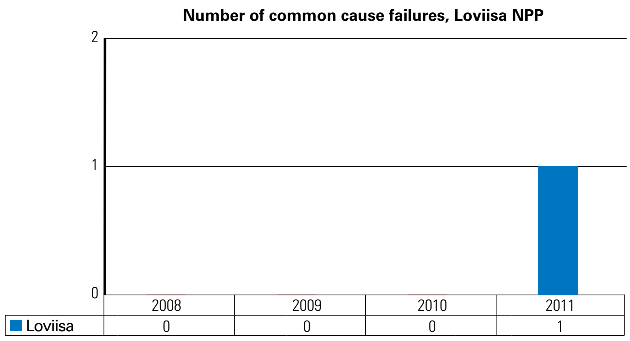
Purpose of the indicator
The indicator is used to follow the quality of maintenance.

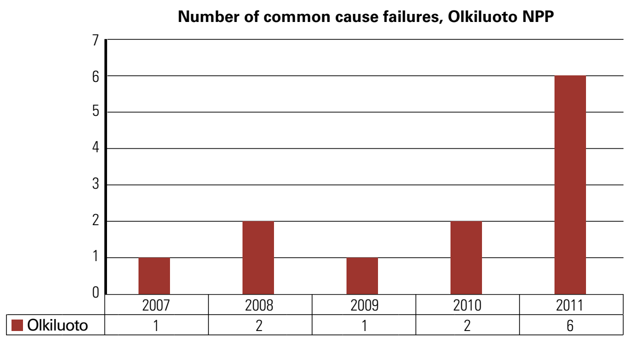
Responsible unit/person
Operational safety (KÄY)
Suvi Ristonmaa

Interpretation of the indicator

Loviisa
In 2011, one safety-significant common cause failure was identified at the Loviisa power plant. The start-up problems occurring in the periodic tests of recombiners at the upper section of the reactor building were identified as such failures. Hence, the situation is almost as good as in previous years.

Olkiluoto
Less common cause failures were identified than in previous years. At Olkiluoto, six common cause failures important to safety were identified in 2011. Four of these cases concerned the EDGs. The other two were the cracks observed in the inner parts of blowdown system valves and the faults in the speed governors of the start-up and shutdown piping system. The EDG system faults were the cracks and damage observed in the exhaust pipes, generator isolation faults and impurities in the cooling water. TVO has initiated a planning process for replacing the EDGs.





A.I.1g Production loss 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)
Jouko Mononen (Loviisa)
Suvi Ristonmaa (Olkiluoto)

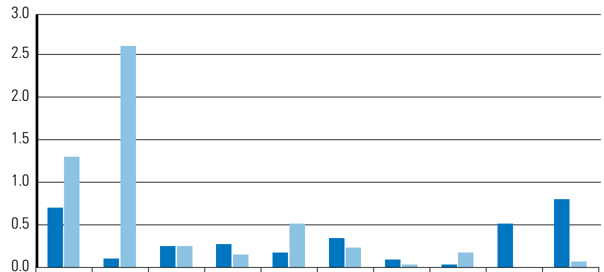
Interpretation of the indicator
Production losses due to failures have been small at both Loviisa and Olkiluoto, as is also indicated by the plants' high load factors.

Loviisa
Loviisa 1 experienced higher production losses from component failures in the previous years. Most of the losses were due to a leaking steam generator flange. The plant was run down to a cold shutdown state for repairing this fault. Loviisa 2 experienced less-than-average production losses from component failures.

Olkiluoto
The production losses due to failures were higher than in previous years. This is particularly due to the fact that there were three maintenance outages during which inspections and repairs were carried out.

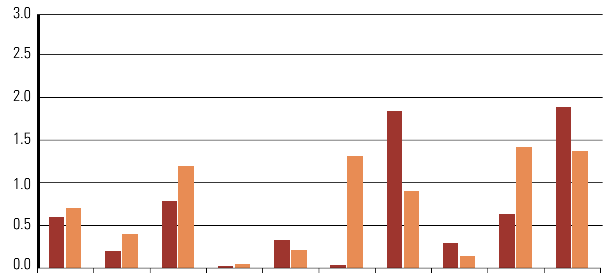
The production losses due to failures at Olkiluoto 1 during 2011 were mainly (>80%) caused by the maintenance outages in June and August. In June, inner parts of the blowdown system valves were inspected and damaged parts were replaced. Inspections were made following the observations made during the annual maintenance outage of Olkiluoto 2. In August, the motor of one main circulation pump was replaced by an overhauled motor because the motor's vibration levels had been increasing during the operating cycle. The inspections revealed that this was caused by a damaged bearing. The production losses due to failures at Olkiluoto 2 were mainly (>70%) caused by the maintenance outages in August, when inner parts of the blowdown system valves were replaced. The damage was discovered during the annual maintenance outage in May–June. All parts could not be replaced at that time due to an insufficient inventory of spare parts.

Loss of power production due to failures, Loviisa NPP



	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
LO1	0.70	0.10	0.25	0.27	0.17	0.34	0.09	0.03	0.51	0.80
LO2	1.30	2.60	0.25	0.15	0.51	0.23	0.03	0.17	0.00	0.07

Loss of power production due to failures, Olkiluoto NPP



	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
OL1	0.60	0.20	0.78	0.02	0.33	0.04	1.84	0.29	0.63	1.89
OL2	0.70	0.40	1.20	0.05	0.21	1.31	0.90	0.14	1.42	1.37

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 OLCs: compliance with the OLCs and identified situations during which it is necessary to deviate from them; of which conclusions can be made as regards the appropriateness of the OLCs.

Responsible unit/person

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

Interpretation of the indicator

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

Non-compliance with the OLCs 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.

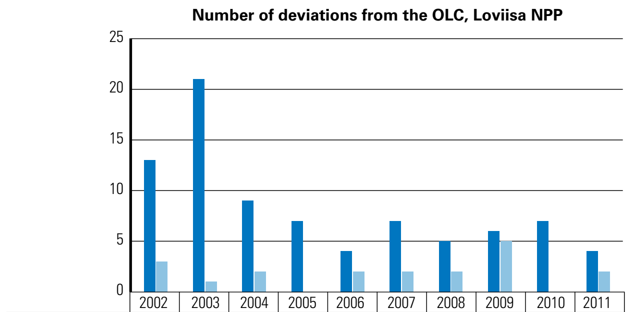
Loviisa

Exemptions

The Loviisa power plant applied for permissions from STUK for four planned deviations from the Operational Limits and Conditions during 2011. The number of applications was slightly lower than the average of previous years (7). The number of deviations in 2011 is at the lower limit of the variation range. Two of the applications were related to fault repairs and one to tests on the new emergency diesel generator. The fourth application was related to the periodic inspection of a chemical tank. STUK approved all the applications because the deviations had no significant safety implications for the safety of the plant or the environment.

Events non-compliant with the OLCs

In 2011, two events took place at the plant during which the plant was not in a state compliant with the Operational Limits and Conditions. One event was a case where the hydrogen analysis had been omitted, and the other related to beginning the annual maintenance operations on the DC systems of the emergency diesel generator while the plant was in a state of power operation. The number of events is similar to that in previous years.



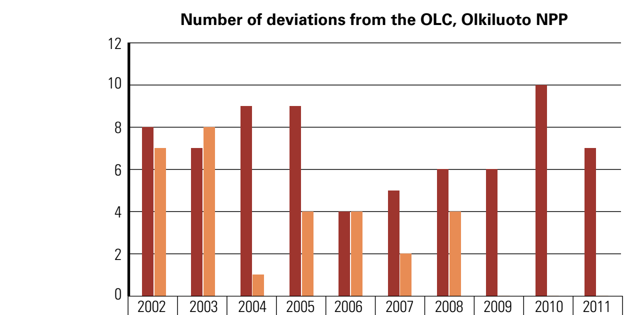
	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Exemptions	13	21	9	7	4	7	5	6	7	4
Deviations	3	1	2	0	2	2	2	5	0	2

Olkiluoto

Based on the results of the last 10 years, the Olkiluoto nuclear power plant applies for STUK's approval for non-compliance with the OLCs seven times per year on average. Hence, the number of applications in 2011 (7) was in line with the average. Five of the applications were related to modifications (including replacement of the plant's radiation measurement systems) and two to periodic tests. The planned deviations had no significant safety implications, so STUK approved all the applications but imposed certain restrictions related to the deviations in a few of its decisions. They concerned, among other things, the period of validity of the permission and operations during the deviation. STUK also approved two applications for extending the validity period of two earlier approved deviations from the OLCs. TVO could not start the work according to the intended schedule before the permissions expired. In 2004 and 2005, the number of deviations was increased by work and installations related to the modernisation of OL1 and OL2 and the construction of OL3. Similarly, major modifications were carried out during 2010 and 2011.

Events non-compliant with the OLCs

The Olkiluoto power plant did not report any situations during the year in which the Operational Limits and Conditions would have been breached.



	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Exemptions	8	7	9	9	4	5	6	6	10	7
Deviations	7	8	1	4	4	2	4	0	0	0

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 are calculated as the indicator. Unavailability hours are the combined unavailability of redundant subsystems 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 amounting to 13.2 hours. Similarly, LO2 had two faults that caused 229.5 hours of unavailability; of this, 206.5 hours were spent in the inspection and complete overhaul of the motor of pump TJ11D0001 following the excess vibration observed in the motor. The failures of TJ systems were not serious. Apart from the repair on TJ11D0001, the repairs were completed within the allowed repair times. In the case of the repair of TJ11D0001, the permissible three-day operation restriction time was deviated from by exemption permit 1/B42272/2011 granted by STUK.

The significant unavailability of the high pressure safety injection systems was caused by a single fault at LO2. When that is taken into account, it can be stated that the unavailability of TJ systems was low in 2011, i.e. their condition and availability were good.

RL system

At LO1, the total unavailability time was 129.1 hours, of which 53.8 hours were attributable to a single fault occurring during power operation. The rest of the unavailability hours at LO2 were caused by annual maintenance of the RL94 system that took 75.3 hours.

At LO2, the total unavailability time was 74.7 hours, which was exclusively caused by the annual maintenance of the RL97 system.

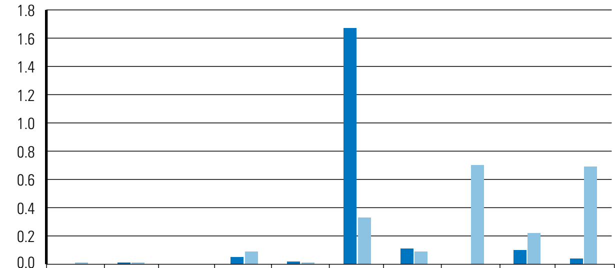
The unavailability of the auxiliary feed water systems was low in 2011, i.e. their condition and availability were good.

EY system

In 2011, the total unavailability for all eight diesel generators was 474.4 hours, of which repairs made up 309.1 hours, and the estimated total duration of unavailability before detecting the faults was 165.3 hours. There were 18 faults in all, of which seven caused immediate operation restrictions while 11 caused operating restrictions from the beginning of the repair work. The failures detected were mainly caused by the normal ageing of components and did not have any serious implications.

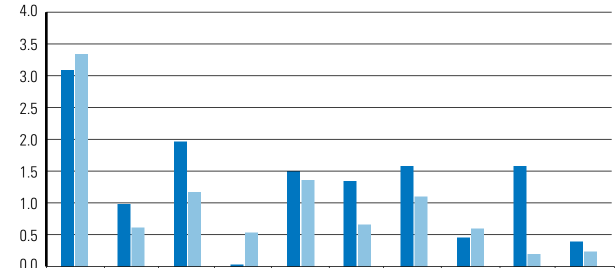
The unavailability of the emergency diesels (EY) increased slightly from the previous year's level, but still remained low, i.e. their availability was satisfactory.

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



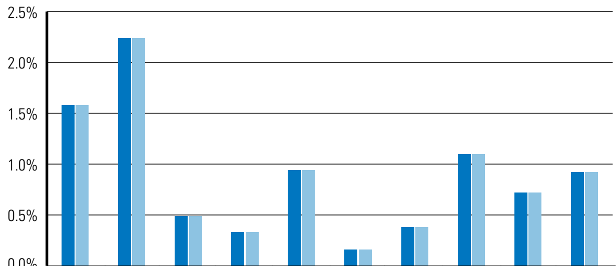
	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
LO1	0.00	0.01	0.00	0.05	0.02	1.67	0.11	0.00	0.10	0.04
LO2	0.01	0.01	0.00	0.09	0.01	0.33	0.09	0.70	0.22	0.69

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



	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
LO1	3.09	0.98	1.96	0.03	1.49	1.34	1.58	0.45	1.58	0.39
LO2	3.34	0.61	1.17	0.53	1.36	0.66	1.1	0.59	0.19	0.23

Unavailability of emergency diesel generators (EY), Loviisa NPP



	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
LO1	1.58	2.24	0.49	0.33	0.94	0.16	0.38	1.10	0.72	0.92
LO2	1.58	2.24	0.49	0.33	0.94	0.16	0.38	1.10	0.72	0.92

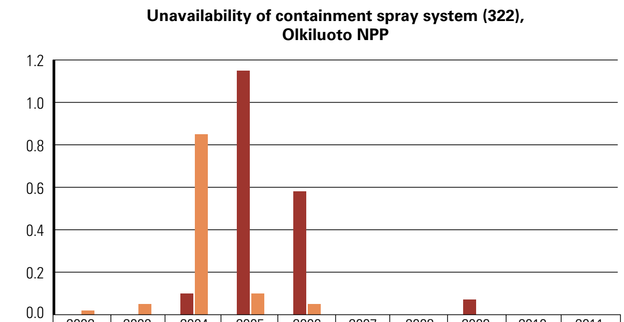
Interpretation of the indicator

Olkiluoto

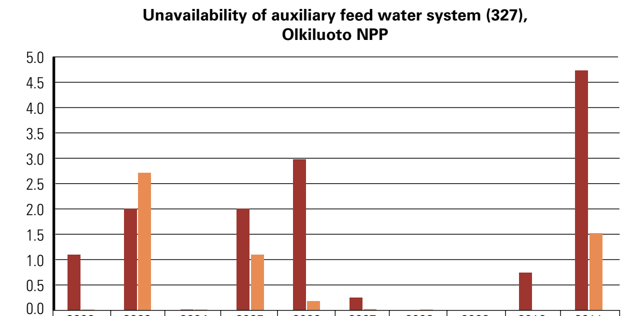
The unavailability times of the containment spray system have been decreasing since 2005. In 2007, 2008, 2010 and 2011, the unavailability was zero for both plant units, and almost zero in 2009.

The unavailability of the auxiliary feed water system increased significantly after 2004, when the unavailability was practically 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 at OL1 was still zero but increased slightly at OL2 from the previous year, mainly as a result of the new faults discovered during the outage. In 2011, the figure for OL1 was multiplied many times over as the result of a latent fault in one auxiliary feedwater system valve that was faulty for 504 hours. Confer with Section A.II.3.

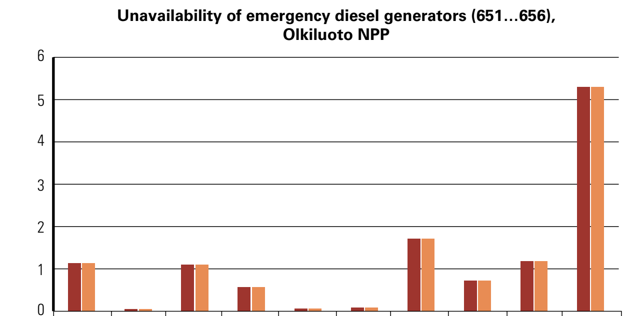
The unavailability of the diesel generators has decreased since 2004, and was very low in 2006 and 2007. In 2008, the value increased by nearly 95% compared to the previous year. The increase was due to latent faults in the compressed air motors of the diesels in both plant units. In 2009, the unavailability of diesel engines decreased considerably from the 2008 figures. In 2010, unavailability increased somewhat from the previous year as a result of failures occurring in connection with periodic tests. At OL1, the stator winding of a diesel generator failed in connection with a periodic test in August 2010, and the generator was replaced with an overhauled unit. The other similar generators were inspected at both plant units, and visual inspection did not reveal any deviations in them. The failed generator was sent for repairs. During the repairs, which lasted until early 2011, there were no spare generators available at either plant unit. In 2011, the unavailability of EDGs was over four times higher than in 2010, the highest figure ever recorded while the parameter has been monitored. The reason for the increase was the generator fault discussed above, which may have lasted as long as from August 2010 to May 2011. In addition, there were faults in exhaust manifolds and exhaust pipes.



	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
OL1	0.00	0.00	0.10	1.15	0.58	0.00	0.00	0.07	0.00	0.00
OL2	0.02	0.05	0.85	0.10	0.05	0.00	0.00	0.00	0.00	0.00



	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
OL1	1.10	2.00	0.01	2.00	2.98	0.25	0.00	0.00	0.74	4.73
OL2	0.01	2.71	0.01	1.10	0.18	0.02	0.01	0.00	0.00	1.52



	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
OL1	1.14	0.05	1.10	0.57	0.06	0.09	1.71	0.72	1.18	5.30
OL2	1.14	0.05	1.10	0.57	0.06	0.09	1.71	0.72	1.18	5.30

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 10 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 10 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

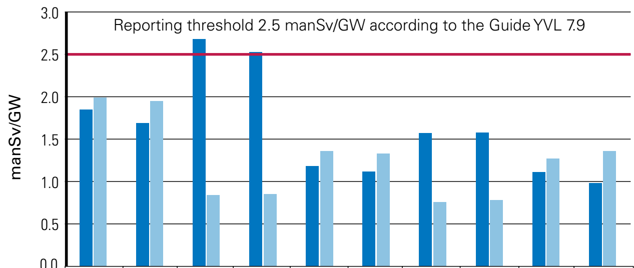
Interpretation of the indicator

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 more extensive 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. The four-year and eight-year outages have been held in even years and normal annual outages in odd years. The effect of annual outages on collective doses can be seen on the *Collective radiation dose, Loviisa* graph. In 2011, the Loviisa 1 and 2 plant units had refuelling outages. The time used for annual maintenance outages was short, and there were few operations of significance for radiation protection, which resulted in the total collective dose of the Loviisa power plant being the lowest ever in the history of the Loviisa NPP. The previous lowest collective dose ever was recorded in 2007.

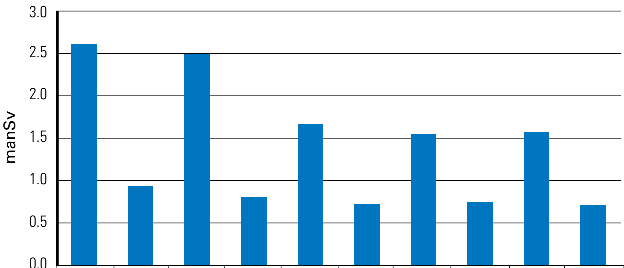
The radiation doses for nuclear power plant workers were below the individual dose limits. In 2011, the average of the 10 highest radiation doses was the lowest ever recorded at the Loviisa power plant. The trend of the 10 highest radiation doses has been a declining one with the exception of 2010 when the individual doses were higher due to the extensive eight-year maintenance. 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 NPP



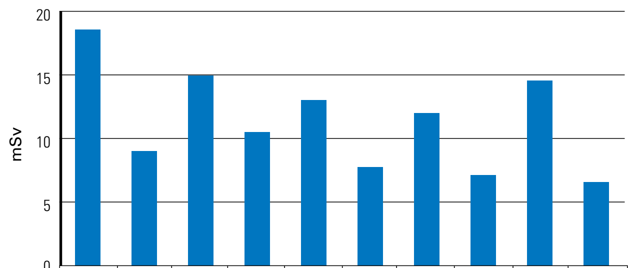
	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
LO1	1.85	1.69	2.68	2.53	1.18	1.12	1.57	1.58	1.11	0.98
LO2	1.99	1.95	0.84	0.85	1.36	1.33	0.76	0.78	1.27	1.36

Collective occupational radiation dose (manSv), Loviisa NPP



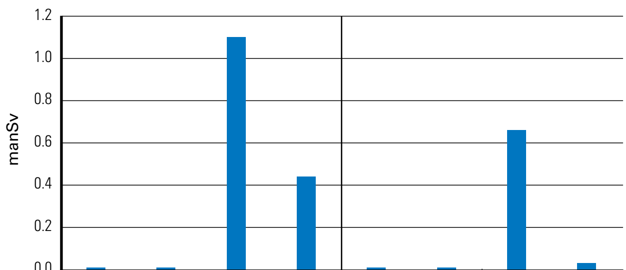
	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
LO	2.61	0.94	2.49	0.81	1.66	0.72	1.55	0.75	1.57	0.71

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



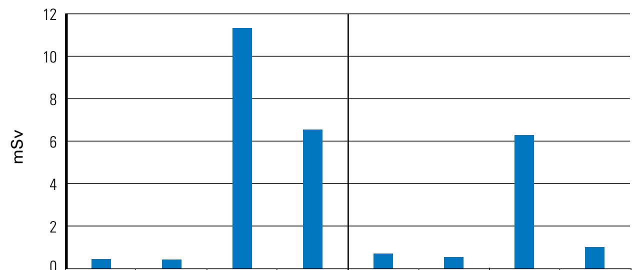
	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
LO	18.54	9.01	14.93	10.48	13	7.76	11.99	7.11	14.55	6.56

Collective occupational radiation dose (manSv) quarterly, Loviisa NPP



	I/10	II/10	III/10	IV/10	I/11	II/11	III/11	IV/11
LO	0.01	0.01	1.10	0.44	0.01	0.01	0.66	0.03

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



	I/10	II/10	III/10	IV/10	I/11	II/11	III/11	IV/11
LO	0.44	0.42	11.32	6.53	0.70	0.54	6.27	1.00

Furthermore, the threshold set for the collective occupational dose was not exceeded in 2011. 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).

