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Regulatory oversight of nuclear safety in Finland

Annual report 2009

Erja Kainulainen (ed.)

Säteilyturvakeskus
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Radiation and Nuclear Safety Authority
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Management review

In 2009, Finnish nuclear power plants caused no danger to the plant environment or employees. Radioactive emissions into the environment were very low. The collective doses of employees at both plants continue to show a decreasing trend. The primary reason for the low dose in the year under review lies in the short durations of annual maintenance and the smaller than usual amount of work performed during maintenances.

In the year under review, the plants operated in compliance with the safety requirements imposed on them. The factors behind the events in the operating year relate mainly to unintentional human error and aging or wear and tear on equipment parts. Functional tests performed on a regular basis revealed that the outer containment isolation valves of the steam lines did not operate in a normal way, which is a noteworthy issue for the safety of the Olkiluoto nuclear power plant. There are two successive valves of different types on each steam line and no failure was detected in the inner containment isolation valves. It was found out that the reason for the valve failure was damage to the small gears on the actuators. At worst, the damage could have prevented a valve from closing in an emergency condition requiring the isolation of the containment building. The gears were replaced. At the Loviisa power plant, STUK called attention to continuing operations and ensuring the safety of the plant in a situation when an oil leak in a reactor coolant pump requiring repair had been detected. Ensuring safety and maintaining plants require that the organisation operating the plant is constantly alert and maintains its competence.

At Loviisa and Olkiluoto, modifications required for safety improvement continued to be carried out in plant systems, equipment and structures and in operating models. At the Loviisa power plant, plates preventing vortices were installed in the intake pipes of the emergency makeup water tanks with a view to obstructing air suction into the reactor emergency injection system. The presence of air in the pumps would jeopardise their functioning and reactor cooling in accident conditions. The first phase of the Loviisa I&C systems upgrade (LARA) was implemented during annual maintenance at Loviisa 2. During the first phase, part of the I&C system controlling and limiting reactor power and its control room user interface were upgraded. The modifications turned out well. The most demanding phases of the upgrade have proven to be more challenging than expected both in terms of design and safety regulation, and it is not possible to implement the modifications in the originally planned sequence. The power company decided to postpone modifications to be made in the most safety-important systems to future years.

TVO carried out the periodic safety review required by STUK at the Olkiluoto power plant in 2008, when ten years had passed from the renewal of the operating licence and the previous extensive review carried out in conjunction with it. STUK inspected the periodic safety review during the year under review. The conclusion was that the safety of the nuclear power plant units is sufficient and that the practices employed by TVO are adequate to enable continuous operational safety. In STUK's opinion, however, it is still possible to improve plant safety. The most important thing is to find out whether it is possible to ascertain safety measures by means of different systems supplementing the current systems. Operators' ability to control exceptional situations can be improved through the elaboration of emergency procedures.

The organisations at both power companies underwent restructuring. The responsible director at the Loviisa power plant changed as a result of the changes in Fortum's organisation. The impact of the changes on the safety of the Loviisa power plant was assessed by Fortum, and the findings of the assessment were submitted to STUK for their information. In STUK's opinion, both power companies still have to invest in their personnel's competence and in securing sufficient resources in particular for modifications carried out at the plants.

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.

Construction of the new nuclear power plant unit at Olkiluoto has proceeded without major quality deviations. However, STUK has not been able to approve the plant design as it is. The most important unsettled issues relate to I&C design, for which the plant supplier and TVO have not been able to demonstrate how the independence of different I&C systems has been ensured. Guidance and supervision of subcontractors at the construction site and manufacturing sites require continuous improvement by the plant supplier and TVO. STUK observed deficiencies in the supervision of work and application of instructions at the site in October when the welding of pipes started. In France, the plant supplier and the power company observed that a subcontractor had carried out minor repair welding on the reactor coolant pipes without making records of it as necessitated by the requirements. In both cases work was interrupted to carry out clarifications and take corrective actions. It is a challenging and continuous task for the organisations involved in the project to create and maintain the safety culture which is necessary for ensuring the top priority of safety and quality. The plant supplier launched an on-site safety culture campaign which aims to ensure that the workers understand the safety significance of their work. TVO created a procedure for evaluating safety culture on site. In the year under review, STUK paid particular attention to TVO's installation supervision procedures. Design, construction, manufacturing and installation supervision procedures were further elaborated during the year under review. Inspection activities at Olkiluoto increased. STUK added its own and outside resources in order to fulfil the regulation obligations within a reasonable time.

Three new separate projects aimed at the construction of a nuclear power plant in Finland proceeded towards a political decision-in-principle on whether the projects are in line with the overall good of society. In the year under review, STUK issued a statement of these projects to the Ministry of Employment and the Economy. STUK assessed the safety of the proposed plant alternatives, the ability of the applicant's organisation to implement the project and the suitability of the proposed plant locations with regard to nuclear power plant operation. Based on a preliminary safety assessment, STUK stated that, in terms of safety, there are no obstacles to making a positive decision-in-principle on any of the applications.

STUK's work input in the regulatory oversight of each of the operating nuclear power plants was equivalent to over 11 person-years. The work input has been approximately the same for the past five years, or during the period that most of the regulatory resources have been occupied with the Olkiluoto 3 plant unit currently under construction. Before the construction project started, the amount of human resources used for the regulatory oversight of operating plants increased to some extent each year, and the reduction compared with the situation in previous years has been 2-3 person-years for each of the power plants. The objectives set for regulation were, however, attained. Altogether, 34 person-years were used for overseeing the design, component manufacturing and construction of the Olkiluoto 3 unit, which is about 5 person-years more than in previous years. The amount of work will remain at least the same in 2010 and 2011, which will see a lot of component manufacturing and installation operations. STUK used about three person-years on overseeing the new projects. The current financing practice for regulatory operations, i.e. direct invoicing from the licensees according to STUK's actual costs, has proven to function very well, and thanks to this operations could be increased to meet the actual needs.

As part of the preparation for the nuclear power plant projects mentioned above, STUK continued the revision of its YVL Guides. In the new guides STUK will present detailed requirements for safety and safety regulation. The requirements will be updated so that the essential requirements needed for any invitations to tender will be known by summer 2010. Meticulous work planning and guide work prioritisation have served as preparation for the revision of the guides in early 2010.

Posiva Oy continued the construction of the research facility needed for the development of the final disposal of spent nuclear fuel by excavating the tunnel leading into the facility, as well as the shafts. Excavation proceeded close to its final target in 2009. STUK oversaw the work, preparing for the possibility that the tunnel and the shafts will, in due course, lead to the actual repository. Proving the safety of final disposal will primarily be based on the reliability of the barrier structures preventing the spread of radioactive substances. These structures will consist of a gas-tight copper canister and surrounding bentonite clay. As the focus of the final disposal project shifted towards technical design and construction, STUK hired a number of experts in various fields and intensified the operations of the team of international experts directly supporting the regulatory oversight. In addition, the international team consisting of European nuclear safety authorities evaluated the effectiveness and correctness of direction of STUK's nuclear waste management safety regulation. The team provided useful recommendations, based on which STUK is improving its operations.

A lot of experience was gained of nuclear safeguards according to the amended nuclear non-proliferation agreement and, in particular, of the division of tasks between the IAEA, the EU and national regulatory authorities. STUK made an active contribution towards finding an optimal division of task between the parties concerned and attempted to show the way to achieving well-functioning procedures ensuring an adequate level of confidence. A model of nuclear safeguards suitable for the final disposal of spent nuclear fuel was developed further, in tandem with the excavation of the tunnel leading to the final disposal facility.

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 2009 included the design, construction and operation of nuclear facilities, as well as nuclear waste management and nuclear materials. The control of nuclear facilities and nuclear waste management, as well as nuclear non-proliferation, concern two STUK departments: Nuclear Reactor Regulation and Nuclear Waste and Material Regulation.

The first parts of the report explain the basics of the nuclear safety regulation included as part of STUK's responsibilities, as well as the objectives of the operations, and briefly introduce the objects of regulation. The chapter concerning the development and implementation of legislation and regulations describes changes in nuclear legislation, as well as the progress of STUK's YVL Guide revision. The chapter also includes a summary of the application of the updated YVL Guides to nuclear facilities.

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 the employees' individual doses, the collective doses, and the results of emission and environmental radiation monitoring. For the Olkiluoto 3 plant unit currently under construction, the report includes descriptions of the regulation of design, construction, manufacturing, installation and commissioning preparations, as well as regulation of the operations of organisations participating in the construction project. At the end of the chapter on the regulation of nuclear facilities there is a summary of new plant projects and the regulation of the research reactor.

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

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

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

Appendix 1 presents a detailed study of the safety performance of the nuclear power plants by means of an indicator system, Appendix 2 includes a summary of employees' doses at the nuclear power plants, and Appendix 3 describes exceptional operational events at the nuclear power plants.

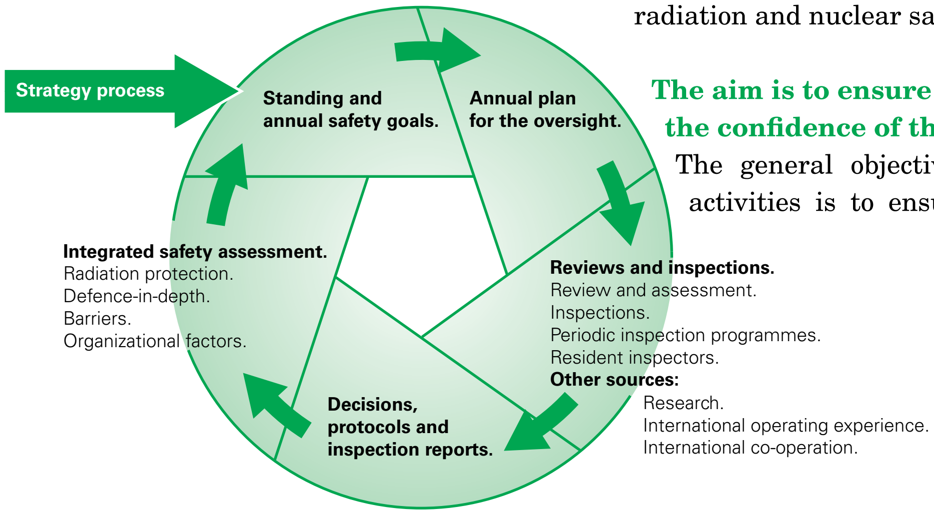
Sisällysluettelo

1 Fundamentals of nuclear safety regulation

Regulatory oversight by STUK is based on the Nuclear Energy Act.
The Radiation and Nuclear Safety Authority (STUK) is responsible for the regulatory oversight of nuclear safety in Finland. Its responsibilities include the control of physical protection and emergency response, as well as the safeguards of 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, oversees 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 oversees compliance with these requirements. In addition, STUK submits proposals for legislative amendments and issues general guidelines concerning radiation and nuclear safety.

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



STUK functions for the oversight of nuclear power plants

Oversight of New Plant Projects and Plant Modifications
- Changes at the nuclear facility

Safety Assessments and Analysis
- Deterministic safety analysis
- Probabilistic risk analysis (PRA)
- Safety performance indicators; analysis and feedback

Oversight of Operations
- Compliance with Technical Specifications
- Incidents
- Oversight of outage management
- Maintenance and ageing management
- Fire protection
- Radiation protection
- Emergency preparedness
- Physical protection

Oversight of Management in Regulated Organizations
- Safety management
- Management systems and QM
- Training and qualification of staff
- Use of operational experiences
- Event investigation
- Nuclear liability
- Inspection and testing organisations
- Manufacturers of nuclear pressure equipment

Oversight of Nuclear Waste Management and Nuclear Materials
- Safeguards of nuclear materials
- Nuclear waste management
- Transport of nuclear material and nuclear waste
- Licences for the nuclear materials and nuclear waste

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

Defence in depth

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

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

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

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

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

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

STUK ensures the adequacy of safety regulations and compliance with the 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 Commission was appointed on 1 October 2006, and its term of office ended on 30 September 2009. The new Commission was appointed on 1 October 2009, and its term of office will continue until 30 September 2012.

The Chairman of the new Commission is Customer Manager Seppo Vuori (VTT, Technical Research Centre of Finland) and the Vice-Chairman is Professor Riitta Kyrki-Rajamäki (Lappeenranta University of Technology). The members are Customer Director Rauno Rintamaa (VTT), Managing Director Timo Okkonen (Inspecta Tarkastus Oy), Senior Researcher Ilona Lindholm (VTT), Senior Inspector Miliza Malmelin (Ministry of the Environment) and Dr. Sc. (Tech.) Antero Tamminen. Professor Jukka Laaksonen, Director General of STUK, is a permanent expert to the Commission. Former members Director Ulla Koivusaari (Pirkanmaa Regional Environment Centre), Branch Manager Runar Blomkvist (the Geological Survey of Finland) and Dr. Sc. (Tech.) Antti Vuorinen left the Commission.

The three Committees established by the Commission early in the year for preparatory work were the Reactor Safety Committee, Nuclear Waste Committee and Emergency Preparedness and Nuclear Material Committee. The role of committees was reconsidered in conjunction with appointing the new Commission, and the decision was taken to revise their duties. From now on, the Commission will have two Committees, the Reactor Safety Committee and the Nuclear Waste Safety Committee. Foreign and Finnish experts will be invited to join the Committees. English will be the working language in the Committees, and questions of principle, more extensive than before, will be brought to them for preparation. At the end of the year, the Committees were yet to convene, but the work of finding the experts to be invited to join them had already begun. It is to be expected that the Committees will convene a few times a year. The members of the actual Commission also participate in the work of the Committees.

Nuclear liability

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

In case of an accident, the funds available for compensation come from three sources: the licensee, the country of location of the facility and the international liability community. In 2009, a total of 300,000,000 SDR was available for compensation from these sources. SDR refers to Special Drawing Right, an international reserve asset defined by the International Monetary Fund (IMF), whose value is based on a basket of key international currencies. In 2009, the average value of the SDR was 1.10 euro. As a result of international negotiations completed in 2004 concerning the renewal of the Paris/Brussels nuclear liability agreements, funds available for compensation will be more than tripled compared with the current situation in the near future. Finland has also decided to enact a law laying down unlimited licensee liability. The legislative amendment has not taken effect as yet, but is pending the entry into force of the relevant international agreements.

The ascertaining of the contents and conditions of a licensee's insurance arrangements in Finland belongs to the Insurance Supervisory Authority. It has approved both Fortum Power and Heat Oy's and Teollisuuden Voima Oy's liability insurance, and STUK has verified the existence of the policies as required by the Nuclear Energy Act.

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

Regulation by STUK ensures the attainment of safety objectives.

STUK ensures, by means of inspections and oversight, that the operational preconditions and operation of the licensee and its subcontractors and the systems, structures and components of nuclear facilities are in compliance with the 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 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 operation 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 encloses its safety assessment.

STUK regulates nuclear facility design and construction stages

The principles and detailed approach of STUK's oversight and inspection activities are described in the YVL Guides issued by STUK. Guide YVL 1.1 describes the oversight and inspection procedures at a general level, while the detailed procedures are described in other YVL Guides. The purpose of oversight and inspection activities regarding plant projects is to allow STUK to verify that the prerequisites for performance of a high standard exist, that the plans are acceptable before the implementation begins and that the implementation is compliant with regulations before the operating licence is granted.

Pursuant to the Nuclear Energy Act, the licensee must ensure safety. Through its oversight, STUK ensures that the licensee fulfills its responsibilities. STUK oversees and inspects the implementation of the plant and the organisations participating in its implementation and operation. STUK does not oversee and inspect every detail; instead, the oversight and inspections are focused on the basis of the safety significance 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 oversees the design and manufacture of equipment and structures that are most critical from the safety point of view. Inspection organisations approved by STUK have been trusted with the inspection of equipment and structures with lower safety significance. STUK oversees the operations of these inspection organisations.

In plant projects, STUK ensures proactively with its oversight and inspections proactively 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 and quality assurance of implementation are evaluated in order to make sure that the plant can be implemented in compliance with high quality standards and Finnish safety requirements. During construction, inspections and oversight are deployed in order to ensure that the plant is implemented in compliance with the principles approved at the construction licence stage. The review and inspections are based on detailed documentation delivered to STUK and on site inspections at the suppliers' premises. Before the manufacture of equipment and structures may commence, STUK reviews both the respective detailed plans and the capabilities of the manufacturing organisations to produce high-quality results. During manufacture and construction, 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 commissioning of the equipment. After that, STUK inspects the results of the commissioning before the actual turnover to operations.

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 and procedures required for operating the plant, security and emergency preparedness arrangements, maintenance programme and staff as well as radiation protection staff. Having verified that the implementation is safe and the organisation has the required capabilities, STUK prepares a safety assessment and statement 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 for renewing 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 operation 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 refer to the 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 the extensive or safety-significant plant modifications and oversees the modification work by reviewing the documents submitted by the licensee and carrying out inspections on site or at manufacturers' premises.

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

Operability of the plant is overseen during operation and annual maintenance

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

Technical specifications

The Technical Specifications 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 Technical Specifications up-to-date and ensuring compliance with them. STUK oversees compliance with the plants' Technical Specifications by witnessing operations on site. Special attention is paid to the testing and fault repairs of components subject to the Technical Specifications.

When annual maintenance outages end, STUK ascertains the plant unit's state in compliance with the Technical Specifications prior to start-up. Any changes to and planned deviations from the Technical Specifications 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 Technical Specifications. In the report, the power company presents its corrective action for approval by STUK. STUK oversees the implementation of corrective actions.

Oversight of operation, operational events 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 resident inspectors working on plant sites oversee the operation on a daily basis. The resident inspectors evaluate faults and oversee their repairs, as well as tests of safety-critical equipment. The inspections on operations contained in the periodic inspection programme focus on major faults, incidents and progress of corrective actions, as well as on operating procedures. The inspections are based on the regular reports submitted by power companies and walkdown inspections conducted on site.

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.*

The power companies are obliged to report any operational transients and any matters that may compromise safety. STUK assesses the safety significance of the incidents and the power company's ability to detect safety deficiencies, take action and rectify them.

The licensees submit event reports to STUK on operational events at nuclear facilities, comprising so called 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 safeguards 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.

Annual maintenance

The 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 fault repairs. These actions ensure the preconditions for operating the power plant safely during the following operating cycles.

STUK is responsible for overseeing 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 oversees the plants' ageing management strategy and its implementation ensuring the maintenance of sufficient safety margins for safety-significant systems, components and structures throughout their lifetime. The organisation of the licensee, the prerequisites for the organisation to carry out the necessary actions, and the condition of components and structures important to safety are subject to inspections and reviews. Regulatory oversight and inspections ensure that the power companies have the ageing 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 executed at any time.

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

Every year, the power companies provide STUK with reports on the ageing of electric 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 licencee 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 oversees 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 oversees the preparedness of the organisations operating nuclear power plants to act in abnormal situations. The inspection focuses on the training of emergency response organisation, premises of the emergency response organisation, securing of the connections used for the plant data transfer of meteorological measurements and radiation monitoring of the surrounding environment during an emergency situation, as well as the development of internal alerting 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 emergency response organisation's premises in practice, which are developed on the basis of the feedback received from the exercises. STUK oversees the actions of power companies during these emergency drills.

Oversight the operation of organisations is part 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 oversees 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 responsible manager 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, security, emergency preparedness and nuclear materials. 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 organisation, number of personnel or their competence, STUK will require the power company to take corrective action as required.

Operational experience feedback

According to Government Decree (VNA 733/2008), the advancement of science and technology and operating experiences must be taken into account for the further enhancement of the safety of nuclear power plants. This principle is not limited to operational experiences 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 oversees 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 oversees the operational experience feedback activities by reviewing the event reports submitted by the licensee and the annual summary of operational experience activities. During inspections included in the periodic inspection programme, the operational experience feedback activities of the plant and utilisation of international experience are reviewed.

Event investigations

An event investigation team is appointed when the licensee's own organisation has not operated as planned during an event or when the event is estimated to 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 are overseen 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. The pressure equipment of 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. Licensees are responsible for managing the nuclear materials in their possession, accounting for them and reporting on plant sites and their activities relating to the nuclear fuel cycle to STUK and the

European Commission. Some of the data is forwarded to the International Atomic Energy Agency (IAEA). STUK maintains a national control system as referred to in Section 118 of the Nuclear Energy Decree. Its purpose is to carry out the safeguards for the use of nuclear energy that are necessary for the non-proliferation of nuclear weapons. STUK verifies the correctness of the licensees' operation reports, accounting and reporting through on-site inspections. STUK also participates in all inspections carried out by the IAEA and the European Commission and, at the same time, carries out its own independent inspection.

Another objective of the oversight of non-proliferation is to ensure that appropriate security arrangements are in place for nuclear materials. In this context, the expression 'security arrangements' refers to the control, prevention and detection of illegal activities related to nuclear and other radioactive materials and responses to such activities, as defined by the IAEA under the heading 'Nuclear Security'.

The National Data Centre based on the Comprehensive Nuclear-Test-Ban Treaty analyses the gamma ray spectrums sent by measuring stations located around the world. The Centre also participates in the work of the Preparatory Commission for the Comprehensive Nuclear-Test-Ban Treaty Organisation (CTBTO) in Vienna to establish a cost-effective 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 oversight 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 oversight 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 May1977	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)	Tyyppi, toimittaja
Olkiluoto 1	2 Sep 1978	10 Oct 979	890/860	BWR, Asea Atom
Olkiluoto 2	18 Feb 1980	1 Jul 1982	890/860	BWR, Asea Atom
Olkiluoto 3	Construction license granted 17 Feb 2005		about 1,600 (net)	PWR, Areva NP

Teollisuuden Voima Oy 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.

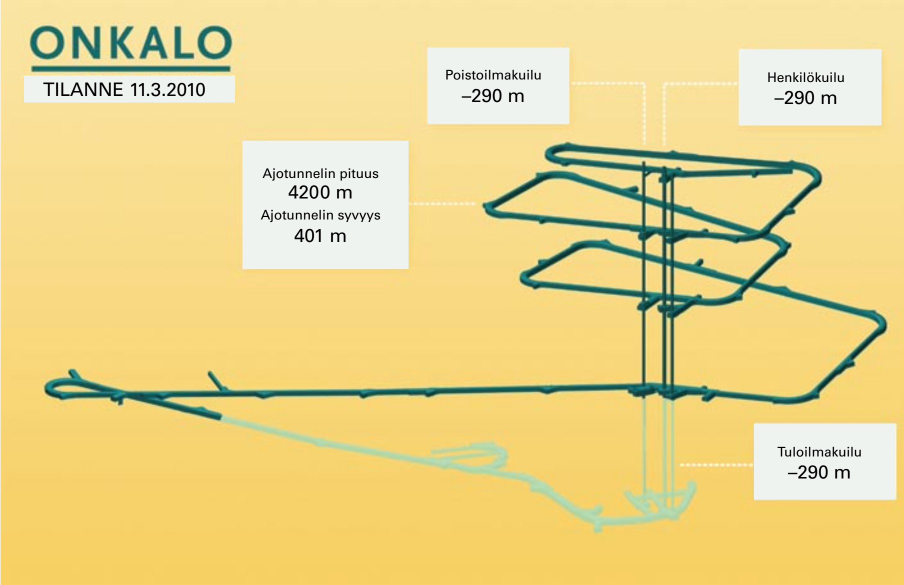
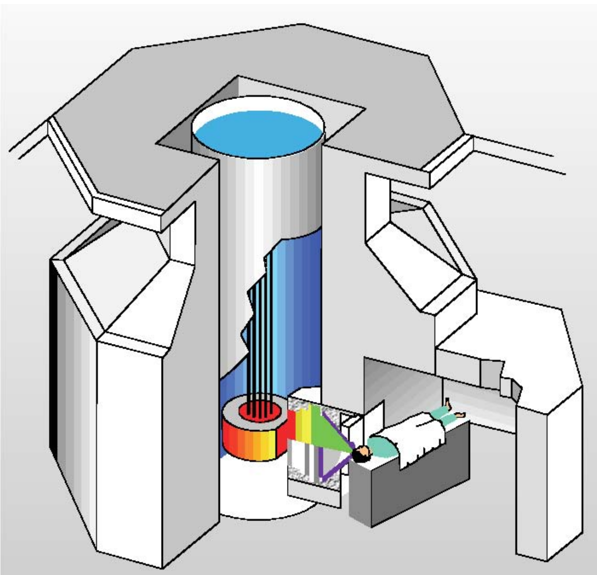


Figure 2. Plan of the underground rock characterisation facility (Onkalo) and status of the construction on 11 March 2010 (Posiva Oy).

The underground research facility consists of a drive tunnel, three shafts and a research gallery quarried to a depth of 437 m. Posiva started constructing Onkalo in 2004. By the end of 2009, the excavation of the drive tunnel had reached a depth of 400 m, and the length of the tunnel was 4000 m. In addition, all three shafts had been quarried using raise boring techniques to a depth of 290 m.

FiR 1 research reactor

In addition to nuclear power plants, STUK regulates the FiR 1 research reactor operated by VTT Technical Research Centre of Finland. The reactor is located in Otaniemi, Espoo, and its maximum thermal power is 250 kW. It began operations in March 1962, and its current operating licence will expire at the end of 2011. The reactor is used for the fabrication of radioactive tracers, activation analysis, student training and Boron Neutron Capture Therapy (BNCT) treatment of tumours, as well as the development of therapeutic methods.



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

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

3 Development and implementation of legislation and regulations

Upper level regulations are up-to-date

In the year under review, there were nuclear safety legislation revision projects falling within STUK's mandate. The revision of the Nuclear Energy Act and Nuclear Energy Decree and its supplementary Government Decrees on the safety of nuclear power plants (733/2008), on safety arrangements in the use of nuclear energy (734/2008), on preparedness arrangements at nuclear power plants (735/2008) and on the safety of the final disposal of nuclear waste (736/2008) were completed in 2008. In consequence of the revisions, Finnish nuclear energy legislation is well up to date.

YVL Guide updates were implemented

The preparation of implementation decisions for YVL Guides which were published earlier continued in 2009. Guides issued in 2008 were taken into effect by preparing implementation decisions for them. YVL guides are detailed safety regulations for nuclear facilities, issued by STUK on the basis of the Nuclear Energy Act and the relevant Government Decision. In addition to requirements for the safety of nuclear facilities, the guides describe STUK's regulatory procedures as well. STUK issues a separate decision on how a new or revised YVL guide applies to operating nuclear facilities, or those under construction, and to licensee operations.

In the implementation decision for Guide YVL 1.15, STUK stated that the new guide must be applied as is to the operating activities of TVO's and Fortum's nuclear facilities and in Posiva's activities.

In the implementation decision for Guide YVL 5.3, STUK stated that the new guide requires an update of plant procedures concerning valve units at both TVO's and Fortum's nuclear facilities. With regard to both power companies, the decisions stated that it is not necessary to take into account the new requirements of the YVL Guide for valve condition monitoring in its entirety. As for Posiva, STUK did not consider it necessary to grant exceptions to the application of the new guide.

In the implementation decision for Guide YVL 5.7, STUK stated that the new guide requires the update of plant procedures concerning pump units at both TVO's and Fortum's nuclear facilities. With regard to both power companies, the decisions stated that it is not necessary to take into account the new requirements of the YVL Guide for pump unit condition monitoring in its entirety. As for Posiva, STUK did not consider it necessary to grant exceptions to the application of the new guide.