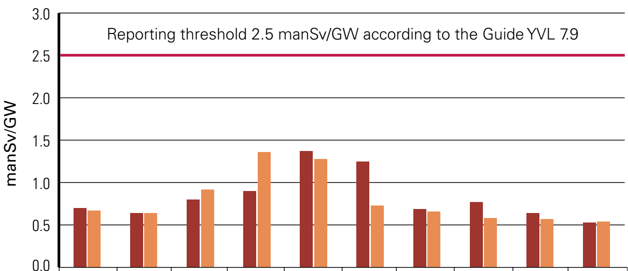
Interpretation of the indicator

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 (approx. 7 days). The length of the maintenance outage depends on the amount of work (2–3 weeks). Annual outages are scheduled so that in the same year, one plant unit has a maintenance outage and the other a refuelling outage. In 2011, the collective radiation dose at the Olkiluoto power plant was the fourth-lowest recorded during the plant's history, in spite of the maintenance outage of Olkiluoto 2 that was extensive both in terms of the personnel involved and the amount of work carried out. The lowest-ever collective radiation dose was recorded at the power plant in 2010. The new steam dryers installed at the plant units in 2005–2006 have reduced the radiation levels and collective doses at the turbine plant.

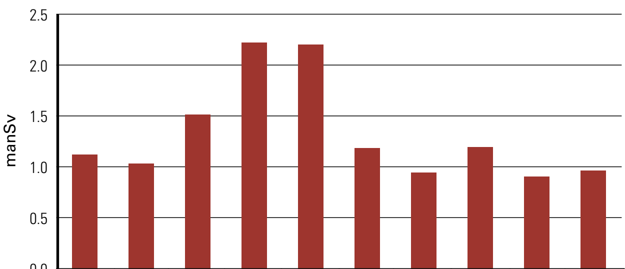
In 2011, the average of the 10 highest radiation doses was lower than average. The prescribed dose limits (Radiation Decree 1512/1991) were not exceeded.

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



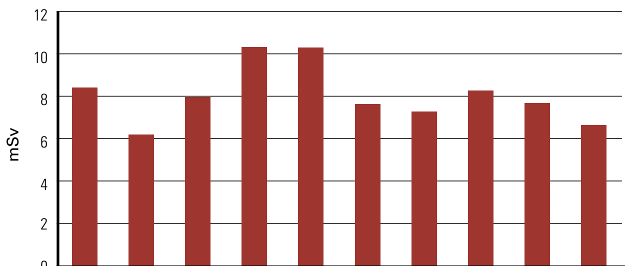
	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
OL1	0.70	0.64	0.80	0.90	1.37	1.25	0.69	0.77	0.64	0.53
OL2	0.67	0.64	0.92	1.36	1.28	0.73	0.66	0.58	0.57	0.54

Collective occupational radiation dose (manSv), Olkiluoto NPP



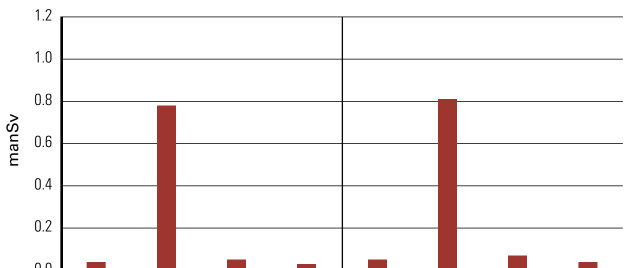
	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
OL	1.12	1.03	1.51	2.22	2.20	1.18	0.94	1.19	0.90	0.96

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



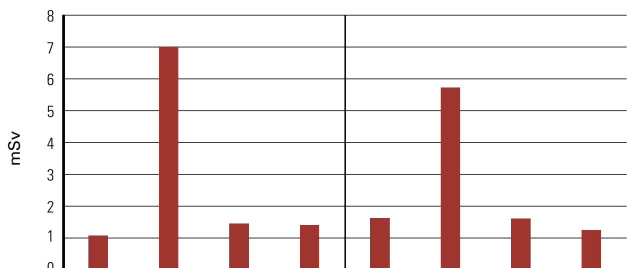
	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
OL	8.41	6.20	7.96	10.32	10.30	7.63	7.28	8.27	7.68	6.65

Collective occupational radiation dose (manSv) quarterly, Olkiluoto NPP



	I/10	II/10	III/10	IV/10	I/11	II/11	III/11	IV/11
OL	0.04	0.78	0.05	0.03	0.05	0.81	0.07	0.04

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



	I/10	II/10	III/10	IV/10	I/11	II/11	III/11	IV/11
OL	1.08	7,00	1.46	1.41	1.63	5.73	1.61	1.25

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.

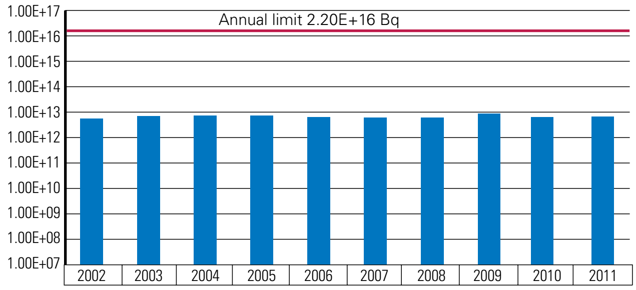
Responsible unit/person
Radiation protection (SÄT), Antti Tynkkynen

A.I.5a Releases into the atmosphere

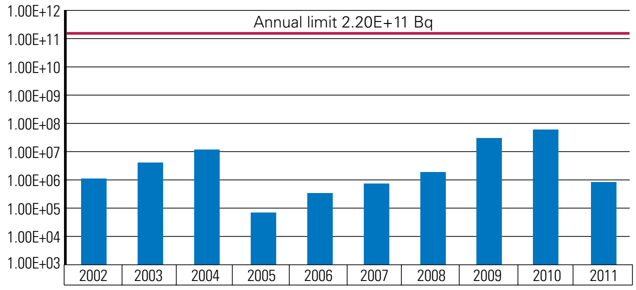
Interpretation of the indicator
In 2011, the radioactive releases into the atmosphere from the Loviisa and Olkiluoto nuclear power plants were of the same magnitude as in previous years. The releases into the environment were small, well below the set limits.

The releases of noble gases and particulate aerosols from the Loviisa power plant were of the same magnitude as in previous years. The releases of iodine isotopes decreased markedly and were at the 2007 level. The iodine releases from the Loviisa power plant were larger than average during 2009–2010 as a result of small fuel leaks.

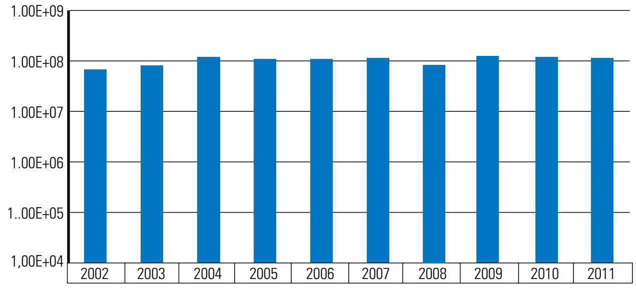
Noble gas releases (Bq $^{87}Kr_{eq}$), Loviisa NPP



Iodine isotope releases to atmosphere (Bq $^{131}I_{eq}$), Loviisa NPP

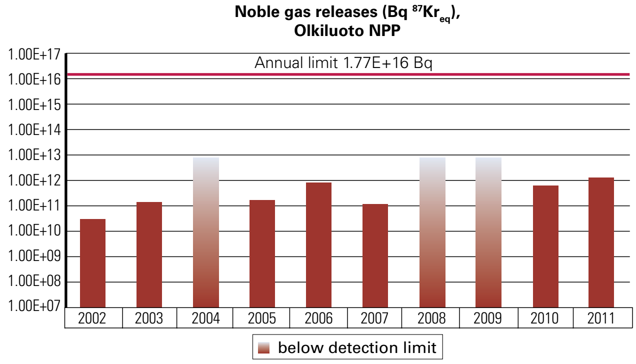


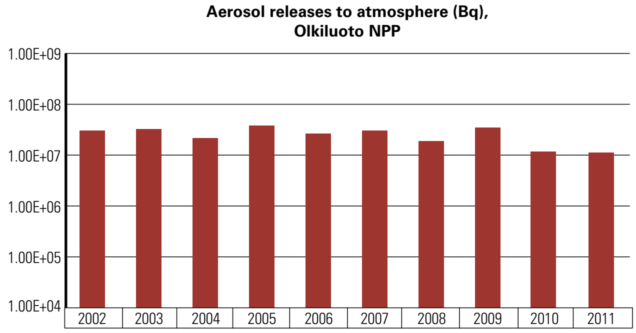
Aerosol releases to atmosphere (Bq), Loviisa NPP

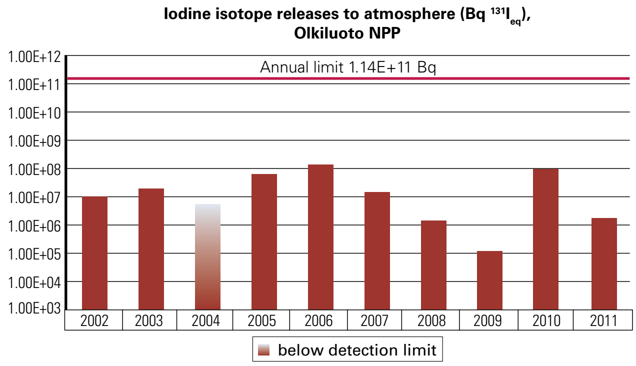


Of the releases from the Olkiluoto power plant, the atmospheric releases of noble gases were larger in 2011 than in previous years, while the iodine releases were smaller than in 2010. The noble gas and iodine releases were affected by the fuel leaks occurring at the Olkiluoto 2 plant unit in 2011. The atmospheric releases of particulate aerosols were smaller than previously.

Gaseous fission products, noble gases and iodine isotopes originate from leaking fuel rods, from the minute amounts of uranium left on the outer surfaces of fuel cladding during fuel fabrication, and from reactor surface contamination from earlier fuel leaks. At both Loviisa and Olkiluoto, there have been very few leaking fuel rods and the leaks have been small. One fuel rod leak was detected at the Loviisa 2 plant unit during the refuelling cycle of 2008–2009 and one at the Loviisa 1 plant unit during the refuelling cycle of 2009–2010. The leaking assemblies were replaced with fresh assemblies during the annual maintenance outages of the plant units. Both plant units at Olkiluoto also had a leak in one fuel assembly each before the annual maintenance outages in 2010, plus a leak in a fuel assembly at Olkiluoto 2 plant unit during the refuelling cycle of 2010–2011. The leaking assemblies were removed from the reactors during the annual maintenance outages of the plant units. Furthermore, a new fuel leak was detected at the Olkiluoto 2 plant unit immediately after the 2011 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.



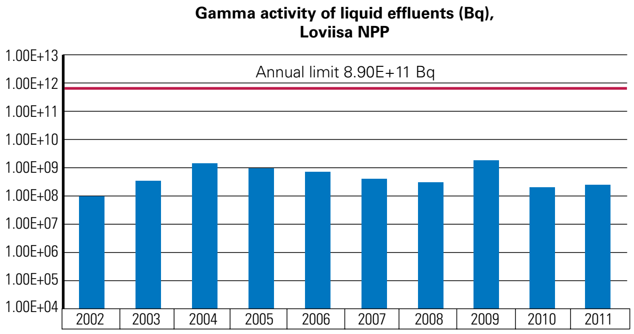


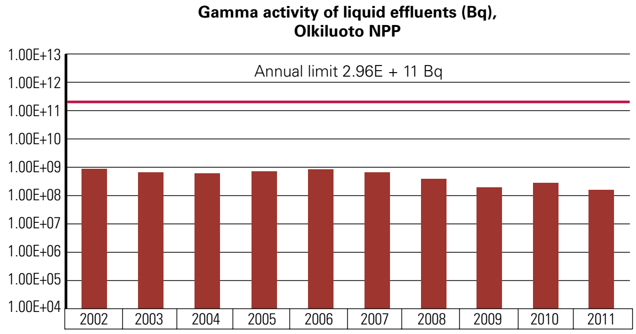


A.I.5b Releases into the sea

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 decreased in recent years.



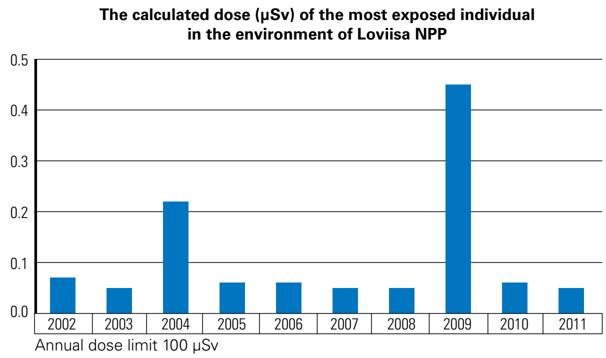


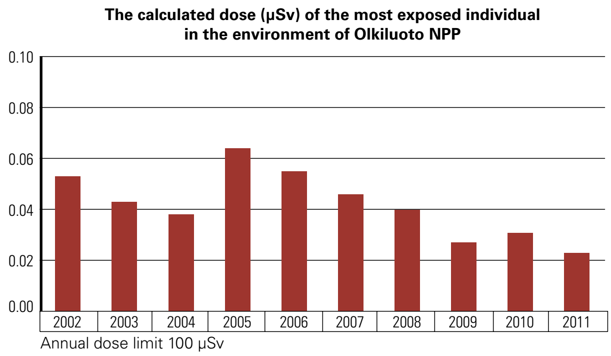
A.I.5c Population exposure

Interpretation of the indicator

In 2011, the doses of the most exposed individual in the vicinity, calculated on the basis of releases from the plant, were below the set limit both at Loviisa and Olkiluoto. At Loviisa, the dose of the most exposed individual in the vicinity was lower than average, while at Olkiluoto, it was the lowest ever recorded in the plant's history. As a result of the planned release of low-level evaporation waste to the sea at Loviisa, the dose of the most exposed individual in the vicinity of the Loviisa power plant 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 established in the 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 euro 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.

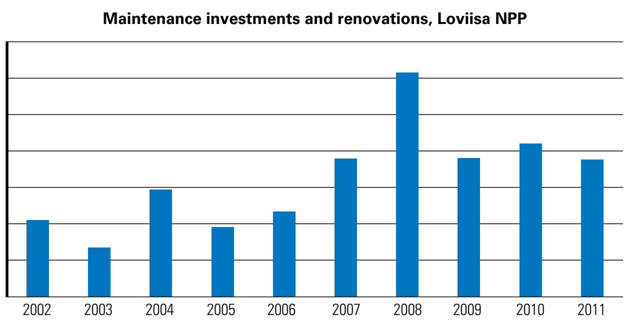
Purpose of the indicator
The indicator is used to follow the amount of investments in plant maintenance and their fluctuations.

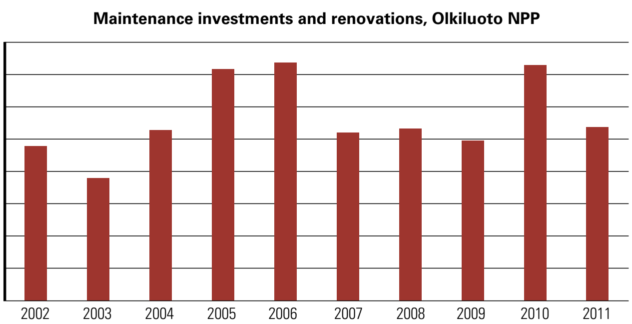
Responsible unit/person
Operational safety (KÄY)
Suvi Ristonmaa

Interpretation of the indicator
The variation in the indicator distinctly shows the investments related to the power upgrades and modernisation projects of the plants. Both plants have paid great 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, starting from 2007, is caused by the modernisation of I&C systems at Loviisa. Other major investments in 2011 included the construction of a new diesel emergency power plant, extension of the repository for low- and intermediate-level waste, modification of the pressure equalisation system, replacement of the service water system pipelines, construction of a new training simulator and the replacement of safety valves in the fresh steam pipelines. Many modification projects span over many years, which means that their total cost is also divided between several years.

Olkiluoto
The major modifications, mainly implemented during the 2010 annual maintenance outage of Olkiluoto 1 and the 2011 annual maintenance outage of Olkiluoto 2, show in the investment figures for 2010 and 2011. These modifications included the replacement of inner isolation valves of the seawater pipes, the replacement of low-pressure turbines and the replacement of 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

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

Interpretation of the indicator

Loviisa

No reactor trips occurred at the Loviisa power plant. The previous occurrences of reactor trips were in 2004 and 2010. The total number of reactor trips has remained small. There have been two during the last 10 years.

Based on data from the last 10 years, the average number of annual events warranting a special report or a transient report is three per year, while the average number of events warranting a transient report is seven per year. In 2011, there were fewer of both types of reportable events than in previous years.

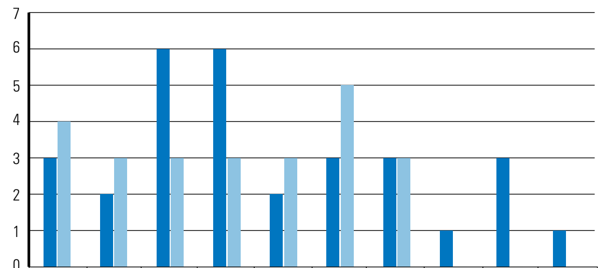
One operational transient occurred in 2011. This was a turbine trip that occurred in connection with a planned ramp-down of power at the Loviisa 1 unit, carried out to allow maintenance work on the control rod mechanism.

The licensee reported two special situations. One was a case of the equipment not being in a condition compliant with the Operational Limits and Conditions. In the other event, the operations were not compliant with the requirements of the Operational Limits and Conditions regarding primary circuit water sampling.

The indicator shows that the plant's operations have continued to be of a good standard.

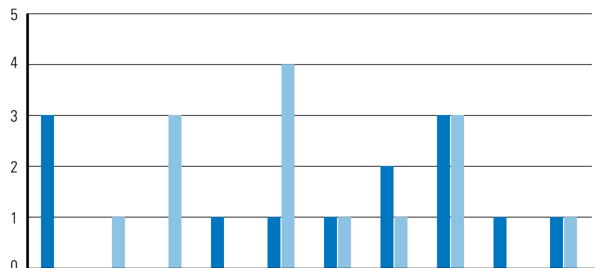
When considering the indicators, it must be noted that the number of reports does not give the correct conception of the division of events by plant unit, since, for system technical reasons, the reports for both plant units have been entered for Loviisa 1.

Number of operational transient reports, Loviisa NPP



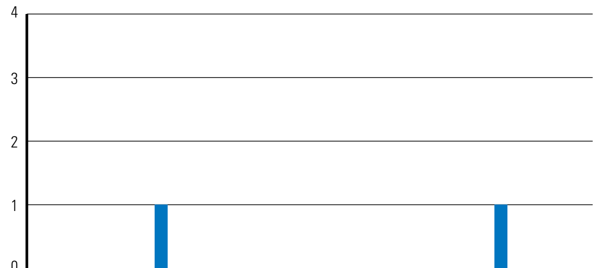
	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
LO1	3	2	6	6	2	3	3	1	3	1
LO2	4	3	3	3	3	5	3	0	0	0

Number of Special Reports, Loviisa NPP



	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
LO1	3	0	0	1	1	1	2	3	1	1
LO2	0	1	3	0	4	1	1	3	0	1

Number of reactor scrams, Loviisa NPP



	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
LO1	0	0	1	0	0	0	0	0	1	0
LO2	0	0	0	0	0	0	0	0	0	0

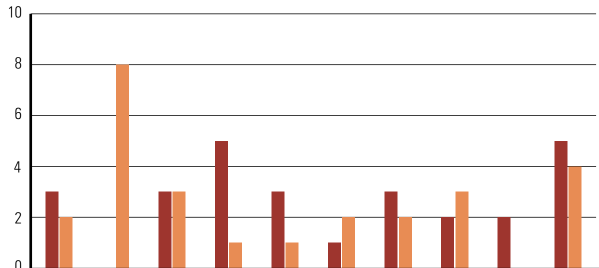
Olkiluoto

No reactor trips occurred at the Olkiluoto nuclear power plant. Based on the data from the last 10 years, an average of one reactor trip per year occurs at the Olkiluoto nuclear power plant. During the previous decade (1993–2001), an average of almost three to four reactor trips occurred per year. The figure is explained by the fact that it also includes reactor trips during annual maintenance outages that occurred, for example, in connection with testing the reactor protection system.

Based on data from the last 10 years, the average number of annual events warranting a special report or a transient report is five. The number of events warranting a special report in 2011 (2) was below the average. In contrast, the number of events warranting a transient report (9) was above the average. Both special reports concerned faults in the emergency diesel generators. The events are described in closer detail in Appendix 3 to the report. The majority of transient reports (6 out of 9) concern the main circulation pumps. Of these, three reports deal with the planned control of one main circulation pump at Olkiluoto 1 and Olkiluoto 2 to lower revs due to a transient in the external electricity grid. One report deals with the control of one circulation pump at Olkiluoto 1 to lower revs, caused by a damaged bearing in the pump motor. The motor was replaced during a maintenance outage (Section 4.2.2). Two reports deal with the stoppages of one main circulation pump at Olkiluoto 1 and Olkiluoto 2. As a rectifying action, TVO replaced parts of the frequency converters and sent them to the equipment manufacturer for investigation. The investigations regarding the cause of the fault are in progress. STUK has sent TVO a letter requesting it to submit the results for information to STUK before the 2012 annual maintenance outages. The other transient reports concern the errors detected during the testing of the new main generator of Olkiluoto 2 and its voltage regulator (wrong setting of the voltage regulator, error in planning the tests) and the closure of the inner isolation valve of one main steam line at Olkiluoto 2 during the operating cycle. The valve closed because the contact breaker of its control valve opened for an unknown reason. One of the most significant events during the year was the discovery of damage in the blowdown system valves at Olkiluoto 1 and Olkiluoto 2. The event is not included in these indicators because a root cause report was produced for the event.

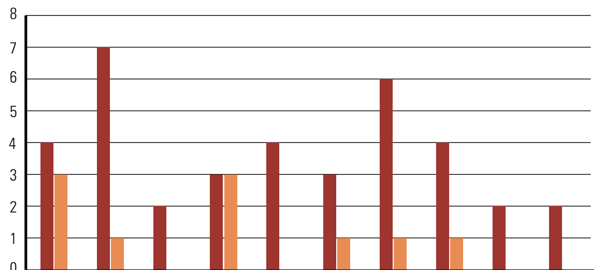
When considering the indicators, it must be noted that the number of reports does not give the correct conception of the division of events by plant unit, since, for system technical reasons, the reports for both plant units have been entered for Olkiluoto 1. In 2011, one event warranting a transient report and three warranting a special report concerned both plant units.