In the implementation decision for Guide YVL 3.7, STUK stated with regard to TVO's nuclear facilities that it is not necessary to comply with the new requirement for furnishing pressure equipment fittings with individual identification information retrospectively in case of equipment which is already installed. In other regards, the Guide was carried into effect as it was. With regard to Fortum's nuclear facilities, STUK stated in its decision that Fortum has already submitted to STUK the plant procedure updates required by the new Guide and that the Guide will be carried into effect as it is.

The implementation decisions for Guide YVL 5.8 were under preparation at the turn of the year 2009-2010 and being examined by Nuclear Reactor Regulation.

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

Table 1. Implementation decisions of YVL guides issued by STUK per nuclear facility in 2009.

Guide	Loviisa 1&2	Olkiluoto 1&2	Olkiluoto 3	Posiva	FiR 1 research reactor
YVL 1.15 Mechanical equipment and structures of nuclear facilities. Construction inspection, 28.4.2008	•	•	•	•	
YVL 5.3 Nuclear facility valve units, 28.4.2008	•	•	•	•	
YVL 5.7 Nuclear facility pump units, 28.4.2008	•	•	•	•	
YVL 3.7 Pressure equipment of nuclear facilities. Commissioning inspection, 26.9.2008	•	•	•		

The revision of YVL guides is progressing

The structural revision of the YVL guides was initiated in 2005 by assessing the existing guides and defining the development objectives. The overall objective is to improve the internal consistency of the regulations and, in particular, to clarify the requirements laid down in the guides. The requirements will be numbered to make it easier to find the individual requirements in the guides. This will also enable the guides to be amended with regard to individual requirements. The objective is to have the new set of YVL Guides completed by the end of 2011.

A working group was appointed to support STUK's experts in the preparation work for each new guide. In addition to STUK, the following organisations are represented in the working group: Teollisuuden Voima Oyj, Fortum Power and Heat Oy, Fennovoima Oy and Posiva Oy. The working groups will discuss the main content of the guides during their preparation, thus improving the openness of regulatory work and reducing the overall period of time spent in their preparation. A follow-up group set up for the entire project, composed of representatives of the above organisations, convened twice in 2009.

In 2009, the preparation of the guides of the new type continued. The plan is to prepare a total of 37 of these new guides, half the number of current YVL Guides.

A Safety management of a nuclear facility	**B** Plant and system design	**C** Radiation safety of a nuclear facility and environment	**D** Nuclear materials and waste	**E** Structures and equipment of a nuclear facility
A.1 Regulatory control of the safe use of nuclear energy	B.1 Design of the safety systems of a nuclear facility	C.1 Structural radiation safety of a nuclear facility	D.1 Regulatory control of nuclear non-proliferation	E.1 Manufacture and use of nuclear fuel
A.2 Siting of a nuclear facility	B.2 Classification of systems, structures and equipment of a nuclear facility	C.2 Radiation protection and dose control of the personnel of a nuclear facility	D.2 Transport of nuclear materials and waste	E.2 Construction plan of the mechanical components and structures of a nuclear facility
A.3 Management systems of a nuclear facility	B.3 Safety assessment a NPP	C.3 Control and measuring of radioactive releases to the environmental of a nuclear facility	D.3 Handling of spent nuclear fuel	E.3 Regulatory control of the mechanical components and structures of a nuclear facility
A.4 Organisation and personnel of a nuclear facility	B.4 Nuclear fuel and reactor	C.4 Radiological control of the environment of a nuclear facility	D.4 Handling of low- and intermediate-level waste and decommissioning of a nuclear facility	E.4 Verification of strength of pressure equipment of a nuclear facility
A.5 Construction of a NPP	B.5 Reactor coolant circuit of a NPP	C.5 Emergency preparedness arrangements of a NPP	D.5 Final disposal of nuclear waste	E.5 In-service inspections of the mechanical components and structures of a nuclear facility
A.6 Operation and accident management of a NPP	B.6 Containment of a NPP			E.6 Buildings and structures of a nuclear facility
A.7 Risk management of a NPP	B.7 Preparing for the internal and external threats to a nuclear facility			E.7 Electrical and I&C equipment of a nuclear facility
A.8 Ageing management of a nuclear facility	B.8 Fire protection 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				
Collected definitions of YVL-guides: a part of the regulations, but a separate document.				

Figure 4. Structure of the new YVL guides.

4 Regulatory oversight of nuclear facilities and results in 2009

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 lincensee, carrying out inspections in line with the periodic inspection programme and by overseeing operations at the plant. On the basis of this regulatory oversight, STUK can state that plant operation did not cause a radiation hazard to the workers, population or environment. Occupational radiation doses and radioactive releases into the environment were low and clearly below the prescribed limits. The licensee has operated the Loviisa power plant in a safe manner and in compliance with YVL Guides. Emergency preparedness at the Loviisa power plant complies with the requirements.

According to the tests and inspections carried out, the condition of the containment and the primary circuit which prevent the release of radioactive material into the environment are in compliance with requirements. Minor fuel leakage was detected at both units in 2009. The volume and trend of the leakages at the plant are monitored on a regular basis. 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. The leakage at Loviisa 2 was located during annual maintenance in 2009, and the fuel element with the leaking rod was removed from the reactor. The leakage at Loviisa 1 was detected after annual maintenance in October 2009. The fuel element will be removed from the reactor during annual maintenance in 2010.

Plant operation has been systematic and safe. Six exceptional events with safety implications were reported. Five of these involved deviation from the Technical Specifications. There were more events than in the previous years, but they did not have any substantial impact on the radiation safety of the plant or its environment. The events related to unintentional human errors. None of the events led to a reactor trip. One event was classified as an operational transient. System and equipment failures had a minor safety implication for the plant. Risks caused by plant operation, however, have slightly increased compared with previous years which, among other things, is due to the large number of air conditioning system failures. Annual maintenance was implemented as planned in terms of nuclear and radiation safety.

During the year, several modifications were implemented which improve plant safety. Plates preventing vortices were installed in the intake pipes of the plant unit emergency makeup water tanks with a view to obstructing air suction into the reactor emergency injection system pumps when the tank water level drops (before the tank is drained intake would be shifted to the floor drains of the reactor building). The first phase of the I&C upgrade (LARA) was implemented during the annual maintenance outage at Loviisa 2, when part of the I&C system controlling and limiting reactor power and its control room user interface were reequipped. The modifications turned out well. The stage designation of the I&C upgrade was changed in 2009 from the original four stages to three stages combining stages two and three, which will be implemented at Loviisa 1 in 2010–2012. The modified stage designation will set challenges to the planning of work to be performed at the following stage and to that of annual maintenance, as well as to inspection and regulatory activities by STUK.

The Safety and Technology units at the Loviisa power plant were restructured in 2009. The licensee conducted an assessment of the restructuring which was submitted to STUK. As a result of the assessment and its examination, it was stated

Table 2. Events at the Loviisa plant units subject to special reports by the power company. The table shows events due to which the plant unit was in non-compliance with the Technical Specifications. All events subject to reporting are discussed in Appendix 1 (indicator A.II.1). Appendix 3 describes events subject to special reports in more detail.

Event	Non-compliances with the Technical Specifications	Special report	INES rating
Inoperability of the external containment spray system at Loviisa 1	•	•	0
Loss of magnetic loads of the pilot valves of pressurizer safety valves at Loviisa 2	•	•	0
Erroneous loss of power supply to the control valve of the standby emergency feedwater line at Loviisa 2	•	•	0
Failure to complete the preventive maintenance operations to the flow rate meters of emergency feedwater lines at Loviisa 1 and Loviisa 2	•	•	0
Irregularities regarding the fuel levels in diesel generator fuel tanks	•	•	0
Fire of the power supply unit of emergency feedwater pump at Loviisa 2		•	0

that the changes do not deteriorate the operating capability of the plant organisation. Furthermore, significant organisational restructuring measures and personnel changes took place in Fortum Power & Heat Oy's nuclear energy functions in the autumn of 2009. They aimed to improve the organisation's efficiency and clarify profit responsibility, as well as simplifying the organisational structure. These changes did not have any direct effect on the organisational structure of the Loviisa power plant but they did clarify, among other things, the plant's procurement activities and the use of resources by Technical Support (formerly Fortum Nuclear Services). The most important personnel change was the transfer of the responsible director of the Loviisa power plant to another position in the Fortum Group and the appointment of a new responsible director from among the personnel of the power plant's safety unit.

Based on its oversight, STUK determined that the procurement activities and the regulatory procedures concerning the suppliers for the Loviisa power plant need to be further elaborated. STUK also required that the power plant prepare a plan for improving the follow-up of the closing of open issues and for the development of project planning and resource management. The Loviisa power plant has launched a development project aimed at improving project activity planning and the coordination of human resources. STUK expects the Loviisa power plant to pay attention to sufficient induction training provision for personnel and to the realisation of basic training programmes. STUK will follow the progress of the above-mentioned issues in 2010.

STUK reviewed the decommissioning plan for the Loviisa power plant based on the assumption that both Loviisa power plant units will be closed after 50 years of operation in 2027 and 2030. Decommissioning will start immediately after the closing and it will last until 2035. In its statement submitted to the Ministry of Employment and the Economy, STUK concluded that the decommissioning of the power plant and provisions for it can be implemented on the basis of the plan.

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

Compliance with the Technical Specifications

The Technical Specifications of the Loviisa power plant are up-to-date and clear. Fortum submitted to STUK for approval nine amendment proposals for the Technical Specifications. The amendments result from modifications carried out at the plant such as the I&C upgrade (LARA), modifications

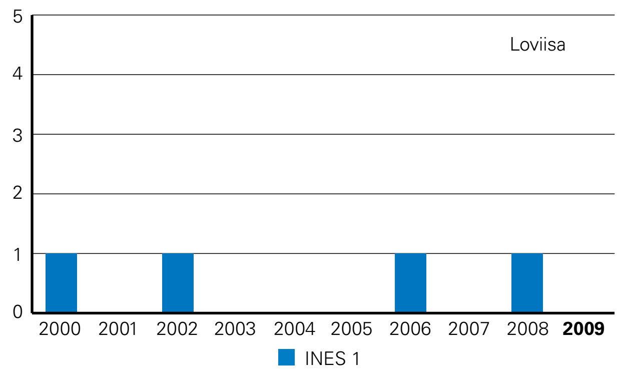


Figure 5. INES classified events at the Loviisa plant (INES Level 1 or higher).

relating to securing the final heat sink (ESCO) and new boron content measurements, opting for a new type of fuel and modifications relating to the water chemistry of the reactor coolant system. New requirements were set for power supply during the annual maintenance outage and for reactor power measurement. STUK has approved eight amendments. One amendment is currently being assessed.

The power company applied for permission from STUK for seven planned deviations from the Technical Specifications. Two of these related to fault repairs, two to the change of mode of plant operation during fault repair in annual maintenance, and three to the I&C upgrade. STUK approved six applications because the deviations had no significant safety implications for the safety of the plant or the environment. One of the applications was not approved by STUK because the deviation application concerned I&C upgrade-related work which STUK had not approved yet.

In 2009, five events in addition to the approved deviations took place at the plant during which the plant was not in a state compliant with the Technical Specifications. The events had no significant safety implications for the nuclear or radiation safety of the power plant.

Events non-compliant with the Technical Specifications

At Loviisa 2, *the power supply to the magnetic loads of the pilot valves of both safety valves of the pressurizer blowdown line was lost in conjunction with a repair operation. The pressurizer safety valves prevent the pressure in the primary circuit from rising in a transient situation. If overpressure occurs, the spring-loaded safety valves open. The purpose of the magnetic loads was to ensure the leak-tightness of the pilot valves and to ensure the operation of the pilot valve at the correct pressure. When the magnetic loads were lost, the pilot valves began to leak. In order to prevent the unnecessary opening of the safety valve, the decision was taken at the plant to switch the magnetic loads to manual control. This will not make the safety valves inoperable but it increases the pressure at which they open. It would have been possible to cancel manual control if required. Manual control was switched on for 16 minutes until the power supply of the solenoids was restored at the plant.*

At Loviisa 1, *both trains of the external containment spray system were temporarily out of order due to an error in the management of maintenance operations. The cooling fan of the electrical switchgear feeding the other train of the external containment spraying system was isolated for periodic inspection, even though an inspection of the spraying pump motor of the other train was in progress at the time.*

At Loviisa 2, *the fuel level in the fuel tank of the diesel generator was found to be low when the diesel generator was being tested. The fuel level had already sunk below the minimum level in conjunction with the previous tests. This diesel generator backs up the power supply to the electrical system of the Serious Accidents Management (SAM) system. The fuel level was also checked in the respective tank at Loviisa 1, and was also found to be low. The event only has minor safety implications because it is unlikely that these diesel generators actually have to be operated for longer periods, and there will be time to fill up the fuel tanks.*

At Loviisa 2, *the control valve of the standby emergency feedwater line was inoperable for a time when electricity was incorrectly isolated during annual maintenance at Loviisa 1. The standby emergency feedwater system of Loviisa 1 was disabled for scheduled maintenance and modification work so that the electricity supply to the standby emergency feedwater line control valve of the steam generator of Loviisa 2 (that was in operation) was isolated instead of the motor-actuated isolation valve. The erroneous isolation was detected after completing the work, when the system operation was restored. The electricity supply isolated for the work was reconnected so that the operability of the valve at Loviisa 2 was restored.*

At Loviisa 1 and Loviisa 2, *all flow rate measurement systems of emergency feedwater pumps were not calibrated during annual maintenance. These calibrations are part of the preventive maintenance operations that are required by the Tech Specs and carried out every 12 months. Flow rate measurements ensure the operation of emergency feedwater pumps during different plant conditions. The event only has minor safety implications because the incorrect operation of pump flow measurements would have been detected in conjunction with testing the standby emergency feedwater system.*

The events are described in more detail in Appendix 3.

Operation and operational events

Plant operation has been systematic and safe. No events with significant safety implications took place in plant operation. Six exceptional events were reported and one event classified as an operational transient took place. During the year, there were no events resulting in a reactor trip.

In 2009, the risks caused by the detected component malfunctions, preventive maintenance and other events at the Loviisa plant were about 4.3% and about 3.0% of the expected value of the annual accident risk calculated using the plant's risk model for Loviisa 1 and Loviisa 2, respectively. The values are slightly higher than in 2008, but of the same order of magnitude as in the early 2000s. A few individual component malfunctions and the

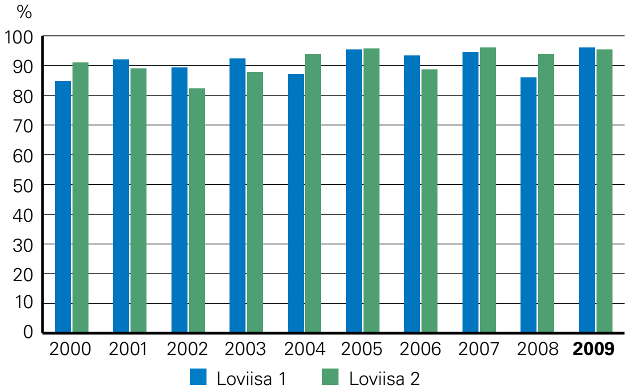


Figure 6. Load factors of the Loviisa plant units.

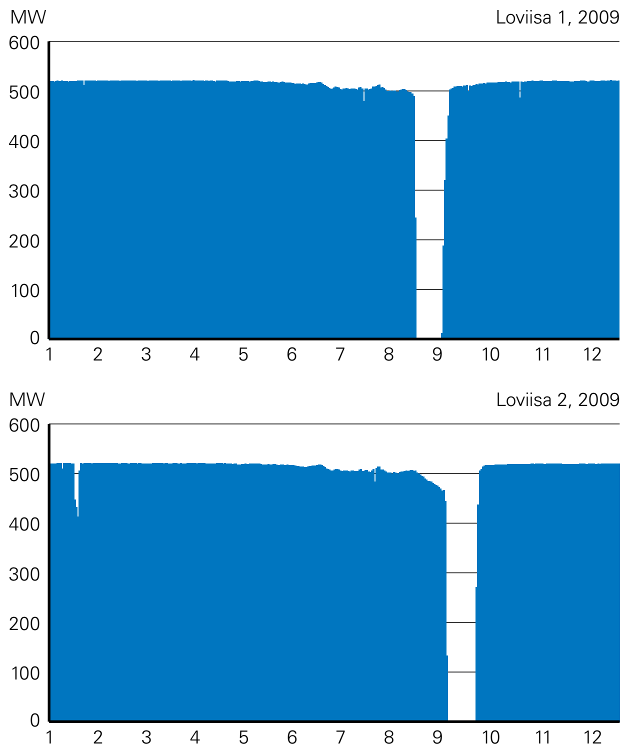


Figure 7. Daily average gross power of the Loviisa plant in 2009.

Operation and operational events

The load factor of Loviisa 1 was 96%, while that of Loviisa 2 was 95.4%. One event was classified as operational transient (indicator A.II.1). The production losses due to failures (indicator A.I.g) were small at both plants. The most significant event was an oil leak in the motor of the main coolant pump observed on 12 January 2009. It was repaired during the period from 17 to 19 January 2009.

At Loviisa 2, *a fire occurred in the electrical supply unit of the emergency feedwater pump during annual maintenance. On 13 September 2009, the personnel noticed smoke coming from the 400 V switchgear. The electrical supply unit of the emergency feedwater pump was identified as the source of smoke. After that, the switchgear power was cut off and the fire was extinguished by the fire brigade. The emergency feedwater pump was switched off from the main switch for the duration of maintenance, as planned. Incorrect wiring of the pump main switch resulted in the power supply contactor coil overheating and catching fire. The wiring had been modified in 2006 when the main switch was replaced with a new type.*

At Loviisa 2, *the throttles restricting the flow in the triggering network of aerial trigger valves of the fire extinguishing system of the turbine were found to be of the wrong size. It was found in conjunction with testing the sprinkler alarms of the turbine lubrication oil tank that the regional sprinkler triggering valve does not trigger automatically or become re-activated after forced triggering. Because of this fault, local fire extinguishing at the lubrication oil tank would probably have failed to operate. The regional trigger valve was opened and the throttle of the trigger network was also inspected. The inspection revealed that the throttle diameter was 6 mm when it should have been 3 mm. After this discovery, all regional trigger valves in sprinkler system of the turbine lubrication oil tanks of Loviisa 2 were inspected, and three examples of too large throttles were found. The throttles were replaced and the systems were successfully tested.*

The events are described in more detail in Appendix 3.

Annual maintenance at Loviisa 1

Annual maintenance at Loviisa 1 was a short refuelling outage. The plant unit was shut down for annual maintenance on 23 August 2009 and connected back to the national grid on 9 September 2009.

The main focus during the outage was on refuelling and its associated dismantling and reassembly work. Extra work was caused during the outage by the problems surfacing in refuelling and the related diagnostic work. The gripper of the refuelling machine jammed during the refuelling operation. The gripper had to be detached from the new fuel bundle using special procedures after which the gripper had to be replaced. Inspection of the gripper mechanism revealed signs of wear and shear in the gripping surfaces; these had prevented the mechanism from operating properly.

Annual maintenance at Loviisa 2

Loviisa 2 had a short refuelling outage. The outage began on 12 September 2009 and ended on 30 September 2009. A fuel leak had been detected at Loviisa 2 during the operating cycle which is why all fuel in the reactor was inspected. The search for the leaking bundle went according to plan during the refuelling operation. The leak was found to be in a fuel bundle that had been in the reactor for two years. This bundle was replaced during the annual maintenance.

The most extensive modification work comprised the installation work of the first phase of the I & C system revision project (the LARA project) at the Loviisa plant and the commissioning of the control automation of reactor control rods. The work was successful as it was possible to utilise the experience gained from the 2008 annual maintenance of Loviisa 1. The plates preventing the vortex phenomenon were also installed in the inlet pipe of the emergency injection water tank at Loviisa 2.

A small leak was detected in the sealing water line of one main coolant pump during plant startup. In addition, a fault was detected in the diesel engine when the emergency diesel generator was being tested. The leak in the main coolant pump sealing water line and the diesel engine fault were rectified before continuing the start-up procedure.

preventive maintenance of the subsystems of the auxiliary feed water system were the most significant in terms of accident risk. Eight of the 15 most significant failures in terms of risk concerned air conditioning. STUK will investigate the air conditioning system failures during 2010.

Annual maintenance outages

Annual maintenance at the Loviisa plant units was carried out safely and all maintenance work was completed in the planned scope. At the Loviisa power plant, special attention has been paid to work planning and induction training of contractors. The most important event during annual maintenance was that one absorber rod was not transferred to the reactor during refuelling at Loviisa 1. The missing absorber was detected during the inspection performed after refuelling. The absorber was not transferred because of a human error which occurred during refuelling. The missing absorber was mounted. The event was examined with the personnel before refuelling at Loviisa 2 and it was ensured that a similar event would not occur.

STUK used a total of 237 person days for overseeing the annual maintenance outages. In addition, two resident inspectors worked regularly on site.

4.1.3 Ensuring plant safety functions

No significant failures were observed during the year in the plant's safety functions nor in the systems, equipment and structures executing them.

In conjunction with assessment of international operational events, the Loviisa power plant became aware of the fact that, in certain situations, air can be sucked into the emergency injection system pumps from the emergency injection water tank. When the pumps are running, the water level in the tank drops and a vortex can develop above the intake pipe leading to the pumps. Air can be sucked from this vortex into the piping leading to the pumps. Air in a pump reduces the pump's capacity and can cause damage to the pump. In order to solve the problem at the Loviisa power plant, plates were installed in the injection water tanks above the pump intake pipes. When the tank water level drops, these plates prevent vortex development and air suction into the piping. Plates were installed on both units during the 2009 annual maintenance outage.

During the 2009 annual maintenance outage at

Loviisa 1, fuel assemblies of a new type were loaded into the reactor. In these assemblies, burnable absorber (Gd_2O_3) has been added to six fuel rods. The uranium enrichment level is higher in the new fuel, which has a bearing on the reactor shutdown margin. With a view to ensuring the reactor shutdown margin, Fortum suggested tighter control rod position limits. STUK approved the changes.

At the end of 2008, STUK requested the Loviisa power plant present an analysis of the effects of long periods of undervoltage in the grid on the power plant's equipment. The request was based on the calculations made for the Oskarshamn power plant, according to which it is possible that the pump motors of safety systems overheat in an undervoltage situation. The analysis was delayed until early 2010. Similar analyses have been prepared before, and this new one is mainly intended to chart the current situation of plants.

4.1.4 Integrity of structures and equipment

No significant faults or signs of wear were detected during 2009 in the integrity of equipment or structures critical to plant safety. The follow-up of flaws detected earlier in the integrity of structures continued during annual maintenance. A small fuel leak was detected at both units. They are insignificant for the radiation safety of the environment, because the leaked radioactive substances were contained in the primary circuit and inside the containment. Because of the malfunctions detected in the emergency diesel generators and the scant stock of their spare parts and the poor availability of parts, STUK required the power company to prepare a reliability analysis and to secure the procurement procedure for critical spare parts.

In earlier years, cracks have been detected in the seal slots of the flange faces of reactor pressure vessels at both Loviisa plant units. The deepest cracks have been repaired by welding. The inspections at Loviisa 1 indicated that the earlier detected fault indications have not increased substantially; new ones were not detected. Two new indications were observed at Loviisa 2 in dye penetrant tests. The earlier detected fault indications have not increased substantially. In addition, one seal out of four successive seals was out of its slot by a distance of 600 mm. The current plan is to recondition the seal faces at Loviisa 1 in 2010 and at Loviisa 2 in 2012.

A fuel leak was detected at Loviisa 2 in November 2008 releasing small amounts of fission products into the reactor coolant. Analyses indicated that this is probably a case of a minor leak in one fuel rod. The leak has been monitored at the plant through normal routines by on-line measurement of the gamma activity of the reactor coolant and sampling by the laboratory. The radioactivity of the fission products dissolved in water remained stable during the whole operating cycle, which indicated that the fuel leak did not increase during operation. All the fuel assemblies in the reactor were inspected during the 2009 annual maintenance outage at Loviisa 2. One leaking fuel rod was found. The fuel assembly with the leaking rod was removed from the reactor.

Slightly increased activity concentrations were detected in the reactor coolant water at Loviisa 1 in October 2009, which indicated a fuel leak. The fuel leak was small and has not increased since it was detected. The plant monitors the leak by water analyses of the reactor coolant at regular intervals. Because of the fuel leak, all fuel assemblies in the reactor will be inspected during the 2010 annual maintenance of Loviisa 1, and the fuel assembly with the leaking rod will be removed from the reactor.

In conjunction with its inspections and regulatory activities, STUK has called attention to the numerous failures of the emergency diesel generators and the scant stock of their spare parts and the poor availability of parts. In October, STUK requested Fortum prepare a report on the issue. The power company submitted the reliability analyses of the diesel generators and their risk-significance, data on major failures for the last four years, and an account of the spare parts stock of critical components. According to the reliability analysis no significant change has taken place in usability or reliability. The power company will start procurement of some of the critical spare parts because certain spare parts have a long delivery time. In order to verify the functionality of the engine manufacturer's quality system and the availability of spare parts, the power company will conduct an audit of said manufacturer's quality system and delivery capacity in early 2010.

The periodic inspections of registered pressure equipment were implemented according to plans for both plant units. There were 33 inspections at

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, four testing organisations to carry out tests related to the manufacture of mechanical equipment and structures. Testing operatives from two different testing organisations were approved to carry out periodic tests of mechanical equipment and structures pursuant to YVL 3.8.

Loviisa 1 and 19 at Loviisa 2. Because the pressure equipment to be inspected belongs to safety classes 3, 4 and EYT, the inspections were carried out by an inspection organisation. STUK oversaw the operations of the inspection organisation.

4.1.5 Development of the plant and its safety

The first round of modifications for the I&C upgrade were carried out at Loviisa 2

Fortum will revise the I&C systems controlling the systems and equipment of both plant units in Loviisa. The control rooms of the plant will also be re-equipped in stages. The power company has changed the stage designation of the revision from four to three stages, which will be implemented mainly during annual maintenance outages.

The upgrade involves replacing the control, steering, protection and detection systems implemented using conventional hard-wired technology with software-based technology. The modification also applies to the control room interfaces, where screen-based control is introduced as the main method. The intention is to keep most of the existing field instrumentation unchanged. During the first phase of the I&C upgrade, part of the I&C system controlling and limiting reactor power and its control room user interface were re-equipped during the annual maintenance outage at Loviisa 2. According to the inspections carried out by the power company and STUK, the modifications turned out well.

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

The second stage of the I&C upgrade at Loviisa 1 is due to be implemented 2010–2012. Due to the new stage designation, stage two has been extended by accident management functions from the former stage three. These modifications concerning higher safety classes will be implemented at the same stage. This will reduce the number of temporary connections between the old and new I&C systems. Modifications concerning lower safety classes will be implemented in the third stage.

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. The power company initiated the commissioning phase of the solidification facility construction project (LOKIT) during 2006 by carrying out system- and plant-level tests using inactive substances. STUK approved in 2008 the results of the pre-operational tests carried out using radioactive evaporation residues.

The power company started pre-operational tests using radioactive resin waste in May 2009. The pre-operational tests were not approved because the level measurement of the proportioning tank did not operate reliably. The pre-operational tests with resin waste will continue in 2010 after the level measurement is fixed and operates as required.

Modification of storage, waste and repair shop facilities

Low- and intermediate-level waste management at the Loviisa power plant will be improved by introducing centralised facilities for waste processing, activity determination and interim storage. The current machine and electrical repair shops in the non-controlled area will be converted to these purposes. These shops will be moved to a new building. This new building was completed in 2009 and renovation work in the existing power plant facilities moved ahead. The new waste management facilities are due to be commissioned in 2010.