Number of operational transient reports, Olkiluoto NPP



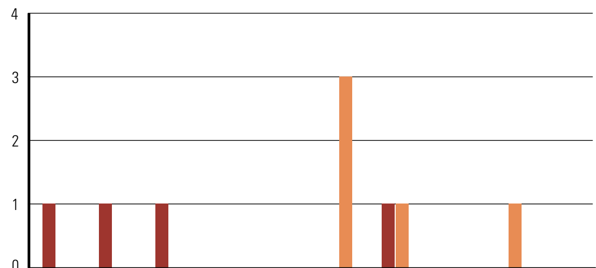
	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
OL1	3	0	3	5	3	1	3	2	2	5
OL2	2	8	3	1	1	2	2	3	0	4

Number of Special Reports, Olkiluoto NPP



	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
OL1	4	7	2	3	4	3	6	4	2	2
OL2	3	1	0	3	0	1	1	1	0	0

Number of reactor scrams, Olkiluoto NPP



	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
OL1	1	1	1	0	0	0	1	0	0	0
OL2	0	0	0	0	0	3	1	0	1	0

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 OLCs are in category 1, if they can be utilised for this indicator. Non-compliances with the OLCs are also dealt with under indicator A.I.2.

N.B.! The calculations concerning the Olkiluoto plant were performed using FinPSA software and those concerning the Loviisa plant using RiskSpectrum software. Calculations for the Loviisa plant regarding simultaneous multiple failures are only based on the power operation model, making them indicative only. All states (17 of them) could be modelled, but the calculation time would be too long compared to the benefits.

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 identify systematically 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 most significant events regarding risk is given below:

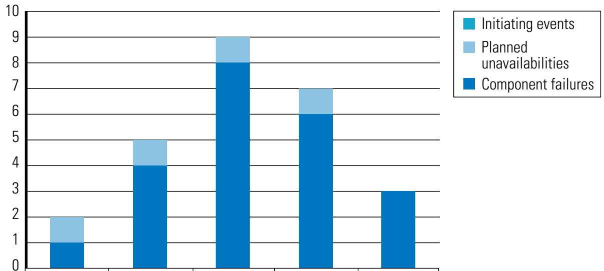
Loviisa 1:

1. On 22 January 2011, the replacement of connecting rod bearings of diesel EY01. According to information received from the supplier, the bearing in the diesel was from an obsolete batch. Unavailability lasted for 123.5 h. CCDP: 1.20 E-7. During the replacement work, valve VF62S006, pump TF12D001 and valve RA54S003 were also broken (part of the time). If these faults are taken into account, we obtain 3.1E-7 for the CCDP of the entire fault complex.
2. On 8 November 2011, valve VC10S0001 stoped in an intermediate position when it was being closed. Seawater is discharged from VF 70/21 to VC through this valve. Unavailability lasted 7.7 h. CCDP: 2.55E-7.
3. On 24 November 2011, a bellow was torn in the suction line of blower UV20D0001, and the blower was rotating in the wrong direction. Unavailability lasted 128.8 h. CCDP: 4.6E-7.

Loviisa 2:

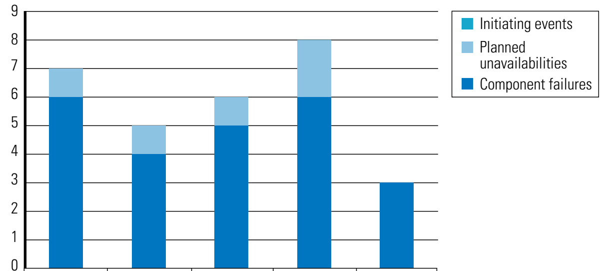
1. On 7 February 2011, the temperature regulator of inlet air heating element UV40W0001 was repaired and checked. Unavailability lasted 241 h. CCDP: 8.8E-7. During the fault, EY02S0204 was also broken (leaked diesel fuel) for 77.5 hours. Combined CCDP: 9.6E-7.
2. On 10 March 2011, leaky diesel fuel valves EY02S0201, 202 and 203 were repaired. The day-tank for diesel fuel could not be filled while the work was in progress. Unavailability lasted 223.6 h. CCDP: 2.8E-7.
3. On 29 August 2012, start-up air valve EY01S014 of diesel EY01 was repaired. Unavailability lasted 339.9 h. CCDP: 3.3E-7.

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



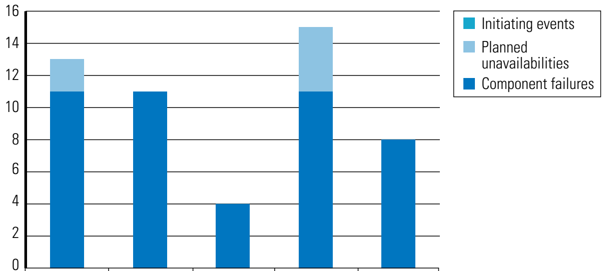
2007	2008	2009	2010	2011
0	0	0	0	0
1	1	1	1	0
1	4	8	6	3

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



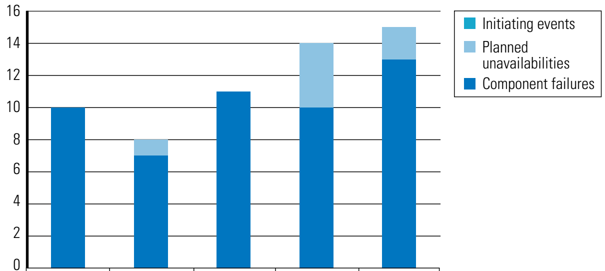
2007	2008	2009	2010	2011
0	0	0	0	0
1	1	1	2	0
6	4	5	6	3

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



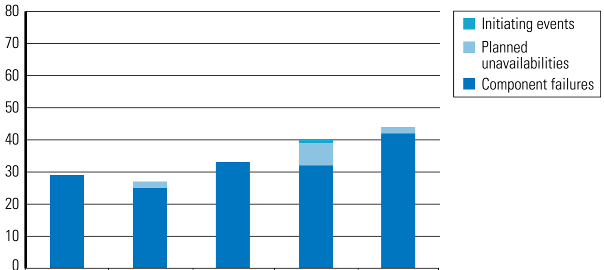
2007	2008	2009	2010	2011
0	0	0	0	0
2	0	0	4	0
11	11	4	11	8

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



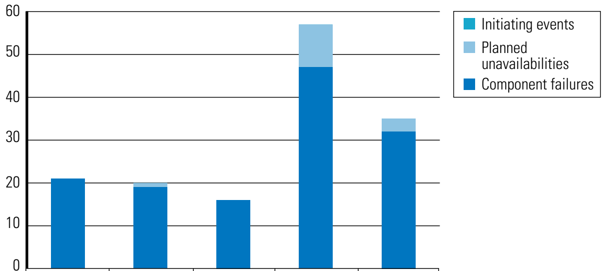
2007	2008	2009	2010	2011
0	0	0	0	0
0	1	0	4	2
10	7	11	10	13

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



2007	2008	2009	2010	2011
0	0	0	1	0
0	2	0	7	2
29	25	33	32	42

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



2007	2008	2009	2010	2011
0	0	0	0	0
0	1	0	10	3
21	19	16	47	32

The analysed events are considered to be part of normal nuclear power plant operation, and no further measures were required from STUK.

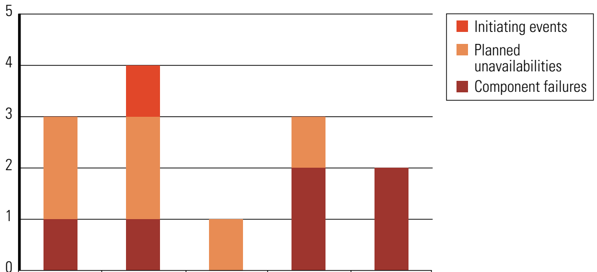
Olkiluoto

A brief description of the significant events is given below:

Olkiluoto 1:

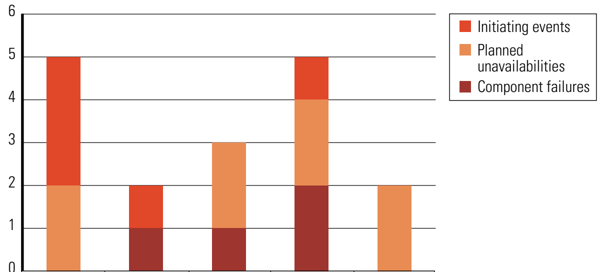
1. On 5 May 2011, the exciter of diesel generator 653G401 was repaired. The fault had demonstrated itself when the switch-over and re-switching automation of the 660 V emergency power supply was tested during annual maintenance R111. The generator switch tripped with overvoltage. TVO identified the fault in a thyristor that did not respond to controls. The fault would not have been found in normal monthly tests, which means that it could have been latent since the previous time of operation (since 18 August 2010). If 3120 h is taken as the value for unavailability, CCDP is 1.65E-6. This also takes into account other faults (327V107, 323P004, 612 T291, 322V436, 653G101, 322V301, 351P001, 653G301, 327P002, 327P004, 321V305, 351P002, 712P003, 327P001, 327P003, 721P001, 721P003, 721P004, 324P001, 721P002) occurring during the time the EDG was faulty.
2. On 18 January 2011, valve 327V107 was repaired. This was a motor-actuated valve in the bypass line. The valve did not close automatically or when controlled from the MI unit. This was a latent fault with an unavailability time

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



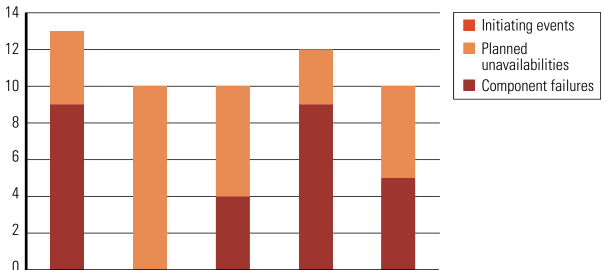
2007	2008	2009	2010	2011
0	1	0	0	0
2	2	1	1	0
1	1	0	2	2

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



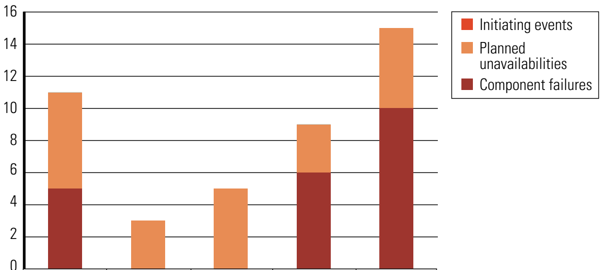
2007	2008	2009	2010	2011
3	1	0	1	0
2	0	2	2	2
0	1	1	2	0

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



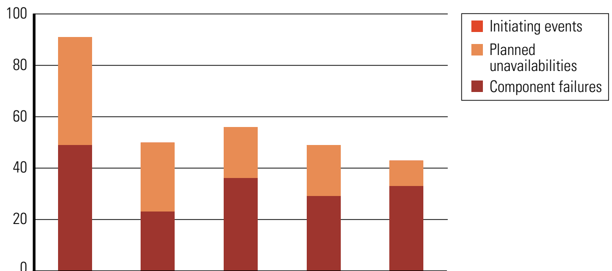
2007	2008	2009	2010	2011
0	0	0	0	0
4	10	6	3	5
9	0	4	9	5

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



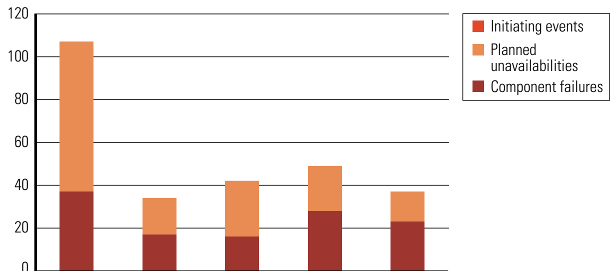
2007	2008	2009	2010	2011
0	0	0	0	0
6	3	5	3	5
5	0	0	6	10

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



2007	2008	2009	2010	2011
0	0	0	0	0
42	27	20	20	10
49	23	36	29	33

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



2007	2008	2009	2010	2011
0	0	0	0	0
70	17	26	21	14
37	17	16	28	23

of 504 h, yielding 4.3E-7 as the value of CCDP when the fact was also taken into account that 653G401 was also faulty at that time (without the diesel vault, the CCDP would be 3.5E-7).

Olkiluoto 2:

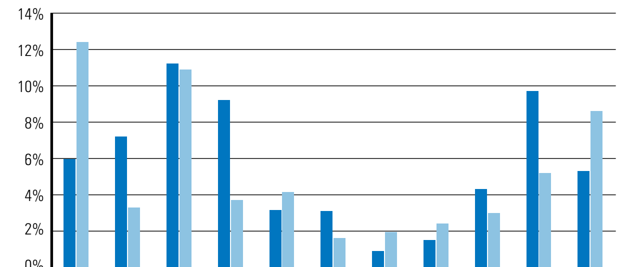
1. Diesel package Dip-D lasted for 102 h (17 Jan 2012 4:03 hrs – 21 Jan 2012 9:55 hrs). CCDP: 1.2E-7.
2. Diesel package Dip-B lasted for 156 h (11 Apr 2012 4:02 hrs – 17 Apr 2012 15:42 hrs). CCDP: 1.4E-7.

OL1 case 1 led to additional investigations because it involved a diesel fault that was not discovered in normal tests. The other Olkiluoto events 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 on average at the same level year after year, the annual fluctuation does not warrant particular attention.

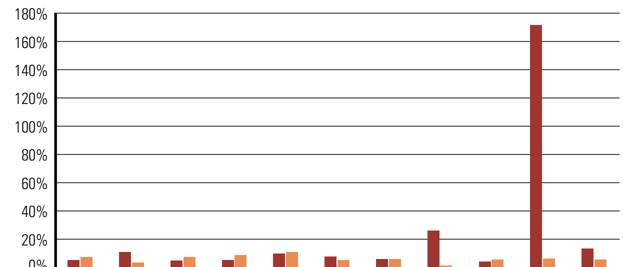
In 2011, the risk arising from operational activities reduced slightly at the Loviisa plant compared to previous years. At Olkiluoto (OL1), the fault detected in the 2010 outage tests in the pilot valves of the pressure reduction system 314 causes alone an increase of 160% in the risk during the operational cycle of 2009–2010. Such events, causing a major increase in the risk, will inevitably occur from time to time. However, they are rare because, roughly speaking, the design principles of nuclear power plants dictate that the probability of events must be smaller, the bigger the risk increase they cause. The pilot valve fault could possibly have prevented the 314 main valves from closing, which would have caused a serious cooling transient in the primary circuit. In addition, the probability of a major coolant leak was considerably increased, because the normal operation of overpressure protection would have caused a major coolant leak that was clearly more probable than usual. The event was discovered during outage tests, which is probably why the major risk increase caused by it was inadvertently ignored when first analysing the events in 2010, and it was not included in the report for 2010. Of course, the seriousness of the event was well understood, and it gave rise to many actions, both at STUK and TVO. Leaving this one serious event aside, the results of Olkiluoto have remained roughly at the same level as in previous years. The latent fault of diesel generator 653G401, present throughout the operating cycle of 2010–2011, slightly increases the result of OL1.

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



	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
LO1	5.96	7.20	11.21	9.20	3.15	3.10	0.90	1.50	4.30	9.70	5.30
LO2	12.39	3.30	10.90	3.70	4.14	1.60	1.95	2.40	3.00	5.20	8.60

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



	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
OL1	5.28	10.90	4.68	5.10	9.64	7.60	6.00	26.10	4.00	171.4	13.10
OL2	7.17	3.50	7.39	8.60	10.95	5.00	6.00	1.30	5.40	6.30	5.40

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.

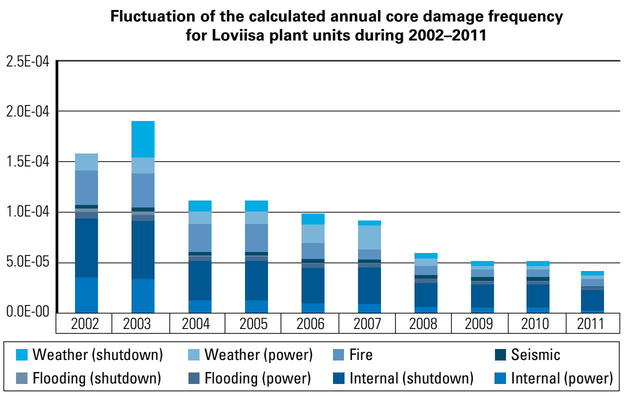
Responsible unit/person

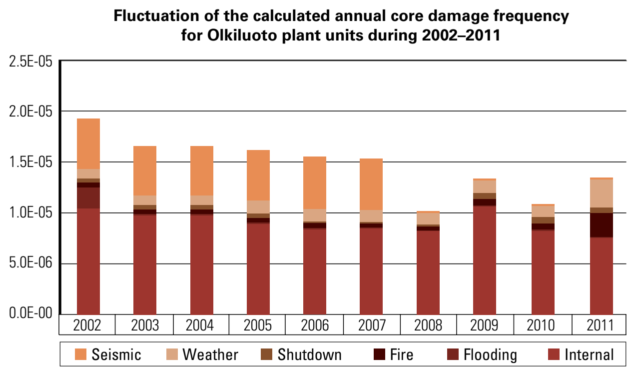
Risk assessment (RIS), Jorma Rantakivi (PRA computation)
Operational safety (KÄY) (failure data)

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 in 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 10 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 renewal 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 annual probability of a severe reactor accident calculated for the Loviisa plant units was approximately 4.3×10^{-5} in 2011. The value has decreased by about 17% from the previous year. Several minor plant modifications and the improvements of the PRA model have contributed to the reduction of the risk. The PRA modifications carried out in 2011 concerned, among other things, the modelling of replaced sump screen meshes in the recirculation pipes of emergency cooling water, new procedures for recovering the 400 kV main transformer in cold shutdown states, replacement of the old gas turbines in Hästholmen with a new diesel emergency power plant (EY07) and replacement of the EDG relays (P8 relays). For the backup system for residual heat removal, the introduction of own operating experience data and further specified assessment of human errors reduced the estimated unavailability of the system. In addition, the assessed seismic risk has decreased when the analysis has been updated and the susceptibility of components to seismic damage has been reassessed using up-to-date computational methods.

The indicator for the Olkiluoto plant decreased approximately 30% in 2008 compared to previous years' relatively stable value. The decrease was mainly due to the more detailed modelling of earthquake events and the plant changes carried out to improve seismic qualification. The increase in 2009 was due to the fact that the heat exchanger of the screening system cannot be used for residual heat removal after all, contrary to earlier assessments. For the Olkiluoto power plant, the most important factors affecting the overall accident risk include internal events during power operation (component failures and pipe ruptures leading to an operational transient).

In 2011, the annual probability of a severe reactor accident calculated for the Olkiluoto plant was 1.33×10^{-5}. The increase of approximately 30% from 2010 is caused by supplementing the model with the risks caused by an oil spill in the sea, as well as by an update of initiating event frequencies of fires and internal transients.

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

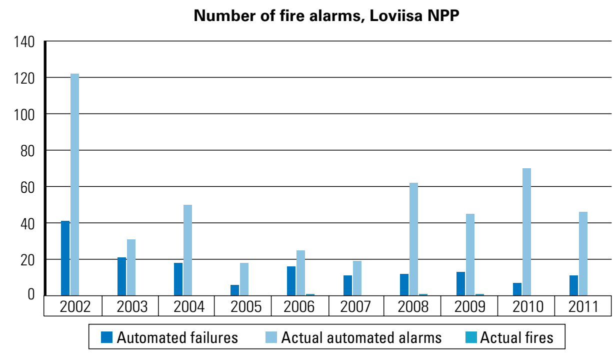
Interpretation of the indicator

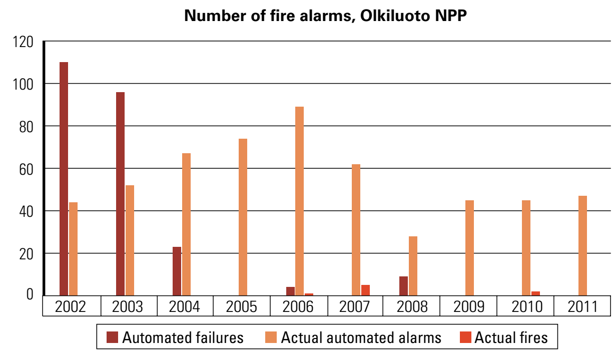
There were no events classified as fires at the Loviisa power plant or outside the plant area in 2011. The fire detection system faults occurring at the Loviisa power plant remained in 2011 at the same level as in 2010. The actual alarms given by the detectors at the Loviisa 1 plant unit remained in 2011 at the same level as in 2010, while they decreased slightly from the 2010 level at the Loviisa 2 plant unit.

No events classified as fires occurred in the Olkiluoto plant area (OL1/2) in 2011. Eight events classified as fires occurred outside the plant area, seven of them at the OL3 NPP unit site (a substation located outside in a container burned, there were cases of insulation panels catching fire, a heater burned, cables on the outside of the building burned), in addition to which, a chip crusher was generating smoke at the landfill site. The fire events were of a minor nature. No fire detection system failures were observed at the Olkiluoto power plant (OL1/2) in 2010. The situation was the same in 2011. The number of actual fire alarms was of the same order in 2011 as in 2010.

The automatic fire detectors were upgraded at the Loviisa power plant in 2000 and at Olkiluoto in 2001. The number of alarms increased at both units after that because of the 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 the Loviisa and Olkiluoto plants has remained at the earlier level, as no events classified as fires have occurred. 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 in conjunction with shutdowns or reactor trips, as well as the number of leaking fuel bundles 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.