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

STUK inspected, in accordance with the periodic inspection programme, the low- and intermediate-level waste management and final disposal of waste materials at the Loviisa power plant. The inspection of reactor waste management focused on the situation of the construction and reorganisation project for the storage, waste and repair shop facilities, the arrangements at the liquid waste solidification facility, waste accounting, organisation and instructions. The inspection concerning the final disposal facility for low- and intermediate-level waste focused on the maintenance procedures for the concrete and rock structures of the final disposal facility. No significant issues with safety implications requiring rectification were observed in the inspections.

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. No events with safety implications for the safety of the power plant or the environment took place. 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 2009, 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.

It was not possible to complete the pre-operational tests of the liquid waste solidification facility in 2009 (see 4.1.5), which is also why the commissioning of the underground repository was put off.

A couple of minor groundwater seepages have been present in the repository ceiling. During the periodic inspection carried out by STUK in June, a new, larger groundwater seepage was detected. Fortum undertook to monitor it. The chemical properties of groundwater can be detrimental for the long-term safety of final disposal. During the filling of the repository, groundwater seepage will be controlled so that water will not come into contact with the disposed of waste.

In 2009, Fortum installed high-density fuel racks in one storage pool of the spent fuel interim storage, which increased the storage capacity by 444 positions. At the end of 2009 the power plant had spent fuel storage capacity for 5,854 fuel assemblies. It is necessary that one of the storage pools can be drained if needed, which restricts the number of fuel assemblies to be stored to 4,881 assemblies.

Volumes of nuclear waste

The volume of spent nuclear fuel stored on-site at the Loviisa power plant at the end of 2009 was 3,961 assemblies (477 tU), an increase of 192 assemblies (23 tU). The volume of low- and intermediate-level waste was 3,180 m^3 at the end of 2009. The total increase of volume from 2008 is 30 m^3. Approximately 62% of the waste has been finally disposed of.

Provisions for the costs of nuclear waste management

STUK reviewed the documents on the financial provision made for the costs of nuclear waste management referred to in Section 90 of the Nuclear Energy Decree and submitted statements on 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. Fortum's extent of liability is €913 million at 2009 prices. A total of €44.1 million has been reserved for regulatory oversight costs. Fortum's share of this sum is €189 million.

Decommissioning plan for Loviisa power plant

Fortum submitted an updated decommissioning plan for the Loviisa power plant to the Ministry of Employment and the Economy at the end of 2008. STUK reviewed the plan in 2009, and submitted a statement on them to the Ministry of Employment and the Economy. The plan is based on the assumption that both Loviisa power plant units will be closed after 50 years of operation in 2027 and 2030. Decommissioning will start immediately after the closing and it will last until 2035. A spent fuel storage facility will remain on the plant site until all spent fuel has been transported to the final disposal facility now under construction in Olkiluoto. It has been estimated that the cost of decommissioning will be €312 million at late 2008 prices. The amount of work is about 2,955 person years. The volume of waste for final disposal will amount to about 27,800 m^3. In STUK's opinion, the decommissioning plan is sufficiently comprehensive and detailed at this point.

Other plans for nuclear waste management

In accordance with Section 74 of the Nuclear Energy Decree, Fortum submitted a report on the plans for the implementation of nuclear waste management activities to the Ministry of Employment and the Economy at the end of September. The report contains a detailed plan for the next three years and a general account of the measures planned for the next six years. The detailed plan covers the period at the end of which those liable for waste management are prepared to submit a construction permit application for a disposal facility. The Ministry of Employment and the Economy requested that STUK issue a statement on the material by the end of September 2010. The statement will be prepared in connection with the processing of preliminary construction permit materials for Posiva's disposal facility.

4.1.7 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, the Loviisa power plant organisation has operated in a systematic and development-oriented way. Modifications aimed at improving safety have been implemented in plant systems, structures and equipment, and in the organisation's operations as well. The Loviisa power plant builds up its personnel's competence and it has started to evaluate the effectiveness of the training courses provided at the power plant. The procedure for evaluating the organisation's function has been developed so that more personnel participate in self-assessment. The current evaluation procedure covers human resources and safety culture issues.

Regulatory activities also revealed needs for development in plant management. In order to ascertain that development programmes and projects are successfully completed, the availability of sufficient human resources should be ensured at the planning stage. Attention should be paid to timely and effective closing of open deviations and corrective actions. Induction and basic training programmes for personnel and subcontractors are in place, but it is essential to ensure that they are carried out as planned. In particular it must be ensured that adequately in-depth radiation protection training materials and training programmes for different professions are available. As more and more outside services and products are used in maintenance and modification work, regulatory procedures concerning procurement and subcontractors must be further developed. The targeting and scope of internal inspections, which are a fundamental part of the verification of the management system's functioning, must be assessed at Loviisa with a view to ensuring the review of different areas in the long term. The Loviisa power plant has prepared plans for improving its functions regarding the detected development needs; STUK will follow the realisation of the plans.

The Safety and Technology units at the Loviisa power plant were restructured in 2009. The licensee conducted safety related assessments of the restructuring which was submitted to STUK. As a result of the assessment and its evaluation, it was stated that the changes do not deteriorate the operating capability of the plant organisation. Furthermore, significant organisational restructuring and personnel changes took place in Fortum Power & Heat Oy's nuclear energy functions in autumn 2009. The changes aimed to improve the organisation's efficiency and clarify profit responsibility, as well as simplifying the organisational structure. These changes did not have any direct effect on the organisational structure of the Loviisa power plant but they did clarify, among other things, the plant's procurement activities and the use of resources by Technical Support (formerly Fortum Nuclear Services). The most important personnel change was the transfer of the responsible manager of the Loviisa power plant to another position in the Fortum Group and the appointment of a new responsible manager from the power plant's safety unit.

STUK participated in examinations of shift personnel where the operators working in the control rooms prove that they are conversant with all salient matters related to plant operation and safety. STUK approved 15 operator licences in 2009.

4.1.8 Operating experience feedback

Regarding operating experience feedback, STUK evaluated the investigation methods applied for Loviisa power plant events. According to STUK's evaluation, the power company has handled technical issues well, but there is scope for improvement in dealing with human and organisational factors, and in making good use of the events. During 2009, the Loviisa power plant elaborated its procedures and created new ways to investigate events. Operating event reports have been assessed by a cross-scientific working group consisting of experts from different units of the organisation. A root cause analysis was performed on three events. Towards the end of 2009, the power plant unit responsible for operating experience feedback enhanced its expertise in human and organisational factors.

Procedures for utilising international operating experience feedback were checked for functioning with the aid of events from abroad which STUK had selected in advance. Based on the check it could be stated that the utilisation of foreign operating event reports had further improved. The amount of reports reviewed, (IRS reports in particular) has been increased by means of changes in screening and operating models, and adding resources. Fortum itself conducts pre-screening of the reports coming from various sources, mainly via the IRS system maintained by WANO and IAEA/NEA. The selection criterion for events to be taken to the International operating experience team is their safety significance for the Loviisa power plant. The most significant events for the plant are those from similar power plants; they are always assessed.

It was detected at Loviisa 1 *in April 2009 that one of the two flow meters at the plant unit vent stack for exhaust air had been showing low flow rate values smaller than the actual flow since 2006. The meter was repaired. Due to the incorrect reading of the flow sensor, the values which had been reported for the atmospheric emissions from Loviisa during 2006–2008 were too low. During that period, the emission figures had been about five per cent too low compared to the corrected readings.*

4.1.9 Radiation safety of the plant, personnel and environment

Occupational radiation safety

In the autumn of 2009, STUK carried out a radiation protection inspection according to the periodic inspection programme at the Loviisa plant, focusing on occupational dosimetric surveillance and radiation measurements in particular. Based on the inspection, it was stated that dosimetric surveillance functions in an acceptable way and in accordance with the power plant's quality system instructions. STUK required a separate report to be prepared on the results of the surface doses (skin dose) reported to STUK's Dose Register for the 2009 annual maintenance outage because the dosimeter's surface dose reporting included a calculation error. The Loviisa power plant corrected the factor that had caused the calculation error and submitted correct surface dose results to STUK's Dose Register. On the basis of the reports, it could be stated that the deviations had no effect on the employees' health.

STUK carried out targeted radiation protection inspections during the annual maintenances at both plant units in Loviisa. In the inspections, STUK assessed the radiation protection personnel's operations and radiation protection methods. At the same time, the operations of employees in radiation work were assessed. It was concluded that radiation protection at the plant units mainly functions well. During the inspections it was concluded that, in order to cut down radiation doses, the plant should still increase task-specific practical training before starting actual radiation work. This concerns all work areas with a high annual employee turnover rate. Further, in order to cut down radiation doses, tools and working methods should be designed to ensure smooth and trouble-free work.

In order to ensure employees' radiation safety, sufficient human resources in the radiation protection unit are fundamental. The Loviisa power plant should pay attention to this issue, in particular in annual maintenance outages, which are demanding in terms of radiation protection, so that unforeseen and exceptional situations can be appropriately taken into account in work arrangements.

Radiation doses

The collective occupational radiation dose was 0.42 manSv at Loviisa 1, and 0.34 manSv at Loviisa 2. According to STUK guidelines, the limit value 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 aggregate collective dose of the Loviisa plant units was the second smallest among the doses during the operation of the plant. The collective occupational radiation doses at the Loviisa plant units were lower than the average of PWRs in OECD countries in 2009. Taking into account the scope of the annual maintenance, the radiation doses have continued to decrease since 2001.

Occupational radiation doses of NPP workers mostly accumulate in work carried out during annual maintenance outages. The collective radiation dose due to operations during the outage at Loviisa 1 was 0.38 manSv, and the collective radiation dose due to operations during the outage at Loviisa 2 was 0.28 manSv. The highest individual radiation dose incurred during the outage amounted to 6.51 mSv at Loviisa 1, and to 6.99 mSv at Loviisa 2. The highest aggregate radiation dose was 8.45 mSv.

The individual radiation dose distribution of workers at the Loviisa and Olkiluoto nuclear power plants in 2009 is given in Appendix 2.

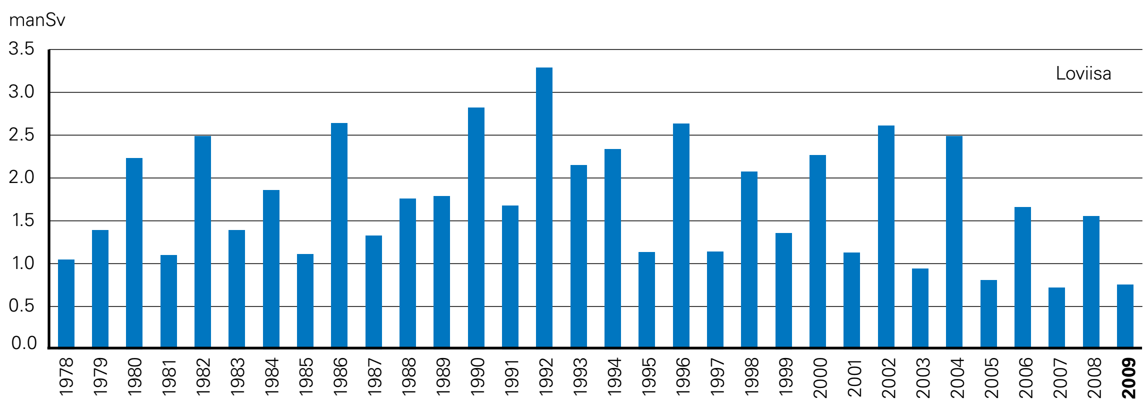


Figure 8. Collective occupational doses since the start of operation of the Loviisa nuclear power plant.

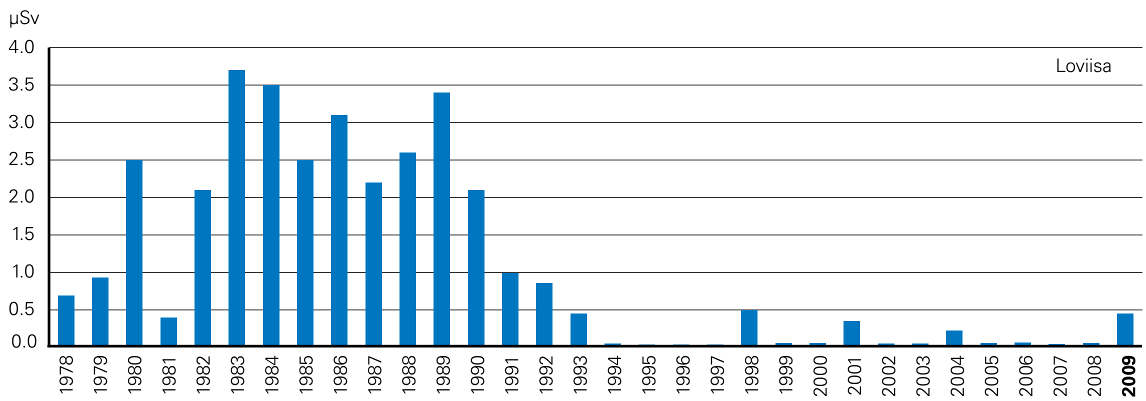


Figure 9. Annual radiation doses to the critical groups since the start of operation of the Loviisa nuclear power plant. Over the recent years, the doses to the critical groups has remained below one percent of the set limit, 0.1 milliSv.

Table 3. Radioactive nuclides found in 2009 in the environmental samples in Loviisa, originating from the Loviisa power plant.

	Number of environmental samples containing radionuclides originating from the NPP (several different nuclides may be found in the same sample)						
Type of sample	**H-3**	**Mn-54**	**Co-58**	**Co-60**	**Ag-110m**	**Te-123m**	**Sb-124**
Fallout	–	–	–	6	2	–	–
Aquatic plants	–	–	1	4	3	1	2
Sedimenting materials	–	1	–	4	1	–	–
Seawater	5	–	–	–	–	–	–

Radioactive releases and environmental radiation monitoring

The Finnish Meteorological Institute submitted to STUK a statement raising the issue of whether the monitoring devices of the Loviisa weather mast are up to date. The Finnish Meteorological Institute states that the current weather monitoring methods do not represent the best available technology. The stability of air, which is used in calculating the dispersion of radioactive substances, should be determined using ultrasonic measuring technology measuring wind turbulence. Present determination is based on temperature differences measured between different heights on the weather mast. The method based on temperature measurements is not precise enough for determining air flow stability. STUK has earlier required the Loviisa plant to assess not only the development of the weather mast system on-site, but also that of off-site real-time additional measurements and the related predictive models with regard to the spread of any atmospheric releases. STUK, the Finnish Meteorological Institute and the power company have continued to investigate the issue. STUK granted Fortum an extension of time until the end of 2011 to prepare a conceptual design plan completing the areal scope of the Loviisa weather measurement system.

The external radiation monitoring network of the Loviisa NPP surroundings was implemented in the 1990s. With the exception of occasional failures it has functioned well, but with regard to the precision of its measurements and external data transmission, it is not as good as the equipment of the upgraded national radiation monitoring network. In its inspection, STUK required that Fortum should consider possible upgrade of the monitoring network.

Radioactive releases into the environment from the Loviisa nuclear power plant were well below authorised annual limits in 2009. Releases of radioactive noble gases into the air were approximately 8.0 TBq, which is approximately 0.04% of the authorised limit. The releases of radioactive noble gases were dominated by argon-41, i.e. the activation product of argon-40, 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 26.3 MBq, i.e. approximately 0.01% of the authorised limit. The emissions through the vent stack also included radioactive particulate matter amounting to 122 MBq, tritium amounting to 0.4 TBq and carbon-14 amounting to approximately 0.3 TBq.

The tritium content of liquid effluents released into the sea, 21 TBq, was less than 14% of the release limit. The total activity of other nuclides released into the sea was about 1.8 GBq, which is 0.2% of the plant location-specific release limit.

The calculated radiation dose of the most exposed individual in the vicinity of the plant was about 0.45 µSv per annum, i.e. less than 0.5% 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 three and a half hours.

A total of 280 samples were collected and analysed from the terrestrial and aquatic environment surrounding the Loviisa power plant during 2009. External background radiation and the exposure to radioactivity of people in the surroundings are also measured regularly. Extremely small amounts of radioactive substances originating in the nuclear power plant have been observed in some of the analysed environmental samples. The amounts are so small that they are insignificant in terms of people's radiation exposure.

4.1.10 Emergency preparedness

STUK monitors the readiness of the organisations operating nuclear power plants to act in abnormal situations. No such situations occurred at the Loviisa power plant in 2009.

The emergency preparedness arrangements at the Loviisa power plant fulfil the key requirements; this was established during emergency preparedness inspections as part of the periodic inspection programme. The objects of inspection included the commissioning of the re-organised preparedness premises and related training and exercises during the spring of 2009, revision of the content and structure of the emergency response instructions and securing of connections used for plant data transfer during preparedness situations. A national rescue exercise at the Loviisa power plant was rescheduled from November 2009 as the authorities prepared for the H1N1 epidemic. The exercise will be carried out in early 2010. A personnel mustering exercise was organised at the Loviisa power plant on 4 December 2009. The aim of the exercise was to test the loudspeaker system and the personnel's operations in an evacuation situation. Both nuclear power plants also organise fire training and drills, with the fire brigade of the plant and the fire and rescue services of the surrounding municipalities participating.

The Loviisa power plant, STUK and Eastern Uusimaa Fire and Rescue Services maintain preparedness for the eventuality of a nuclear accident at Loviisa. A training programme for the members of the preparedness team was launched in 2009 by organising visits to the sites and presentations on the actors' tasks and co-operation in a nuclear accident.

4.2 Olkiluoto nuclear power plant units 1 and 2

4.2.1 Overall safety assessment of Olkiluoto 1 and Olkiluoto 2

A comprehensive safety assessment of the Olkiluoto nuclear power plant was made during the year as STUK reviewed the periodic safety review submitted by TVO at the end of 2008. The assessment is required in the terms and conditions of the operating licence valid until 31 December 2018. Based on the examination of the periodic safety review, STUK stated that the safety of the nuclear power plant units is at a sufficient level and that the practices employed by the licensee are adequate to enable continuous operational safety.

In addition to examining the periodic safety review, 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 licensee, carrying out inspections in line with the periodic inspection programme and by overseeing operation at the plant. On the basis of this regulatory oversight STUK can state that plant operation did not cause a radiation hazard to the workers, population or environment. Occupational radiation doses and radioactive releases into the environment were low and clearly below the prescribed limits. The licensee has operated the Olkiluoto power plant in a safe manner and in compliance with YVL Guides.

According to the tests and inspections carried out, the condition of the fuel, containment and primary circuit which prevent the release of radioactive materials into the environment are in compliance with requirements. No fuel leaks have occurred at the power plant in 2009.

Plant operation has been systematic and in compliance with the Technical Specifications and guidelines. During the year, there were no events resulting in a reactor trip. Three exceptional events with safety implications were reported. The most significant events in 2009 included the isolation valve actuator failures which deteriorated the reliability of the main steam lines shut-off, and the jamming of a spent fuel element in the refuelling machine when transfering fuel during annual maintenance.

During the year, several modifications were implemented for plant safety improvement. A so-called outage building was built between the plant units. This improved access to the controlled areas of the units and occupational radiation measurements. The replacement of the shutdown cooling system's inner isolation valves which started in 2006 was completed when the last valve was replaced during the annual maintenance of Olkiluoto 2. Continuing multi-year projects included the upgrading and repair of the fine screening units in the seawater screening system, and the renewal of the plant radiation measurement systems. The latter also included the renewal of measurements related to the control of releases into the sea. TVO also made preparations for an extensive upgrade starting in 2010 in which the inner isolation valves on the main steam lines will be replaced, among other things.

Thanks to the new steam dryers, the radiation levels in the turbine building have decreased, and this has also reduced the occupational radiation doses of turbine plant workers. Emergency preparedness at the Olkiluoto power plant is in compliance with requirements.

STUK reviewed the decommissioning plan for the Olkiluoto power plant based on the assumption that both Olkiluoto power plant units will be closed after 60 years of operation in 2038 and 2040. Decommissioning will start 30 years after the termination of monitored storage. In its statement submitted to the Ministry of Employment and the Economy, STUK concluded that the decommissioning of the power plant and provisions for it can be implemented on the basis of the plan.

In the inspection of management and safety culture, STUK noted that among the results of the safety culture survey which TVO conducted at the end of 2008, strengths such as the personnel's motivation and sense of responsibility could be demonstrated. Areas for development include ensuring competence, handling of personnel's worries related to safety and project management in modifications.

As there is a generation change going on in TVO's organisation, STUK has stressed in its inspections the importance of work induction and ensuring competence. It was required in the inspection of human resources that TVO must assess the competence assurance activities as a whole and draw up a development plan to make the activities more systematic and to improve quality.

Periodic safety review of the Olkiluoto 1 and 2 plant units

The operating licence for the Olkiluoto 1 and 2 NPP units is valid until 31 December 2018. According to the licence conditions, the licensee must carry out an intermediate safety assessment covering the Olkiluoto NPP by the end of 2008. Since the operating licence was granted, STUK has revised the Guide YVL 1.1, which sets out more detailed requirements regarding the contents of periodic safety reviews. The purpose of the assessment prepared by the licensee is to ensure that the plant has been operated safely during the current operating licence period and that the licensee has foreseen the status of plant safety and its development during the remaining licence period.

TVO submitted its assessment to STUK for review at the end of 2008. STUK's reviewing work was based on the inspections of matters and documents related to the periodic safety review, as well as the results of continuous regulatory oversight. The key areas for review comprised aging management, plant safety, safety analyses, issues related to plant operation and the safety culture, as well as environmental and nuclear waste-related issues. STUK presented to TVO the findings of the review and requests for further information in its decisions of 27 February 2009 and 1 April 2009. TVO submitted further information to STUK during the spring and summer. STUK requested a statement from the Ministry of the Interior on emergency preparedness and physical protection, and a statement from the Advisory Committee on Nuclear Safety on STUK's draft safety assessment.

STUK made a decision on the periodic safety review on 30 October 2009. The decision's appendices included the safety assessment, the review of documents according to section 36 of the Nuclear Energy Decree and the statement of the Advisory Committee on Nuclear Safety. The decision approved the periodic safety review prepared by TVO as a safety review referred to in to the operating licence condition of Olkiluoto 1 and 2 nuclear power plant units and in Guide YVL 1.1. STUK stated in its decision that the safety of the nuclear power plant units is sufficient and that the practices employed by the licensee are adequate to enable continuous operational safety.

The objective during the operation of Olkiluoto plant units 1 and 2 has been to continuously improve plant safety. Substantial upgrades have been carried out at the plant units since their commissioning, and extensive modifications have been implemented in several systems in order to improve safety. Work for the improvement of plant safety will continue further during the current operating licence period. TVO has presented STUK with action plans concerning the improvement areas identified in the course of the periodic safety review. In its decision, STUK imposes requirements for completing the action plans; the requirements are related to compliance with the requirements of the Government decrees that were revised in 2008 on nuclear plant safety and physical protection.

Regarding the revised decree on the safety of nuclear facilities, STUK stated that Olkiluoto nuclear power plant units 1 and 2 fulfil the requirements set for operating facilities. The requirements presented in the decision were set by virtue of Section 7a of the Nuclear Energy Act and they call for continuous improvement. Among other things, the application of the diversity principle at the plant must be assessed again as a whole and TVO must prepare an action plan for its further development. For example, the residual heat removal systems of the power plant units have not been designed in compliance with the diversity principle. Also, each subsystem of the reactor water level measurement system is based on the same measurement method. The risk of a common cause failure arising from the loss of the external power grid must also be reduced. Because of the revision of the decree on physical protection, STUK allowed a reasonable period of time during which the requirements of the decree must be fulfilled in the power plant's and TVO's operations.

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

Technical Specifications

The Technical Specifications of the Olkiluoto plant are up-to-date. TVO has initiated work for developing the Technical Specifications in order to improve their legibility and ease of use. In particular, the justifications for the conditions and requirements presented in the Technical Specifications will be developed, and the structure of the requirements part will be harmonised and clarified. The development plan was submitted to STUK for inspection as part of the periodic safety review. No situations were observed during the year in which the plant would have been in non-compliance with the Technical Specifications (Appendix 1, Indicator A.I.2).

The power company applied for permission from STUK for six planned deviations from the Technical Specifications (Appendix 1, indicator A.I.2). The

Operation and operational events

The load factor of Olkiluoto 1 was 97.0%, while that of Olkiluoto 2 was 95.1%. The annual maintenance outages caused the most significant reductions in the load factor. The outage at Olkiluoto 1 lasted for 8½ days, while that of Olkiluoto 2 lasted for 16½ days. The losses in gross energy output due to operational transients and component malfunctions were 0.29% at Olkiluoto 1 and 0.14% at Olkiluoto 2.

At Olkiluoto 1, *the pump of the shutdown service water system stopped during periodic testing when the LED signal lamp indicating its operating status became faulty and caused a short-circuit in the pump control circuit. Similar pump tests are performed at four-week intervals but this was the first occurrence of any faults.*

At Olkiluoto 1, *the testing of the isolation valve of the containment spray system using a portable diesel generator could not be successfully done during the periodic tests. The contactor installation plates had been replaced during annual maintenance in 2008 for the switchgear outputs controlling this isolation valve and three other valves. In that modification operation, two separate connectors on top of each other had been incorrectly connected together. This erroneous construction would have prevented opening the valves when supplied by a portable diesel generator.*

At Olkiluoto 1, *malfunctions were observed in the outer isolation valves of the steam lines during tests carried out after annual maintenance. The malfunctions were caused by a gear in the actuator opening and closing the valve. It had failed due to fatigue from its long history of use.*

At Olkiluoto 2, *the refuelling machine had a malfunction during annual maintenance when spent fuel was being transferred out of the reactor. The spent fuel element had already been lifted completely out of the reactor when an excessive need for lifting force triggered the overload limiter of the refuelling machine and prevented the lifting operation from being continued. It was found that the malfunction was caused by the compressed air hose of the refuelling machine jamming between the tubes of the telescopic mast of the refuelling machine.*

At Olkiluoto 2, *the actuator of strainers in the shutdown service water system failed during annual maintenance. The actuator was replaced and the faulty device was inspected. Wear was detected in the planetary gear of the device which was found to be the reason for the malfunction. TVO will inspect all similar actuators during 2009–2010. Similar faults were not detected in inspections carried out by the end of 2009.*

The events are described in more detail in Appendix 3.

Table 4. Events at the Olkiluoto plant units subject to special reports by the power company. The table shows events due to which the plant unit was in non-compliance with the Technical Specifications. All events subject to reporting are discussed in Appendix 1 (indicator A.II.1). Appendix 3 describes events subject to special reports in more detail.

Event	Non-compliance with the Technical Specifications	Special report	INES rating
Stoppage of the pump of the shutdown service water system as a result of signal lamp failure at Olkiluoto 1		•	1
Inoperability of an isolation valve in the containment vessel spray system when using an external diesel generator for power supply in a periodic test carried out at Olkiluoto 1		•	0
Malfunctions of the outer isolation valves of main steam lines at Olkiluoto 1		•	1
Jamming of the fuel transfer machine during transfers of spent fuel at Olkiluoto 2		•	1
Actuator faults in the strainers of shutdown service water systems		•	0

applications concerned moving the Olkiluoto 2 containment leak test from 2009 to 2011, removing protection from the Olkiluoto 2 fuel transfer machine to enable repair work, inoperability of the radiation measurements controlling the liquid waste discharge line during the replacement of the equipment, preventing disturbances of the radioactivity monitors of the Olkiluoto 2 main steam lines, and possible violation of the limit used for reactor core monitoring to ensure representative stability measurement. Since the planned deviations had no safety significance, STUK approved the applications except the postponement of the containment leak test. This deviation was not urgent yet, because according to the Technical Specifications the test can also be performed in 2010.