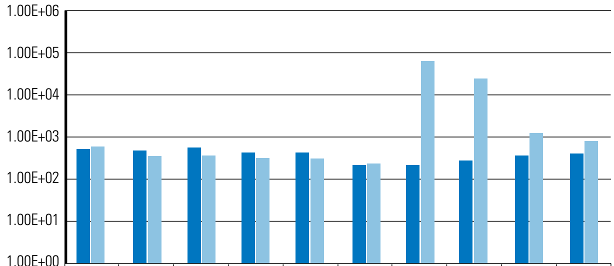
Purpose of the indicator

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

Responsible unit/person

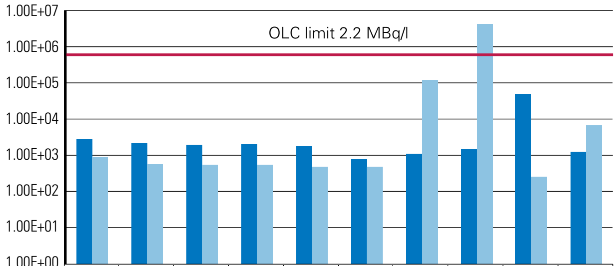
Reactor and Safety Systems (REA),
Kirsti Tossavainen

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



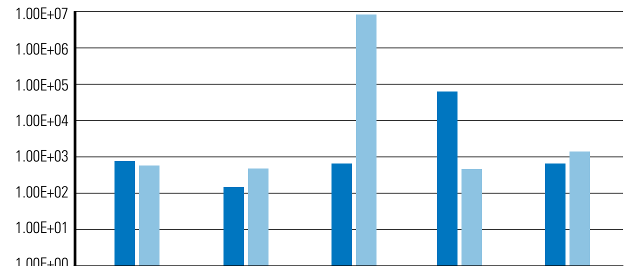
	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
LO1	4.71E+02	4.32E+02	5.01E+02	3.89E+02	3.91E+02	1.90E+02	2.00E+02	2.60E+02	3.80+02	3.90E+02
LO2	5.74E+02	3.22E+02	3.39E+02	2.91E+02	2.72E+02	2.10E+02	4.90E+04	2.40E+04	1.20+03	8.50E+02

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



	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
LO1	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	1.49E+03
LO2	9.30E+02	6.00E+02	5.80E+02	5.90E+02	5.20E+02	5.00E+02	1.30E+05	3.85E+06	3.20E+03	6.64E+03

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



	2007	2008	2009	2010	2011
LO1	5.70E+02	1.40E+02	4.80E+02	5.60E+04	6.70E+02
LO2	4.40E+02	4.30E+02	6.40E+06	4.10E+02	1.40E+03

A.III.1a Primary coolant activity

Interpretation of indicators (Loviisa)

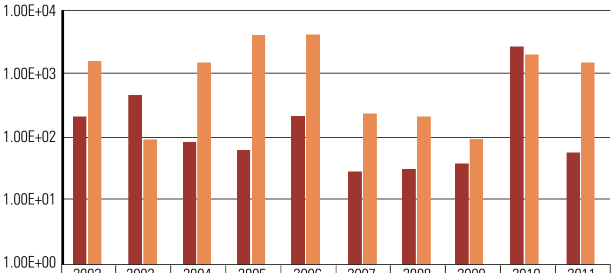
In 2011, neither plant unit reactor at Loviisa had any leaking fuel. A leaking fuel assembly was last removed from the reactor of Loviisa 1 in 2010 and from the reactor of Loviisa 2 in 2009. The fuel leak at Loviisa 1 had been so small that the removal of the leaking fuel assembly did not affect the I-131 activity content of primary coolant. The I-131 activity content of primary coolant at Loviisa 2 has clearly decreased following the removal of the leaking fuel assembly. In 2009, the I-131 activity content of primary coolant at Loviisa 2 briefly exceeded the OLC limit value (see STUK-B 118). In 2011, the maximum values of I-131 activity content related to shutdowns occurred during shutdowns for annual maintenance outages. After removal of the leaking fuel assemblies, the maximum activity values related to shutdowns also returned to the level before the leaks.

In 2011, fuel integrity at both Loviisa plant units was good.

Interpretation of indicators (Olkiluoto)

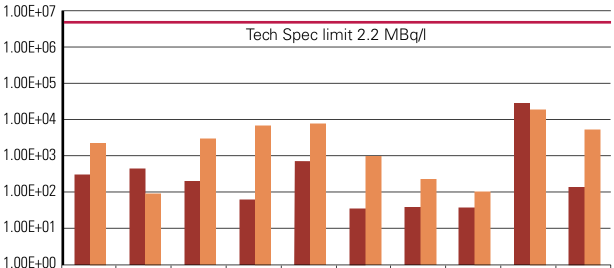
The reactor of Olkiluoto 1 did not have leaking fuel in 2011, whereas the reactor of Olkiluoto 2 had leaking fuel almost throughout the year. A fuel leak was detected at the plant unit immediately after the 2010 annual maintenance outage. The leak remained very small, and the leaking assembly was removed from the reactor during the

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



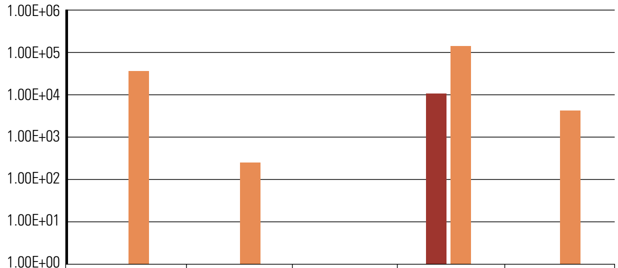
	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
OL1	2.00E+02	4.30E+02	8.20E+01	5.80E+01	2.00E+02	2.70E+01	3.00E+01	3.50E+01	2.45E+03	5.50E+01
OL2	1.50E+03	9.00E+01	1.49E+03	4.00E+03	4.00E+03	2.30E+02	2.10E+02	9.10E+01	1.87E+03	1.46E+03

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



	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
OL1	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	1.40E+02
OL2	2.37E+03	9.10E+01	3.12E+03	6.52E+03	7.03E+03	9.99E+02	2.30E+02	1.00E+02	2.01+04	4.84E+03

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



	2007	2008	2009	2010	2011
OL1	0.00E+00	0.00E+00	0.00E+00	1.03E+04	0.00E+00
OL2	3.70E+04	2.52E+02	0.00E+00	1.61E+05	3.93E+03

2011 annual maintenance outage. A new fuel leak was detected at Olkiluoto 2 on 5 August 2011. The leak has remained small throughout the reported period. The leaking fuel assembly will be removed from the reactor during the 2012 annual maintenance outage at the latest. The maximum I-131 activity content during shutdown at Olkiluoto 2 was measured in a situation where the plant unit was shut down for a generator maintenance outage. At Olkiluoto 1, the shutdown did not affect the I-131 activity content.

In 2011, fuel integrity was good at Olkiluoto 1. The fuel integrity of Olkiluoto 2 was weakened by minor fuel leaks.

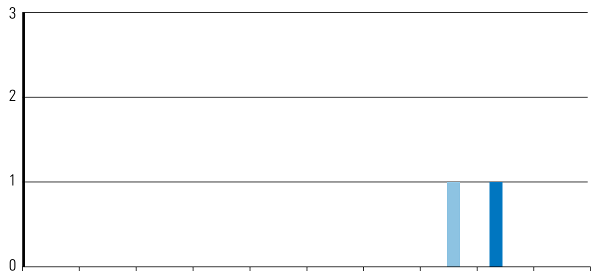
Several fuel leaks have occurred in the 2000s at the Olkiluoto plant units, particularly at Olkiluoto 2. The main reason for the leaks has been small loose objects, such as metal chippings, entering the reactor during maintenance operations, which can get caught in the fuel assembly structures. The coolant flow may make the loose objects vibrate and break the fuel cladding. In addition to enhancing administrative procedures, technical solutions are also being sought to eliminate the problem. Among other things, foreign object sieves of a new type have been designed for the fuel assemblies. Fuel assemblies fitted with these are to be introduced in 2012.

A.III.1b Number of leaking fuel assemblies

Interpretation of indicators (Loviisa)

In 2011, neither plant unit reactor at Loviisa had any leaking fuel.

Number of leaking fuel bundles removed from the reactor, Loviisa NPP

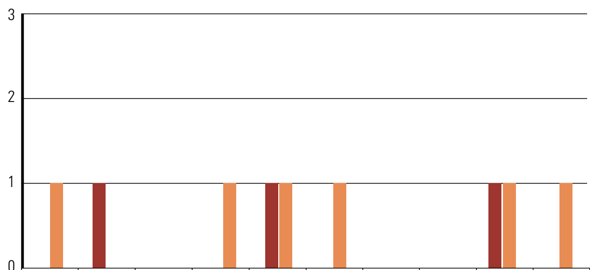


	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
LO1	0	0	0	0	0	0	0	0	1	0
LO2	0	0	0	0	0	0	0	1	0	0

Interpretation of indicators (Olkiluoto)

In 2011, the reactor of Olkiluoto 1 had no leaking fuel. A leaking fuel assembly was removed from the reactor of Olkiluoto 2 during the annual maintenance outage. It had been leaking since 2010. Yet another fuel leak was detected at Olkiluoto 2 in August. The leaking fuel assembly will be removed from the reactor in the 2012 annual maintenance at the latest.

Number of leaking fuel bundles removed from the reactor, Olkiluoto NPP



	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
OL1	0	1	0	0	1	0	0	0	1	0
OL2	1	0	0	1	1	1	0	0	1	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 licensees, depicting the effectiveness of water chemistry control in the secondary circuits of PWRs and in the reactor circuits of BWRs. The chemical conditions in the secondary circuit of a pressurized water reactor affect the integrity of the interface between the 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 feedwater. For steam generator blowdown, the calculation includes the chloride, sulphate and sodium concentrations and acid conductivity. For feedwater, it includes the iron, copper and oxygen concentrations. The chemistry index of the Olkiluoto plant consists of the chloride and sulphate concentrations of the reactor water and the iron concentration in the feedwater. The indices for both plants only cover the aforementioned parameter values during power operation.
- The maximum chloride concentration of the steam generator blowdown at the Loviisa plant units and the reactor water at the Olkiluoto plant units during operation compared with the OLC limit in the monitoring period. At the Olkiluoto plant, the maximum sulphate content of reactor water on even, steady-state operation is also followed.
- 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 feedwater (maximum values for the monitoring period) are followed. For the Olkiluoto plant, the iron concentration of feedwater (maximum value for the monitoring period) is followed. In addition, the maximum Co-60 activity concentration in the reactor coolant while bringing the plant to a cold shutdown or after a reactor trip is followed for both plants.

Source of data

The licensees submit indicators describing water chemistry control to the respective responsible person at STUK. The 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 license 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)

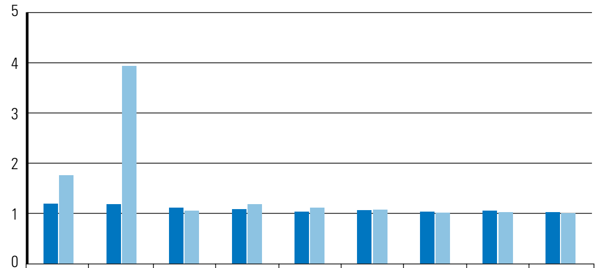
In 2011, the impurity and corrosion product levels in primary and secondary circuits, followed in STUK's indicator scheme, were in keeping with the guide values set by the license holder at both plant units. The chemistry index of both Loviisa plant units has remained in recent years at almost the best possible value. The exceptional value of the index for Loviisa 2 in 2004 was caused by a seawater leak in the condenser, which had caused the chloride concentration of the steam generator blowdown, affecting the index, to become greater than normal. The condenser leak was repaired in the annual maintenance outage in 2004, after which the chloride concentration also decreased. The maximum Co-60 activity levels associated with shutdowns were measured during shutdowns for annual maintenance outages. In 2011, the concentrations did not deviate from previous years' values.

The indicator shows that primary circuit integrity has been good at the Loviisa plant units in 2011.

Interpretation of indicators (Olkiluoto)

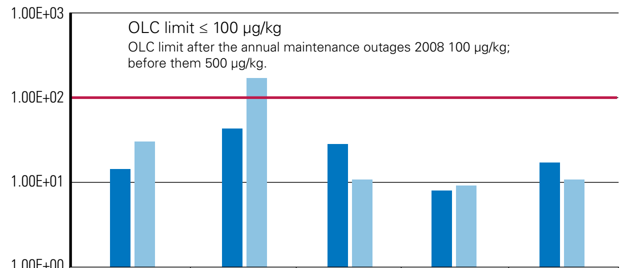
The impurity and corrosion product levels in reactor water and feedwater, followed in STUK's indicator scheme, were in keeping with the guide values set by the license holder at both plant units almost throughout the year. Olkiluoto 1 had individual cases of exceeding the target values for reactor water iron content and sulphate content. The iron content of Olkiluoto 1 feedwater has been increasing. However, the iron content was in keeping with the licensee's guide value apart from one sampling. Usually, the installation of new components causes an increase of iron content but, in this case, no obvious causal link to component re-

Integrity of the secondary circuit: Chemistry index, Loviisa NPP



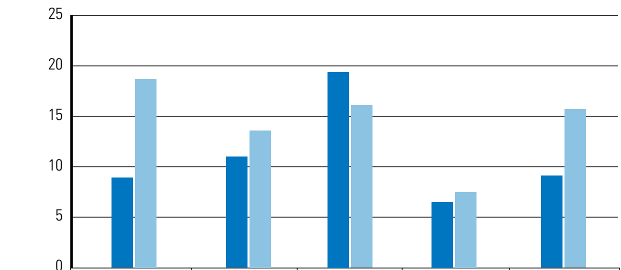
	2003	2004	2005	2006	2007	2008	2009	2010	2011
LO1	1.19	1.18	1.11	1.08	1.03	1.06	1.03	1.05	1.02
LO2	1.76	3.93	1.05	1.18	1.11	1.07	1.01	1.02	1.00

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



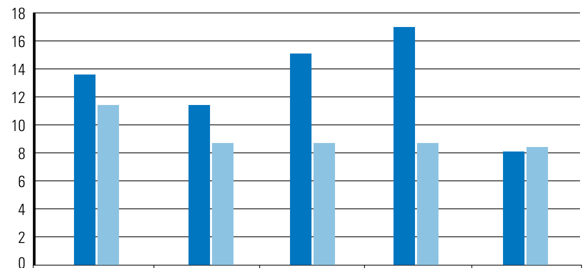
	2007	2008	2009	2010	2011
LO1	1.43E+01	3.64E+01	2.90E+01	7.80E+00	1.93E+01
LO2	3.19E+01	2.10E+02	1.14E+01	9.10E+00	1.10E+01

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



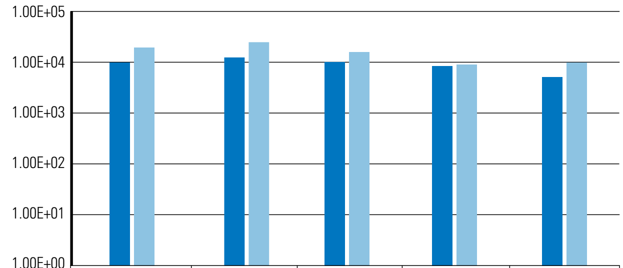
	2007	2008	2009	2010	2011
LO1	8.9	11.0	19.4	6.5	9.1
LO2	18.7	13.6	16.1	7.5	15.7

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



	2007	2008	2009	2010	2011
LO1	13.6	11.4	15.1	17.0	8.1
LO2	11.4	8.7	8.7	8.7	8.4

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



	2007	2008	2009	2010	2011
LO1	1.09E+04	1.29E+04	1.03E+04	8.21E+03	5.26E+03
LO2	2.30E+04	2.40E+04	1.71E+04	8.60E+03	9.88E+03

placements exists. The iron content of feedwater is affected by corrosion and the filter material used in the ion exchangers of the condensate purification system. The licensee is investigating the reason for the increase in iron content.

Olkiluoto 2 had cases of exceeding the target values for reactor water chloride content and sulphate content. The higher-than-usual chloride content was caused by a seawater leak in the condenser. The leak was repaired within two weeks of detecting it, after which the chloride content has been in line with the guide value. Exceeding the target values for sulphate content is associated with the use of the ion exchange filters of the condensate purification system, and the situation will be rectified by changing the exchanger resin, which is done from time to time in the course of normal operations.

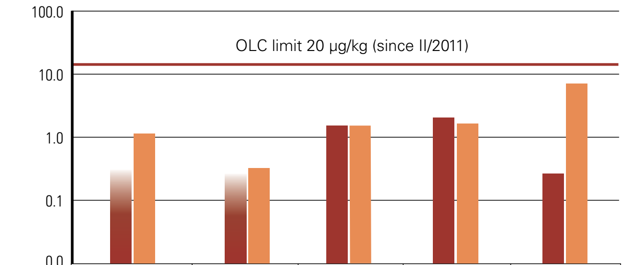
At Olkiluoto 1, the deviations from target values were so small that they did not affect the chemistry index, which was at its optimum value. At Olkiluoto 2, the chemistry index was slightly higher than the optimum value due to the exceptional exceeding of the target value for chloride content.

At both plant units, the shutdown-related maximum value of Co-60 activity content occurred during shutdowns for annual maintenance outages. The Co-60 activity content values did not significantly change from previous years.

A change in the OLCs regarding chemistry was introduced at both Olkiluoto plant units before the annual maintenance outages. The changes affecting the followed in STUK's indicator scheme were the addition of a limit value for reactor water sulphate content in the OLCs and the introduction of a stricter value for reactor water chloride content.

The indicator shows that reactor circuit integrity has been good at the Olkiluoto plant units in 2011.

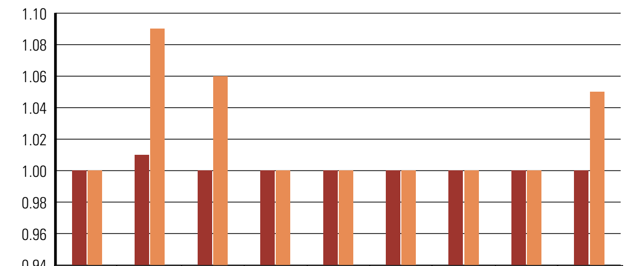
Integrity of primary circuit: Corrosive impurities; Maximum chloride concentration in primary coolant (µg/kg) in power operation, Olkiluoto NPP



	2007	2008	2009	2010	2011
OL1	0.5	0.5	2.1	3.0	0.7
OL2	1.2	0.6	2.0	2.1	7.8

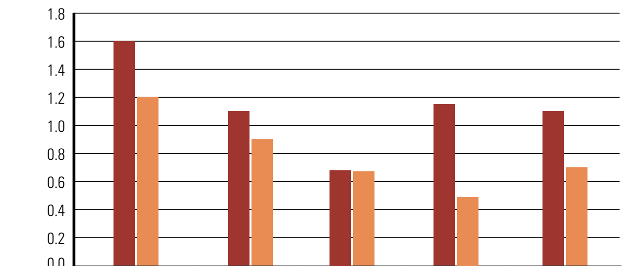
below detection limit

Integrity of primary circuit: Chemistry index, Olkiluoto NPP



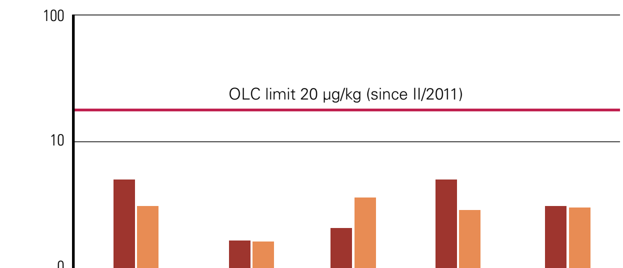
	2003	2004	2005	2006	2007	2008	2009	2010	2011
OL1	1.00	1.01	1.00	1.00	1.00	1.00	1.00	1.00	1.00
OL2	1.00	1.09	1.06	1.00	1.00	1.00	1.00	1.00	1.05

Integrity of primary circuit: Corrosion products; Maximum iron concentration in reactor feed water (µg/l) in power operation, Olkiluoto NPP



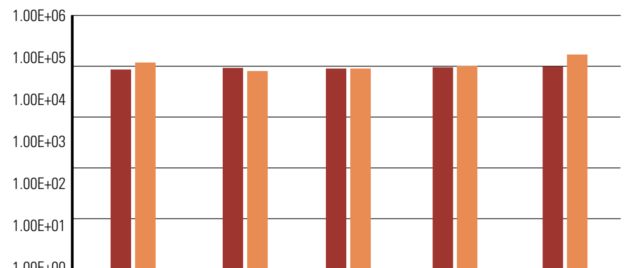
	2007	2008	2009	2010	2011
OL1	1.60	1.10	0.68	1.15	1.10
OL2	1.20	0.90	0.67	0.49	0.70

Integrity of primary circuit: Corrosion products; Maximum sulphate concentration in primary coolant (µg/l) in power operation, Olkiluoto NPP



	2007	2008	2009	2010	2011
OL1	7.0	2.2	3.2	7.0	4.9
OL2	4.9	2.1	5.6	4.6	4.8

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



	2007	2008	2009	2010	2011
OL1	7.08E+04	8.34E+04	7.83E+04	8.59E+04	1.10E+05
OL2	1.46E+05	7.01E+04	7.54E+04	1.01E+05	2.66E+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 (m^3) 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 OLCs (outflow water volume of water condensing in the air coolers of the containment cooling system 725/OLCs 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 2010–2011

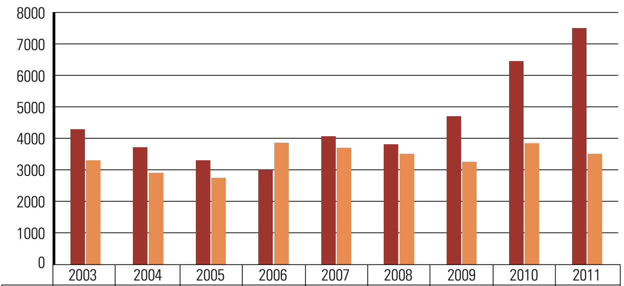
One of the purposes of controlled leakage 352 is to collect seal box leakages from valves, pumps and other such components. The drains from the seal boxes of the valves within the containment are equipped with temperature sensors to locate any leaks. Temperature sensors installed on the drains above the main lines will detect any leakage in the specific line. Other methods must then be used to locate the actual leaking object. The containment leakages identified at OL1 during the four last operating cycles have increased a little. At OL2, the identified leakages have remained almost constant. The leakage volumes do not include the drainage of process systems during annual maintenance outages and other outages. The identified leakages include sampling flows of approximately 1,000–1,500 m^3 from the reactor building.

At the lowest point of the containment drywell, there is the drain water pit T33, which collects the drain water from the containment drywell floor drains and any leakage from the control rod actuator seals. The volumes of unidentified primary circuit leakages during the operating cycle 2010–2011 decreased at both plant units.

One of the purposes of containment gas cooling system 725 is to remove moisture from the containment atmosphere. Moisture may originate from steam leaking from the primary circuit. In the operating cycle of 2010–2011, the containment's largest internal daily leak volume's ratio to the maximum allowable volume, as specified in the Operational Limits and Conditions, was low for both plant units.

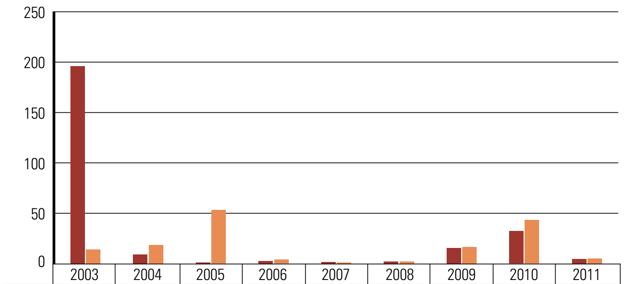
The primary circuit has been relatively leakproof in the 2010–2011 operating cycle.

Identified leakages of primary circuit (352T1, m^3), Olkiluoto NPP



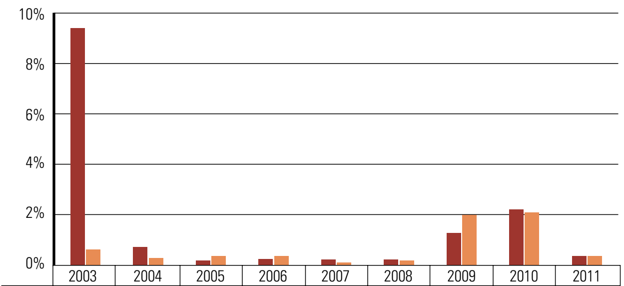
	2003	2004	2005	2006	2007	2008	2009	2010	2011
OL1	4281	3716	3300	3004	4058	3805	4697	6448	7496
OL2	3307	2908	2741	3862	3696	3502	3252	3847	3505

Unidentified leakages of primary circuit (345T33, m^3), Olkiluoto NPP



	2003	2004	2005	2006	2007	2008	2009	2010	2011
OL1	196.00	9.20	1.14	2.52	1.56	2.16	15.48	32.28	4.74
OL2	14.00	18.60	53.00	3.84	1.26	2.04	16.5	43.08	5.10

The maximum unidentified leakage in ratio to the OLC limit, Olkiluoto NPP



	2003	2004	2005	2006	2007	2008	2009	2010	2011
OL1	9.40	0.70	0.18	0.23	0.21	0.21	1.27	2.20	0.35
OL2	0.60	0.27	0.35	0.35	0.09	0.16	1.97	2.08	0.35

A.III.3 Containment integrity

Definition

As the indicators, the parameters below are followed: the total as-found leakage of outer isolation valves following the first integrity tests, compared with the highest allowed total leakage from the outer isolation valves; 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. At Loviisa, the combined leakage rate is comprised of the leakage test results from personnel airlocks, the material airlock, the cable penetrations of inspection equipment, the containment maintenance ventilation systems (TL23), the main steam piping (RA) and the feedwater system (RL) penetrations; the seals of blind-flanged penetrations of ice-filling pipes are also included.

Source of data

Data is 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 integrity of the containment isolation valves, penetrations and airlocks.

Responsible unit/person

Reactor and Safety Systems (REA)
Päivi Salo

Interpretation of the indicator

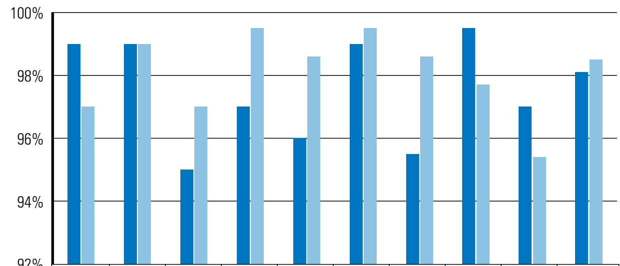
Loviisa

The overall as-found leakages of outer containment isolation valves have decreased at both plant units.

The percentage of isolation valves which passed the leakage test at the first attempt has remained high.

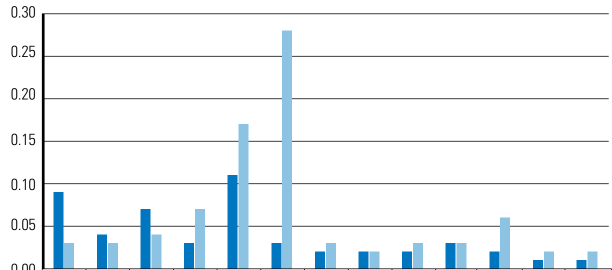
The overall as-found leakage of containment penetrations, which at Loviisa includes the leakage test results for the personnel airlock, the emergency personnel airlock, the material airlock, the reactor pit, inward relief valves, cable penetrations and bellow seals (RA, RL, TL23), was small at both plant units.

Isolation valves passing the leakage test at the first attempt, Olkiluoto NPP



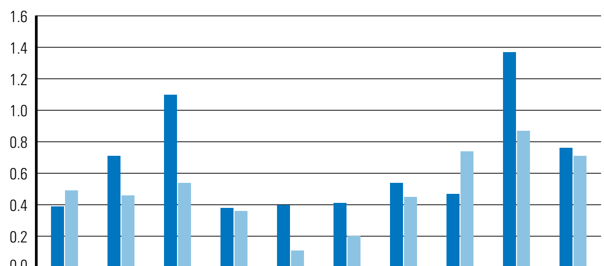
	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
LO1	99.0	99.0	95.0	97.0	96.0	99.0	95.5	99.5	97.0	98.1

Combined leak rate of containment penetrations and air locks compared to the leak limit, Loviisa NPP



	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
LO1	0.09	0.04	0.07	0.03	0.11	0.03	0.02	0.02	0.02	0.03	0.02	0.01	0.01
LO2	0.03	0.03	0.04	0.07	0.17	0.28	0.03	0.02	0.03	0.03	0.06	0.02	0.02

The overall as-found leakage of outer isolation valves compared with the highest allowed overall leakage of outer isolation valves, Loviisa NPP



	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
LO1	0.39	0.71	1.10	0.38	0.40	0.41	0.54	0.47	1.37	0.76
LO2	0.49	0.46	0.54	0.36	0.11	0.20	0.45	0.74	0.87	0.71

Olkiluoto

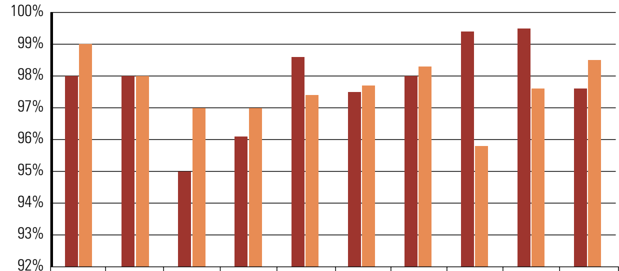
The total as-found leakages of outer isolation valves at the Olkiluoto 1 plant unit was extremely small, clearly below the limit set in OLCs.

At the Olkiluoto 2 plant unit, the as-found leakage of the outer isolation valves was below the limit set in the OLCs and has remained approximately the same as before.

The percentage of isolation valves that passed the leak tightness test at first attempt has remained high for both plant units.

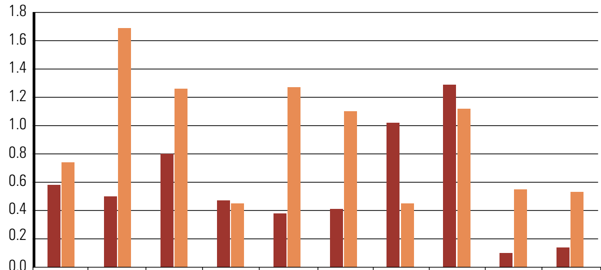
The total as-found leakage rate of containment penetrations, in which TVO includes leakages in the upper and lower personnel airlocks, the maintenance dome and the containment dome, has remained small for both plant units.

Isolation valves passing the leakage test at the first attempt, Olkiluoto NPP



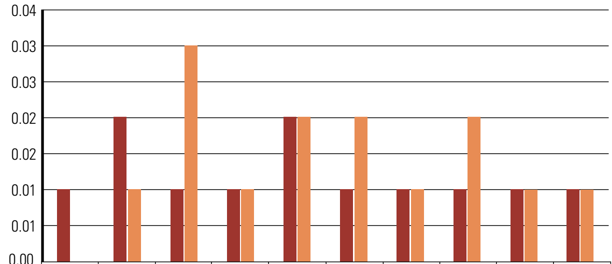
	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
OL1	98.00	98.00	95.00	96.10	98.60	97.50	98.00	99.40	99.50	97.60
OL2	99.00	98.00	97.00	97.00	97.40	97.70	98.30	95.80	97.60	98.50

The overall as-found leakage of outer isolation valves compared with the highest allowed overall leakage of outer isolation valves, Olkiluoto NPP



	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
OL1	0.58	0.50	0.80	0.47	0.38	0.41	1.02	1.29	0.10	0.14
OL2	0.74	1.69	1.26	0.45	1.27	1.10	0.45	1.12	0.55	0.53

Combined leak rate of containment penetrations and air locks compared to the leak limit, Olkiluoto NPP



	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
OL1	0.01	0.02	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.01
OL2	0.00	0.01	0.03	0.01	0.02	0.02	0.01	0.02	0.01	0.01

APPENDIX 2 Occupational radiation dose distribution at Loviisa and Olkiluoto nuclear power plants in 2011

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 9.9 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 2007 to 2011 was 55.9 mSv. The dose was accumulated at Swedish nuclear power plants.

dose range (mSv)	number of persons by dose		
	Loviisa	Olkiluoto	total*
< 0,1	736	1424	2066
0.1–0.49	177	732	872
0.5–0.99	111	235	336
1.00–1.99	111	188	292
2.00–2.99	42	64	115
3.00–3.99	35	26	58
4.00–4.99	20	10	42
5.00–5.99	8	9	19
6.00–6.99	9	4	17
7.00–7.99	2	2	6
8.00–8.99	0	0	3
9.00–9.99	0	1	3
10.00–10.99	0	0	0
11.00–11.99	0	0	1
12.00–14.99	0	0	0
15.00–20	0	0	0
> 20	0	0	0

* The data in this column include Finnish workers who have received doses also at Swedish nuclear power plants. The same person may have worked at both Finnish nuclear power plants and in Sweden.

Source: STUK's dose register

APPENDIX 3 Significant operational events

Loviisa NPP

Replacement of EDG bearings due to suspected fault

On 14 January 2011, the Loviisa power plant learned through unofficial channels that the emergency diesels used in France had suffered serious bearing failures. On the basis of this information and negotiations with the equipment manufacturer, the Loviisa power plant established that one emergency diesel at Loviisa 1 uses the same bearing type. This connection rod bearing had been installed in 2009 in connection with a complete overhaul. The power plant took immediate action and replaced the bearing during the following week. In order to carry out the replacement work, an external power connection was made to replace the emergency diesel generator isolated for the replacement work. No defect could be found in the removed bearing in preliminary inspections, although there were some signs of excess wear.

Outage at Loviisa 1 for repair of a leaky flange seal in the steam generator

A steam leak was detected inside the containment of Loviisa 1 during the evening of Friday 18 February. The steam leak was a minor one, and the steam contained no radioactivity as it came from the secondary circuit containing pure water. The leak did not put the safety of people or the surrounding environment at risk. The location of the leak was such that in order to repair it, the plant had to be shut down and cooled down. After repairs, the start-up of the plant unit began on Sunday, 20 February, and the unit resumed electricity production during Monday, 21 February.

Irregularities regarding the cooling capacity of emergency cooling pump rooms

The circulation air cooling system of emergency cooling pump rooms in Loviisa is intended for removing from the room the heat load caused by the pumps and their motors. The system has originally had two circulation air cooling units for each room. At a later stage, two circulation air cooling units with larger capacities were installed in each room because the design temperature of cooling water was increased. The blowers have diesel back-up, and the coolers are cooled using pure intermediate circuit water.

The system is on standby during normal operating conditions at the plant. If the temperature increases, the room thermostats automatically start the cooling process. In that instance, the cooling system valves are opened and the blowers are started. At Loviisa 1, the power supply and cooling water connection have been implemented so that two small-capacity circulation air cooling units (2 x 30%) and two large-capacity circulation air cooling units (2 x 70%) are connected in series. The connection is such that the cooling power may fall short of the design value. The room temperatures have been analysed in cases like this, and the analysis results indicate that the temperatures are higher than in earlier analyses. Comparison of the results with the design temperatures of components located in the rooms shows that the temperatures may become too high for the components when seawater is warm.

In the same connection, the situation of the Loviisa 2 cooling system was also analysed; it has one low-capacity and one large-capacity cooling unit in series, giving 100% cooling power. The temperatures in the rooms were lower than at Loviisa 1, but the rooms contained components more sensitive to temperature.

As an immediate corrective action, the cooling water circulation valves at Loviisa 1 will be locked open in the summer to ensure sufficient cooling. The power company will draw up a plan regarding other actions required.

Spare part problems regarding the pump motors of the high-pressure safety injection system

During condition monitoring measurements at Loviisa 2 on 8 June 2011, fluctuations and an increase in vibration level were observed in the pump motor of the high-pressure safety injection system. The motor was found to be operable in spite of the higher vibration levels. Nevertheless, Fortum decided to send the motor to the supplier for inspection and maintenance because it wanted to make sure of the motor's operability and reliability. The power company also decided to verify the condition of the other pump motors of the safety injection system. The condition monitoring measurements carried out did not reveal any deviations in the other motors.

The motor overhauled by the supplier was installed back in its position, and assessment of its operability continued. However, the vibration readings measured during test operation exceeded the approval limits, which is why the power plant found the motor inoperable.

The three-day repair time allowed in the OLC was not sufficient to diagnose the motor, which is why the power company applied for an extension of nine days for the repair time.

The motor was sent back to the supplier where it was opened. A spare part rotor was installed in the motor, and its bearings were replaced. After successful test operation at the supplier's test field, the motor was delivered back to the Loviisa power plant. On the basis of the test run in the motor's ordinary place of operation, the power company found the motor to be operable, and the operation restriction of the plant unit was lifted.

This pump and its motor are part of the reactor's high-pressure safety injection system that pumps boron-containing water in the primary circuit in the initial stage of a possible accident situation. The system has two independent subsystems, each with two pumps in parallel. During normal operation, the pumps are on standby, and they are only used when the system is being tested. On those occasions, they are kept running for about two hours.

A fault was also detected during the 2010 maintenance outage in the motor stator of a safety injection pump at the Loviisa power plant. The faulty motor was replaced with a spare one and sent to the supplier for inspection. The examination revealed that the motor stator had permanent deformations, which is why it was decided to scrap the motor. The replacement motor installed in the component location was the last spare motor in store for the safety injection system at the Loviisa power plant. This is why the power plant initiated procurement of several new motors with the intention of having the motors available at the plant for the 2011 annual maintenance outage.

Because the procurement of new motors did not progress as planned, Fortum initiated a process to find out the possibilities for procuring the motors from other European NPPs. Consequently, the power company succeeded in procuring four used motors from Slovakia. They were of the same type and make as the motors in use at the Loviisa power plant. The plan is to use two of them as spare motors. This requires, in addition to inspecting and test running the motors, re-winding them to achieve better heat resistance.

STUK requires power companies to have spare part procurement systems in place for ensuring that there are enough spare parts available for installation at the plant. Since the assessment performed indicated that the procurement system-compliant actions of the Loviisa power plant for procuring new motors had been insufficient, STUK required Fortum to clarify the matter. In the same context, the power plant was required to assess, by the end of 2011, the comprehensiveness of the periodic inspection, preventive maintenance and replacement programmes concerning structures and components important to safety in order to ensure the operability of these structures and components.

According to the clarification, the procurement of new motors had to be suspended because ambiguities were observed in the procurement specifications of the motors. Replacing the motors with the alternative offered by the manufacturer would have required modifications to the motor base and also, depending on the location of the motor, to the system pipelines because the new motors offered had outside dimensions considerably larger than the old ones.

Following the faults that have occurred in the pump motors of the high-pressure safety injection system, STUK has assessed that the original motors, made in the Soviet Union, are approaching the end of their life span. STUK has required Fortum to prepare a plan and time schedule regarding the replacement of the motors.

Initiation of annual maintenance operations on the DC systems of an emergency diesel generator at Loviisa 2 while in power operation, in breach of the Operating Limits and Conditions

Both Loviisa plant units have four emergency diesel generators that start and supply power, when required, to systems and components important to safety, such as the pumps cooling the reactor. For example, the diesel generators are required in a situation where connection to the Finnish national grid is lost.

During the 2011 annual maintenance outage of Loviisa 2, one of the diesel generators underwent a complete overhaul where the entire diesel engine was replaced with a completely overhauled engine. Fortum initiated, as planned, the replacement work before the annual maintenance outage during power operation of the plant, and therefore, the Operating Limits and Conditions dictated that the subject diesel generator had to be replaced with a power supply connection between the Loviisa power plant and the nearby Ahvenkoski hydropower plant.

In connection with the diesel generator maintenance operation, a temporary power supply was connected to the DC control switchgear of the diesel generator's control system from the DC switchgear of another diesel generator. In this connection, the battery array and rectifier backing up the control system of the diesel being overhauled was also disconnected, in breach of the Operating Limits and Conditions, for maintenance operations. According to OLC, the control voltage-supplying DC switchgears of all diesel generators in the plant unit must be operable during power operation because the switchgears also supply control power for the Ahvenkoski power supply connection. However, disconnection of one emergency diesel generator for maintenance is permissible if the diesel generator being maintained is replaced with a power supply connection from the Ahvenkoski hydropower plant.

As a result of the isolation and connection actions carried out, the supply of control voltage to one Loviisa 2 diesel generator and to the Ahvenkoski supply connection replacing the other diesel generator relied on one DC switchgear only. Had the switchgear then failed in a situation where it was needed, this would have prevented the deployment of the Ahvenkoski connection and the start-up of one diesel generator, which means that two of the four emergency switchgears of Loviisa 2 would have been unavailable.

The event caused no danger to the environment or the personnel, but it weakened the operability of the emergency switchgear in case of loss of offsite power. The event demonstrated that there were deficiencies at the Loviisa power plant in the planning and implementation of maintenance operations important to safety. Following the event, Fortum draw up a special report and root cause analysis.

On the INES scale, the event is rated at level 0.

Omission of primary coolant hydrogen concentration measurements

A measurement of the hydrogen concentration of primary coolant, prescribed in the OLC, was omitted at the Loviisa NPP on 2 October 2011. The hydrogen concentration affects the integrity of the primary circuit and fuel cladding. Hydrogen concentration is a so-called monitoring parameter, and its limits are set in the Operating Limits and Conditions. The purpose of setting a minimum limit hydrogen concentration is to ensure that the reducing conditions, necessary for minimising corrosion, are maintained. If the hydrogen concentration is too high, it may cause, among other things, embrittlement of the fuel cladding, which is why an upper limit has also been set for the hydrogen concentration.

At the Loviisa plant unit, hydrogen is produced by feeding ammonia into the primary coolant. The neutron radiation in the reactor decomposes the ammonia, releasing hydrogen. The hydrogen eliminates the corrosion-inducing oxygen, generated in the primary coolant by the radiolysis of water and also fed into the coolant in make-up water.

At the Loviisa power plant, the hydrogen concentration of primary coolant is usually measured using two continuously operating analysers. However, one of the two analysers is inoperable, and there are no spare parts available for it. The measurement result obtained from the analyser in operation indicated that the hydrogen concentration was increasing on Thursday, 29 September 2011. Another measurement was taken using a portable hydrogen analyser in order to solve the situation. The continuously operating hydrogen analyser was found to be faulty, so it was repaired.

However, the measured value of hydrogen concentration started to rise again on Saturday, 1 October, and repairs on the hydrogen analyser were initiated. According to the OLC, a hydrogen analysis must be performed every 24 hours using a portable hydrogen analyser if the continuous measurement function is inoperable. However, the hydrogen concentration was only determined on Sunday, 2 October, using a portable hydrogen analyser, and the 24-hour time limit was exceeded. The integrity of the primary circuit or fuel cladding was not at risk, because the other parameters measured at the plant allow the assumption that the hydrogen concentration had been normal.

The event is classified as 0 on the INES scale, i.e. it has no significance for radiation or nuclear safety.

Error in determining radioactive releases

The Loviisa power plant introduced a new gamma activity measurement system on 11 June 2010, which is used, among other things, for determining the aerosols and iodine isotopes in the emissions released into the atmosphere. At the same time, the method for calculating the air volume of emissions was also amended. Had it functioned correctly, the new method for calculating the air volume would have been more accurate than the old one, but the measurement system did not apply the correct measurement data of sample flow, but instead a value set for the instrument. However, the true air flow in the sampling channel was close to the set value. Due to the error in the air volume of the sampling flow, the figures reported to STUK for gamma-active emissions into the atmosphere had been incorrect during the period 11 June 2010 to 2 September 2011. Having discovered the error, the plant reported the matter to STUK on 2 September 2011.

STUK required the Loviisa power plant to supply new, corrected figures for the incorrectly reported emissions. The error concerned the atmospheric releases of particulate aerosols and iodine isotopes that only represent a small part of all the radioactive releases from the power plant. Due to the error, the atmospheric release values that the Loviisa power plant had reported to STUK had been about 3 MBq smaller than the actual values in 2010 and about 10 MBq larger than the actual values in 2011. These deviations correspond to 2% and 9% of the atmospheric releases of particulate aerosols and iodine isotopes of those years, respectively.

Olkiluoto NPP

Incorrect operation of the emergency diesel generator at Olkiluoto 1

The generator switch of the diesel generator opened when the switch-over and re-switching automation of the 660 V emergency power supply was tested. The opening was caused by overvoltage resulting from the incorrect operation of the generator exciter. Because of the fault, the generator would not have operated according to specifications in a real situation where it would have been required.