TVO submitted 18 amendment proposals of the Technical Specifications to STUK for approval, concerning issues such as periodic testing, chemistry and power supply. STUK approved six amendment proposals as they were. Nine amendment proposals were approved partly or with additional require-

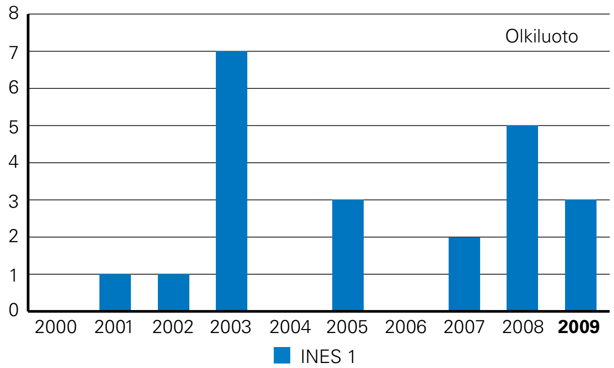


Figure 10. INES classified events at the Olkiluoto plant (INES Level 1 or higher).

Annual maintenance at Olkiluoto 1

The refuelling outage at Olkiluoto 1 took place between 3 May and 12 May 2009 and lasted for about 8½ days. During the outage, almost a quarter of the fuel was replaced. No major maintenance or modification work took place. The intention was to replace the inner isolation valves of the main steam lines of the reactor during the 2010 outage which is why preparations were made for that modification during annual maintenance. These included replacement of the rails that are required for installing the valves.

Towards the end of annual maintenance operations, the water level in the reactor tank was lowered, following a misunderstanding, about one metre lower than planned. The intention was to drain off washing water collected at the bottom of the reactor pool when the pool was being washed, but the draining was carried out erroneously by lowering the water level in the reactor instead of using the draining line of the gutter at the bottom of the pool. When the layer of water on top of the fuel, intended for attenuating the radiation, became thinner, the radiation level at the bottom of the reactor pool increased. Fuel cooling was not at risk, but the persons working at the bottom of the pool received a minor dose of radiation (less than 0.5 mSv/person). The malfunction was detected when the radiation meters produced an alarm, and the workers were asked to leave the pool. TVO will take this event into account for employee training and kick-off meetings for operations.

Annual maintenance at Olkiluoto 2

The maintenance outage at Olkiluoto 2 took place between 13 and 30 May 2009 and lasted approximately 16½ days. The outage lasted about 1½ days longer than planned. The delay was due to the inoperability of the fuel transfer machine.

No major modernisation work was made to the plant during annual maintenance. One of the most extensive operations was that of replacing a valve in the shutdown cooling system with a new type. The new outage building improved access to the controlled areas and the radiation measurements of employees.

The most significant observations regarding the integrity of equipment were the cracks found in the steam dryer and the damaged valve seals in the reactor trip system.

ments. Three amendment proposals were returned for further preparatory work.

Operation and operational events

Plant operation has been systematic and in compliance with the Technical Specifications and guidelines. During the year, there were no events resulting in a reactor trip. The most significant events in 2009 included the isolation valve actuator failures which could have prevented the valves from closing, and the jamming of a spent fuel element in the refuelling machine when transporting fuel during annual maintenance. Observations made in the operation-related inspections by STUK concerned issues such as the implementation and follow-up of corrective actions, cleanliness and order at the plant, and the marking of storage areas.

In 2009, the risk caused by the detected component malfunctions, preventive maintenance and other events at the Olkiluoto 1 plant was 4.0%, and at the Olkiluoto 2 plant 5.4%, of the expected value of the annual accident risk calculated using the plant's risk model. The events can be considered to be part of normal nuclear power plant operation, and they did not give rise to any further measures by STUK.

Annual maintenance outages

Annual maintenance ensures the preconditions for operating the power plant efficiently and safely during the next operating cycles. STUK oversaw the planning and implementation of annual maintenance by reviewing the documents required by the regulations, such as outage plans and modification documentation, and by performing on-site inspections during annual maintenance. Based on its oversight, STUK determined that annual maintenance was safely implemented at the Olkiluoto 1 and Olkiluoto 2 units.

According to STUK's indicator, proportionally more exceptional events with safety implications take place or are observed during annual maintenance than during power operation. The number of events is probably partly due to the fact that the

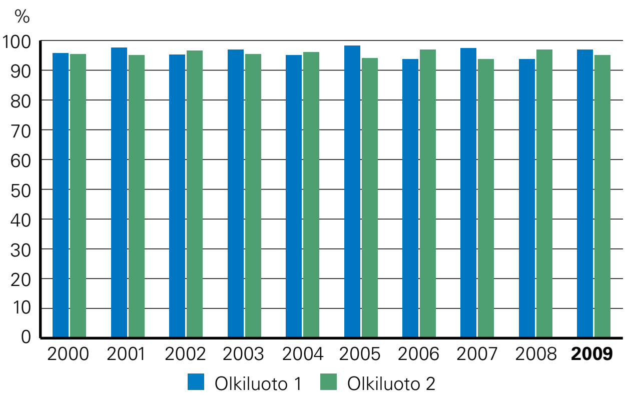


Figure 11. Load factors of the Olkiluoto plant units.

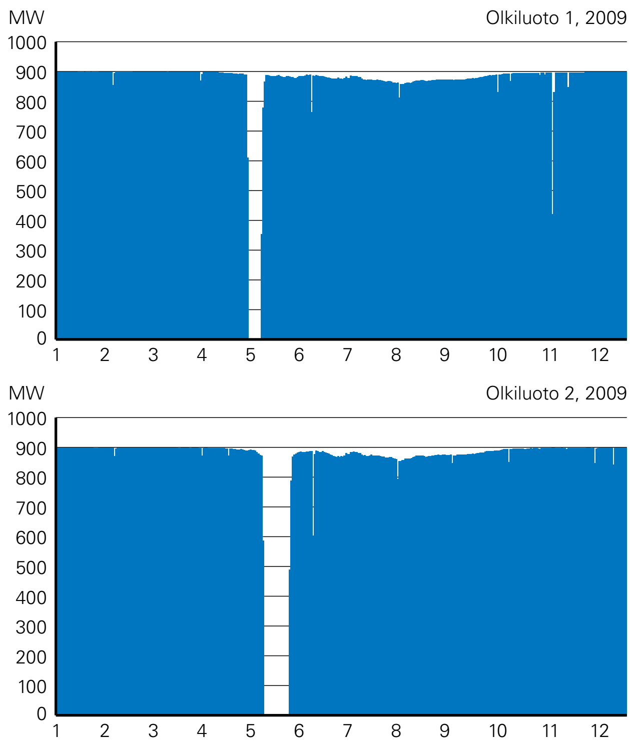


Figure 12. Daily average gross power of the Olkiluoto plant in 2009.

major part of annual inspection, repair and modification work is done during annual maintenance, which lasts for about a month.

STUK used a total of 212 person days for the regulatory oversight of the annual maintenance outages. In addition, two resident inspectors worked regularly on site.

4.2.3 Ensuring plant safety functions

The reliability of plant safety functions was affected by malfunctions observed in the steam line isolation valves. The function of the steam line isolation valves is to shutdown the steam lines in an accident and to contain radioactive substances possibly released in the accident inside the containment. There are two successive isolation valves on the steam lines. The malfunction of the outer isolation valve on the main steam line at Olkiluoto 1 was caused by a gear on the actuator opening and closing the valve. The gear was broken by fatigue resulting from long use. All these gear units were replaced at Olkiluoto 1 and Olkiluoto 2, and incipient cracks caused by material fatigue were detected on some of the removed gears. STUK required that TVO investigate by the end of 2009 whether the gear dimensioning is sufficient for maintaining the gear undamaged in long-lasting continuous operation, or whether the damage was due to insufficient strength of material caused by a manufacturing defect. The malfunction did not cause any direct hazard to the environment; yet in certain accidents it could have had an impact on the leaktightness of the containment. The significance of the malfunction was increased by the fact that cracks were detected on the gears of several valves.

In Sweden, an analysis has been carried out, concentrating in particular on the effects of voltage drops of long duration on the pump motors in safety systems. Similar studies were carried out in Finland, and TVO's results will be completed in early 2010. Similar analyses have been carried out before, and these new ones are mainly intended to establish the current situation of the plants.

4.2.4 Integrity of structures and equipment

At Olkiluoto 1, a malfunction was detected in the opening of the outer isolation valve on the reactor main steam line due to the actuator, and at Olkiluoto 2 damage to a steam dryer guide plate was detected. In addition, at Olkiluoto 2 a reactor scram valve seal damage and an actuator failure of the strainers in the seawater system were detected. No fuel failures were detected on either plant unit in 2009.

Damage that had earlier escaped attention was detected in the Olkiluoto 2 reactor steam dryer (a broken guide plate, the so-called chevron plate). TVO assessed the condition of the dryer and the safety of its use, and based on the assessment, proposed that the dryer be installed back into the reactor. STUK approved the proposal. The damage was visible in the pictures taken after the 2006–2007 operating cycle, and there has been no change during two operating cycles. As a result of the event, STUK required a plan to be prepared for steam dryer inspection principles. The steam dryer has also presented problems in previous years. It was installed in the reactor during the 2005 annual maintenance, but it was found in the following year's maintenance that the flow guide plate had partly come loose. The old steam dryer was installed in the reactor for the 2006–2007 operating cycle, and the guide plates were removed from the new dryer. The new dryer was installed again during the 2007 annual maintenance. The inspections carried out during the 2008 annual maintenance revealed four cracks in the steam dryer panels; the cracks were repaired during the 2009 outage. None of the above failures have been in actual load-carrying structures.

Towards the end of the annual maintenance outage at Olkiluoto 2, it was observed that the scram valves in the reactor scram system were not tight. The reason was that the seals, which had been in use for one year, had been damaged. The seals were replaced. During the annual maintenance outage,

Pressure equipment manufacturers, and inspection and testing organisations

A total of 28 nuclear pressure equipment manufacturers were approved for the Olkiluoto plant (plant units Olkiluoto 1, 2 and 3). STUK approved 15 testing organisations to carry out tests related to the manufacture of mechanical equipment and structures for the Olkiluoto plants. Testing operatives from four different testing organisations were approved for carrying out periodic tests of mechanical equipment and structures pursuant to YVL 3.8.

the reactor is shut down and there are no operability requirements for the scram valves, which is why the failures could be repaired without safety implications. It is also possible to repair individual failures during power operation, but it is not possible to repair this many scram valves simultaneously without shutting the reactor down. There were no leaks in the Olkiluoto 1 scram valves. The event shows that there are shortcomings in the corrective actions and their impact, because TVO also dealt with similar leaks due to sealing material damage in 2007.

During annual maintenance at Olkiluoto 2, the actuator of the strainers in the seawater system failed. Wear preventing operation was found in the planetary gear of the actuator. TVO will check all similar actuators during 2009-2010; in the inspections carried out by the end of 2009, no failures of a similar type were detected.

Altogether 11 inspections of pressure equipment were carried out; all these inspections were in the inspection mandate of an inspection organisation. A total of 82 inspections were carried out at Olkiluoto 2; of these, 19 inspections were in STUK's inspection mandate.

4.2.5 Development of the plant and its safety

Major modifications at Olkiluoto

During the year, the Olkiluoto nuclear power plant will implement several modifications improving plant safety or plant operation.

The replacement of the reactor cooling system's inner isolation valves, which started in 2006, was completed when the last valve was replaced during the annual maintenance of Olkiluoto 2. The upgrading and repair project of the fine screening units in the seawater screening system continued; it started in 2007, and one screen was upgraded on each unit during the year. According to the plans, the project will be completed in 2010, when all eight fine screening units will be changed. Also, the radiation measurement system upgrading project continued. A so-called outage entrance building was built between the plant units before the annual maintenances.

Coming large-scale modifications were planned during the year. These will mainly take place during the 2010 annual maintenance at Olkiluoto 1 and during the 2011 annual maintenance at Olkiluoto 2. According to these plans, the inner isolation valves of the main steam lines will be replaced, the low pressure turbines and the generator will be renewed, and the main seawater pumps upgraded.

Upgrade of the radiation measurement systems

The radiation measurement system upgrade project involves the renewal of practically all the stationary radiation measurement equipment on the plant units. The first new devices were installed and operational in 2008. At the end of 2009, there were over ten renewed stationary radiation monitors on each plant unit. In addition, several new devices have been installed for test operation. The purpose of test operation is to compare the measurement results of the new devices with the measurement results of the old devices. The aim has been to place the new devices in accordance with operating experience gained in more representative places. An additional aim has been to find alarm limit set values that would be optimal in terms of radiation safety and plant processes.

In 2009, TVO revised the personnel monitoring system. The system was installed in the new outage building which was commissioned before the annual maintenance outages. At the same time, some of the electronic dose measurement equipment was replaced. The outage building enables centralised access of workers to the controlled areas of both plant units.

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

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

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 2009, maintenance waste below the activity limits to be taken to the local landfill for burial, waste oil to be delivered to Ekokem Oy, and recycling metal and certain objects and a site hut delivered for reuse were cleared from control with STUK's approval. In addition, the power plant employs efficient procedures for reducing the volume of waste subject to final disposal.

Waste volumes

The volume of spent nuclear fuel on-site at the Olkiluoto plant at the end of 2009 was 7,212 assemblies (1,277 tU, tonnes of original uranium), an increase of 228 assemblies (52 tU) in 2009.

The volume of low- and intermediate-level waste at the Olkiluoto power plant was 6,410 m³ at the end of 2009. The total increase in volume from 2008 is 170 m³. Approximately 80% of the waste has been finally disposed of.

Provisions for the costs of nuclear waste management

STUK reviewed the documents on the financial provision made for the costs of nuclear waste management referred to in Section 90 of the Nuclear Energy Decree and submitted statements on 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. TVO's extent of liability is €1160.7 million at 2009 prices. A total of €44.1 million has been reserved for regulatory oversight costs. TVO's share of this sum is €25.2 million.

Decommissioning plan for Olkiluoto power plant

TVO submitted an updated decommissioning plan for the Olkiluoto power plant to the Ministry of Employment and the Economy at the end of 2008. STUK reviewed the plan in 2009, and submitted a statement on to the Ministry of Employment and the Economy. The plan is based on the assumption that both Olkiluoto power plant units will be closed after 60 years of operation in 2038 and 2040. Decommissioning will start 30 years after the termination of monitored storage. The duration of decommissioning after the monitored storage period is about 15 years. The justification for delayed decommissioning is occupational radiation protection. It has been estimated that the cost of decommissioning will be €170 million at late 2007 prices. The volume of waste for final disposal will amount to about 26,600 m³. The decommissioning of the Olkiluoto 3 plant unit currently under construction will start immediately after 60 years of operation in 2071, and its decommissioning will start after the older plant units have been decommissioned. In STUK's opinion, the decommissioning plan is sufficiently comprehensive and detailed at this point.

Other plans for nuclear waste management

In accordance with Section 74 of the Nuclear Energy Decree, TVO submitted a report on the plans for the implementation of nuclear waste management activities to the Ministry of Employment and the Economy at the end of September. The report contains a detailed plan for the next three years and a general account of the measures planned for the next six years. The detailed plan covers the period at the end of which those liable for waste management are prepared to submit a construction permit application for a disposal facility. The Ministry of Employment and the Economy requested STUK submit a statement on the material by the end of September 2010. The statement will be prepared in connection with the processing of preliminary construction permit materials for Posiva's disposal facility.

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. As a result of an assessment launched on STUK's initiative in 2008, TVO has identified strengths and development areas in the power plant's safety culture. With regard to strengths, TVO noted that the personnel are motivated and have a sense of responsibility. Areas for development include ensuring competence, handling of personnel's worries related to safety and project management in modifications. STUK will monitor progress gained with the development areas in 2010.

TVO has created a management system for managing the power plant. Guide YVL 1.4, which STUK has recently implemented, sets requirements for this system. TVO has conducted an assessment of the functionality of its management system and started to develop the system in order to fulfil the requirements of Guide YVL 1.4. The responsibility for management system development has been delegated to new people due to organisational change and guality management and auditing activities have been chosen as areas for development. The follow-up of the areas for development and deviations will be improved in TVO by introducing a new application for deviation management. STUK has followed the development of the management system and required TVO to develop their self-assessment procedure and its description. As part of the plant management system, TVO has a bonus scheme for the personnel. STUK has assessed the impact of TVO's bonus scheme in terms of the focus on plant safety. In STUK's opinion, TVO could further develop the bonus scheme with a view to making the importance of safety more evident in the bonus criteria.

With regard to personnel competence, STUK has drawn attention to the fact that the reasons and underlying factors of the previous years' events emphasize the importance of ensuring personnel competence. TVO has come to the same conclusions in their own assessments. STUK has required TVO to assess their procedures related to ensuring competence and to prepare a development plan for improving the systematic character and quality of these activities. In STUK's opinion, TVO must pay special attention to work induction and ensuring the competence of those in expert posts. TVO has initiated an assessment of their training programmes; the assessments will also take into account the needs of Olkiluoto 3. Based on STUK's regulatory acitivites, it can be stated of TVO's training activities that they are subject to continuous improvement and training data is managed in a systematic way.

In its inspections, STUK has assessed TVO's human resource planning and resourcing practice. As a result of regulatory activities, it has been noted that the practice inside TVO varies because the guidelines are of a general character and, for example, there are no guidelines for human resource allocation in project activities. STUK's observations are in line with the results of TVO's assessment of safety culture. TVO has initiated a development project for project activities, including personnel training.

TVO made changes in the organisation and personnel in 2009. The most important organisational change was the transfer of the Corporate Safety Office from the Corporate Services Department to the Production Department. TVO has assessed the safety significance of the changes and submitted the assessment to STUK as an attachment to the updated management code. STUK reviewed and approved the changes suggested by TVO, as well as the change of the deputies of the director responsible for plant operations. STUK drew attention to updating the training plans and to induction training plans for persons who have moved to new posts.

STUK participated in examinations of shift personnel where the operators working in the control rooms show that they are conversant with all salient matters related to plant operation and safety. STUK approved 18 operator licences for Olkiluoto 1 and Olkiluoto 2 in 2009.

4.2.8 Operating experience feedback

Systematic follow-up of operating experiences and their entry into processing belong to TVO's operating experience team's activities. The operating experience database has been made more user-friendly and its structure changed for better usability, but the database is not used very extensively. Systematic research methods are not much applied to event studies; the database leads the analysis of causes. It would be worthwhile to apply more systematic and documented methods to event studies, and to add weight to the analysis of root causes. Corrective actions are monitored by means of database applications.

The inspection concerning international operating experience feedback and the utilisation of experience focused on the state of TVO's development work on operating experience feedback aiming to embrace the needs of Olkiluoto 3, and the verification and assessment of the functionality of TVOs' operating experience procedures with the aid of events from abroad which STUK had selected in advance. Thanks to a new meeting practice, the number of clarification requests to the company's technical experts by TVO's operating experience team (KÄKRY) concerning external events was doubled in 2008 compared to the previous year. However, there is scope for improvement in reporting the measures taken on the basis of such events and their follow-up.

In screening international operating experience (WANO, IRS and NRC reports) and its assessment, TVO draws strongly on EFRATOM, an operating experience organisation jointly established by Swedish power companies, Westinghouse, and Vattenfall Group's training centre (KSU). It has been established in previous inspections that the screening criteria of ERFATOM are not sufficient for the needs of Olkiluoto 3. Until now the nuclear technology representative in KÄKRY has screened out international reports the lessons of which need to be taken into account in the technical solutions of Olkiluoto 3, and the reports have been submitted to the Olkiluoto 3 plant supplier for statement. From the beginning of 2009, the Operational Safety Engineer of Olkiluoto 3 has drawn attention to events the lessons of which could be applied to operating activities and administrative procedures. Events and lessons selected with these criteria are presented to the shift personnel on operating training days. The development of TVO's operating experience feedback to embrace the needs of Olkiluoto 3 appears to be promising, because the process of assessing events from Olkiluoto 3 and from outside has already been described up to the beginning of commissioning.

4.2.9 Radiation safety of the plant, personnel and environment

Occupational radiation safety

In the spring, STUK carried out a radiation protection inspection according to the periodic inspection programme at the Olkiluoto plant, focusing on occupational dosimetric surveillance and radiation measurements in particular. Based on the inspection, it was stated that dosimetric surveillance functions in an acceptable way and in accordance with the power plant's quality system instructions. STUK requested that, with regard to dosimetric measurements, the power company submit the unreported result material of annual calibrations and quality tests for previous years to STUK for information. The power company was also requested to describe the procedures for controlling the radiation doses employees have been exposed to before starting work and for ensuring that all employees undergo measurement of internal doses after the completion of annual maintenance.

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 operations and radiation protection methods. At the same time, the operations of employees in radiation work were assessed. It was concluded that radiation protection at the plant units mainly functions well. During the inspection, observations were made of individual issues for improvement relating to entering arrangements of radiation control areas requiring the use of additional protective equipment, use of protective equipment and the presence of workers in a radiation work environment. Also, some incidents were observed where the radiation protection personnel had not been adequately informed of ongoing work in the controlled area.

Radiation protection resources at a nuclear power plant are very essential for gaining good results. The requirements imposed on radiation protection at the Olkiluoto plant are fulfilled. The current human resources will not be sufficient during the commissioning of the new unit and annual maintenance outages of the operating units. The power company has drawn up plans for organising radiation protection duties and for recruiting and training new people for the duties in the future. STUK will assess the implementation of the plans in its inspections.

The annual maintenance entrance building built between the plant units was commissioned before the annual maintenance. This is why the access to the controlled areas of both plant units was, unlike earlier, primarily through one building. Also, the measurement of individual contamination improved with the new building. A person leaving the controlled area goes through two measurements to ensure that there are no radioactive substances on the person's skin or clothes. Also, the contamination cleaning facilities are now more functional than earlier.

Radiation doses

The collective occupational radiation dose was 0.40 manSv at Olkiluoto 1 and 0.79 manSv at Olkiluoto 2. According to STUK guidelines, 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 2.10 manSv per Olkiluoto plant unit. This limit value was not exceeded at either plant unit.

The collective radiation dose of the Olkiluoto plant units was lower than average compared to the dose in its operating history. The collective radiation dose of the Olkiluoto power plants was clearly below average for BWRs in the OECD countries.

Occupational radiation doses of NPP workers mostly accumulate in work carried out during annual maintenance outages. The collective radiation dose due to operations during the outage at Olkiluoto 1 was 0.26 manSv, and the collective radiation dose due to operations during the outage at Olkiluoto 2 was 0.72 manSv. The radiation levels at the turbine plants continued to decrease thanks to the new steam dryers. A new steam dryer has been installed in the Olkiluoto 1 reactor since 2006. The steam dryer installed at Olkiluoto 2 in 2005 has been in the reactor with the exception of the 2006–2007 operating cycle. The new dryers are effective in removing moisture from the steam, and they have clearly reduced the transportation of radioactive substances to the turbines.

The highest individual radiation dose incurred during the outage amounted to 5.4 mSv at Olkiluoto 1, and to 9.45 mSv at Olkiluoto 2. The highest individual radiation doses at Olkiluoto have been less than 10 mSv during the last three years. The individual radiation dose distribution of workers at the Olkiluoto and Loviisa nuclear power plants in 2009 is given in Appendix 2.

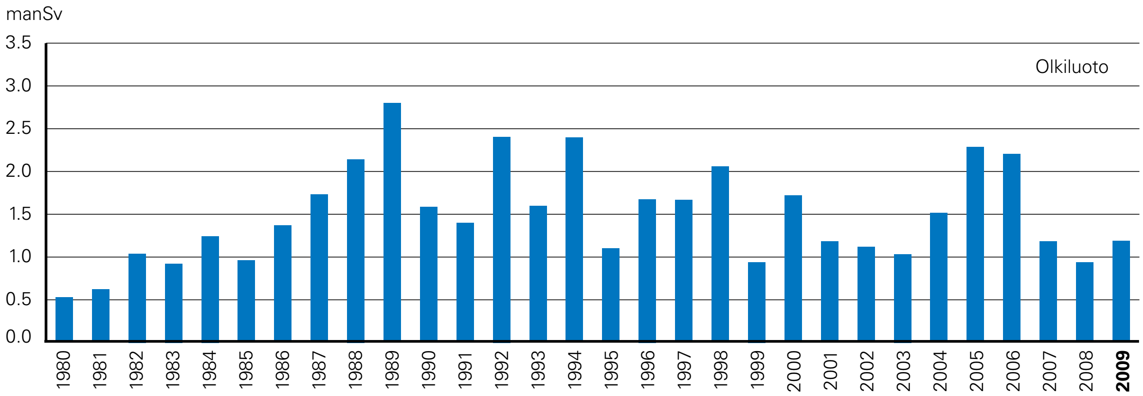


Figure 13. Collective occupational doses since the start of operation of the Olkiluoto units 1 and 2.

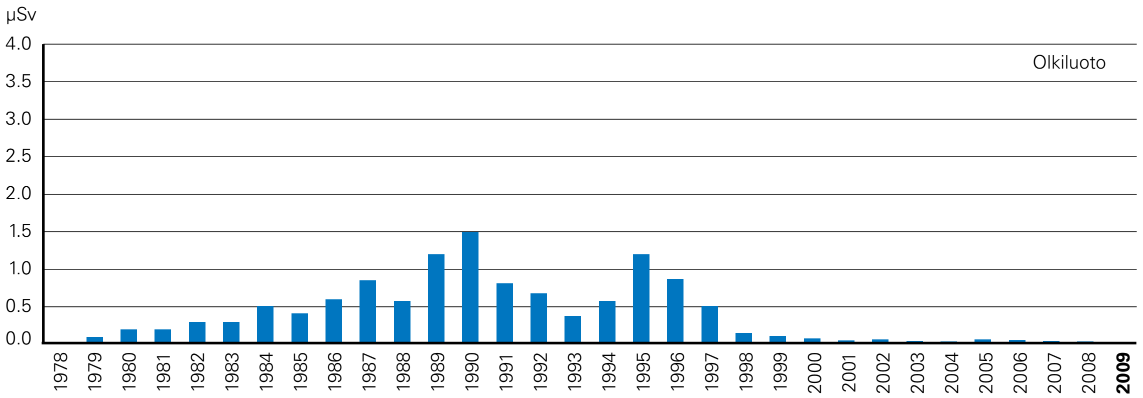


Figure 14. Annual radiation doses to the critical groups since the start of operation of the Olkiluoto units 1 and 2. Over the recent years, the doses to the critical groups has remained below one percent of the set limit, 0.1 milliSv.

Radioactive releases and environmental radiation monitoring

The measurement results of the replaced monitoring sensors of the site weather mast on-site were assessed in cooperation between STUK, the Finnish Meteorological Institute and TVO. The new sensors which were introduced in late 2008 and the data transmission has functioned well, with the exception of individual device failures. The weather measurement results produced by the upgraded weather measurement equipment are more precise than those of the removed sensors. The stability of air is measured with direct turbulence measurements using ultrasonic measuring technology. STUK, together with the Finnish Meteorological Institute, will check the values of the roughness parameters and their impact on dispersion calculation using the measurement results for 2009. Roughness parameter values are used for determining the stability of air flows.

STUK has earlier required the Olkiluoto plant to assess not only the development of the weather mast system on-site, but also that of off-site real-time additional measurements and the related predictive models with regard to the spread of any atmospheric releases. STUK, the Finnish Meteorological Institute and the power company have continued to investigate the issue. STUK granted TVO an extension of time until the end of 2011 to prepare a conceptual design plan completing the areal scope of the Olkiluoto weather measurement system.