The reason for the incorrect operation was found to be a faulty thyristor in the rotary exciter inside the generator. As a precaution, the exciter was repaired by replacing all three thyristors and one rectifier diode. After the repair, the generator was tested and found to be in order.

The fault that now occurred cannot be detected in tests other than those of the re-switching automation or in preventive maintenance operations, because the load does not fluctuate enough in those situations. When testing the re-switching automation, the generator is loaded by starting the electrical motors.

The power company will find out the possibilities for improving the comprehensiveness of the operational tests of diesel generators performed in connection with preventive maintenance and after generator replacement.

On the INES scale, the event is rated at level 0.

Defects in the internal parts of blowdown system valves at Olkiluoto 2 and repair outage at Olkiluoto 1 on 26–28 June 2011

TVO discovered in the inspections performed during the annual maintenance outage of Olkiluoto 2 that there were cracks in the valve pistons of the system required for overpressure protection of and residual heat removal from the primary circuit. The inspections revealed other damage as well; for example, the hard chrome plating of the pilot cylinder had been damaged. However, the cracks and other damage had not affected the operation of the valves; they had operated correctly in regular tests.

TVO replaced the parts of the worst damaged valves during the annual maintenance. Not all damaged parts could be replaced due to an insufficient inventory of spare parts. On the basis of results from tests carried out during the preceding operating cycles, the valve manufacturer's assessment and analyses performed by VTT, TVO assessed that these valves were operable as well. Immediate replacement of the parts was not deemed necessary. Nevertheless, STUK found, on the basis of the reports produced by TVO regarding the faults discovered, that the original pistons and pilot cylinders of the valves were approaching the end of their life span. It was nevertheless not likely that the valves would quickly become inoperable, which is why STUK gave, on 6 June, permission to start up Olkiluoto 2 after the annual maintenance outage. STUK required that new spare parts should be changed to the valves immediately when a sufficient number of new spares has been received from the manufacturer. The requirement was to carry out the replacement by 15 September.

Olkiluoto 1 is using similar valves, which is why STUK required that TVO must also inspect them. During the repair outage of 26–29 June 2011, damage was observed in the pistons of four valves and in the pilot cylinders of 11 valves. TVO replaced them with flawless spare parts.

The faulty valves were part of a system intended for protecting the nuclear reactor against overpressure and for removing its residual heat in a situation where the steam generated in the reactor cannot enter the turbine plant. The necessary number of valves is opened, and the steam generated in the reactor is led along the system's pipelines to a condensation pool in the reactor containment building. From the condensation pool, the heat is transferred to the sea by other systems.

On the seven-step International Nuclear Event Scale (INES), the event is rated as class 1, i.e. it is classified as an anomaly, an incident affecting safety.

Short between core windings discovered in the maintenance of a diesel generator

The tests carried out during the annual maintenance outage of Olkiluoto 1 in May 2011 revealed that one emergency diesel generator was operating incorrectly due to a faulty thyristor in the exciter. The fault was repaired, and the generator was sent for basic overhaul after the plant's annual maintenance. The measurements on the rotor core winding performed in the basic overhaul of the generator in August 2011 revealed a short between windings. A short between core windings means a short circuit between two or more insulated windings. On the basis of further measurements on the faulty rotor, the fault was diagnosed as an earth fault occurring at a certain voltage level. A short between core windings was discovered in another EDG of Olkiluoto 1 in connection with a repair and basic overhaul operation in August 2010. The operability of other generators at Olkiluoto 1 and Olkiluoto 2 was tested for shorts between windings in August 2011. The tests revealed indications of a short between windings in two generators, which is why the power company will replace these generators with overhauled units.

The short between core windings discovered in 2010 was repaired by replacing the core winding insulators. The other core windings will be similarly insulated as an immediate corrective action for the fault now discovered. Following the observation made in 2010, the generator maintenance instructions have been supplemented with a test to be carried out at the workshop, intended for detecting any shorts between windings and for testing the condition of the insulation during maintenance. The power company has decided to carry out maintenance on the generators more frequently.

A short between the core windings of a generator may remain latent if the windings are not tested with special measurements. A latent short between windings can occur without affecting the operability of the generator for a long time, but it can also rapidly escalate and damage the core winding and cause a risk of fire.

Both Olkiluoto plant units have four emergency diesel generators that start and supply power, when required, to systems and components important to safety, such as the pumps cooling the reactor. Such situations include disturbances resulting in a loss of the connection to the national grid. According to the Operating Limits and Conditions, unrestricted use of the reactor is allowed for thirty days when only one of the diesel generators is unavailable. In an operational transient of the plant, at least two of the four diesel generators are required to secure the safety functions in all situations where they are needed.

On the INES scale, the event is rated at level 0.

APPENDIX 4 Licences and approvals in accordance with the Nuclear Energy Act in 2011

Teollisuuden Voima Oy

- 6/G42214/2010, 12 January 2011, OL3. Import of spent fuel transfer machine and fuel handling tools from Germany; amendment to licence 3/G42214/2010. Last date of validity 31 December 2013. The licence supersedes licence 3/G42214/2010, granted on 28 October 2010.
- 14/C42214/2010, 12 January 2011, OL1/OL2. Import of fission chambers from Germany, France and the United States. Last date of validity 31 December 2020.
- 5/G42214/2010, 12 February 2011, OL3. Amendment to import licence 1/G42214/2010 for reactivity measurement and analysis equipment. Last date of validity 31 December 2013.
- 1/G42214/2011, 12 July 2011, OL3. Possession of a spent nuclear fuel transfer machine at Olkiluoto Harbour. Last date of validity 29 February 2012.
- 2/G42214/2011, 14 July 2011, OL3. Possession of components for a spent nuclear fuel transfer machine at Olkiluoto Harbour. Last date of validity 31 March 2012.
- 4/G42214/2011, 2 September 2011, OL3. Possession of components for spent nuclear fuel handling equipment at Olkiluoto Harbour. Last date of validity 31 March 2012.
- 9/C42214/2011, 2 September 2011. Import of a rod made of zirconium alloy from Sweden. Last date of validity 31 March 2012.
- 7/C42214/2011, 24 October 2011. Import of nuclear fuel with Euratom obligation code “C”, from Sweden (OL2 E32, part of the batch). Last date of validity 31 December 2012.
- 8/C42214/2011, 24 October 2011. Import of nuclear fuel with Euratom obligation code “P”, from Sweden (part of batch OL2 e32). Last date of validity 31 December 2012.
- 6/C42214/2011, 24 October 2011. Import of nuclear fuel with Euratom obligation code “C”, from Sweden (OL1 e34). Last date of validity 31 December 2012.
- 5/G42214/2011, 14 November 2011, OL3. Amendment to import licence 4/G42214/2010 for dual-use items required in the construction and operation of an NPP. Last date of validity 31 December 2013.

Fortum Power and Heat Oy

- 1/A42214/2011, 24 February 2011, Loviisa 1 and 2; Import of a protective assembly from Russia. Last date of validity 31 December 2011.
- 2/A42214/2011, 24 February 2011, Loviisa 1 and 2; Import of intermediate range neutron flux detectors from Russia. Last date of validity 31 December 2011.
- 4/A42214/2011, 8 June 2011, Loviisa 1 and 2; Import of power range neutron flux detectors from Russia. Last date of validity 31 December 2015.

VTT

- 2/F42214/2010, 24 February 2011, import of a control rod mechanism for the FiR 1 reactor from the USA. Extension of validity of the licence F214/16 granted on 22 September 2006 until 31 December 2012.
- 1/F42214/2011, 11 March 2011, import of plutonium standards from Austria. Last date of validity 31 December 2011.

Others

- 3/A42214/2011, 11 May 2011, Loviisa 1 and 2. Import, possession and assignment of documentary material for the design of sampling autoclaves. Last date of validity 31 December 2021. The licence supersedes licence Y214/170, granted on 9 January 2008 for possession of documentary material.
- 23/A42214/2011, 19 December 2011, assignment of documentary material for the design of sampling autoclaves. Last date of validity 31 December 2021.
- 2/A42214/2011, 24 May 2011, Celer Oy. Creation, possession and assignment of documentary material for the design of sampling autoclaves. Last date of validity 31 December 2013.
- 4/A42214/2011, 20 May 2011, Siimet Oy. Possession of documentary material for the design of sampling autoclaves. Last date of validity 31 December 2021.
- 5/A42214/2011, 24 May 2011, Lujax tmi. Possession and assignment of documentary material for the design of sampling autoclaves. Last date of validity 31 December 2021.
- 6/A42214/2011, 24 May 2011, Pemco Oy. Possession and assignment of documentary material for the design of sampling autoclaves. Last date of validity 31 December 2021.
- 7/A42214/2011, 20 May 2011, Nasto Welding Pipe Oy. Possession of documentary material for the design of sampling autoclaves. Last date of validity 31 December 2021.
- 8/A42214/2011, 20 May 2011, Rejlers Oy. Possession and assignment of documentary material for the design of sampling autoclaves. Last date of validity 31 December 2021.
- 10/A42214/2011, 20 May 2011, Esys Oy. Possession and assignment of documentary material for the design of sampling autoclaves. Last date of validity 31 December 2021.
- 11/A42214/2011, 20 May 2011, Simsotec Oy. Possession of documentary material for the design of sampling autoclaves. Last date of validity 31 December 2021.
- 13/A42214/2011, 25 May 2011, Instrumentti Mattila Oy. Possession of documentary material for the design of sampling autoclaves. Last date of validity 31 December 2021. Superseded licence 13/Y42214/2011 granted on 20 May 2011.
- 16/A42214/2011, 24 May 2011, Holming Works. Possession and assignment of documentary material for the design of sampling autoclaves. Last date of validity 31 December 2017.
- 17/A42214/2011, 24 May 2011, KTS-Mekano Oy. Possession of documentary material for the design of sampling autoclaves. Last date of validity 31 December 2021.
- 18/A42214/2011, 20 May 2011, Smartweld Oy. Possession of documentary material for the design of sampling autoclaves. Last date of validity 31 December 2021.
- 19/A42214/2011, 24 May 2011, IS Works Oy. Possession and assignment of documentary material for the design of sampling autoclaves. Last date of validity 31 December 2021.
- 22/A42214/2011, 21 November 2011, Suomen Teknohaus Oy. Possession of documentary material for the design of sampling autoclaves. Last date of validity 31 December 2021.
- 25/A42214/2011, 19 December 2011, Planray Oy. Possession of documentary material for the design of sampling autoclaves. Last date of validity 31 December 2021.

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.

Periodic inspection programme 2011, Loviisa

Management, management system and personnel

A1 Management and safety culture, 25 August 2011

In August, STUK conducted an inspection of the management and safety culture at the Loviisa plant, focussing on the planning and monitoring of activities, the handling of matters important to safety in management as well as the management of modification projects and procurement operations. The power company has appropriate procedures in place for planning and monitoring the activities. The example discussed during the inspection indicates that the management is quickly informed of any matters important to safety and follows the progress of measures taken to clarify the issue. Following the inspection, STUK imposed three requirements. One requirement concerned the development of operations in order to ensure that matters important to safety are put in order within the set deadline. Two requirements concerned procurement: the licensee must see to it that the organisation has sufficient competence and that procedures are compliant with the requirements for implementing and monitoring nuclear procurement operations. STUK has repeatedly prompted the licensee to put matters important to safety in order within the set deadline and to take the nuclear industry-specific requirements into account in its procurement operations.

A2 Personnel resources and competence, 7–8 June 2011

The inspection of human resources and competence at the Loviisa power plant, carried out by STUK in June, assessed the personnel planning, training and personnel management at the Loviisa power plant. The inspection found that these functions are guided by Fortum's corporate-level documents that have not been clearly included in the power plant's management system. It was further found that the resources required for the development of the plant and its operations are not sufficiently taken into account in personnel planning. STUK required that these issues should be rectified.

A3 Functionality of the management system, 7 and 9 March 2011

The inspection of management and safety culture concerned the functionality of the management system at the Loviisa power plant from the perspective of nuclear and radiation safety, and the progress made in developing procurement was also inspected. In February 2011, the power plant established a working group to plan the development of the management system into a process-like system and tasked a member of the management with the responsibility for improving and developing the management system. The Loviisa power plant has made improvements in its procurement process and taken into account the requirements imposed by STUK in earlier inspections. Following the inspection, STUK required the Loviisa power plant to specify further the procedures for self-assessment by a more systematic description and to supplement the description of assessment procedures of safety culture. Furthermore, as a result of the inspection, the power plant was required to ensure that a quality-related vocabulary compliant with ISO 9000: 2005 is systematically used in Loviisa's management system documentation and communications..

A3 Functionality of the management system, 13 June 2011

STUK had discovered deficiencies in the way the licensee processed management-related documents at the Loviisa power plant and therefore carried out an additional inspection concerning the functionality of the power plant's management system and its continual improvement. Following the inspection, STUK required the Loviisa power plant to create a procedure for assessing the possible impacts of the amendments made to the licensee's management system on the power plant's management system and operations. Furthermore, STUK required the Loviisa power plant to assess the competence and expertise of the organisation regarding the safety culture as well as its assessment and continual promotion.

Plant safety and its improvement

B1 Assessment and improvement of safety, 18–19 April 2011

STUK carried out an inspection regarding assessment and improvement of safety in April, and it concerned the procedures guiding plant modifications management at the Loviisa power plant. The functionality of the procedures was assessed through two plant modification projects in progress. The power plant introduced a new project management model in 2010. It is now also observed for the management of some old modification projects. Following the inspection, STUK imposed requirements regarding further specification and development of the procedures.

B2 Plant safety functions, 28 February 2011

The inspection of the plant's safety functions concerned the software suites applied for designing and monitoring the reactor core as well as their use, maintenance and quality management. The inspection was conducted at the Nuclear Safety Department of Fortum Power and Heat's Power Division's Technical Support that provides the Loviisa power plant with analysis services. Following the inspection, STUK required Fortum to supplement the procedures related to core design and monitoring so that the input files for outsourced work can also be verified and the information therein traced. In addition, Fortum must develop its procedures, including those related to testing the computer software used for planning the reactor refuelling operations after modifications made to the production version.

B3 PRA and safety management, 2 November 2011

The main subjects of the inspection concerning the use of Probabilistic Risk Analysis (PRA) in safety management were the resources, up-to-dateness of the procedures, monitoring of the fault frequencies and repair times of critical faults in emergency generators, as well as the criticality classification of certain ventilation systems on the basis of their importance measures. The number of persons participating in PRA work at Fortum has increased, and the procedures have been updated appropriately. Fortum has further specified the classification of critical faults, and monitoring of their fault frequencies and repair times is continued. A marked increase in the fault frequency of EDG relays was detected in 2009, after which many or the relays were replaced, bringing the fault frequency down to the earlier level. The significance of ventilation systems to the safe operation of the plant was assessed using the PRA importance measure, and a significant deviation was discovered regarding the maintenance classification and preliminary importance measures of two circulation water pumps. Fortum will continue the assessment of maintenance classification in 2012.

B4 International operating experience feedback, 9 November 2011

The inspection of international operating experience feedback focussed on the processes of international operating experience feedback and their associated procedures and instructions, as well as on the utilisation of international operating experience feedback. The inspection also briefly touched the analysis of own operating experience feedback and the materialisation of corrective actions. Procedures were verified in the inspection, and their functionality was assessed using example cases. STUK found that there was scope for improvement in the follow-up of corrective actions decided on the basis of operational events at the plant as well as in the assessment of implementation of corrective actions and their effectiveness.

Operational safety

C1 Operation, 9 March 2011

The focus areas of inspecting the operation were the planning and assessment of the operating unit's operations as well as the maintenance and review procedures regarding operation-related documents. Following the observations made during the inspection, STUK required the Loviisa power plant to assess the up-to-dateness of documentation in the main control room and to delete or update any outdated documents. It was also found that there was scope for improvement in the signing off practices of training information sheets included in the control room documentation.

C1 Operation, 10 August and 21 September 2011

The inspection of operation consisted of oversight and inspections by STUK in connection with the annual maintenance outages of Loviisa plant units in September and October, focussing on the activities of the power plant's operating and maintenance organisations and its quality assurance unit. The oversight included assessment of the maintenance of operating procedures, work permit practices, shutdown and start-up of the plant units, implementation of modifications, general tidiness and housekeeping as well as testing activities. Following the observations made in the course of oversight and inspections, STUK required the Loviisa power plant to develop further the flow of information between Fingrid, the company responsible for the monitoring and maintenance of the national grid, and the Loviisa power plant, as well as the processing of information provided by Fingrid in the different organisational units of the power plant. It was further noted that the power plant must complete the procedures for kick-off meetings and implement the related induction training. STUK also imposed the requirement of further developing the assessment and follow-up procedures regarding the success of corrective actions taken on the basis of internal follow-up inspections.

C2 Plant maintenance, 17 August 2011

In the inspection it conducted in August STUK assessed ageing management at the Loviisa power plant as well as its development following the extensions to the plant's operating life and the organisational changes carried out. Particular attention was paid to the control measures that the responsible units use to identify the actions required by the ageing of components, such as basic overhauls or improvements to the maintenance, inspection and testing programmes. The chosen practical examples of mechanical or electrical engineering and I&C components were the internal parts of the reactor pressure vessel, the spare parts for and repair capabilities of relays and plant protection system PC cards, as well the spare parts for the main steam line radiation measurement. In ageing management based on the plant's procedures, the extent of actions is decided at the Loviisa plant on the basis of the operating life and availability of components, systems and structures. In the future, it must be verified whether the plant is also in control of physical and technological ageing in such parts of the plant required for important safety functions which, according to the procedures, are not included within the scope of the ageing management programme. Furthermore, the Loviisa power plant must assess whether the system responsibilities regarding ageing management have been defined in such a manner that the parts of the plant important for safety are covered and that sufficient human resources have been allocated to system responsibility duties.

C3 Electrical and I&C systems, 1–2 November 2011

The electrical subjects inspected in the inspection of electrical and I&C systems were electrical design, acceptance inspections, oil leaks in the main circulation pump motors, vibration measurements on EDGs, relay protection and the monitoring of electrical equipment ageing. Following the inspections, STUK required Fortum to supplement and further specify the maintenance procedures for the inspected subjects. Furthermore, STUK required Fortum to submit an account of the oil leaks occurring in the main circulation pump motors and the related corrective actions. The I&C subjects included component repair procedures, management of ageing and qualifications, organisation and competence of the maintenance personnel dealing with new programmable technology, as well as the organisation, competence and design process development of the plant's I&C design activities. Following the inspection, STUK required the power company to draw up inspection and testing plans for component repairs, to describe the procedures in the competence development process of the plant's I&C design and installation personnel and to submit to STUK the interim results of competence development and rectify the deficiencies in the I&C design process.

C4 Mechanical engineering, 15 November 2011

The subjects of mechanical engineering inspection were primary circuit load measurements, pressure and temperature transients as well as the ageing management of pressure-bearing components. The Loviisa power plant has not recorded the interrupted heat-ups of the primary circuit from cold shutdown state to operating state as primary circuit loading situations. STUK required the power company to assess if the interrupted heat-ups can have caused significant additional strains on the primary circuit. When assessing the replacement of pressurizer spraying lines at the Loviisa power plant, STUK paid attention to the possibility of strains induced by fluctuations in the flow conditions. STUK required the power company to submit an account of the strain measurements to be carried out in conjunction with replacing the pipelines. Measurements of loads inducing fatigue to pipe material have been carried out at the Loviisa power plant in the system designed for blowing out secondary circuit impurities accumulating in the steam generator. STUK required the power company to verify further these observations by nondestructive tests on the subject pipeline sections. Furthermore, STUK required the power company to produce an account of the current level and acceptability of the auxiliary feed water system pipeline vibrations observed at the Loviisa power plant after the latest power uprates.

C5 Structures and buildings, 27 October 2011

In the inspection of structures and buildings at the Loviisa power plant, the maintenance procedures of structures, buildings as well as seawater channels and tunnels were assessed. In addition, the results of inspections carried out by the power company and the modifications made were discussed. The scope of inspections included the organisation of the power company, inspection procedures issued by the power company, in-service inspections by the power company, maintenance, repairs and modifications of seawater tunnels and channels, supplementary construction works at the plant area, operational experience feedback activities and other inspections within the sphere of responsibility. No requirements were imposed following the inspections.

C6 Information management and security, 1–2 February 2011

The focal areas selected for the inspection of information security practices at the Loviisa power plant were the procedures issued for information security-related activities and maintenance of these procedures, as well as analysis of information security-related operational experience and taking it into account when developing operations. During the inspection, STUK found scope for improvement in certain areas.

C7 Chemistry, 22–23 February 2011

The subjects of the inspections on chemistry were the chemical conditions of the primary and secondary circuits compared to guide values, reporting of chemical and radiochemical results to STUK, spare parts management and functionality of the modification process as well as certain areas of quality management. The reporting of chemical and radiochemical deviations to STUK has been made less ambiguous, although there is still scope for improvement. In radiochemistry, the uncertainty regarding activity measurements has only been based on statistical uncertainty, which is why the requirement of producing a budget of overall uncertainty was imposed during the inspection. The requirement was imposed so that the procedures would have to be supplemented with descriptions of certain current practices and that the decontamination instructions would have to be completed before the 2011 annual maintenance. The plant has established a working group to find a solution to the procurement of spare parts for the continuous chemical process measurements. Some continuous measurements have been inoperable or have malfunctioned due to the lack of spare parts, and measurements have had to be replaced with laboratory measurements. Following the inspection, it was required that the examinations in progress are completed without delay and that the responsibilities and necessary procedures for ensuring the availability of spare parts are defined.

Personal and plant protection

D1 Radiation protection, 10–11 November 2011

The particular subject of the inspection of radiation protection at the Loviisa power plant was the measurement of radiation. The subject of the inspection included the environmental radiation monitoring programme as well as the portable and fixed radiation measurement instruments in use at the plant. In addition, the faults and disturbances observed in measurements were discussed, and the spare parts inventory of instruments and the procedures for monitoring the ageing of instruments were inspected. Following the inspection, STUK required the power company to assess whether more accurate environmental dosimetry measurement results can be obtained by utilising the recommendations of the new standard. Furthermore, the equipment used for collecting atmospheric samples from the environment must be included within the scope of the periodic maintenance programme. The new equipment procured by the power company has improved the standard of radiation monitoring at and around the Loviisa power plant. In addition, the plant is in the process of further modernising the existing range of radiation measurement equipment.