The new measuring equipment of the external radiation monitoring network of the Olkiluoto NPP surroundings was commissioned in November 2008. The installed equipment is identical to that used in the nationwide radiation monitoring network of Finland. The Olkiluoto monitoring network has 14 radiation measurement stations, four inside the plant perimeter and 10 outside it.

Radioactive releases into the environment from the Olkiluoto nuclear power plant were well below authorised annual limits in 2009. No releases of radioactive noble gases into the environment were detected. Releases of radioactive iodine isotopes into the air were approximately 0.1 MBq, which is approximately 0.0001% of the authorised limit. The emissions through the vent stack also included radioactive particulate matter amounting to 29 MBq, tritium amounting to 0.3 TBq and carbon-14 amounting to approximately 0.8 TBq.

Table 5. Radioactive nuclides found in 2009 in the environmental samples in Olkiluoto, originating from the Olkiluoto power plant.

	Number of environmental samples containing radionuclides originating from the NPP (several different nuclides may be found in the same sample)		
Type of sample	**H-3**	**Mn-54**	**Co-60**
Air sampling	–	1	2
Aquatic plants	–	3	8
Seabed fauna (clams)	–	–	1
Sedimenting materials	–	–	7
Seawater	2	–	–

The tritium content of liquid effluents released into the sea, 1.9 TBq, is approximately 10% of the annual release limit. The total activity of other radionuclides released into the sea was 0.2 GBq, which is about 0.1% of the plant location-specific release limit.

The calculated radiation dose of the most exposed individual in the vicinity of the plant was about 0.03 microSv, i.e. less than 0.1% 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 15 minutes.

A total of 280 samples were collected and analysed from the terrestrial and aquatic environment surrounding the Olkiluoto power plant during 2009. External background radiation and the exposure to radioactivity of people in the surroundings are also measured regularly. Extremely small amounts of radioactive substances originating in the nuclear power plant have been observed in some of the analysed environmental samples. The amounts are so small that they are insignificant in terms of people's radiation exposure.

4.2.10 Emergency preparedness

STUK monitors the readiness of the organisations operating nuclear power plants to act in abnormal situations. No such situations occurred at the Olkiluoto power plant in 2009.

The emergency preparedness arrangements at the Olkiluoto power plant fulfil the key requirements; this was established during emergency preparedness inspections as part of the periodic inspection programme. The objects of inspection included securing of connections used for plant data transfer during preparedness situations at the operating Olkiluoto plant units and for Olkiluoto 3 now under construction, and emergency preparedness related to the commissioning of the new plant unit. The inspection also concerned training and mustering drills for the personnel working on the construction sites of Olkiluoto 3 and Onkalo concerning the evacuation of personnel from the site in case of an accident at Olkiluoto 1 or 2. A personnel mustering exercise was organised in the limited area of the Olkiluoto 3 construction site on 11 December 2009. Both nuclear power plants also organise fire training and drills, with the fire brigades of the plants and the fire and rescue services of the surrounding municipalities participating. Fire drills were organised at the Olkiluoto power plant site as follows: a cooperation drill at Olkiluoto 1 and 2 on 9 November 2009, a cooperation drill at the Olkiluoto 3 construction site on 20 April 2009 and a map drill on 2 December 2009. A fire drill was organised at the Onkalo site on 8 June 2009.

The licensee and public authorities have continued their co-operation for maintaining emergency preparedness. In 2009, a cooperation group of TVO and the authorities studied feedback from the rescue drill organised in Olkiluoto in 2008 and the implementation of development areas such as the improvement of exchange of information and creating a simultaneous status assessment, training of preparedness organisations and making communication with citizens more effective via the Internet

4.3 Regulatory oversight of the construction of Olkiluoto 3

4.3.1 Overall safety assessment of Olkiluoto 3

The overall safety assessment of Olkiluoto 3 is based on the observations made by STUK in the review of plans, the oversight of manufacturing, construction and installation, results of the construction inspection programme during construction, oversight of the plant vendor and its subcontractors, as well as experience acquired as a result of interactions between STUK, TVO and the plant vendor.

Detailed design of the plant systems continued in 2009. To some extent the plans still do not meet the objectives set for them in terms of quality and content, and hence STUK required further elaboration of the plans. STUK's decisions required improvements to be made in the design of systems which would further improve plant safety. The design of the systems must be completed before the requirements for the system's components can be finally specified, the components manufactured and the installation phase started. At the end of 2009, this was still ongoing for some process and electrical systems, but in particular for the I&C systems.

Regarding the I&C systems, STUK required the design of overall architecture preceding system design to be supplemented with unambiguous requirements for design, and that the I&C architecture created on the basis of the requirements is described. STUK required that the requirements set in STUK's guides and decisions for the I&C systems which back-up each other and for the failure criteria to be observed are taken into account in design. STUK also required that the realisation of the requirements for independence and failure criteria must be demonstrated by means of analyses. The first analyses submitted to STUK for demonstrating the realisation of failure criteria were not acceptable. The plant vendor and TVO must pay special attention to the completion of the design and assessment of the I&C systems, and to compliance with safety requirements.

Construction work at the plant site has made significant progress. Concrete construction has proceeded almost without problems, and the procedures created for determining readiness for concrete casting have proven to function well. The procedures have served to ensure that the plant vendor and TVO have inspected and approved the structure to be concreted and the plans for the concreting before STUK is requested to give permission to start the work.

The most significant construction-related steel structure is the steel lining of the containment building which ensures that radioactive substances are contained inside the containment building in an accident. In STUK's inspections, deviations were detected in the grinding of steel lining welds which the contractor, the plant vendor and TVO had not noticed during their own inspections. STUK requested TVO take measures in order to improve welding quality control. STUK had no remarks concerning welds performed later on, and TVO's quality control was considered to be sufficient in this regard.

At the end of 2009, the installation of the first Safety Class 2 pipelines started on the Olkiluoto 3 nuclear island. The oversight of the start of installation work and the assessment of TVO's installation supervision procedures, instructions and resources have been one of the focus areas in STUK's oversight activities in 2009. In October, STUK found deviations in pipeline welds which the subcontractor, plant vendor and TVO had not detected. Thus, the supervision of welding work was not adequate, due to which welding work was interrupted for improvement measures. The event revealed deficiencies in the plant vendor's and TVO's quality control similar to those detected earlier in connection with welding of the containment steel lining. STUK has required TVO also apply the quality control practices they have learnt from these events in the installation supervision of other safety-critical objects. It is also necessary that TVO follows and assesses whether the supervision and inspections carried out by the plant vendor are adequate and function well, and, if necessary, steers the plant vendor's work.

Of the Olkiluoto 3 main components, the reactor pressure vessel, steam generators and pressurizer are ready and delivered to the plant site awaiting for installation. However, the manufacturing of several other mechanical components, such as valves, pumps, heat exchangers and pipes, is still ongoing. During 2009, STUK carried out over 500 construction inspections related to manufacturing. It was necessary to interrupt some of the inspections due to the lack of the necessary prerequisites for the inspection. In many cases it has been a question of a need to complement manufacturing documentation or the incompleteness of manufacturing or related testing and inspection or its documentation. STUK has required that the plant vendor and TVO carry out the inspection phases preceding STUK's inspection well in advance before requesting that STUK visit the manufacturing site, not just before it or at the same time as STUK's construction inspection.

A major deviation was detected in the manufacturing of the primary circuit main coolant pipes in October 2009: an inspection carried out by the plant vendor and the licensee revealed repairs made by welding on the inside and outside surfaces of pipes. The welds had been made to repair some millimetre-deep notches which had emerged during manufacturing and inspections; these welds had not been documented during manufacturing. The technical assessment of the significance of the repairs was not completed yet at the end of 2009. The event demonstrated serious deficiencies in the pipe manufacturer's quality and safety culture, as well as in oversight carried out by the plant vendor and TVO, and in the guidance of subcontractors. Following the observation, STUK will carry out a repeated assessment of whether the manufacturer can be approved as a nuclear pressure equipment manufacturer.

With regard to the manufacturing of the electrical systems' main components, the most significant problems have related to taking into account electrical transient situations and environmental conditions in manufacturing and to the qualification of electrical devices containing software-based automation for nuclear power plant application. STUK has required that, in the design of electrical devices for Olkiluoto 3, such electrical transient situations must be taken into account which are not taken into account in a normal industrial environment and which have not been wholly taken into account in the basic design of an EPR plant. STUK has also required changes to be made in the radiation qualification of some electrical devices for ensuring the functioning of the devices in a possible accident condition. These devices include part of the motors of safety system pumps.

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

In 2008, STUK carried out an inspection concerning the safety culture at the Olkiluoto 3 construction site and named assessment and improvement as development areas. In 2009, STUK carried out a follow-up inspection on the construction site for inspecting the measures taken to assess and improve the safety culture. Based on the inspection, it was noted TVO has conducted a safety culture survey, established a safety culture team to follow and develop safety culture and hired a person who speaks with people on the construction site and observes the site safety culture. TVO has also defined safety principles for the construction site. STUK required TVO to continue the development and description of the construction site safety culture assessment method.

STUK has inspected TVO's preparations for plant commissioning and noted that the situation is good enough at this point. When Olkiluoto 3 starts commercial operation, the licensee will be responsible for three power plant units, two of which are identical boiling water reactor units and one is a pressurized water reactor unit. STUK has received from TVO the first plans for the coming operating organisation which comprises, in addition to the actual operating personnel, the necessary technical experts and maintenance personnel. STUK made a remark to TVO that the experience gained from the design and implementation of the systems during the construction of Olkiluoto 3 should be utilised as extensively as possible in plant operation. This means, for example, that the Olkiluoto 3 project should employ in all areas of technology people who will also work in TVO's operating organisation.

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. Manufacturing defects have either been corrected so that the original quality requirements are fulfilled, or it has been demonstrated by means of additional inspections or analyses that the requirements are fulfilled. The flaws in the work of different parties and in product quality have resulted in additional work to solve the problems. This has had an impact on the progress of the project, not on the fulfilment of its quality requirements. In summary, based on the results of regulatory activities, STUK can state that the original safety objectives of the plant can be achieved.

In 2010, it will be specially challenging for the plant vendor and TVO to manage the extensive installation of equipment and pipes. This will also be one of the focus areas of STUK's oversight in addition to inspections concerning the I&C systems.

4.3.2 Design and planning

Plant and system design

STUK continued to review the overall architecture of the I&C systems throughout the year. STUK has required that TVO and the plant vendor specify unambiguous requirements for the design of the I&C system overall architecture, and that the I&C architecture created on the basis of the requirements is described. In terms of safety, it is particularly important to specify unambiguous requirements for the independence of different I&C systems involved in the architecture, because different I&C systems back each other up. Another issue with particular safety significance has been the specification of the failure criteria to be observed in the I&C systems – the internal redundancy of the systems improves the reliability of their operation in device and other failures. STUK also required that the realisation of the requirements for independence and failure criteria must be demonstrated by means of analyses. During 2009, STUK has reviewed the first analyses demonstrating the realisation of failure criteria and noted that their scope is not sufficient.

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

STUK was supplied with an analysis of a situation where the air conditioning necessary for the cooling of electrical and I&C rooms is lost. An updated report is being reviewed by STUK.

In 2009, the plant vendor submitted to STUK reports on external and internal voltage and frequency transients at Olkiluoto 3; STUK approved most of them. In 2009, STUK also approved the plan for plant power cable routing. Further, STUK approved the cable dimensioning principles for Olkiluoto 3 with a few exceptions. Following the approvals, STUK gave permission to start the installation of electrical systems, devices and cables on the nuclear island in December 2009.

STUK continued to review the detailed design of process, support and electrical systems in 2009. Some modifications were made in the systems to improve their reliability and take into account the modifications to be made in the I&C controlling the systems.

The most important modifications are discussed in section *Design modifications*.

In addition to assessing the acceptability of the system modifications, STUK's inspection concerned in particular I&C and electrical design, how radiation protection issues are taken into account in system plan, and the failure analyses of the systems. There was still scope for quality improvement in system design, in particular in the descriptions of airconditioning and auxiliary systems. For this reason STUK required an update of the plans.

Transient and accident analyses

No new transient and accident analyses were submitted to STUK in 2009.

Probabilistic risk analyses (PRA)

In 2009, STUK assessed the realisation of the fundamental design principles affecting plant safety in the detailed design documentation for systems and structures.

The review work concentrated on the design of safety systems, reactor coolant pump protection concept against oil fires, cable fire safety, risk analyses of I&C systems and fuel handling systems, and heavy load drop analyses.

The objective was to ensure that adequate provisions have been taken against area events (such as internal fires and flooding) and external events in particular, and that the interdependencies of systems and possibilities for common cause failures have been sufficiently taken into account in plant design.

No significant needs for improving the design were detected in STUK's review. An update of the Probabilistic Risk Analysis (PRA) computer model was submitted to STUK for information as well as part of the PRA documentation.

Of the documentation related to risk analyses, STUK reviewed the methodology description of the risk-informed in-service inspection programme., description of the fire risk analysis method, report on the building-specific fire hazard analysis methods, and description of the human error analysis (HRA) method. The reliability assessment of the overall I&C architecture required by STUK was moved to 2010.

Radiation safety

As part of its inspection of process systems, STUK reviewed the requirements for radiation safety, such as radiation shielding, equipment layout, accessibility and decontamination possibilities. STUK approved the power company's reports related to the radiation shielding and radiation classification of rooms, and taking the ALARA principle into account in design work.

Fire safety at the plant

STUK reviewed structural fire hazard analyses (FHA), the purpose of which was to demonstrate that the plant structures will withstand the fire loads in fire compartments in all potential fire situations. In addition to the structural fire hazard analyses, STUK received for review fire hazard functional analyses (FHFA) showing the impact of fires on the safety functions of the plant. STUK required that the FHFA descriptions are subjected to a boundary analysis. A boundary analysis serves to ensure that no principal contradictions remain between the FHFA and probabilistic fire analyses (fire PRA). In addition, STUK required an assessment to be made of the adequacy of the fire compartmentation in large cable rooms in case of fire protection system failures in situations when e.g. fire dampers will not close or ventilation remains in operation.

In 2008, STUK contracted VTT to conduct an independent verification analysis of a reactor coolant pump oil fire inside containment. As a result of VTT's analysis, it was concluded that in a situation when the whole oil volume of a pump has burnt, the plant's safety functions are at risk. STUK required that the effects of mechanical damage and the extent of oil leaks in different failure situations must be assessed in more detail. STUK approved the fire safety concept submitted in 2009 describing measures to prevent large oil leaks and fires.

VTT continued to investigate the safety of Olkiluoto 3 specific fire-retardant (FRNC) power cables, which should self-extinguish when installed in bundles.. The fire characteristics of the FRNC cables proved to be better than what VTT estimated on the basis of the first tests in 2008. Based on VTT's study completed in 2009, it was concluded that the fire retardant characteristics of the tested cables are sufficient in design basis situations for cable room fire compartments, and that the projected fire compartment concept is sufficient. A corresponding study of FRNC type instrumentation cables will be conducted in 2010.

It was found out that flooding caused by a possible rupture in the fire water pipeline in the annulus space between the inner and outer (structural protection against aircraft crash) containment walls could threaten safety functions. A plan aiming at preventing flooding from the fire water system in the annulus space was submitted to STUK for review in 2009. The plan will be reviewed in 2010.

Design of components and structures

STUK continued the review of detailed plans for Safety Class 2 components and structures in 2009. The key objects of this review were the construction an work plans of concrete and steel structures, as well as the construction plans of pressure equipment. For pressure equipment, STUK received, in particular, many documents concerning the isometrics, supporting structures and stress analyses of pipelines. STUK relied on the assistance of consultants in this review work. STUK reviewed the documents referred to in YVL 3.8 containing input information related to qualifications of inservice inspections of pipelines. Another important documentation package was that related to the design and manufacture of valves. In addition to these, STUK reviewed the construction and manufacturing plans of equipment and structures related to fuel handling, as well as those of the most important hoisting equipment. The review of the final stress analysis of primary circuit main components was continued.

STUK received for review documents describing the environmental conditions of equipment in operational and accident situations. The documents present the temperatures, pressures, radiation conditions and vibrations caused by seismic events in which the equipment must be able to operate. The assessment of ageing management was continued in 2009.

Design modifications

As system design has become more detailed, STUK has required modifications to be made in order to improve safety. In early 2009, the plant supplier proposed modifications to the I & C system design for reducing the interdependencies between I & C systems. STUK did not approve the modifications as they were proposed, but instead required that the plant supplier should produce a less ambiguous description of I & C architecture and its requirements, as well as an analysis of the interdependencies between I & C systems. The processing of this issue will continue in 2010.

TVO and the plant supplier proposed design modifications regarding the operation of the reactor emergency cooling systems. STUK did not approve the design modification where the diversity principle (i.e. a different principle of operation) would not have been applied for cooling the motors of pumps required for emergency cooling. The plant supplier justified the modification by, among other things, lack of space in the room where the pump motors are located.

A design modification was made in 2009 to the nuclear fuel of Olkiluoto 3 with the intention of reducing the mechanical loads exerted on the fuel. The fuel modification documents were submitted to STUK for approval, and the matter will be further processed during 2010.

4.3.3 Construction

Construction oversight by STUK focused on the manufacturing and installation of Safety Class 2 steel and concrete structures in particular. STUK inspected the readiness to start the concreting of Safety Class 2 concrete structures and authorised the start of concrete casting. These concrete structures include the containment wall and its internal structures. Concrete casting has been rather successful from a technical point of view; in some castings concrete pumping to the casting object was interrupted from time to time due to power failures, but because of the short duration of the interruptions and long setting time of concrete, they had no significance for the quality of the cast structures. Following the interruptions, STUK required TVO to be prepared also for possible longer interruptions in concrete casting. The procedures to determine readiness to start concreting have proven to function well. These procedures have served to ensure that the plant vendor and TVO have inspected and approved the structure to be concreted and the plans for the concreting before STUK is requested to give permission to start the work.

Welding and installation of the cylindrical and dome sections of the containment steel lining were completed at the factory in Poland and on site in Olkiluoto. It was found in STUK's construction inspection of the welding of the steel lining that in places the weld had been ground too thin. The thin parts were repaired immediately. Because TVO, the plant vendor and the manufacturer had not detected these thinned welds while supervising the work and inspecting the welds, STUK requested TVO to present a report on quality control. Thanks to improvements in quality control, welds performed later did not require remarks in STUK's inspections, and TVO's quality control was considered sufficient in this respect.

4.3.4 Manufacture

Manufacture of main components

Of the primary circuit components, the reactor pressure vessel was put into storage at the plant site in early 2009. The manufacture of four steam generators and one pressurizer was also completed at the plant vendor's factory in St. Marcel, France. STUK oversaw the pressure tests performed on the equipment after manufacture and carried out a construction inspection before transportation to the plant site in the autumn of 2009.

STUK oversaw the manufacture of the reactor coolant pumps and the control rod drive mechanisms by regular visits to the plant vendor's factory in Jeumont, France. A test run of three coolant pumps was performed in the manufacturer's test equipment. The manufacturing of the internals of the reactor pressure vessel was supervised by STUK at Skoda's Pelzen factory in the Czech Republic. Through its supervision and inspections, STUK aims to verify the performance of the manufacturers, the plant vendor and the power company, and to ensure that the products comply with the requirements.

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

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

Manufacture of other equipment

During 2009, STUK supervised and inspected, besides the main components, the manufacture of Safety Class 1 and 2 pipelines, tanks, heat exchangers, pumps, valves and steel structures as well. STUK has maintained a permanent supervision at the German factory manufacturing pipeline prefabricates. The prefabrication of pipelines was also supervised at the Olkiluoto harbour. STUK also supervised and inspected the manufacture of fuel handling equipment and the polar crane intended for the containment.

In addition to supervising the manufacture of pressure equipment and steel structures, STUK has supervised and inspected the manufacture of emergency diesel generators used for emergency power supply. The emergency diesel generator which was dropped during transportation in 2008 was inspected with the machine disassembled. Based on the inspections, STUK concluded that the dropping had not caused any damage to the machine and gave permission to assemble it.

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 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 present. TVO and the plant vendor have now changed their supervision and inspection procedures so that the aim is to ensure readiness for inspection prior to STUK's inspection

4.3.5 Installation work

The installation of equipment with significant implications for nuclear safety commenced during 2009 in the reactor plant with the installation of the first pipelines and electrical cables with significant implications for safety. STUK paid special attention to installation supervision at the plant site with a view to tackling any possible flaws in installation work as soon as they occur. STUK inspected TVO's installation supervision in several inspections carried out in accordance with the inspection programme for the construction stage during 2009 in order to ensure the adequacy of TVO's supervision procedures. STUK has participated in quality audits carried out by the plant vendor and TVO at the plant site for subcontractors with significant implications for safety.

In early October, *it was found in conjunction of a site visit that incorrect welding parameters were used for welding Safety Class 2 pipelines: the welding current used was too high. The person performing the welding was also unfamiliar with the relevant welding instructions, nor was he able to tell who his supervisor was. STUK stopped the welding work immediately in that location and also issued a decision to consequently stop all welding work in other installation sites of this subcontractor because the supervision of installation work by the subcontractor, plant supplier and TVO was obviously inadequate. Following the event, the welders were provided with further training regarding welding instructions and adherence to them. The parties also improved their supervisory procedures so that STUK was able to give a permission to continue the welding work. The welding seams produced using too high current settings were inspected after the event. The investigation showed that the deviation had no impact on the durability of the final welds.*

4.3.6 Preparations for commissioning

The training of operating personnel for the plant and their induction continued during 2009. The future operating personnel participated in the processing of technical documents and in this way also became familiar with their future duties. STUK reviewed the training programme as part of the periodic inspection programme during construction. The inspection evaluated, among other things, how the future plant operators are prepared for simulator training and the readiness of test arrangements related to the regulatory qualification of the operators. No issues requiring rectification were observed in the inspections.

The processing of technical and administrative instructions for commissioning started with a wider scope during 2009. The content of preoperational test programmes was specified more in detail during the processing. STUK oversaw the preparations for commissioning as part of the periodic inspection programme during construction.

4.3.7 Organisation and quality management

Organisational changes took place in the quality assurance unit of the Olkiluoto 3 project during 2009. The most important of these changes was the nomination of a new manager. Since the manufacturing of equipment is about to be completed, the quality assurance unit is shifting the focus of its supervision from factory supervision to supervising the compliance with requirements of the installation and manufacturing organisations' activities at the Olkiluoto 3 site.

The observations concerning the operation of site organisations showed that the difficulties in quality management in the construction of Olkiluoto 3 continued. In 2009, STUK evaluated in particular the operations of the plant vendor's subcontractors working in nuclear island in terms of their compliance with requirements. It was noted in site audits carried out by the plant vendor and TVO that there were plenty of quality-management-related deviations in the operations of Areva's subcontractors. In some cases it was necessary to stop the supplier's work even repeatedly because basic preconditions for the work were missing. The subcontractors' work was hampered by, among other things, deficiencies in the management of materials, documents and working methods. Regardless of the flaws in procedures, the subcontractors' end products were as a rule implemented in accordance with the requirements imposed on them or they were repaired to comply with the requirements. Because the flaws in the subcontractors' operations were found only after the plant vendor's acceptance and evaluation process, it is possible that said process had been planned or implemented inadequately. This is why STUK required the licencee to review the actual evaluation processes and their impact instead of individual corrective actions.

STUK required TVO to improve their supervision with regard to the kick-off meetings between the plant vendor and their subcontractors. One of the objectives of kick-off meetings is to evaluate a new supplier's readiness to commence work in terms of quality management. TVO must plan their supervision activities to be timely and they must be extensive enough to make it possible to evaluate the appropriateness of decisions the plant vendor has made in order to determine a supplier's readiness in terms of quality management. It was required that supervision and its results are documented.

Handling of non-conformances is one of the main tools for ensuring the compliance of products with quality requirements. In 2009, TVO continued to work out procedures for non-conformances reporting and handling. TVO aimed to further improve their non-conformances handling procedure by means of systematic classification and analysis of non-conformances. TVO intends to utilise the results of non-conformance analyses in project management and decision making by assessing the results twice a year in management reviews. STUK continues to assess the functionality of non-conformance handling methods with regard to site operations in particular.

Flaws in the flow of information between different areas of technology and procedural flaws have also surfaced during the installation phase. The smooth flow of TVO's equipment installation management process concerning the Olkiluoto 3 project from a safety point of view was one of the focus areas of regulatory oversight by STUK in 2009. In 2009, STUK carried out an inspection of TVO's installation and manufacturing supervision, and two follow-up inspections. As a result of the observations made in the inspections, TVO was required to elaborate, among other things, its procedure and performance instructions, to ensure that organisations are aware of their duties and to ensure that the installation supervision organisation is made familiar with the procedures followed by different organisations during the installation phase of the Olkiluoto 3 project.

STUK's regulatory activities in 2010 will focus strongly on installation and manufacturing activities at the Olkiluoto 3 construction site. In order to support regulatory activities and decision-making, STUK will commision an external, independent review of the impact of TVO's equipment installation management process in the spring of 2010.

Safety culture at the Olkiluoto 3 construction site

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

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

Based on the inspection, STUK required TVO to further develop their operations with the aim of evaluating and developing on-site safety culture in a systematic way. This means that information and training measures are completed so that new people coming to the site are familiar with the safety principles to be observed at the site and are aware of expectations and alternative routes for bringing up drawbacks and problems. In addition, STUK required TVO to ensure that the new supervisors and inspectors of the plant vendor and their subcontractors working on safety-classified objects get sufficient induction training, and to present a continuous procedure for overseeing that on-site communication is ensured.

TVO has submitted to STUK a plan for taking into account the requirements set in the inspection. STUK will follow up the implementation and effectiveness of these actions during 2009 in conjunction with its own inspections.

4.3.8 Nuclear waste management

STUK inspected and approved the pre-inspection material for the solid low- and intermediate-level waste processing system. Nuclear waste management during construction was inspected in conjunction with a periodic inspection. The inspection dealt with the progress of Olkiluoto 3 plant unit construction, personnel training and increase in personnel, state of documents and procurement of equipment needed for waste processing.

The method chosen for the processing of intermediate-level waste at Olkiluoto 3 is drying in drums. TVO suggested in the construction permit material that the drums are embedded in concrete cases and disposed of in the silos for intermediate-level waste (KAJ Storage) in the repository for current nuclear waste (VLJ Storage) . It turned out in practice that the solution is difficult to implement because the dimensions of the final disposal packages differ from those of the final disposal packages of the waste from the operating units. This makes it difficult to place the packages. In addition, embedding in a concrete case is technically demanding.

TVO presented to STUK a new procedure which will be proposed in conjunction with the operating licence application. In this procedure, waste dried in drums is stored in an existing radioactive waste storage facility at the plant site and later on disposed of in a repository designed for this new waste type and to be excavated at VLJ Storage. Preliminarily STUK considered this suggestion acceptable because provisions for extending VLJ Storage have already been made. It is necessary to monitor the condition of the waste drums during long-term storage.

Extension of spent fuel storage

TVO has planned to start the extension of the Olkiluoto spent fuel storage (KPA Storage) with three additional pools in 2010. In 2009, the Ministry of Employment and the Economy specified the licence process for the extension at TVO's request so that construction will be carried out under the operating licence for Olkiluoto 1 and Olkiluoto 2, and the construction permit for Olkiluoto 3. STUK gave the Ministry of Employment and the Economy a statement concerning the licence process. In accordance with the Ministry of Employment and the Economy's decision, the extension is regarded as modification work, and STUK will make a decision concerning the safety of construction on the basis of TVO's conceptual design plan. In 2009, STUK established an oversight project for inspection work and drew up a plan for reviewing the conceptual design plan. TVO submitted the conceptual design plan to STUK for approval in December 2009.

4.4 New NPP projects

Assessment of environmental impact of the planned nuclear facilities and land use planning

The environmental impact assessment (EIA) for Fennovoima's nuclear power plant project was completed when the company submitted supplements to the report on the environmental impact assessment required by the statements of the Ministry of Employment and the Economy and the environmental authorities.

STUK has issued statements required for the project on the land use planning concerning the drafts for local detailed plans for Hanhikivi in Pyhäjoki and Karsikkoniemi in Simo and on proposals for phased regional land use plans related to nuclear power. The safety zones entered in the prepared regional plans include the population centres situated on the border of the said area in their entirety.

In Olkiluoto, the process of town planning is underway. Its purpose is to amend the town plan for the nuclear plant site because of the spent fuel disposal operations. STUK issued a statement on the town plan proposal to the municipality of Eurajoki. STUK had no remarks concerning the town plan proposal.

Preliminary safety assessments of the projected nuclear power plants

TVO's Olkiluoto 4 project

Teollisuuden Voima Oyj (TVO) is planning to build a new Olkiluoto 4 plant unit with 1,000 to 1,800 MW of electrical power in Olkiluoto, Eurajoki. In the application for a decision-in-principle, TVO presents five plant options, two of which are boiling water reactors and three pressurized water reactors. At the decision-in-principle phase, it is STUK's task to assess whether there are any factors showing that there are not sufficient preconditions for building a safe nuclear facility. The preliminary safety assessment comprises an evaluation of TVO's organisation and the location of Olkiluoto.

On 29 May 2009, STUK submitted to the Ministry of Employment and the Economy a preliminary safety assessment of the Olkiluoto 4 project and a related statement by the Advisory Committee on Nuclear Safety. In its statement STUK concludes that the nuclear facilities suggested by TVO can be constructed to comply with Finnish safety requirements. All the plant options, however, do not fulfil safety requirements as they are. The character and scope of the necessary modifications vary. For some plant options relatively small modifications would suffice, whereas other options would require more extensive structural modifications. Technical solutions for some of the necessary modifications are open.

With regard to the organisation, STUK estimates that TVO has the prerequisites for creating a management system for the construction and operation of a new plant unit which would allow the realisation of safety and quality management, and good safety culture.

Geological, hydrological and seismological surveys of the Olkiluoto 4 site location did not reveal any factors which would present an obstacle to building a new plant unit or related extensions of nuclear facilities in Olkiluoto. STUK has evaluated the suitability of the projected site location for its purpose as well as preconditions for the implementation of safety and preparedness arrangements, nuclear waste management and nuclear safeguards. Final disposal of the spent fuel from the Olkiluoto 4 unit is assessed by STUK in a separate preliminary safety assessment of Posiva's decision-in-principle application for an extension of the repository to accommodate spent nuclear fuel from the Olkiluoto 4 unit.

Fortum's Loviisa 3 project

Fortum is planning to build a new Loviisa 3 plant unit with 1,200 to 1,700 MW of electrical power on the southern tip of Hästholmen island, Loviisa. In the application for a decision-in-principle, Fortum presents five plant options, two of which are boiling water reactors and three pressurized water reactors. At the decision-in-principle phase, it is STUK's task to assess whether there are any factors showing that there are not sufficient preconditions for building a safe nuclear facility. The preliminary safety assessment comprises an evaluation of Fortum's organisation and the site location.

On 5 October 2009, STUK submitted to the Ministry of Employment and the Economy a preliminary safety assessment of Fortum's decision-in-principle application for the construction of a third nuclear power plant unit in Loviisa and attached to it a statement by the Advisory Committee on Nuclear Safety. In its statement STUK concludes that the plant options suggested by Fortum do not fulfil Finnish safety requirements as they are, but it is possible to modify the plants to comply with the requirements. For some plant options relatively small modifications would suffice, whereas other options would require more extensive structural modifications. Technical solutions for some of the necessary modifications are open. In STUK's opinion, the necessary additional work and modifications can be done at later stages of the licence procedure.

With regard to the organisation, STUK estimates that Fortum has the prerequisites for creating a management system for the construction and operation of a new plant unit which would allow the realisation of safety and quality management, and good safety culture. Fortum is also prepared to allocate a sufficient number of competent personnel to project implemetation.

The survey of the Loviisa 3 plant site location did not reveal any factors which would present an obstacle to building a new plant unit or related extensions of nuclear facilities. STUK has evaluated the suitability of the projected site location for its purpose, as well as preconditions for the implementation of safety and preparedness arrangements, nuclear waste management and safeguards. The evaluation considered, among other things, geological and seismological conditions in the area, sea water level, weather phenomena and the impact of climate change on them. Final disposal of the spent fuel from the Loviisa 3 unit is assessed by STUK in a separate preliminary safety assessment of Posiva's decision-in-principle application for an extension of the repository to accommodate spent nuclear fuel from the Loviisa 3 unit.

Fennovoima's nuclear power plant project

Fennovoima has applied for a Government decision-in-principle on building a nuclear power plant with electrical power of 1,500 to 2,500 MW. The power plant would consist of one or two nuclear power plant units. Fennovoima has three plant options, two of which use a boiling water reactor and one with a pressurized water reactor.

On 20 October 2009, STUK submitted to the Ministry of Employment and the Economy a preliminary safety assessment of Fennovoima Oy's decision-in-principle application for the construction of a nuclear power plant in Pyhäjoki, Ruotsinpyhtää or Simo. In its statement STUK concludes that the nuclear power plants suggested by Fennovoima can be constructed to comply with Finnish safety requirements.

The suggested plant options do not fulfil Finnish nuclear safety requirements as they are, but STUK estimates that it is possible to make them comply with the requirements at later stages of the licence procedure. To achieve this, the plant designs must be changed.

With regard to the suggested site locations – Pyhäjoki, Ruotsinpyhtää and Simo – STUK states that in none of the locations do the conditions contain any features which would present an obstacle to building a new nuclear power plant in compliance with safety requirements. It is also possible to implement the necessary safety and preparedness arrangements in all the locations. There are no existing nuclear power plants in any of the suggested municipalities. Concerning the projected site locations, extensive surveys of geology, seismology, availability of cooling water from the sea, and climatic and other environmental factors, such as oil transportation and air traffic, have also been conducted.

With regard to the final disposal of nuclear waste, STUK evaluated the suitability of the suggested locations for a final disposal facility placed in the bedrock and final disposal of very low-level waste in the soil. The evaluations studied geological, seismic and hydrological features of the areas and surveys of natural resources located in the vicinity of the suggested site locations. In STUK's opinion, it is possible to implement final disposal of nuclear waste in a safe manner in all three site options.

Regarding intermediate storage of spent nuclear fuel, the evaluation concluded that the suggested wet and dry storage solutions can be implemented in a safe manner. For the final disposal of spent nuclear fuel, Fennovoima's application presented a plan which, according to STUK's assessment, is in compliance with statutory requirements and which, in terms of its scope, is sufficient for the decision-in-principle phase. The presented development and implementation plans for final disposal are preliminary. The implementation of the final disposal of spent nuclear fuel requires a separate decision-in-principle process.

STUK estimates that Fennovoima has the prerequisites for creating a management system for the construction and operation of a new plant unit which would allow the realisation of safety

http://www.stuk.fi/ydinturvallisuus/ydinvoimalaitokset/uudet_laitosyksikot/en_GB/uudet_laitosyksikot/

and quality management, and good safety culture. Fennovoima is also prepared to allocate a sufficient number of competent personnel to project implementation.

At STUK, the safety assessment work on the new nuclear power plant projects was organised in the form of a separate oversight project which ended after the safety assessments were completed.

4.5 FiR 1 research reactor

The FiR 1 research reactor has continued to operate regularly. It has been possible to give two radiation treatments per week to patients at the reactor. In addition, the operations included research-related isotope irradiation commissioned by external enterprises and basic training in reactor physics.

STUK regularly assesses and reviews the safety documents on the FiR 1 reactor required by the Nuclear Energy Decree. In 2009, STUK approved the revised preparedness manual of the reactor. STUK carried out inspections on the operational safety, physical protection and emergency preparedness, nuclear safeguards and radiation protection of the FiR 1 reactor in accordance with the annual plan. STUK's remarks concerned, among other things, the repair of the control rod drive mechanism, the change of the person working as a production manager, training of the personnel responsible for quality matters, and nuclear safeguards.

The personnel and training plan drawn up on the key duties of the FiR 1 reactor operating personnel continues to concern the training and duties of, among others, the person responsible for physical protection.

STUK approved the new person in charge of nuclear material issues in May 2009. In December, an examination of new supervisors and operators was arranged at the FiR 1 reactor, and the documents were submitted to STUK for approval. Supervisor licences were renewed for two persons and operator licences for three.

The nuclear safety of the FiR 1 reactor, the condition of its structures, systems and components, as well as the human resources and the related operating plans, are sufficient for continued operation. The current operating licence period will expire at the end of 2011. The Ministry of Employment and the Economy, STUK and VTT have started preparations for a licence application and its processing.

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 ongoing 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 transfered to the State.

In 2001, Parliament ratified the decision-in-principle issued by the Government in the year before that the final disposal of spent nuclear fuel in the bedrock at Olkiluoto is in line with the overall good of society. The decision-in-principle states that the spent nuclear fuel disposal project may proceed to the construction of an underground research facility and more detailed investigation. With this statement, the Government 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.

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

In 2009, the disposal project and its regulatory oversight were at stage two, the "research construction stage". Research, development and analysis work related to the safety and technology of final disposal continued and so did the site investigations from above ground and in Onkalo with the aim of ensuring the suitability of the disposal site. The construction of Onkalo continued as planned in 2009.

5.1 Regulatory oversight of the Onkalo underground rock characterization facility

The construction of Onkalo is divided into five excavation stages. In 2009.excavation stage four was being implemented. During the year, the construction of the access tunnel proceeded from chainage 3,310 metres to over 4,055 metres (to a depth of about 385 metres). The disposal is projected to be implemented at a depth of 420 metres, and the technical facilities of Onkalo at a depth of 437 metres. STUK's oversight covered geological mappings 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

Posiva's construction organisation and its operating methods were focus the Onkalo construction inspection programme. In addition, STUK did regular inspections 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 follows:

- The excavated access tunnel penetrated a few water-conducting structures, which were sealed by means of injections. Rock bolting to reinforce the rock proceeded to about 4,020 metres. The inlet air shaft was bored from below upwards and now reaches a depth of 290 metres. The boring of the inlet and exhaust air shafts between 290 and 440 metres was prepared by sealing the rock with grouting. STUK carried out six inspections in order to give permission for shotcreting of excavated rock surfaces. The aim of the inspections is to ensure the sufficient scope and correctness of the survey data before the rock surfaces are covered by shotcreting.
- The impact of excavation on the surrounding bedrock was regularly discussed at site monitoring meetings. During the year, two investigation niches were completed; they serve the development of excavation methods and studies related to rock mechanics and groundwater. Posiva provided STUK with the plans for rock mechanics investigations for review.
- In addition to regular site inspections, STUK carried out a review of Onkalo documentation which covered the plans for compiling as-built Onkalo documentation and part of the quality assurance documentation of grouting and reinforcement.
- The installation of heat, water, air conditioning and electrical systems in Onkalo continued as planned.

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

- the design of Onkalo
- management of the excavation damaged zone (EDZ)
- processing of safety issues
- drilling in the Onkalo area
- site supervision carried out by Posiva
- keeping groundwater leakage into Onkalo small, grouting (too much groutting can disturb the bedrock's chemical conditions which secure the slow corroding of the copper canisters)
- use and amount of foreign materials which could disturb the bedrock's chemical conditions (for example explosives, concrete, fuels)
- Onkalo's impact on bedrock flow conditions (pumping water from Onkalo can change the natural flow of groundwater).

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

- improvement of grouting instructions and stricter control of use of approved foreign materials
- development of the analysis of groundwater disturbances caused by Onkalo
- taking into account STUK's approval practices in construction drawing review and control procedures
- improvement of some instructions concerning excavation and drilling
- improvement of plans for submission of and responsibility for documentation to be submitted to STUK.

STUK's regulatory oversight of Posiva's subcontractors was based on the safety significance of the work they perform. STUK participated in the following Posiva's audits: SK-Kaivin, the excavation contractor for Onkalo, and Kalliosuunnittelu Oy, carrying out rock engineering design for Onkalo.

Construction document reviews

At the end of 2008, Posiva revised the plans for Onkalo's construction so that the lower research level (below 520 m) will not be implemented. STUK assessed long-term safety implications of the modifications and implications on the research of the Olkiluoto bedrock. Posiva was requested to provide a report on how the modification of the access tunnel routing will affect the disturbances of bedrock properties caused by construction and how Posiva intends to ensure the adequacy of bedrock data and the development of the bedrock classification system (RSC) after the modifications. According to Posiva's report the modification does not have any long-term safety implications. Posiva's report also included new plans for characterising the bedrock from Onkalo and for the development of the RSC. In addition to the modifications in the Onkalo lay-

out, Posiva submitted to STUK for review a report on a modification in the following implementation stage of Onkalo (stage five). The modification will reduce the bedrock volume to be excavated before the construction license, and in this way also bring down the disturbances caused by Onkalo.
Based on the safety analyses conducted, STUK saw no obstacles to approving the suggested modification.

Due to the modifications in Onkalo and the design of Onkalo's systems becoming more detailed, STUK requested Posiva to update the report corresponding to the preliminary safety analysis report for Onkalo and submit it to STUK for approval. The documentation submitted by Posiva describes, among other things, the design bases of the Onkalo systems, their implementation and the consequences of possible malfunctions. STUK approved the documentation but requested that how the requirements set by standards and the long operating life are taken into account be specified in more detail. At the same time, STUK reviewed the main drawings describing the implementation scope of Onkalo. Posiva's plan follows the decision-in-principle's line concerning the final disposal facility, thus STUK, based on the conducted safety analyses, saw no obstacles to approving the report.

STUK reviewed Posiva's application for approving the person in charge of the construction of Onkalo. STUK arranged an examination to ensure that the person is suitable for the task with regard to experience and familiarity with the construction of Onkalo. STUK approved the person in charge of the construction of Onkalo to assume responsibility, considering Onkalo's scope of implementation, for duties equivalent to those of a director in charge of the construction of a nuclear facility.

Posiva submitted their updated management system for approval at the end of 2008. STUK inspected whether Posiva had taken into account the remarks made in the previous review and approved the management system with remarks. The review shows that Posiva still needs to pay attention to the operating methods employed when introducing suppliers and subsuppliers to Posiva's safety and quality policy.

Excavation is causing damage to the bedrock close to the rock surface. The increase in fragmentation may have safety implications, especially for the tunnel sections which are near the deposition holes. For that reason, it is one of the factors possibly affecting Onkalo's long-term safety which Posiva's management system has placed under special monitoring. Posiva started preparations for excavating a niche intended for investigating the damaged zone caused by excavation. In April, STUK reviewed the project plan for the research undertaking; the progress of research will be monitored at monthly meetings at the construction site.

STUK reviewed the updates of Posiva's rock construction standard designs. 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.

Posiva presented to STUK a delivery plan for Onkalo plans and an update of the construction communication plan and accordingly submitted research plans for Onkalo (for example, plans for groundwater measuring stations, a pilot drilling plan, and a research plan for a test to study bedrock spalting).

In addition, STUK reviewed the plans submitted by Posiva for information. The plans concern bedrock design for Onkalo, the heat, water, air conditioning and electrical systems of Onkalo and Onkalo research work.

5.2 Reviews of safety documentation

During the year, STUK evaluated a plan for final disposal safety documentation. STUK's evaluation focused on the safety case as a whole, its content and its implementation in terms of schedule, taking into account the needs set by the construction licence application. STUK concluded in its evaluation that, from the point of view of the construction licence application, the plan presented by Posiva is sufficient in its scope, and no issues have been observed which would prevent the safety case from being approved. There are, however, sections which require more improvement such as more detailed definition of safety functions, description of probable and improbable scenarios and their hierarchy, and quality management in the generation of the safety case. During 2009, STUK completed the evaluation of two safety case documentation sets for final disposal (the safety analysis and so-called process documentation of a horizontal deposition solution) and started the evaluation of one safety case documentation (the description of the final disposal site) and the review of Posiva's three-year research, development and planning documentation (TKS-2009). This work will continue in 2010. STUK also reviewed approximately seventy research reports. Their main subjects were mainly site survey results and final disposal technology.

In its reviews, STUK has identified issues which warrant further investigation or analysis for their safety significance, or the safety implications of which are not fully known at this time. The safety issues are related to encapsulation and disposal technology, site confirmation/investigation and safety assessment methodology. These issues are discussed in semiannual meetings between STUK and Posiva. The 2009 meetings were focused on the licence applicant's and STUK's preparations for the construction licence stage, and discussions of the safety case evaluation. In addition to Finnish experts, STUK was supported by experts from Sweden, the United Kingdom, Germany and the USA.

Encapsulation and disposal technologies

STUK's review of the safety analysis of a horizontal deposition solution (KBS-3H) was completed at the end of September. In its review, STUK took account of the needs of the forthcoming construction licence application. According to STUK, the documentation is a major step forward and it covers the requirement areas of the safety case . It is considered that the flaws in the technical feasibility of a horizontal solution and in the presentation of the safety analysis can be largely supplemented by the construction licence stage. The analysis of one separate canister serving as a basis for the long-term safety assessment is not sufficient to be granted a construction licence. The actual uncertainty analysis is missing and there is scope for further elaboration in the event development analysis and its presentation. In addition, putting the horizontal solution to use presumes that the solution is included in the forthcoming construction licence application.

Repository site

Posiva continued to survey the eastern part of the Olkiluoto island using research excavation and drilling three new deep boreholes, which, as well as being used for geological surveys, were also used for the geophysical and hydrological studies required for modelling and, at the beginning of 2010, for geophysical hole measurements and optical imaging of the hole.

In 2009, STUK started the combined review of a repository site description (Olkiluoto Site Description) and a classification system describing the suitability of the bedrock. Repository site descriptions comprise all geological, rock-mechanical and chemical research data, as well as research data describing groundwater properties and flows. This research data has been accumulated as a result of years of research of the Olkiluoto bedrock. The rock suitability criteria for the bedrock direct the detailed design of the repository facilities and the choosing of the location of the deposition holes. In addition, STUK reviewed research reports related to site surveys concerning, *inter alia*, the results of the Olkiluoto seismic station network, ground and bedrock surveys, hydro-geological modelling and the impact on the bedrock of the heat generated by spent nuclear fuel.

Regulatory oversight of safety analysis and safety case development

STUK's review of the so-called process documentation concerning characteristic features, events, natural phenomena and their development in the repository facilities was completed in April. STUK considered the documentation to be mainly prepared in a systematic and clear way, but stated in the remarks, among other things, that:

- the procedure employed by Posiva is not sufficient to ensure that the characteristic features, events and phenomena with long-term safety significance have been comprehensively identified and included in further processing;
- the description and justification of developments deemed probable and improbable developments detrimental to long-term safety are still too meagre.

Review of preliminary construction permit documentation

The Ministry of Employment and the Economy required in 2003 that Posiva submit so-called preliminary construction licence documentation for the final disposal facility in 2009. The preliminary construction licence documentation refers to documentation equal to the documentation of a construction licence application pursuant to the Nuclear Energy Act. It indicates which parts of the documentation required by the construction permit are still insufficient and what the schedule is for its completion. STUK drew up a draft review plan for the large documentation. Posiva Oy submitted on schedule the application documentation pursuant to Section 32 of the Nuclear Energy Decree at the end of the year, when STUK began to review it. In the first stage, STUK will review the scope of the material, and after that the review will focus on content requirements.

Regulatory oversight of Posiva's safety studies

Posiva's safety studies are based on Posiva's own projects and on long-term bilateral or multilateral collaboration projects. The majority of the bilateral research projects are included in the collaboration between Posiva and SKB, Sweden. The most significant multilateral research projects are the integrated projects NF-PRO, FUNMIG, PAMINA and THERESA within the EU's sixth framework programme, in which Posiva and Finnish research institutes are participating. In addition, Posiva is participating in the international DECOVALEX project. In addition to technical and scientific benefits, international collaboration will increase openness concerning Posiva's activities among the international scientific community; STUK considers this openness to have a significant impact promoting safety and the safety culture. STUK reviewed Posiva's research work by evaluating its quality and adequacy, as well as the results of research work.

To the extent that Posiva employed and will employ the results of R&D conducted by others directly in the activities regulated by STUK, STUK reviews this work in the same way as the operation and output of Posiva's other subcontractors. Depending on the safety significance, STUK follows the activities of the participating organisations through inspections, by participating in audits performed by Posiva, and in connection with document processing, meetings, construction inspections of components and structures, and construction site and laboratory rounds.

5.3 Regulatory oversight of disposal facility extension projects

Posiva submitted an application for a decision-in-principle for an extension of the spent nuclear fuel repository facilities for the spent fuel of Olkiluoto 4 in April 2008, and correspondingly for the spent fuel of Loviisa 3 in March 2009. STUK provided the Ministry of Employment and the Economy with a statement and a preliminary safety assessment concerning the extension of the repository facilities for the spent fuel of Olkiluoto on 29 May 2009 and for the spent fuel of Loviisa 3 on 2 October 2009.

In the preliminary safety assessments, STUK assessed Posiva's applications for decisions-in-principle in accordance with the safety requirements of the Nuclear Energy Act and Government Decree 736/2008. The preliminary safety assessments dealt with the following subjects:

- implementation manner and timing of final disposal
- organisational requirements
- design of encapsulation and final disposal facility
- nuclear safeguards
- operating capability of barriers
- demonstration of compliance with safety regulations
- radiation safety

STUK concluded in its assessment that the suggested disposal solution is in compliance with the Nuclear Energy Decree and that the implementation schedule is flexible enough and in compliance with the decisions of the Ministry of Employment and the Economy. Posiva's organisation was deemed to be adequate for the current implementation stage. The plans for the encapsulation and final disposal facility were deemed to be sufficiently detailed and appropriate at this point. The safety assessments of the operation of the facilities and the transportation of nuclear fuel demonstrate compliance with safety regulations concerning them to the extent which is necessary for a decision-in-principle.

The extension is to be implemented by constructing the facilities at one level in the eastern part of the Olkiluoto island, the bedrock of which is still rather unexplored. This fact and transitions taking place in the bedrock in the long term require more research. The optimal layout of the repository facilities in the bedrock, as well as the minimisation of detrimental effects of their construction, operation and closing on the bedrock, require method development and testing.

The demonstration of long-term safety is based on the safety case for a horizontal deposition solution, research conducted over 30 years and the multiple barriers principle. Successive barriers are composed of engineered and natural barriers complementing each other. On the basis of these, STUK stated that the final disposal solution projected in the extension application and the suggested site have the capabilities to fulfil the requirements imposed on long-term safety.

5.4 Joint convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management

The Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management requires that the states that have joined the Convention prepare a report every three years on how the obligations stated in the Convention are met. The reports are assessed country by country at a joint meeting of the parties. In 2009, the parties convened for the third time at a joint review meeting in Vienna. Altogether, 48 countries have joined the Convention, which is far less than there are countries with radioactive waste (about 200). STUK played an active role at the review meeting and acted as one of the presiding officers for one group of countries.

Finland's report received a favourable response. In addition to questions (approximately 130) received before the meeting, further questions were answered at the meeting. The meeting considered the following to be good practices: the persistent work and progress of Finnish nuclear waste management, the strong role and technical competence of the regulatory authorities, proactive communication and active measures to pass competence from one generation to another. Challenges were pointed out in the continuation of the spent fuel disposal programme according to its objectives, the resources of the authorities and licence applicants in a changing operating environment and the retirement of baby boomers. The report is available at the STUK website (http://www.stuk.fi/julkaisut/stuk-b/stuk-b96.html).

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 in Finland 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. Finland has in place a national state system of accounting for and control of nuclear material (SSAC), maintained by STUK. Provisions on the control system are laid down in section 118 of the Nuclear Energy Decree, and its purpose is to carry out the safeguards for the use of nuclear energy that are necessary for the non-proliferation of nuclear weapons. In addition, STUK's task is to attend to the control pertaining to international agreements in the field of nuclear energy signed by Finland.

International safeguards are implemented by the International Atomic Energy Agency (IAEA) and the European Commission's Directorate General for Transport and Energy, Directorates H and I, currently the Directorate General for Energy, Directorates D and E, called 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 to the Safeguards Agreement (INFCIRC/193/Add.8). EU safeguards are based on the Euratom Treaty and Commission Regulation EURATOM 302/2005. According to Section 63 of the Nuclear Energy Act, STUK's presence is required in all inspections performed by the IAEA and the European Commission in Finland.

The Additional Protocol entitles the IAEA to gather more information on activities in the nuclear field. States must declare to the IAEA the nuclear facility sites, research and development projects related to the nuclear fuel cycle, as well as the manufacture of certain, separately defined, components in the nuclear field and their export. 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 nuclear activities in a state.

Combined, the regulatory control under the Nuclear Safeguards Agreement and that under the Additional Protocol constitute Integrated Safeguards. In Integrated Safeguards, the IAEA performs fewer routine inspections, but it has the option of carrying out random interim inspections giving a short period of notice to facilities or activities related to the nuclear fuel cycle. This allows the IAEA to verify that the member state has no undeclared activities related to the nuclear fuel cycle, and that the member state complies with its obligations under the Nuclear Non-Proliferation Treaty. The IAEA's integrated safeguards control began in Finland on 15 October 2008. The efficient implementation of the IAEA's Integrated Safeguards in Finland is made possible by the national control system maintained by STUK. STUK has increased its inspector's capabilities to participate in the IAEA's Unannounced Inspections (UI) or short notice random inspections (SNRI). In parallel with the development of the IAEA's regulatory control, the Commission also developed its inspection activities. In 2009, the number of inspections carried out by the IAEA and the Commission decreased significantly: in 2008 the IAEA carried out altogether 26 and the Commission 25 inspections, whereas in 2009 the IAEA carried out only

11 inspections and the Commission 13 inspections. As expected, the number of inspections by STUK remained the same as in previous years; STUK carried out a total of 40 inspections in 2009.

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

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

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

The technical analysis methods applied in safeguards contribute to ensuring that nuclear materials and operations are in accordance with the declarations and that there are no undeclared activities or materials. STUK applies non-destructive assay methods and environmental sample analyses to verify that the information declared by the facilities regarding nuclear materials and their use, e.g. 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

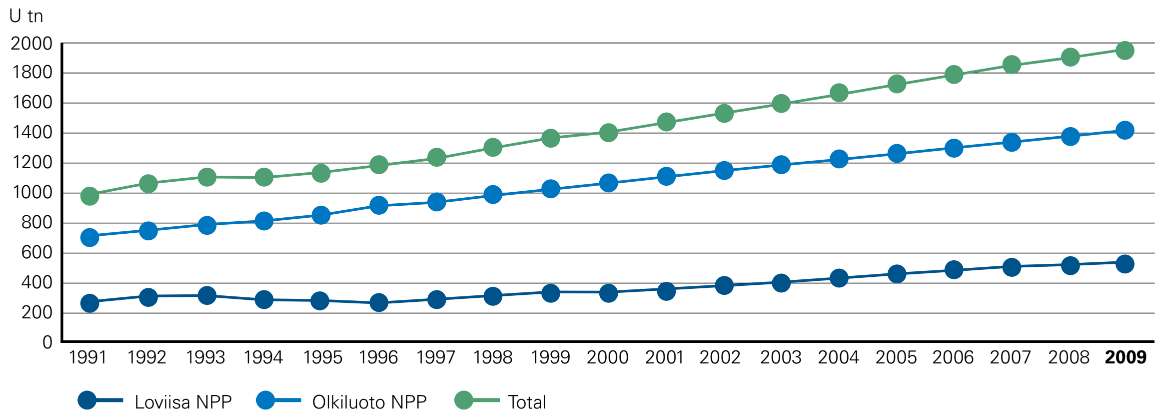


Figure 15. Amount of uranium in Finland.