D2 Fire protection, 8 March 2011

The subjects of the fire protection inspection included improvements and modifications, training and fire brigade equipment, procedures as well as fire detection and extinguishing systems. Fire alarms in the turbine hall were raised by the extinguishing systems. It was established in the inspection that the Loviisa power plant will find out and follow up, among other things, new solutions and equipment for fire alarm systems. The purpose of this is to find a fire alarm system solution that would allow room-specific surveillance of the turbine hall. Following the inspection, the power company was required to produce an account of the methods allowing the use of wooden scaffolding planks to be reduced, thus reducing the fire load they cause.

D3 Emergency response, 4 and 18–19 October 2011

STUK inspected the emergency response arrangements of the Loviisa power plant, and the emergency response arrangements of Fortum's Technical Support in Keilaniemi was included within the scope of the inspection for the first time. Following the inspection, STUK imposed five requirements, one of which concerned the emergency response arrangements of Fortum's Technical Support. The equipment used by Fortum for emergency response have been modernised, and their development continues.

D4 Security, 2 November 2011

STUK inspected the security arrangements at the Loviisa power plant; they are deemed to include structural, technical, operational and organisational arrangements for detecting, delaying and preventing illegal activities in the nuclear power plant. No significant deviations were detected in the inspection. The measures resulting from remarks made in the course of STUK's earlier inspections were also considered to be appropriately implemented.

Nuclear waste and its storage

E1 Reactor waste, 9–10 June 2011

The focal points of the inspection of nuclear waste management at the Loviisa power plant were the arrangements for low- and intermediate-level waste management as well as the new treatment facilities at the Loviisa power plant, the sufficiency of personnel and up-to-dateness of the procedures. Following the inspection observations, STUK required the Loviisa power plant to assess the rusting and corrosion mechanism of low-level waste barrels placed in the VLJ repository, as well as the impacts that the deteriorating condition of the barrels will have on nuclear waste management and its safety.

E2 Final disposal facilities, 13–14 October 2011

When inspecting the final disposal facilities at the Loviisa power plant, STUK assessed the maintenance procedures at the plant site, the repairs and modifications carried out as well as the results of the power company's inspections. No requirements were imposed following the inspections.

Special items

F1 LARA

On the basis of its inspection of the requirements management, change management, configuration management and supervision of the project supplier in the I&C modernisation project of the Loviisa NPP (the LARA project), STUK required the procedures for the project to be further developed, particularly with respect to configuration management. In addition, STUK required the supervision work to be more precisely instructed and planned so that Fortum can ensure that the I&C design work progresses in compliance with the safety requirements.

F2 Spare parts management, 22–23 November 2011 and 11 January 2012

STUK inspected the responsibilities and procedures regarding the management of spare parts for systems and equipment important to safety at the Loviisa power plant, as well as the determination of spare parts requirements, the sufficiency of spare parts in stock and their storage. A comprehensive task to find out the exact situation of and future requirements for spare parts is in progress at the Loviisa power plant. In addition, STUK required the power plant to develop the allocation of responsibilities and the procedures related to spare parts management as a whole so that spare parts compliant with the requirements will be available for systems and equipment important to safety. For the purpose of developing the spare parts management procedures, STUK required the Loviisa power plant to produce a documented plan for 2012–2016.

Periodic inspection programme 2011, Olkiluoto

Management, management system and personnel

A1 Management and safety culture, 29–30 August 2011

The inspection of management and safety culture focussed on the planning and monitoring of operations, the management of modifications and projects as well as development of the management system from the perspective of the power company's top management. In the inspection, TVO's management and STUK's inspection team also paid a joint inspection visit to Goods Inwards and stores. Following the inspection, STUK required that the procedures for TVO's management reviews must be updated to comply with the requirements of YVL Guide 1.4.

A2 Personnel resources and competence, 7 and 9 September 2011

The inspection of personnel resources and competence dealt with personnel planning, allocation of resources and assessment of their sufficiency. The inspection focussed in particular on the planning and management of TVO's personnel resources between project and line organisation work. Following the inspection, STUK noted that TVO has different practices in different parts of its organisation regarding the allocation of human resources and the monitoring of their sufficiency. According to TVO, the procedures have sufficiently met the company's requirements, but the practices and the associated procedures do not, however, fully comply with the requirements of YVL Guide 1.4. Following the inspection, STUK required TVO to develop its HR planning and its associated procedures, observing the requirements of YVL Guide 1.4 and the risks associated with the ageing of the plant. In addition, the inspection also concerned the actions for training development and the training register to which STUK found no objections.

A3 Functionality of the management system, 14–15 November 2011

The inspection of functionality of the management system focussed on the quality management of modifications, as well as on the management of procurement operations and control of the supply chain that are its essential parts. Following the inspection, STUK required TVO to develop further its quality management procedures and practices regarding modifications so that they are clear and unambiguous to their users and guide the quality management to comply with the requirements of the YVL Guides. Furthermore, STUK required TVO to develop the training for modification-related quality management.

Plant safety and its improvement

B1 Assessment and improvement of safety, 11–12 October 2011

STUK inspected the assessment and improvement of safety at TVO by evaluating the procedures guiding the plant modifications for Olkiluoto 1 and Olkiluoto 2 as well as the functionality of the procedures through two plant modification projects that were in progress. During 2011, TVO has compiled a Project Manual to guide project activities; it contains procedural instructions and also best practices. Following the inspection, STUK imposed the requirement that benchmarks should be developed to measure the operation of modification projects.

B2 Plant safety functions, 2 November 2011

The inspection of plant safety functions focused on the software suites applied for designing and monitoring the reactor core as well as their use, maintenance and quality management. The development of software and related analyses are the responsibility of TVO's Reactor Physics Office in Helsinki, while the use and maintenance of the operation monitoring program is the responsibility of the Reactor Monitoring Office in Olkiluoto. Following the inspection, it was found that the organisational units have sufficient personnel resources and competence. The interface procedures and uniform working methods, necessary for good cooperation, are also well established, and version management is in place. There are also sufficiently detailed procedures available for the operations. STUK required that the procedure update, required as a corrective action regarding the tilting of a fuel rack during the 2011 annual maintenance, must be completed before the 2012 annual maintenance and sent to STUK for information. The action and its deadline had already been entered in TVO's database of corrective actions, but STUK had not been officially informed of the deadline.

B3 PRA and safety management, 8 September 2011

In September, STUK carried out an inspection regarding the use of PRA (Probabilistic Risk Assessment) in safety management. The inspection covered the organisation, resources, procedures, training, the situation regarding PRA updates and the delivery schedule, as well as the use of PRA for "Fukushima analyses" and diversity analyses. Further subjects included the risk-informed in-service inspection programme (RI-ISI) for pipelines, the use of PRA in decision-making and event analysis, as well as the use of PRA in ageing management. Following the inspection, STUK found that the state of the inspected PRA functions complies with the requirements of YVL Guide 2.8. Following the inspection, it was required that the updated schedule of the risk-informed in-service inspection programme for pipelines be submitted to STUK.

B4 International operating experience feedback, 1–2 November 2011

The inspection of international operating experience feedback focussed on the processes of international operating experience feedback and their associated procedures and instructions, as well as on the utilisation of international operating experience feedback. The inspection covered both the plant units in operation (Olkiluoto 1 and 2) and the unit under construction (Olkiluoto 3). The inspection also briefly touched on the analysis of own operating experience feedback and the implementation of corrective actions. Procedures were verified in the inspection, and their functionality was assessed using example cases. No requirements were imposed by STUK following the inspections.

Operational safety

C1 Operation, 30–31 March 2011

The inspection of operation focussed on the Operating Limits and Conditions (OLC), main control room documentation and periodic tests for which Operation is responsible. In addition, the planning of operation and operational safety functions at Olkiluoto 1 and Olkiluoto 2 were inspected, together with their results. Following the inspection, STUK imposed requirements related to keeping the control room documentation up to date, to supplementing the procedures and to practices related to amending the OLC.

C1 Operation R211, 10 May–3 June 2011

The purpose of the second inspection of operation during the year was to verify the safety of annual maintenance, and the inspection was carried out during the annual maintenance outage of Olkiluoto 2. The inspection focussed on the actions of the operators in the control room, on events related to fuel handling, as well as on operations most important regarding the outage-related risk. Following the inspection, STUK required TVO to assess the situation and availability of the fuel transfer machine, the safety significance of fire doors wedged ajar and the sufficiency of corrective actions regarding events where operators have responded to alarms during the outage only after some delay. The corrective actions required must be determined on the basis of the assessments.

C2 Plant maintenance, 17 October 2011

The inspection of plant maintenance concentrated on analysing the situation with regard to the requirements imposed in the previous inspections and on the exhaust pipe damage observed in the EDGs. Following the inspection, STUK found that there are deficiencies in the way the ageing mechanisms of components and parts most important to safety are identified in the related maintenance planning and analysis. STUK required TVO to establish whether the ageing mechanisms and the actions they require could be defined for the components and parts in closer detail.

C3 Electrical and I&C systems / electricity, 16–17 March 2011

The electricity-related part of the inspection of electrical and I&C systems assessed the power company's procedures for ensuring the reliable operation of the plant units' electrical systems and equipment. The particular subjects included monitoring the ageing of electrical equipment and cables, the electrical maintenance of diesel generators, the gas turbine power plant and installation inspections. No significant deficiencies were detected in the inspection.

C3 Electrical and I&C systems / I&C, 30–31 March 2011

The focus of the I&C part of the inspection of electrical and I&C systems was on the maintenance of measuring accuracy, the I&C design and implementation process, the qualification monitoring programme, ageing and inventory management. Scope for further development was observed in particular in the design and implementation process for I&C modifications and in the management of measurement accuracy coverage.

C4 Mechanical engineering, 1–2 November 2011

The inspection of mechanical engineering concerned the ageing management of pressure-bearing equipment, the results of and projects related to load monitoring, the topical projects of vibration monitoring and the situation of mechanical engineering studies aimed at extending the operating life. Following the inspection, STUK required the power company to present a summary of the current status of measurements carried out for identifying the pipework points where temperature stratification takes place.

C5 Structures and buildings

The inspection of structures and buildings included an inspection of the maintenance procedures of structures, buildings as well as seawater channels and tunnels. In addition, the results of inspections carried out by the power company and the modifications made were discussed. No requirements were imposed following the inspections.

C6 Information management and security

An inspection of information security was carried out at the Olkiluoto NPP on 17–18 November 2011.

C7 Chemistry, 13–14 September 2011

The inspection of chemistry focussed on the resources of the organisational unit responsible for chemistry-related functions, alternative analysis methods for the parameters most important to safety, management of spare parts inventory for chemical and radiochemical instruments, functionality of the plant's modification process from the perspective of chemistry and radiochemistry, the up-to-dateness of chemistry-related procedures as well as certain areas of the laboratory's quality management and emergency response. The validation of activity measurements and determination of overall uncertainty are areas of quality management that were already inspected in the previous year's inspection. The licensee had left the determination of overall uncertainty to be done in connection with validating the new analysis method, which is why the requirement was repeated during the inspection. It was required that the timing of closing the ventilation system of the laboratory in an emergency should be revised. The requirement was imposed due to the fact that in an emergency, the radioactive contamination carried in the ventilation system may cause an increase in background activity in the laboratory with the result that the activity measurement results of analysed samples are not reliable. The contamination level affecting the activity measurements is considerably lower than the level relevant to employees' radiation safety. Following the inspection, the requirement was also imposed that emergency situations must be taken into account in the liquid nitrogen supply of the gamma spectrometers used in activity measurements. The nitrogen required for the gamma spectrometers is kept in liquid nitrogen tanks located outdoors, which means that in an emergency situation, the outdoor radiation conditions may restrict the transfer of the tanks indoors.

Personal and plant protection

D1 Radiation protection, 15–17 March 2011

The radiation protection inspection focussed on radiation measurements. The subjects covered in the inspection included the situation regarding portable and fixed radiation measurement systems, the environmental monitoring programme, the spare parts situation as well as the faults and disturbances observed in the radiation measurement systems. Following the inspection, STUK required TVO to assess the shortcomings in the spare parts inventory for radiation meters and to determine the corrective actions. Furthermore, TVO must assess the effect that the carrying cases of dosimeters used for environmental radiation measurements and the ambient conditions have on the results and further specify the procedures regarding the functional tests on radiation monitoring equipment and the calibration protocol of portable radiation measurement instruments.

D2 Fire protection, 31 August 2011

In the inspection of fire protection, the efficiency of the NPP's fire protection arrangements and the power company's operations was assessed and the amendment plans for fire protection arrangements were analysed. The round made at the plant in connection with the inspection revealed excess fire load in the relay rooms next to the control rooms – for example, packing crates and furniture made of combustible materials. STUK required the excess fire load to be removed. A non-compliant electrical penetration was observed on the wall of a cable room. STUK required all penetrations in that room and in similar rooms to be inspected and rectified.

D3 Emergency response, 6–7 June 2011

The subjects of the inspection of emergency response included emergency response training and exercises, the facilities, equipment, emergency-related documents and the emergency response organisation. Following the inspection, STUK required TVO to repair the external radiation measurement station in the vicinity of the plant. The station had been out of order for almost a year. The situation regarding revision of the information transfer connection between the plant units was discussed during the inspection. STUK required TVO to submit a technical specification and assessment regarding the availability of certain spare parts. In an emergency response situation, TVO would use the subject system for sending to STUK the measurement data most important to plant safety.

D4 Security, 16 November 2011

STUK inspected the security arrangements at the Olkiluoto power plant; they are deemed to include structural, technical, operational and organisational arrangements for detecting, delaying and preventing illegal activities in the nuclear power plant. In addition, the actions taken on the basis of an extensive assessment of security arrangements were inspected. No significant deviations were detected in the inspection. All the actions regarding the remarks and requests made in STUK's earlier inspections had not yet been fully implemented.

Nuclear waste and its storage

E1 Reactor waste, 1–2 November 2011

STUK conducted an inspection of nuclear waste management, focussing on waste accounting and the foreseen waste management facilities of the Olkiluoto 3 plant unit under construction. STUK required TVO to update the mass limit set for the amount of waste cleared from control and received at its own landfill site. The waste volumes have increased as the plant has aged, and, in the future, the operation of Olkiluoto 3 will further increase the amount of waste. However, the activity limits important for radiation safety have been appropriate, and the activity values of waste cleared from control are well below the set limits.

E2 Final disposal facilities

Not inspected in 2011.

Special items

F1 Spare parts management, 20–21 April 2011

STUK carried out an additional inspection regarding spare parts management. The inspection identified areas for development, related to, among other things, the goods reception area and the goods reception practices, the determination of spare parts requirements of systems and components important to safety as well as to the size and monitoring of the inventory. Following the inspection, STUK required TVO to produce a report on spare parts maintenance regarding systems and components important to safety and submit it to STUK by the end of November 2011. The report must indicate the responsibilities and procedures as well as the implemented and planned development actions.

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 quality management	21 January 2011
Commissioning processes and procedures	9–10 March 2011
Project management and the management of safety	28–29 April 2011
Quality management – functionality of the management system	21 December 2011
Work processes	
Radiation safety	18–19 January 2011
Information security	23 March 2011
Quality control – electrical and automation engineering	4 May 2011
OL3 – readiness for commissioning, turbine island	7 June 2011, 14–16 June 2011
Delivery supevision, receiving inspections and erection supervision (mechanical engineering)	15 June 2011
Preparation of operating license application	22–23 September 2011
Information security of electrical systems	6 October 2011
Equipment installation steering process (electrical engineering)	3–4 November 2011
Utilisation of PRA	8 December 2011
Quality management – review and evaluation of safety implications of documents and time extension requests	15–16 December 2011

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	15 March 2011
Planning and management		
ONP-B1	Project management and control	Not in 2011
ONP-B2	Safety management	5–6 May 2011
ONP-B3	Project quality management	19–20 May 2011
ONP-B4	Planning and management of the research and monitoring programme	Not in 2011
ONP-B5	Design of Onkalo	Not in 2011
Implementation		
ONP-C1	Site inspection and monitoring procedures	28–29 September 2011
ONP-C2	Drilling and modelling	Not in 2011
ONP-C3	Foreign substances	15–16 December 2011
ONP-C4	Excavation and EDZ	20–21 December 2011
ONP-C5	Onkalo in-flows	10–11 November 2011
ONP-C6	Monitoring and research methods	Not in 2011

APPENDIX 8 Assignments funded by STUK in 2011

Safety of NPPs

The subjects of assignments presented in the 2011 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 2011 were postponed to 2012.

Of the assignment proposals for 2011, 34 were related to the project of overseeing the construction of Olkiluoto 3 (FIN5/OL3), five to the Olkiluoto plant units already in operation, nine to Loviisa plant units and three to new NPP projects. The most significant framework agreements related to overseeing the construction of Olkiluoto 3 in 2011 were:

- FIN5/OL3, Oversight and inspection of the manufacture of pipeline prefabricates of Safety Classes 1 and 2 (Quality Factory Oy, EUR 260,700)
- FIN5/OL3, Inspection of mechanical components for pipelines of Safety Classes 1 and 2 (Lamprotek Oy, EUR 120,100)
- FIN5/OL3, Inspection of stress and strength analyses of components for pipelines of Safety Classes 1 and 2 (VTT, EUR 81,900)
- FIN5/OL3, Strength analyses of nuclear pressure vessels (VTT, EUR 18,200)
- FIN5/OL3, Strength analyses of structural plans (Inspecta Nuclear AB, EUR 91,300)
- FIN5/OL3, Buildings and structures: inspection of detailed structural plans (Pontek Oy, EUR 64,800)

Safety of nuclear waste disposal

The volume of the technical support programme for the oversight of nuclear waste management was about EUR 412,000 in 2011. 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
  - External specialist work related to the construction of ONKALO (EUR 35,000)
- Overseeing the research, development and planning/design work for the disposal facility
  - Safety Case documentation
  - EBS Design Report, Structural Design of Disposal Canister (EUR 21,150)
  - Detailed design report for the buffer (EUR 5,000)
  - Replaceability of bentonite (EUR 21,600)
  - THC modelling possibilities (EUR 15,000)
  - Increase of fuel burn-up (EUR 47,000)
  - Improvement of biosphere assessment capabilities (EUR 8,000)
  - Comparison of the disposal locations of Forsmark and Olkiluoto (EUR 15,250)
  - Safety analysis training (EUR 20,000)
  - SAS-SAFARI consultancy (EUR 60,000)
  - Assessment of Posiva's FEP documentation 2011–2012 (EUR 77,000)
  - Posiva's climate scenario report (EUR 16,000)
  - Development of independent safety analysis (EUR 17,000)
  - Creation and assessment of scenarios (EUR 36,000)
  - Assessment of Posiva's final EDZ report (EUR 10,000)
  - Possibilities for site-scale hydrogeological modelling (EUR 7,650)

APPENDIX 9 International co-operation in 2011

IAEA

IAEA working groups

- CSS, Commission of Safety Standards – a body steering the preparatory work for IAEA's safety standards, Lasse Reiman, Vienna 1–2 Nov 2011
- Regulatory Co-operation Forum Meeting, Petteri Tiippana, Vienna 14–15 April 2011
- NUSSC, Nuclear Safety Standards Committee, Marja-Leena Järvinen, Vienna 3–6 July 2011, 2011, 17–20 Oct 2011
- NUSSC, Nuclear Safety Standards Committee, Keijo Valtonen, Vienna, 4–5 July 2011
- WASSC, Waste Safety Standards Committee, Kaisa-Leena Hutri, 27–30 June, 12–15 Dec 2011
- TRANSSC, Transport Safety Standards Committee, Anna Lahkola 24–27 Oct 2011
- IAEA Steering Committee Meeting for Regulatory Training, Kaisa Koskinen, Vienna 22–24 Feb 2011, 27 Nov – 2 Dec 2011
- GEOSAF, International Project on Demonstrating the Safety of Geological Disposal, Jussi Heinonen 10–17 Apr, 16–20 May 2011
- CEG, Contact Expert Group for International Radwaste Projects in the Russian Federation, Henri Niittymäki 17–20 May, 6–7 Oct 2011; Esko Ruokola 16–17 Feb 2011
- ASTOR, Application of Safeguards to Geological Repositories, Elina Martikka, , 31 Mar – 1 Apr, , 24–25 Oct 2011; Tapani Honkamaa 31 Mar – 1 Apr, 23–26 Oct 2011

IAEA's expert duties

- IRRS, International Regulatory Review Service, IAEA expert group to assess national nuclear safety regulation
  - Review of the Korean regulatory framework, Kaisa Koskinen, 8–23 July 2011
  - Review of the German regulatory framework, Marja-Leena Järvinen, 4–10 Sep 2011
  - Review of the Swiss regulatory framework, Petteri Tiippana, 20 Nov – 2 Dec 2011
- IAEA, IPPAS mission to Sweden, Ronnie Olander, Stockholm 16–27 May 2011

IAEA's expert meetings

- CNS, International Nuclear Safety Convention, meeting and presentation of the country report of Finland, Petteri Tiippana, Vienna 6–7 Apr 201, Kirsi Alm-Lytz, Pekka Salminen, 3–8 Apr 2011, 10–14 Apr 2011
- IAEA Technical Meeting on Safety Goals, Lasse Reiman, Vienna 11–15 Apr 2011
- IAEA/ISSC, International Seismic Safety Centre
  - Extra-budgetary donors' meeting, Pekka Välikangas, Vienna 18–21 Jan 2011
  - Working area 7 meeting and meeting with construction and fire protection specialists of CNSC, Pekka Välikangas, Ottawa, 27–31 Mar 2011
  - IAEA/ISSC -EBP, 1st Meeting of Working Group 8.1, Ulla Vuorio, Madrid 26–29 Sep 2011
  - Consultancy meetings on design safety margin evaluation (DSME), Vienna, Pekka Välikangas, Vienna 2–5 Aug 2011
    - Method development for DSME guidelines,, Pekka Välikangas, Vienna 23–25 Aug 2011
    - Drafting of DSME guide, Pekka Välikangas, Liverpool, Bootle 6–9 Sep 2011
    - DSME guide development, Pekka Välikangas, Vienna 20–23 Sep 2011
- IAEA, Consultancy meetings on design safety margin evaluation (DSME), Tomi Routamo, Vienna 2–4 Aug 2011
- IAEA Ministerial Conference on Nuclear Safety, Risto Sairanen, Vienna 20–23 June 2011
- IAEA TM on Safety Culture Oversight and Assessment, Anna Aspelund, Vienna 14–18 Feb 2011