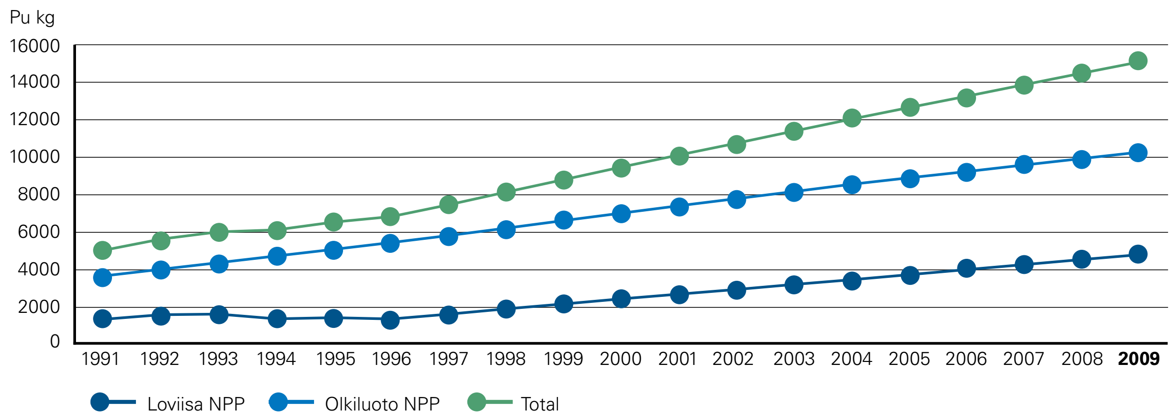


Figure 16. Amount of plutonium in Finland.

Table 6. Amounts of nuclear materials in Finland 31 December 2009.

Location	Natural uranium kg	Enriched uranium kg	Depleted uranium kg	Plutonium kg	Torium kg
Loviisa plant	–	540 477	–	4 809	–
Olkiluoto plant	–	1 417 833	–	10 273	–
VTT / FiR 1 research reactor	1 511	60	~0	–	–
Other facililties	~ 2344	~ 1,7	~ 1694	~ 0	~ 5

by material category are shown in Figures 15 and 16 and in Table 6. The licences granted by STUK pursuant to the Nuclear Energy Act are listed in Appendix 4.

Regulatory control of the transfer of nuclear items

In order to prevent the proliferation of nuclear weapons and sensitive nuclear technology, STUK controls the transfer of nuclear items and provides expert assistance to 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. Permission from STUK, as well as a transport plan and safety plan approved by STUK, are required for the transport of nuclear materials. Customs and STUK co-operate in preventing illegal import and export at Finnish borders.

Nuclear security co-operation between authorities to prevent illegal activities

Another objective of the regulatory control of nuclear materials is to ensure that appropriate security arrangements are in place for nuclear materials. 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'.

Cooperation in the field of nuclear security includes co-operation with Customs in investigating anomalies observed in radiation monitoring at borders and in developing these radiation monitoring operations. It further includes participation in the national network of authorities aimed at preventing illegal CBRN activities and acting as the national contact point for the Illicit Traficking Database (ITDB) maintained by the IAEA to keep records of observed anomalous events regarding nuclear materials and radiation sources.

Regulatory control of the disposal facility

Final disposal of nuclear fuel in inaccessible underground premises 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 long-term storage. STUK has obliged 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 activities relevant to nuclear safeguards exist in the final repository area.

The objective of the early implementation of nuclear safeguards at the final disposal facility is also to enable international regulatory organisations to take care of their regulation obligations in an appropriate way: The IAEA must be convinced that, with regard to final disposal, there are no undeclared nuclear activities in Finland either. The Commission, on the other hand, makes sure that the operator employs adequate measures for carrying out nuclear safeguards in a facility for which experience of regulatory control is not found elsewhere 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 state.

In early 2009, the IAEA and the Commission finalised the official Design Information Questionnaires needed for declaring the Basic Technical Characteristics (BTC) of a final disposal facility. In November 2009, Posiva Oy submitted the preliminary BTC of the final disposal research facility, Onkalo. The delivery of the Basic Technical Characteristics has made it possible to initiate international nuclear safeguards of final disposal.

6.2 Nuclear safeguards, activities and results in 2009

Licences and approvals

In 2009, STUK granted eight import licences, one export licence and one transfer licence for nuclear materials to Teollisuuden Voima Oy, and two import licences to Fortum. An import licence was granted to VTT FiR 1 for plutonium standard materials from the IAEA. OMG Kokkola was granted a licence to produce, store and possess natural uranium which is generated as a by-product of processing industry.

STUK approved four transport plans for fresh nuclear fuel. In 2009, fresh fuel was imported by Finnish nuclear power plants from Sweden, Spain and Russia. In addition, STUK granted a transport licence for spent nuclear fuel and approved a transport plan for spent nuclear fuel. STUK granted approval for three types of transport package design.

STUK approved the responsible person for nuclear safeguards of VTT FiR 1 in 2009. STUK also approved the responsible manager for nuclear safeguards of the Radiation and Nuclear Safety Authority and her deputy and the deputy of the new responsible manager of OMG Kokkola Chemicals. STUK also approved the updated nuclear safeguards manuals of the Olkiluoto and Loviisa power plants.

In 2009, STUK approved six new Euratom inspectors and 44 new IAEA inspectors to carry out inspections in Finland.

Declarations pursuant to the Additional Protocol to the Safeguards Agreement

Declarations pertaining to Finland, required under the Additional Protocol, totalled 18 in 2009, and they were submitted within the time limits set out in the Protocol. STUK inspected the received declarations and sent the annual reports to the IAEA. STUK also sent the IAEA quarterly the details of entries pursuant to the Additional Protocol. Euratom submitted to the IAEA the declarations pertaining to Finland under its responsibility.

Inspections as part of regulatory control of nuclear materials and activities

In 2009, STUK carried out a total of 40 safeguards inspections in Finland. Of these, the Commission participated in 13 and the IAEA in 11 inspections. STUK carried out 10 inspections at the Loviisa nuclear power plant; the Commission and the IAEA participated in two of these inspections. STUK carried out 19 inspections at the Olkiluoto nuclear power plant; the Commission and the IAEA participated in seven of these inspections. The IAEA initiated two short notice random safeguards inspections, which both were carried out at Olkiluoto NPP. STUK and the Commission carried out one joint physical inventory verification of the FiR 1 research reactor operated by VTT.

In 2009, STUK verified data on nuclear materials and their use by means of applying non-destructive methods to 25 spent fuel assemblies at the Olkiluoto power plant and to 106 spent fuel assemblies at the Loviisa power plant. Furthermore, a measurement campaign was planned to be carried out at the Olkiluoto power plant using a new tomographic measurement device but, due to the failure of the device's commissioning test, it was necessary to postpone the campaign to 2010.

STUK inspected two transports of fresh fuel and one transport of spent fuel in 2009. The records of international transfers of nuclear fuel owned by TVO were inspected with respect to the fuel consignments destined for the Olkiluoto power plants in 2009 and with respect to natural uranium in TVO's storage facilities outside Finland.

STUK carried out three periodic inspections of the final disposal facility construction site. The inspection verified that the underground premises of the final disposal facility's Onkalo part are as declared. The IAEA and the Commission participated as observers in one inspection of Onkalo. The IAEA and the Commission will define the Design Information for this new type of facility for their monitoring purposes. A planning meeting was organised with the IAEA and the Commission in June and November regarding the implementation of monitoring. In December, STUK delivered the BTC of the final disposal facility prepared by Posiva through the Commission to the IAEA.

On the basis of inspections and swipe sample analyses carried out by STUK, it was found that the licensees and other operators had appropriately fulfilled the obligations of nuclear non-proliferation, and that no unreported materials or activities existed.

The IAEA conducted a Complementary Access to the Olkiluoto plant site at two hours' notice and another one to the VTT site at 24 hours' notice. STUK and the Commission participated in both Complementary Accesses.

The results of the inspections and audits show that Finnish plants implement their nuclear safeguards well. No materials or operations conflicting with the notifications were observed, and the inspected materials and operations corresponded to the notifications submitted by the facilities. The IAEA and Euratom made no remarks concerning the inspections. All of the facilities operated in a way that facilitated STUK's fulfilment of the obligations of the international agreements in the nuclear field signed by Finland.

Upgrade of radiation control at the borders

Customs and STUK launched a joint project for revising radiation control at the borders. The project is called RADAR. The project will be implemented in 2009–2014. The project includes equipment purchases, an update of common operational methods and instructions, as well as a training plan and provision of training together with Customs School. The 2009 budget was EUR 0.9 million, which was used for updating control equipment at the eastern border, replacing outdated electronics and purchasing neutron detectors. Purchases for Customs also included manual measuring devices which are also able to detect radioactive matter. The devices will be handed over in March 2010. STUK and Customs School started to design a training programme for customs officers together with the European Commission. The first training course will be delivered in early 2010.

STUK began the exchange of information through the Illicit Tracking Database (ITDB) maintained by the IAEA to keep records of observed irregularities regarding nuclear materials and radiation sources. STUK acts as a contact point for the database in Finland.

Illicit Trafficking Database (ITDB) maintained by the IAEA.

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. Finland ratified it in 1999. Adherence to the Treaty is monitored by means of an international monitoring system which, when complete, will comprise 321 monitoring 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, hydroacoustic or infrasound waves. The measurement results of the monitoring system are available to all Member States.

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

The National Data Centre (NDC), which is based on the CTBT and operates in conjunction with STUK, contributed to the work of the Preparatory Commission in establishing a cost-effective organisation that is functional from the Finnish perspective. The automatic analysis software used for the NDC's own routine monitoring analysed on average about 700 spectra per day towards the end of 2009. Routine monitoring is facilitated by an alarm system transmitting data on unusual observations to NDC personnel. During 2009, backup systems were developed for the NDC.

The DPRK nuclear test on 25 May 2009 was clearly detected by the seismic devices of the CTBT monitoring network. Underground tests usually do not release radioactive particles to the atmosphere, but it is often possible to detect radioactive xenon gas. This was not detected this time by the CTBT network, neither have any other parties reported such observations in public. For about a week after the event, STUK provided the cooperation partners daily with situational pictures both prepared by the CTBTO and based on STUK's own analyses.

7 Safety research

The purpose of publicly funded safety research is to ascertain that the authorities have adequate expertise available, including concerning unforeseeable issues affecting the safety of nuclear facilities. Safety research is divided into two research programmes, of which SAFIR2010 focuses on nuclear power plant safety and KYT2010 on strategic analyses of nuclear waste management. The projects under the research programmes are selected annually on the basis of a public call for projects. The projects selected for the programmes must be of a high scientific standard and their results must be available for publication. The results must have a broader scope of applicability than the nuclear facility of a particular licensee. Funding is not granted for research which is directly connected with projects licensees or parties representing them carry out for their own needs or for research which is directly provided by nuclear energy regulatory oversight. STUK controls this research by contributing to the work of the programmes' steering and reference groups. Every year, The Ministry of Employment and the Economy ascertains that the proposed set of projects meets the statutory requirements and STUK's research needs related to nuclear safety. STUK issued its statement on the projects under the publicly-funded SAFIR2010 research programme for 2009 in January, and a corresponding statement on the KYT2010 programme in February. Research results were pre-

Nuclear safety research in Finland

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

Public research programmes related to nuclear safety currently operational in Finland are the nuclear power plant safety research programme SAFIR2010 (2007–2010) and the national nuclear waste management research programme KYT2010 (2006–2010).

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 avail****able on the websites of the research programmes at http://virtual.vtt.fi/virtual/safir2010/ and http://www.ydinjatetutkimus.fi/index.html.*

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.

sented at seminars dedicated to the SAFIR2010 and KYT2010 research programmes (websites: http://virtual.vtt.fi/virtual/safir2010/ and http://www.ydinjatetutkimus.fi/tiedotteetmain.html).

The core areas of the SAFIR2010 programme are fuel and reactor physics, the structural safety of the reactor circuit, thermal hydraulics and accident analyses. A slightly lesser focus is placed on organisations and human factors, automation and the control room, and the employment of probabilistic risk analysis in safety management and control. The funding of the SAFIR2010 research programme totalled €7.0 million in 2009, which represents about half of nuclear facility safety research in Finland. The research programme provided funding to 31 research projects in various areas of research. The areas of research under SAFIR2010 and their shares of the total funding are shown in Figure 17.

The SAFIR2010 safety research programme supports the safe operation of existing nuclear power plants, and also prepares for the development of the capabilities required by new plant projects. The expertise created during the research programme has been utilised, *inter alia*, in assessing the safety of the new Olkiluoto 3 plant unit under construction. Experts, calculation methods and test equipment have been deployed on issues related to the ageing management of plant materials, structures and equipment and to the review of accident analyses, and, in particular with regard to the Olkiluoto 3 plant unit, to assessing the quality and manufacturing methods of reactor circuit pipelines, to estimating the fire resistance of cables and to ensuring that requirements regarding aircraft impact are met.

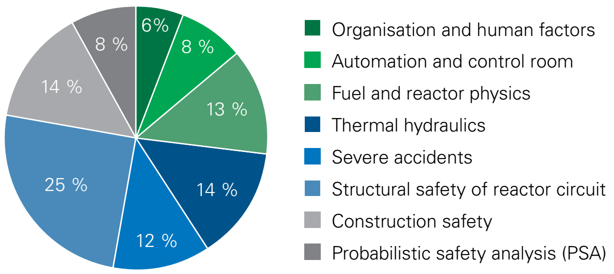


Figure 17. Research areas of SAFIR2010 programme and their shares of the total funding in 2009.

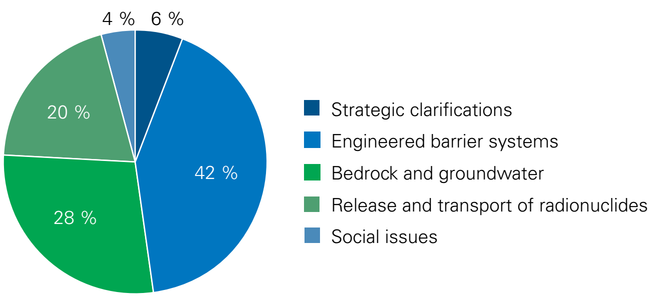


Figure 18. Research areas of KYT2010 programme and their shares of the total funding in 2009.

Twenty-seven applications were received for the KYT2010 programme for 2009, 19 of which were accepted. The total budget of the programme was €1.7 million. The projects represented all subjects of the research programme – safety assessment, strategic studies and studies of social impact. The KYT steering group gave its funding recommendations to the Ministry of Employment and the Economy, relying on the assessments of the support group. The studies mainly concentrated on the safety assessment of final disposal of nuclear fuel, such as engineered barriers (8), bedrock and groundwater (3), and the release and transportation of radionuclides (6). In 2009, the programme included also one social research project and one strategic research project. Figure 18 shows the relative shares of these areas of the total funding. A total of 24 research project proposals were submitted for 2010, and the work of evaluating them is in progress.

In 2009, the development of the processes and methods of the KYT2010 programme continued in the form of preparing guidelines describing the procedures for the implementation of the framework programmes and annual programmes, and setting up a working group for establishing a national training provision for nuclear waste management. Furthermore, working groups investigated the possibility of establishing a nuclear waste management competence centre and enhanced the support group's activities to follow the progress of research projects.

8 Enforcement of regulatory oversight of nuclear facilities

8.1 Review of documents

In all, 4,121 documents were submitted to STUK for review in 2009. Of these, 1,815 concerned the nuclear power plant under construction, and 138 were related to the final disposal of spent nuclear fuel. A total of 3504 document reviews were completed, including documents submitted in 2009, 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 93 days. The number of documents and their average review times in 2005-2009 are shown in Figure 19. Figures 20, 21 and 22 present the distribution of document review times for the different plant units.

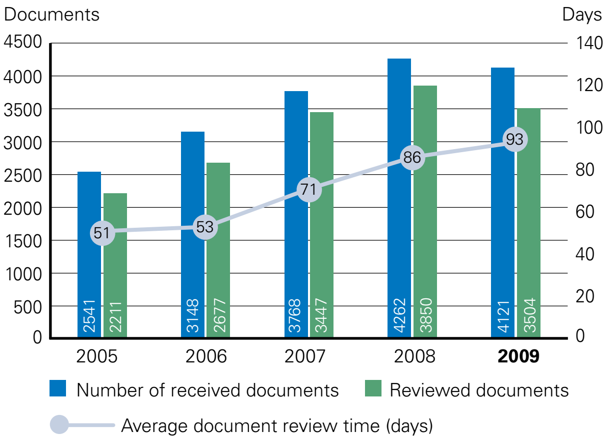


Figure 19. Number of documents received and reviewed as well as average document review time.

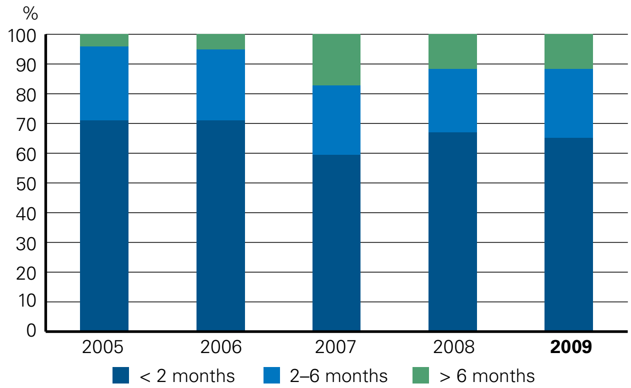


Figure 20. Distribution of time spent on preparing decisions on the Loviisa plant.

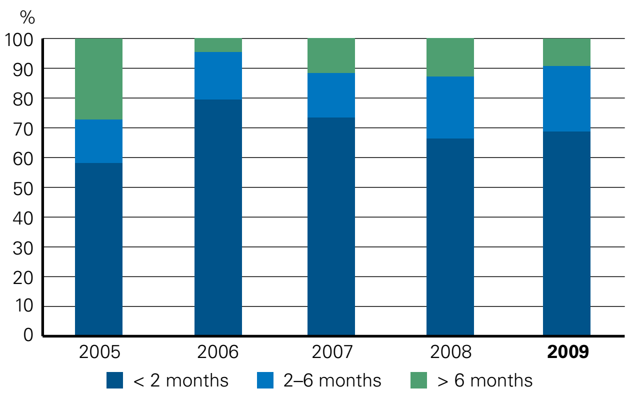


Figure 21. Distribution of time spent on preparing decisions on Olkiluoto plant units 1 and 2.

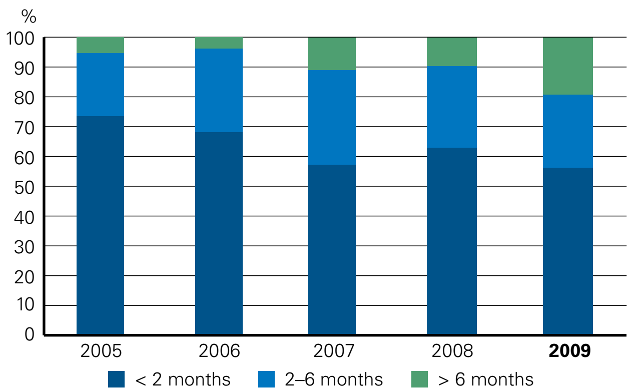


Figure 22. Distribution of time spent on preparing decisions on Olkiluoto plant unit 3.

8.2 Inspections on site and at suppliers' premises

Inspection programmes

In 2009, STUK carried out 18 inspections at the Loviisa power plant and 17 at the Olkiluoto power plant in accordance with the periodic inspection programme (Appendix 5). STUK carried out 14 inspections within the Olkiluoto 3 construction inspection programme (Appendix 6) and eight inspections within the Onkalo construction inspection programme (Appendix 7). The findings of the inspections are presented in the chapters on regulatory oversight.

Other inspections at plant sites

A total of 1,110 inspections on site or at suppliers' premises were carried out in 2009 (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, 594 were related to the regulatory oversight of the plant under construction and 516 to that of the operating plants . Relevant documents are reviewed prior to on-site inspections.

The number of inspection days on site and at component manufacturers' premises totalled 3085. 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 241 inspection days outside normal working hours were spent at operating nuclear power plants, mostly during annual maintenance outages, as well as 113 inspection days at the plant under construction. Six resident inspectors worked at the Olkiluoto power plant and two resident inspectors at the Loviisa power plant. The number of on-site inspection days in 2005–2009 is shown in Figure 23.

8.3 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 2009, the costs of the regulatory oversight of nuclear safety subject to a charge were €16.0 mil-

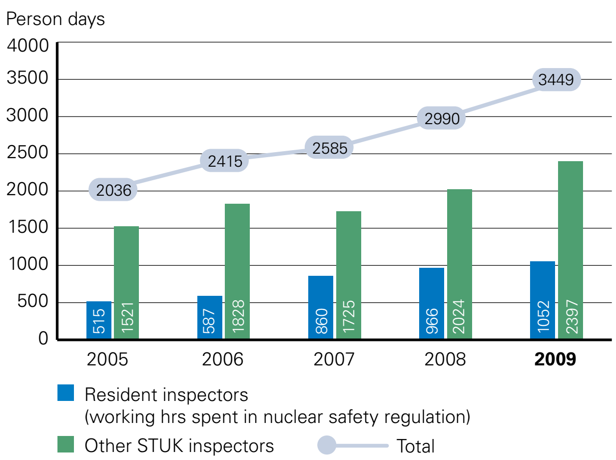


Figure 23. Number of inspection days onsite and at component manufacturers' premises.

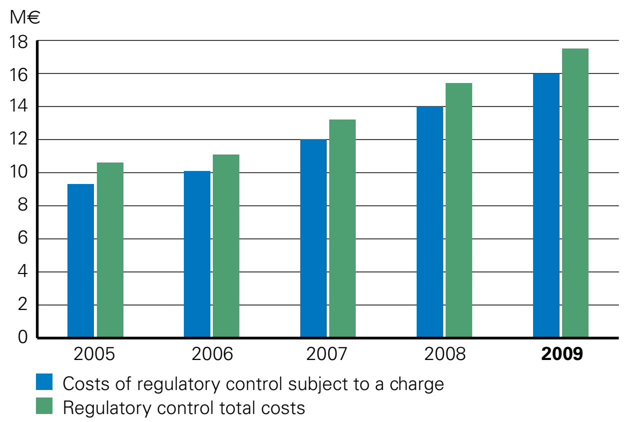


Figure 24. Income and costs of nuclear safety regulation.

lion. The total costs of nuclear safety regulation were €17.5 million. Thus the share of activities subject to a charge was 91.4%.

The income from nuclear safety regulation in 2009 was €16.0 million. Of this, €2.5 million came from the inspection and review of the Loviisa nuclear power plant and €9.4 million from the Olkiluoto nuclear power plants. In addition to the operating plant units, the income from the Olkiluoto plant includes that derived from the regulatory oversight of the Olkiluoto 3 construction project. The income from the regulatory oversight of the Loviisa and Olkiluoto nuclear power plants also includes the costs invoiced for the safety assessment of the new nuclear power plant projects. The income derived from the safety assessments of Fennovoima's nuclear power plant project was about €240,000. The income from the inspection and review of Posiva Oy's operations was €2.0 million. Figure 24 shows the annual income and costs from nuclear safety regulation in 2005–2009.

The time spent on the inspection and review of the Loviisa nuclear power plant was 11.3 person-years, i.e. 8.5% of the total working time of the nuclear regulatory personnel. For Olkiluoto nuclear power plant's operating units it was 12.0 person-years, which accounts for 9.0% of the total working time. In addition to the monitoring of the operation of nuclear power plants, the figure includes nuclear material control. The time spent on inspection and review of Olkiluoto 3 was 33.6 person-years, i.e. 25.2% of the total working time. Work related to the new power plant projects accounted for 2.6 person-years, i.e. 2.0% of the total working time. The time spent on nuclear waste management inspection and review was 8.5 person-years. The time spent on international co-operation regarding regulatory oversight of nuclear safety was 5.3 person-years, and that spent on the FiR 1 research reactor was 0.1 person-years. The working time spent on small-scale users of nuclear material was 0.01 person-years. Figure 25 shows the division of working hours of the personnel engaged in nuclear safety oversight (in person-years) by subject of oversight in 2001–2009.

Where necessary, STUK commissions independent safety analyses and research in support of regulatory decision making. Figures 26 and 27 show the costs of nuclear safety research in 2005–2008. In addition to technical support projects, the 2005 figures also reflect the costs of national nuclear safety research. The costs for 2009 mostly relate to reference analyses and independent assessments made for the plant unit under construction and to the reviews of safety documentation for the final disposal of nuclear waste. Appendix 8 lists STUK-financed, nuclear power plant safety-related commissions completed in 2008. The reviews of the safety documentation for the final disposal of nuclear energy are discussed in section 5.2.

The distribution of the annual working time of the nuclear safety regulatory personnel to different duty areas is shown in Table 7.

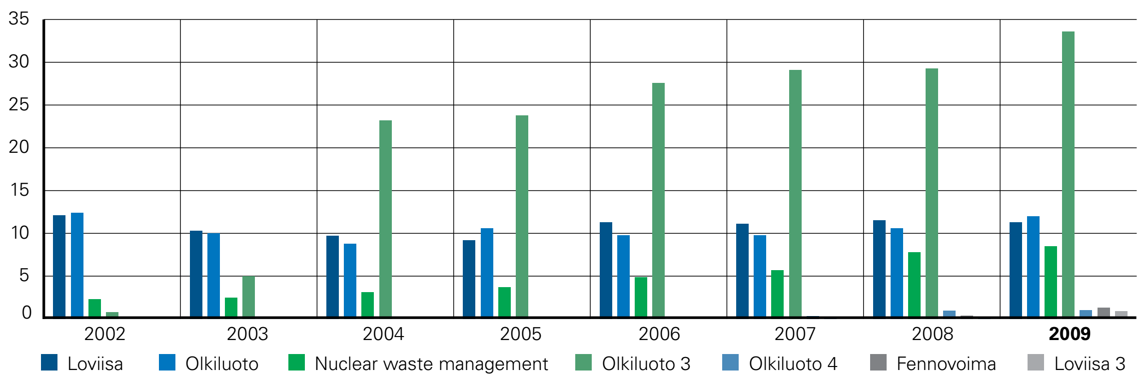


Figure 25. Distribution of working hours (person-years) of the regulatory personnel by subject of control in 2002–2009.