- IAEA INES-workshop, Tomi Koskiniemi, Hanna Kuivalainen, Vienna 10–15 Oct 2011
- IAEA,Consultancy Meeting to agree the way forward for Draft Safety Guide, Keijo Valtonen, Vienna 14–18 Nov 2011
- IAEA Meeting of the Security Information Portal (NUSEC) Liaison Officers , Paula Karhu, Vienna 8–9 Nov 2011
- IAEA TM Guide on Nuclear Security Infrastructure, Paula Karhu, Vienna 12–16 Dec 2011
- IAEA, International Meeting on Application of the Code of Conduct on the Safety of Research Reactors, Pöllänen Lauri, Vienna 15–20 May 2011
- IAEA European Regional Workshop, Janne Nevalainen, Budapest 15–20 May 2011
- IAEA Follow up to 3–7 May Consultancy on Regulatory Oversight, Janne Nevalainen, Vienna 2–7 Oct 2011
- IAEA 23rd TWG-NPPIC-meeting, Harri Heimbürger, Vienna 23–27 May 2011
- IAEA Consultancy Meeting on GNSSN, Erja Kainulainen, Vienna 13–16 Nov 2011
- IAEA Workshop on National Nuclear Regulatory Portals, Erja Kainulainen, Bonn 3–6 July 2011
- IAEA/NEA Joint Technical meeting to Exchange Experience on Recent Events in Nuclear Power Plants and the Technical Committees Meeting of the IRS National Coordinators, Erja Kainulainen, Paris 25–29 Sep 2011
- IAEA Workshop on the Lessons Learned from the IAEA IRRS Missions, Kaisa Koskinen, Washington 25–29 Oct 2011
- IAEA Technical Meeting/ Environmental Impact assessment of nuclear facilities, Olli Vilkamo, Vienna 27–30 Nov 2011
- IAEA DBT-workshop, Paula Karhu, Stockholm 13–16 Feb 2011
- IAEA Safety Assessment Workshop, PSA Level 1 and Level 2, Janne Laitonen, Trieste 2–15 Oct 2011
- Safeguards Bilateral Meeting, Risto Paltemaa, Elina Martikka, Marko Hämäläinen 22 Sep 2011
- IAEA/SSM International Workshop on High Level Radioactive Waste, Risto Paltemaa, Jussi Heinonen, Kai Hämäläinen, Kaisa-Leena Hutri 29 Nov –1 Dec 2011
- Better use of Joint Convention, Risto Paltemaa 3–4 Nov 2011
- Joint Convention Organization Meeting, Kai Hämäläinen, Kaisa-Leena Hutri 10–12 May 2011
- Consultants Meeting; Guidance on the use of nuclear material accountancy and control for nuclear security at facilities, Elina Martikka 12–13 May, 26–30 Sep 2011
- Technical Meeting on the Accountancy and Control of Nuclear Material for Nuclear Security at Facilities, Elina Martikka 9–11 Feb, 26–28 Apr 2011
- Trilateral Meeting IAEA-EURATOM-STUK on safeguards issues related to the Finnish facilities for final disposal, Elina Martikka, Marko Hämäläinen 13 Apr 2011
- Seminar on Optimizing the IAEA safeguards system, Elina Martikka 14–15 Apr 2011

CTBTO

- CTBT WGB and Radionuclide Expert Group (RNEG), Mikael Moring 23 Feb –4 Mar, 31 Aug –2 Sep, 6–9 Sep 2011

OECD/NEA

- CNRA, Committee on Nuclear Regulatory Activities, Petteri Tiippana, Paris 4–7 Dec 2011
- OECD/NEA, Working group LTO Green Booklet, Martti Vilpas, Paris 21–24 Feb 2011 ja 26–28 Sep 2011
- CNRA/WGRNR meeting, Tapani Virolainen, Paris 5–9 June 2011, 18.–21 Sep 2011
- CNRA Fukushima Senior Task Force meeting, Petteri Tiippana, Paris 4–6 May 2011
- CNRA meeting and Fukushima forum, Petteri Tiippana, Lasse Reiman, Paris 8 June 2011
- CNRA Fukushima Task Force meeting, Petteri Tiippana, Paris 20–23 Sep 2011
- OECD/NEA/WGOE meeting, Seija Suksi, Paris 25–30 Sep 2011
- WGIP, Working Group on Inspection Practices Workshop, Jukka Kupila, Paris 10–14 Oct 2011
- NEA Technical Experts Meeting on national Fukushima assessment, Risto Sairanen, Tokyo 7–10 Nov 2011
- OECD FIRE meeting and PSA2011 conference, Matti Lehto, Washington 8–17 Mar 2011
- OECD FIRE and HEAF working group working meetings, Matti Lehto, Paris 7–10 Sep 2011

- OECD/NEA Workshop on PSA for New and Advance, Reino Virolainen, Paris 19–25 June 2011
- OECD/NEA CSNI/DIDELSYS meeting, Kim Wahlström, Paris 9–11 May 2011
- OECD PKL-2 project PRG and MB meetings, Eero Virtanen, Erlangen 7–10 Nov 2011
- OECD PKL-2 Management board of the OECD PKL2 Project, Risto Sairanen, Eero Virtanen, Budapest 13–15 Apr 2011
- OECD/NEA Working Group on Fuel Safety, Risto Sairanen, Paris 21–22 Sep 2011
- WG WGHOF seminar and NEA/IAEA Workshop, Milka Holopainen, Kirsi Levä, Chester 25–29 Sep 2011
- WG CNRA Regulatory Oversight of NCFSI, first meeting, Kirsi Levä, Paris 18–21 Oct 2011
- CNRA Meeting, Kirsi Levä, Paris 4–7 Dec 2011
- Expert Group on the Implications of ICRP Recommendations, Arto Isolankila 3–4 Oct 2011

CSNI

- CSNI Meeting, Petteri Tiippana, Lasse Reiman, Paris 9.6.2011
- CSNI/WGRisk Annual Group Meeting, Reino Virolainen, Paris 27.3.–1.4.2011
- CSNI/IAGE Working Group on Integrity and Ageing of Components and Structures, "Sub group on the integrity of metal components and structures", 16th Metal Subgroup Meeting, Rauli Keskinen, Paris 4–8 Apr 2011
- CSNI COMPSIS SG-Meeting, Heimo Takala, Paris, 19–21 Sep 2011
- CSNI/CAPRI Management Board meeting, Keijo Valtonen, Paris, 7–8 Feb 2011, 8–10 June 2011, 5–9 Dec 2011
- WGAMA Programme Project Meeting,
    - SETH2-Project seminar and Hymeres-project meeting, Eero Virtanen, Paris 11–14 Sep 2011
    - Management Board of the OECD-NEA-ROSA-2 Project, Eero Virtanen, Paris 18–20 Oct 2011
- CSNI HALDEN Board Meeting Keijo Valtonen, Washington 20–24 June 2011 ja 5–9 Dec 2011 Paris
- HALDEN Enlarged Halden Programme Group Meeting 2011, Advisory Groups and Nordic TC45 Meeting, Harri Heimbürger, Sandefjord 2–7 Oct 2011
- HALDEN Enlarged Halden Programme Group Meeting 2011, Lena-Hansson Lyyra, Sandefjord 2–7 Oct 2011
- HALDEN Workshop on VVER Fuel behavior, Risto Sairanen, Budapest 10–11 May 2011
- OECD, Post-Tensioning Group Workshop, Jari Louhivirta, Lyon 19–22 Apr 2011

CRPPH

- NEA CRRPH Annual Meeting, Olli Vilkamo, Paris 16–18 May 2011

RWMC, Radioactive Waste Management Committee

- Radioactive Waste Management Committee, Regulators' Forum (RWMC/RF), Esko Ruokola 22–24 Mar, 31 May –1 June 2011
- Radioactive Waste Management Committee, Integration for the Safety Case (RWMC/IGSC-13), Petri Jussila 19–21 Oct 2011

EU

- Ad Hoc Group Nuclear Security, Lasse Reiman, 21 Sep 2011, 21 Oct 2011, 18 Nov 2011
- Ad Hoc Group Nuclear Security, Tapani Hack, Brussels 26–27 July 2011, 20–21 Sep 2011, 4–5 Nov 2011
- ENSREG, European Nuclear Safety Regulator's Group, Petteri Tiippana 27–29 June 2011
    - WG2, Risto Paltemaa 21 Jan, 1 Feb, 1 Mar, 29 Apr, 12–13 May, 11–13 Sep, 11–12 Oct, 4–6 Dec 2011
- EC A37, Penly npp General Data, Olli Vilkamo, Luxembourg 27–29 Sep 2011
- EC A31 meeting, Olli Vilkamo, Luxembourg 21–24 Nov 2011
- A37 Expert Group Meeting, Lauri Pöllänen, Luxembourg 7–10 Nov 2011
- EU Extra ordinary meeting – Response to Japan events, Jorma Sandberg, Brussels 15–16 Mar 2011
- Annual Meetings (TB & SC) of EC CH, Seija Suksi, Petten 25–27 Jan 2011
- EU Stress Tests – Peer Review Task Force – meeting, Tomi Routamo, Paris 19–20 Sep 2011
- Pilot Topical Peer Review in EU Stress Tests, Riku Mattila, Tomi Routamo, Ulla Vuorio, Risto Sairanen, Luxembourg 7–8 Dec 2011
- EU Clearinghouse Technical Board and Steering Committee, Mika Kaijanen, Petten 25–27 Jan 2011

- Regional Joint IAEA/EC-JRC Workshop Ulla Vuorio, Petten 22–26 Aug 2011
- ENSRA-European Nuclear Security Regulators Association, Tapani Hack, Ronnie Olander, Bonn 28 Nov – 1 Dec 2011
- SARNET2 – Advisory Committee Meeting, Tomi Routamo, Paris 14–15 Feb 2011
- Joint Research Centre (JRC) Decommissioning and Waste Management Expert Group, Risto Paltemaa 18–19 Apr, 21–22 Nov 2011
- Working Party on Atomic Questions, Safety case/safety assessment in the context of the waste management directive, Risto Paltemaa 23 Feb 2011
- Crystalline Rock Retention Processes (CROCK) -project, Ari Luukkonen 9–12 Feb 2011
- Monitoring Developments for Safe Repository Operation and Staged Clorue (MoDeRn), Expert stakeholders workshop, Rainer Laaksonen 4–6 May 2011
- Advisory Committee for implementation of Council Directive 2006/117/Euratom, Arja Tanninen 4 April, 8 Dec 2011
- ESARDA, European Safeguards Research and Development Association, Steering Committee, Elina Martikka 16–19 May 2011
- ESARDA, Executive and WG, Elina Martikka 18–20 Jan 2011
- ESARDA Novel Approaches/Novel Technologies working group, Tapani Honkamaa 19–20 May 2011
- ESARDA symposium, Anna Lahkola, Timo Ansaranta 17–21 May 2011
- ESARDA, Verification Technologies and Methodologies Working Group, Olli Okko 16–19 May, 3–5 Oct 2011
- Meeting with the Commission on safeguards implementation in Finland, Elina Martikka, 12 Oct 2011

Nordic cooperation

- NSFS conference, Nordic Society for Radiation Protection,board meeting (board member 2005–2011), Olli Vilkamo, Reykjavik 21–25 Aug 2011
- Swedish Radiation Safety Authority (SSM), Comparison of nuclear waste safety regulation and licensing procedures, Risto Paltemaa, Jussi Heinonen, Kai Hämäläinen, Janne Viertävä, Jaakko Leino, Esko Ruokola 27 Jan 2011
- Inspection to a repository for operational waste in Forsmark, Sweden (SFR). Katriina Labbas (observer), 22–23 Nov 2011.
- Visit to SKB's Canister Laboratory and Äspö Hard Rock Laboratory in Oskarshamn, Sweden, Rainer Laaksonen, Jarmo Lehikoinen, Ari Luukkonen 28–29 Apr 2011
- Visit to interim storage facility (CLAB) and hard rock laboratory (Oscarshamn) Janne Viertävä, Kai Hämäläinen, Jaakko Leino 26 Jan 2011
- Participation in hearing of international review (NEA) of Swedish Nuclear Fuel and Waste Management Company (SKB) , Jarmo Lehikoinen, Kai Hämäläinen 12–13 Dec 2011
- Presentation of the use of Digital Cherenkov Viewing Device (DCVD) in the Swedish interim spent fuel storage (CLAB), Antero Kuusi 17–18 Feb 2011

Other multinational working groups

WENRA

- Western European Nuclear Regulator's Association, Lasse Reiman, Kirsi Alm-Lytz, Berliini 15–16 Nov 2011
- WENRA Inspection Working Group, Lasse Reiman, Marja-Leena Järvinen, Mirka Schildt, Liverpool 7–10 Feb 2011
- WENRA/RHWG, Reactor Harmonization Working Group, Lasse Reiman, Paris 5–6 Apr 2011
- WENRA/RHWG, Reactor Harmonization Working Group, Lasse Reiman, Kirsi Alm-Lytz, Praha 23–28 May 2011
- WENRA Inspection Working Group, Lasse Reiman, Marja-Leena Järvinen, Mirka Schildt, Stockholm 31 May –1 June 2011
- WENRA RHWG Reactor Harmonization Working Group, Lasse Reiman, Kirsi Alm, Portoroz 26 Sep – 1 Oct 2011
- WENRA RHWG Reactor Harmonization Working Group, Lasse Reiman, Kirsi Alm-Lytz, Brussels 9–10 Nov 2011
- WENRA multiple failure working group meeting, Keijo Valtonen, Köln 17–19 Aug 2011, 30 Nov – 2 Dec 2011
- WENRA Practical Elimination, meeting Keijo Valtonen, Ljubljana 17–19 Jan, 18–21 Apr 2011
- WGWD, Working Group for Waste and Decommissioning, Esko Ruokola 10–11 Feb 2011

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 meetings 18–20 Jan 2011 ja 26–29 Apr 2011 and 11–16 Sep 2011, STC meeting and MDEP conference, Petteri Tiippana, Paris
  - MDEP/EPRWG, Multinational Design Evaluation Programme, Petteri Tiippana, Kim Wahlström, Paris 16–18 May 2011
  - MDEP/EPRWG Internal hazards ad-hoc meeting, Ari Julin, Vesa Meuronen, Paris 5–6 Sep 2011
  - MDEP/EPR Working Group and PRA Meeting, Ilkka Niemelä, Paris 16–19 May 2011
  - MDEP/EPR Technical Expert Subgroup, Risto Sairanen, Riku Mattila, Paris 15–19 May 2011
  - OECD/MDEP Meeting, Tomi Routamo, Paris 15–18 May 2011
  - OECD/NEA-MDEP meeting, Keijo Valtonen, Paris 16–18 Apr 2011
  - MDEP/DI & C Working Group Meeting, Mika Johansson, Paris 7–9 Feb 2011, 27–28 June 2011
  - MDEP/CSWG Codes and Standards Working Group, Yrjö Hytönen, Paris 4–7 Dec 2011
  - MDEP CSWG meeting, Rauli Keskinen, Paris 18–20 Apr 2011
  - Observation of NRC Inspection at Westinghouse Sweden, Riku Mattila, Västerås 10 Sep 2011
  - MDEP/VICWG NRC audit (Westinghouse), Jenny Laine, Västerås 13–16 Sep 2011
  - MDEP/VICWG meeting, Jouko Mononen, Paris 10–13 May 2011
  - MDEP/VICWG kokous, Martti Vilpas, Paris 6–9 Dec 2011
  - Task force on safety critical software meeting, Mika Johansson, Liverpool 4–7 Apr 2011

VVER-Forum

- VVER-forum PSA WG, Reino Virolainen, Janne Laitonen, Sofia 27 June –1 July 2011
- VVER forum PSA working group meeting, Janne Laitonen, Reino Virolainen, Bratislava 1–4 Feb 2011
- VVER working group meeting, Ann-Mari Sunabacka-Starck, Milka Holopainen, Köln 21–24 Feb 2011
- VVER-forum, Jouko Mononen, Bratislava 6–8 July 2011

Participation in international meetings in the capacity of a lecturer, panel member or session chairpersons

- SMIRT 21 pre-conference – Fire Safety, Pekka Välikangas München 12–16 Sep 2011
- EUROSAFE 2011 seminar, Marja-Leena Järvinen, Ulla Vuorio, Tommi Renvall, Paris 6–9 Nov 2011
- Participation in symposium Current and Future Challenges, Marja-Leena Järvinen, Brygg 18–21 Jan 2011
- PSAM11&ESREL2012 presentation of the progress meeting of ESREL2011, Reino Virolainen, Troyes 18–23 Sep 2011
- VATESI 20 years: NP Regulation conference, Paula Karhu, Vilna 9–11 Nov 2011
- Conference of the Nordic Society for Rdiation Protection, Veli Riihiluoma, Reykjavik 21–25 Aug 2011
- AtomEco-2011 Forum, Risto Paltemaa 31 Oct – 2 Nov 2011
- Institute of Nuclear Materials Management (INMM) annual meeting, Elina Martikka, Tapani Honkamaa, Antero Kuusi 16–23 July 2011
- ESARDA-INMM (Institute of Nuclear Materials Management) Workshop, Elina Martikka 17–21 Oct 2011
- International Conference on the Safe and Secure Transport of Radioactive Materials: The Next Fifty Years – Creating a Safe, Secure and Sustainable Framework, Anna Lahkola 17–21 Oct 2011

Standardisation working groups

- Kick-off meeting of the CEN-CENELEC Focus Group on Nuclear, Marja-Leena Järvinen, Brussels 15–17 Nov 2011
- Fifth Meeting of CLC/TC45AX, Marja-Leena Järvinen, Brussels 6–8 Dec 2011
- ISO/IEC JTC1 SC7 meeting, Mika Johansson, Paris 25–24 May 2011

Participation in foreign committees

- Advisory committee on nuclear safety to support the Swedish nuclear authority (SSM, Strålsäkerhetsmyndigheten), Lasse Reiman, Stockholm 9 Mar 2011, 15 June 2011, 14 Dec 2011, 24 Nov 2011
- SSM, Swedish Radiation Safety Authority, Avfallsnämnden, Risto Paltemaa 23 Aug 2011

Bilateral cooperation between authorities

- Meeting with SSM MTO, Milka Holopainen, Hanna Kuivalainen, Ann-Mari Sunabacka-Starck, Stockholm 27–28 Jan 2011
- Beredskapsövning, SAMÖ (Hubbard/Eksborg), Olli Vilkamo, Oskarshamn 2 Feb 2011
- SSM Cooperation meeting on nuclear safety research issues, Marja-Leena Järvinen, Stockholm, 31 Aug – 1 Sep 2011
- Authority meeting with SSM Nuclear Safety Department, Petteri Tiippana, Marja-Leena Järvinen, Kaisa Koskinen, Kirsi Alm-Lytz, Keijo Valtonen, Stockholm 12–13 Dec 2011
- SSM-YTO/KÄY meeting, Hanna Kuivalainen, Stockholm 16–17 Nov 2011

Others

- NERS, Network of Regulators of Countries with small Nuclear Programmes, Petteri Tiippana, Capetown 12–17 Feb 2011
- Meeting with NRC and participation in RIC (Regulatory Information Conference), Petteri Tiippana, Bethesda, Maryland 6–11 Mar 2011
- Participation in ICG-EAC:n annual meeting, Yrjö Hytönen, Dresden 8–15 May 2011
- FAK (German expert Group) + TUEF PSA Symposium, Reino Virolainen, Mannheim-Heidelberg 24–27 May 2011
- Security workshop, Timo Wiander, London 5–8 Sep 2011
- Workshop on PSA for New and Advanced Reactors, Janne Laitonen, Paris 19–22 June 2011
- Participation in Nordic PSA conference, Ulla Vuorio, Johannesbergs Slott, Gottröra 4–6 Sep 2011
- SMiRT 21 Pre-conference seminar – fire safety, Matti Lehto, München 12–16 Sep 2011
- Serpent conference, Jukka Mettälä, Dresden-Rossendorf 14–17 Sep 2011
- PLIM & PLEX 2011, conference participation, Charlotte, Petri Vuorio, Charlotte 28 Sep – 2 Oct 2011
- Nureth-14 conference, Eero Virtanen, Toronto 25 Sep – 1 Oct 2011
- Seismic Engineering Knowledge Transfer Seminar, Yrjö Hytönen, Rez 20–25 Nov 2011
- 14th Technical Meeting on Risk-based Precursor Analysis, Janne Laitonen, Brussels 20–23 Nov 2011
- Northnet RM3 meeting, Eero Virtanen, Västerås 2 Dec 2011
- Interpol Global RN Terrorism Prevention Conference, Paula Karhu, Lyon 17–19 May 2011
- Excursion to Canada to become acquainted with the regulatory control of uranium mining and milling activities, Arja Tanninen, Tuulikki Sillanpää 11–17 Sep 2011
- Visit in uranium mine and milling facilities in Czech Republic, Antero Kuusi 21–24 June 2011
- Visit in Grimsel hard rock laboratory, Kai Jakobsson 19 July 2011
- Uranium mining and hydrogeology -konferenssi (Freiberg), Ari Luukkonen 19–22 Sep 2011
- SSM/STUK/ASN-IRSN meeting, Ari Luukkonen, Rainer Laaksonen 15–17 Nov 2011
- European Nuclear Society (ENS), Nuclear Engineering Science and Technology, Nestet 2011, Tapani Honkamaa 15–18 May 2011
- Implementation of the Integrated Safeguards in Ukraine, exchange on the national experiences/practices between Ukraine, Finland and Sweden, Elina Martikka, Marko Hämäläinen 8–9 Nov 2011
- Global Initiative to Combat Nuclear Terrorism (GICNT), Implementation and Assessment, Detection subgroup, Tapani Honkamaa, 27 Feb – 4 Mar 2011

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 2012. The last old style YVL Guides with number-only id's were issued in 2008.