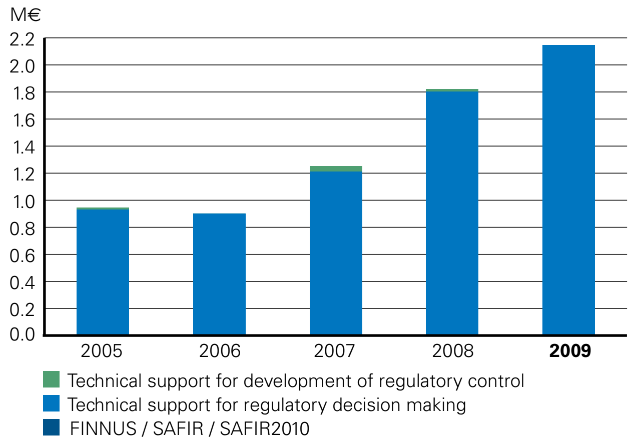


Figure 26. The costs of research and commissioned work pertaining to the safety of nuclear power plants.

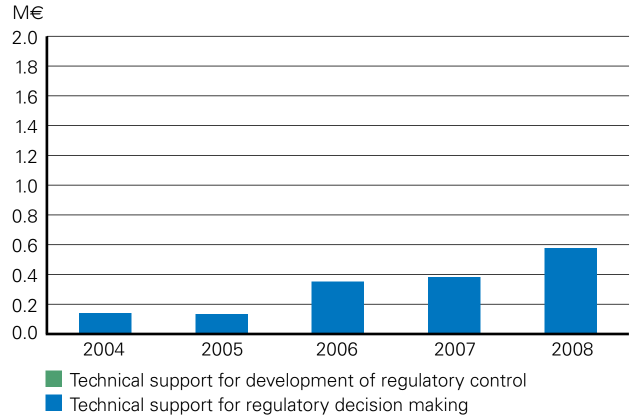


Figure 27. The costs of research and commissioned work pertaining to nuclear waste management and nuclear non-proliferation.

Table 7. Distribution of working hours (person-years) of the regulatory personnel in each duty area.

Duty area	2005	2006	2007	2008	2009
Basic operations subject to a charge	47.1	53.6	55.7	60.7	68.0
Basic operations not subject to a charge	7.2	5.7	6.1	6.3	6.6
Contracted services	3.3	3.0	2.2	2.2	1.7
Rule-making and support functions	27.5	28.8	30.3	31.5	33.6
Holidays and absences	16.9	20.0	19.1	21.1	23.5
Total	101.9	111.0	113.4	121.8	133.5

9 Development of regulatory oversight

9.1 STUK's own development projects

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

A total of 21 guides were updated in the quality manual for nuclear safety regulation, and two new guides completed. The new guides apply to external expert groups in nuclear waste management and to conveying data on exceptional events related to nuclear materials and other radioactive materials to the database maintained by the IAEA. Updates were required due to, for example, new upper-level regulations, changed procedures, the organisational change carried out in the Nuclear Reactor Regulation department, and the changes in persons responsible for various tasks.

STUK's internal regulations preparation process was enhanced

The development of STUK's internal process for preparing regulations continued during the year. The guides in STUK's quality system concerning drafting of regulations were evaluated and updated, the Regulations team consisting of representatives from different departments was regularised, and due to feedback received, the structure and naming of YVL Guides now being revised were reconsidered and clarified. Changes took place in persons coordinating and managing regulations work at department level. STUK nominated a director who is responsible especially for the preparation of safety regulations in STUK's mandate. The director reports to the Director General.

Review of nuclear waste management by international regulatory authorities

STUK arranged a European peer review of the regulatory authorities' operations in nuclear waste management on 2–6 November 2009. The reviewers were invited from all EU member states and also from Norway, Switzerland and the European Commission. The objective was to receive a detailed collegial assessment of the level of our regulatory control and suggestions for the development of the safety assessment of a nuclear facility of a new type. The review was carried out using the IAEA's international peer review model and safety criteria.

Eleven reviewers participated in the review, that is from practically all EU countries using nuclear energy (Belgium, the Czech Republic, France, Hungary, Lithuania, Slovakia, Rumania, Sweden, Switzerland, the UK). The review group set to work on, among other things, management of nuclear waste regulatory control, safety assessment work, inspection activities, preparation of safety regulations, adequacy of competence and organisation, resource and training issues, and corporate relations.

The review group's recommendation to STUK was that the safety regulations and instructions should be elaborated to be more detailed and focusing more on the future stages of nuclear waste management. The group identified persistent nuclear waste work and the efficiency of the regulatory system as good practices and a useful lesson to other EU countries.

The results and an action programme based on them are available at STUK's website (http://www.stuk.fi/stuk/fi_FI/palveluksessasi).

International review of physical protection

As a commission from the Ministry of Employment and the Economy, an International Physical Protection Advisory Service mission (IPPAS) pertaining to Finnish nuclear facilities and radiation sources was carried out by the IAEA on 22 June–3 July 2009. The assessment concerned legislation and other regulations related to physical protection, authority activities and practical implementation of physical protection.

An expert team of seven persons participated in the assessment. The team had discussions with experts representing many different official organisations and visited Finnish nuclear power plants and some facilities where radiation is used.

The assessment team observed several good practices in Finland and compiled several recommendations and proposals to further improve physical protection and its monitoring. After the IPPAS mission, STUK's resources in physical protection oversight and coordination of oversight have been strengthened.

Based on the results of the assessment, an action programme has been drawn up, according to which an interim report was prepared on the status of the implementation of the actions at the end of January 2010. All the necessary actions will be carried out by the end of 2010.

Faltering start for the records management system

Records management software covering all STUK's activities was introduced. The new software combines STUK's earlier separate records and registers. The introduction of the records management solution also required that STUK's earlier records management plan (AMS) was reviewed and updated.

During the implementation of the software, technical flaws were still detected in some of its functions due to which, for example, the introduction of electronic workflows had to be postponed. Also abundant feedback from the users necessitated reconsidering some choices made in the original requirement specification. After the commissioning some critical corrections and modifications were made without delay, which made it possible to continue the commissioning. The records management system was named the SAHA system and at the end of 2009 it was available to all at STUK for preparing and recording official documents. The development needs of the system have been systematically collected and in this respect the work will continue in the next few years.

Electronic inspection records will be introduced

Over 10 different inspection record forms have been used in nuclear safety regulation. The manual procedures for these protocols in their current format do not allow optimal information management, such as reports on the effectiveness of STUK's own operations, compilation of statistics on inspection observations and follow-up of remarks made in inspections. In early 2009, work with the system supplier's experts started. The project continued in the spring of 2009 with the designing of forms, and the first model records were introduced for trial in the summer of 2009. The project has made progress, and the first inspection records will be put into service in 2010.

Regulatory control of final disposal project

Processing of construction permit applications

During 2009, STUK worked out the processing of the construction permit application for the final disposal and encapsulation facility for spent nuclear fuel. In this connection the requirements for these facilities set forth in related STUK YVL Guides were looked through. The purpose of this was to chart which of the requirements concerning primarily nuclear facilities concern final disposal of spent fuel.

Regulatory control of the manufacture of the bentonite buffer and copper canister

Since 2008, procedures have been developed and documentation prepared for the regulatory control of the manufacture and installation of the canister and the buffer material as well as backfill, and for quality verification. The aim is to be able to control the quality of the manufacture of the canister and other EBS (Engineered Barrier System) components, and the success of installation. The documentation will be revised later on to form part of the renewed YVL Guides and/or of STUK's internal operational guides (YTV Guides). A dialogue with the licence applicant has been set in motion.

Assessment of the long-term safety of final disposal

STUK strengthened its capabilities to analyse the long-term safety of final disposal of spent fuel by purchasing the first version of the Ecolego software. The programme can be used for conducting comparative independent analyses, and in this way the main results of a preliminary safety analysis can be assessed, as well the long-term safety significance of the initial data and assumptions used in the analysis. The long-term objective is the assessment of the significance of the open safety issues in Posiva's licence projects and consequently the prioritisation of resources for the assessment of the whole licence project.

Requirements management system

A browser-based requirements management system was under development by STUK in 2009. The purpose of the system is to improve the dialogue between the regulatory authorities and mainly Posiva, as well as the traceability of correspondence. Also, the most important issues from transactions between Teollisuuden Voima Oy, Fortum Oy and Nuclear Waste and Material Regulation are recorded in the system.

9.2 Renewal and human resources

Training was organised for STUK inspectors on nuclear power plant systems and regulatory operations, for example. New STUK inspectors participated in a national training programme in the nuclear safety field (the YK course), which STUK organises together with other actors in the field. The total duration of the sixth YK course was 19 days in six periods. Three phases took place in spring 2009. Nine STUK employees participated in the YK6 course. In autumn 2009, the YK7 course began with ten STUK inspectors participating. The total number of participants in the YK7 course was 65.

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

In 2009, a Master of Science thesis (Mikko Aho, Configuration Management in Automation System Projects, 2009) was completed at the department of Nuclear Reactor Regulation. The thesis examines factors and procedures related to configuration change management in automation systems. In configuration management, leadership and procedures employed by the organisation often play a bigger role than technology. A lot of changes are often made in big projects. Hence it is important that all parties share a common point of view and guidelines for configuration management.

On average, 10.6 days per inspector in the field of nuclear waste and materials regulation and 9.5 days per inspector in the field of nuclear reactor regulation were spent on developing the expertise of STUK's nuclear safety experts in 2009.

Six new inspectors were hired for nuclear reactor regulation in 2009. They are engaged in the inspection of mechanical components, in the field of I&C technology, in construction technology, physical protection regulation and installation oversight. Two new inspectors were hired for nuclear waste regulation. The first of them started work in June 2009, and the second in January 2010. Their areas of responsibility are radiation protection and system design.

10 Emergency preparedness

In 2009, STUK organised emergency training and exercises related to nuclear facility and radiation emergencies. The exercises test the operation of the emergency response organisation, the functionality of the emergency response guidelines and the usability of the emergency response premises in practice, and develop these spheres on the basis of the feedback received from the exercises. In addition, they familiarise new personnel with STUK's operations in emergency situations and their personal duties in the emergency response organisation.

STUK participated in Barents Rescue exercise arranged by the Nordic countries and Russia on 8–10 September 2009 in Murmansk, Russia, and in a emergency exercise at the Loviisa power plant in the spring of 2009. Part of the STUK emergency response organisation also participated in international emergency exercises organised by the IAEA and the EU.

The functioning of the equipment and communications in STUK's alert area with emergency power supply was tested in conjunction with substation maintenance in the building on 2 June 2009.

11 Communication

New power plant projects attracted interest of the public and the media

In 2009, nuclear safety issues invoked a lot of discussion and questions in Finland. STUK experts gave several interviews in particular on new nuclear power plant projects and on problems observed in Olkiluoto 3 I&C design, safety culture and welding work.

STUK experts also appeared in public hearings arranged in conjunction with the preparation of the decision-in-principle for the nuclear power plant projects. These hearings were arranged in projected nuclear power plant localities. The experts also provided locals with basic information on nuclear and radiation safety in other local events.

A total of 21 press releases were issued. STUK provided information about the results of the preliminary safety assessment of TVO's new power plant project at the end of May, and of Fortum's and Fennovoima's assessments in October. According to the press releases, all the projected power plant options can be constructed in compliance with Finnish safety regulations.

At midsummer, STUK announced that it had requested TVO to provide additional clarifications of the Olkiluoto 3 I&C design. The I&C issues came up again in October, when STUK, together with French and British nuclear safety authorities, prepared an announcement, in which the authorities jointly require that the automation-based safety systems of the EPR nuclear power plant must be improved from the original design.

STUK also provided information about the flaws detected in the welds of the reactor coolant pipes, containment building and cooling system pipes and about two events classified as INES 1 at the operating Olkiluoto power plants. In addition, a press release was issued in June relating information about an assessment carried out by an IAEA expert team of physical protection in Finland. The team recorded a number of recommendations which have proven useful and which help to perfect physical protection.

At the end of October, STUK reported that it had inspected the periodic safety review carried out by TVO on the operating Olkiluoto power plant units. STUK's press release stated that the safety of the plant units is good but it can still be improved with practical measures. The safety review itself, as all important decision documents concerning nuclear power plant regulation, was published by STUK on the Internet.

The fifth "Säteilyn salat" (Secrets of Radiation) reporter course was arranged in spring. Twenty-two reporters participated in the course, during which STUK experts gave informative lectures on radiation-related subjects and also on nuclear safety. In addition to lectures, the participants had an opportunity to make an excursion to the Loviisa nuclear power plant and, on a study trip, to the Chernobyl power plant site in Ukraine.

STUK's Alara magazine dealt with nuclear safety issues taking into account the entire life cycle of a nuclear power plant. Among other things, the magazine considered the reasons for the delay of the Olkiluoto 3 construction project, the impact of nuclear power plants' waste heat release into the sea and the responsibilities of environmental monitoring and challenges presented by nuclear power plant decommissioning.

The last issue of the year, a thematic issue on nuclear safety, also estimated how the worldwide construction of more nuclear energy, advancement of technology and the proliferation of nuclear arms challenge the nuclear safety branch to enhance their international cooperation. In the same issue Daniel Jåfs, a fresh doctoral graduate, recounted in his interview how the first introduction of nuclear energy to Finland at the turn of 1960s–1970s also improved safety culture in Russia.

12 International cooperation

Participation in cooperation within international organisations in the fields of radiation and nuclear safety regulatory control, bilateral cooperation with various countries, participation in cooperation projects involving several countries, and presentations given at international meetings in 2009 are listed in Appendix 9.

The following includes short summaries of the international cooperation domains which were the most significant from a nuclear safety regulation perspective in 2009.

Cooperation 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, viz. 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 representative acts as the deputy chairperson of the group. STUK's representative is also included in another group invited by the Director General, the SAGSI, dealing with nuclear material safeguards.

STUK's representatives participated in expert groups summoned by the IAEA; the groups reviewed the regulatory authorities' operations in the United Kingdom, Russia and Canada. Furthermore, STUK's representative participated in an OSART review carried out at the Oskarshamn nuclear power plant, in which a team of 13 international experts set up by the IAEA reviewed the nuclear power plants operation for almost three weeks.

Cooperation within the OECD/NEA

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

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

Cooperation within the EU

STUK participated in the activities of the EU member states' nuclear safety regulators' co-operation group (ENSREG, European Nuclear Safety Regulators Group) and in two of its subgroups (nuclear safety and nuclear waste management). The cooperation group participates in the preparation of directives pertaining to nuclear safety and coordinates the implementation of directives in the member states.

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

MDEP

The Multinational Design Evaluation Programme (MDEP) was originally established on the initiative of the United States nuclear safety authority (Nuclear Regulatory Commission, NRC) with the objective of improving cooperation in the field of the assessment of new nuclear power plants and to develop convergent regulatory practices. Nuclear safety authorities from 10 countries participate in the programme: the USA, South Africa, Japan, Canada, China, Korea, France, Finland, the United Kingdom and Russia. Participants in the programme include only countries with new nuclear power plants at some stage of assessment by the regulatory authorities. Some other countries have also expressed their interest in joining the programme, but for the time being no new countries have been accepted. The programme has contracted the OECD Nuclear Energy Agency to function as its secretariat. In addition to meeting arrangements, the secretariat takes care of the library where all the documents are entered. The MDEP work is organised in Design-Specific and Issue-Specific working groups. Currently there are two Design-Specific working groups: the EPR working group and the AP 1000-working group. Finland participates in the EPR working group only. The other countries in the EPR group include France, the USA, the United Kingdom, Canada and China. The Finnish representative is the chairperson of the EPR working group. The EPR group's work was originally a continuation of cooperation between the Finnish and French authorities concerning safety assessment of EPR power plants.

There are three Issue-Specific working groups:

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

Finland participates in the activities of all three Issue-Specific Working Groups. The objective of the Vendor Inspection Working Group is to achieve an understanding of the participating countries' inspection procedures concerning primary circuit main components, their biggest differences and similarities and possibilities to utilise inspections carried out by other regulatory authorities. In 2009, the group carried out 13 joint inspections. The objective of the Pressure Boundary Working Group is the harmonisation of the requirements in different standards, not their complete unification. For harmonisation it is necessary to know the differences between standards and to understand the reasons for them. Stage one deals with Class 1 pressure vessels and stage two is going to deal with Class 1 pipelines, valves and pumps. Stage one is almost completed. The Digital Instrumentation and Controls Working Group aims to promote coordinated development of the IEC and IEEE standards. In addition, some individual issues have been chosen, on which common position type opinions have been drafted.

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

WENRA, Western European Nuclear Regulators' Association

STUK participated in the WENRA (Western European Regulators' Association) working groups on nuclear safety, nuclear waste and decommissioning. The groups developed common safety reference levels on the basis of the IAEA standards. The leading nuclear safety authorities who comprise the WENRA group have set as their objective that the requirements for nuclear safety be brought into compliance with these reference levels in the WENRA member states by the end of 2010. The target schedule for the requirements for nuclear waste storage is the end of 2012; for the requirements for decommissioning, the end of 2013; and for the requirements for final disposal of nuclear waste, the end of 2015. In 2009, the nuclear safety group also drew up general safety principles for new reactors. At the end of 2009, STUK's Director General was elected to chair WENRA.

VVER cooperation

STUK participated in the cooperation between the regulatory authorities of countries with VVER power plants via the VVER Forum. Two working groups chaired by STUK representatives function in conjunction with the forum:

- Probabilistic risk analyses of VVER-440 power plants. The final report for three years' work was completed.
- Regulatory oversight of organisations. The working group's theme was the assessment and oversight of management systems.

Bilateral cooperation

In 2009, STUK continued bilateral cooperation in the form of meetings and conferences with the nuclear safety regulatory authorities of Sweden, Russia, France and the USA, among others.

APPENDIX 1 STUK's safety performance indicators for NPPs in 2009

Summary of the safety performance indicators for nuclear power plants

Background and objectives of the indicator system

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

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

In the indicator system the nuclear safety is divided into three sectors: 1) safety and quality culture, 2) operational events, and 3) structural integrity. These three sectors are futhermore divided into a total of 14 sub-areas to be interpreted (see the table below).

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. In 2003, the nuclear safety indicators were first connected with STUK's strategy and reported as part of regulatory oversight of nuclear safety. Indicators monitor the implementation and success of the strategy.

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

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 Technical Specifications. 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.*

STUK's long-term safety objectives concerning nuclear power plants were as follows in 2009:

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

The nuclear safety performance indicators show that the operation and maintenance of the Loviisa and Olkiluoto power plants have complied with these objectives. A brief summary of the safety situation in each plant in 2009 is presented below, followed by the detailed results by indicator.

Results for the safety performance indicators for the nuclear power plants in 2009

Loviisa NPP

Summary

A fuel leak occurred at both plant units of the Loviisa power plant. The fuel leak at Loviisa 2 was detected in late 2008. However, the fuel leak remained small and the leaking bundle was removed from the reactor during the 2009 annual maintenance. At Loviisa 1, the fuel leak was detected after annual maintenance in October 2009 and the leaking bundle will be removed from the reactor during the 2010 annual maintenance at the latest. The causes for the fuel leaks have not been established yet. The integrity of the primary circuit and the containment building remained good.

Regarding plant operation, the licence holder reported six exceptional situations, five of which were non-compliant with the Technical Specifications. The events were minor and their safety significance small. In 2009, both plant units had short refuelling outages with few significant works as regards radiation protection, and the radiation doses received by employees were small. Systematic development work has been done at the Loviisa power plant for reducing the radiation doses received during annual maintenance in particular. The results of developing radiation protection measures are also reflected in the favourable trend of indicators describing exposure to radiation. The releases of radioactive materials to the atmosphere and aquatic environment were small and clearly below the release limits. In 2009, the Loviisa power plant discharged low-activity evaporation residues into the sea as planned. This was shown as increased releases of materials with gamma activity and further as an increase in the calculated dose for the most exposed individual in the vicinity of the plant. The small scale of releases is reflected in the fact that the calculated dose (0.449 µSv) was less than 5% of the limit set in the Government Decision (733/2008).

The calculated risk of accident at the Loviisa power plant has constantly decreased during the last ten years. This is due to both the improved accuracy of risk analyses and, in particular, the significant modifications carried out at the plant for improving plant safety. The most significant accident risks include actions during annual maintenance, such as the lifting of heavy loads in the reactor hall or a power surge caused by sudden dilution of the boron used to adjust reactor operation, oil accidents at sea during refuelling outages, fire and high levels of seawater during power operation. However, the risks due to operating activities have slightly increased compared to previous years. This is in part explained by the unusually high number of faults associated with the ventilation systems of the plants as well as faults and maintenance operations in the auxiliary emergency feedwater systems. Attention must be paid in the future to the management of ventilation faults at the plant.

The functionality of safety systems is followed at the Loviisa power plant on the basis of unavailability of the high-pressure safety injection system, the emergency feedwater system and the emergency diesel generators. The safety systems were in good condition, although the availability of diesel generators had slightly decreased from the previous years. The maintenance of and fault repairs to components important to safety was appropriate.

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

Olkiluoto NPP

Summary

The integrity of fuel and the primary circuit remained good. The integrity of the containment building was affected by the fact that the total as-found leakages of outer isolation valves at both plant units exceeded the limit set in Tech Specs during the first leak tests. At Olkiluoto 1, most of the total as-found leakages were caused by a leaky valve of one measurement fitting in the reactor pressure vessel. At Olkiluoto 2, most of the total as-found leakages were by a single leaking valve in the reactor pressure vessel cover spraying system. The isolation valve fitted in the same line inside the containment did not leak. After repairs, the total leakage of outer isolation valves met the requirements of the Technical Specifications.

A total of five events warranting special reports occurred at the Olkiluoto power plant in 2009. This is in line with the ten-year average. The radiation doses received by employees and the releases to the environment remained small and clearly below the limits set in official regulations. The number of fire alarm occurrences increased somewhat in 2009. This is at least in part explained by the modification and repair operations in 2009 as the dust, fumes and humidity generated by these operations caused some alarms in the detectors.

In 2009, the accident risk indicator for the Olkiluoto power plant increased because the new analyses indicated that the reactor cleaning system can no longer be utilised as the ultimate means of residual heat removal. In order to reduce the accident risk, TVO has established a working group for designing a separate route for the transfer of residual heat. The most important factors affecting the overall accident risk include events during power operation, such as component failures and pipe ruptures resulting from operational transients. The risks caused by operating activities have remained at the previous years' level.

The functionality of safety systems at the Olkiluoto power plant is assessed by monitoring the unavailability of the containment building spraying system, the auxiliary feed system and the diesel generators. The indicators describing the containment building spraying system and the auxiliary feed system show that no significant deterioration has taken place in the condition of these systems. The availability of diesel generators was lower in 2008 which was caused by faults in the starter motors. The starter motors have now been included in the regular maintenance schedules, and the indicators describing the availability of diesel generators in 2009 showed that they were in good condition.

The maintenance of components covered by the Technical Specifications has functioned well. The number of fault repairs and associated operation restrictions has gradually decreased, and the repairs have, as a rule, been carried out quickly. The operability of components covered by the Technical Specifications were mainly reduced by the following faults at Olkiluoto 1: a fault in the isolation valve of the containment spray system, faults in the system controlling the neutron flux measurement system actuators, washing operations of the component cooling system heat exchangers, and a fault in the position indication of the control valve of the steam system blowdown line. At Olkiluoto 2, the decrease in operability was caused by faults in two systems: washing operations of the component cooling system heat exchangers due to their reduced capacity and a fault in the position indication of the control valve of the steam system blowdown line. All fault repairs were carried out within the time constraints set out in the Technical Specifications.

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

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 Technical Specifications

Definition

The number of failures causing unavailability of components defined in the Technical Specifications (Tech Spec 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

Organisations and Operations (OKA),
resident inspectors
Pauli Kopiloff (Loviisa nuclear power plant)
Jarmo Konsi (Olkiluoto nuclear power plant)

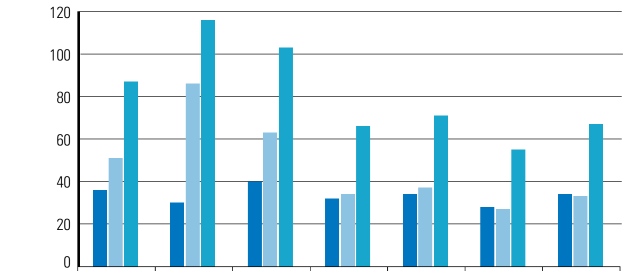
Interpretation of the indicator

Loviisa

In 2009, the number of failures in Tech Spec components causing an operating restriction was 181 while it was 180 in 2008. The number of failures occurring in 2009 was significantly lower than the average of the four preceding years (210).

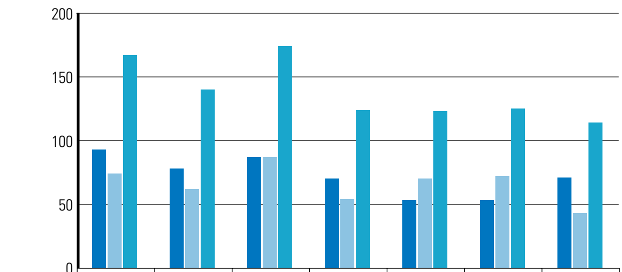
The number of failures per year has remained relatively stable. Any variation therein is caused by the random occurrence of failures that are difficult to predict but will occur in any large number of components. The recurrences of failures causing operating restrictions observed in 2009 are a matter that must be addressed in future plant maintenance.

Number of failures of Tech Spec components causing immediate operation restriction, Loviisa NPP



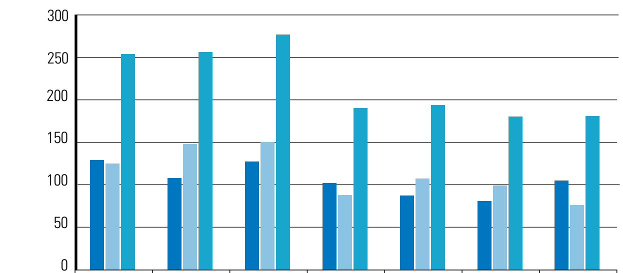
	2003	2004	2005	2006	2007	2008	2009
LO1	36	30	40	32	34	28	34
LO2	51	86	63	34	37	27	33
LO1,2	87	116	103	66	71	55	67

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



	2003	2004	2005	2006	2007	2008	2009
LO1	93	78	87	70	53	53	71
LO2	74	62	87	54	70	72	43
LO1,2	167	140	174	124	123	125	114

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



	2003	2004	2005	2006	2007	2008	2009
LO1	129	108	127	102	87	81	105
LO2	125	148	150	88	107	99	76
LO1,2	254	256	277	190	194	180	181

Failure detection and anticipation have been continuously improved in plant maintenance operations at Loviisa, and components have been replaced. Thanks to these measures, the operability of components affecting the safe operation of the plant has remained under control.

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

Interpretation of the indicator

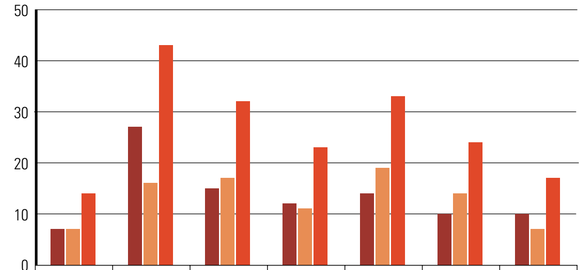
Olkiluoto

The number of failures occurring during power operation and causing the unavailability of components subject to Technical Specifications has been decreasing since 2007. The number of failures indicates that maintenance work has been successful.

The inoperability period at OL1 during the first quarter of 2009 mainly consisted of faults in the containment spraying system isolation valve and the actuating system of the neutron flux measurement system. The longest periods of inoperability during the second quarter were caused by the washing operations of the component cooling system heat exchangers. The inoperability period of the last quarter mainly consisted of a fault in the position indicator of the control valve of the blowdown line of the steam system. In other respects, the periods of inoperability of individual components have been very short.

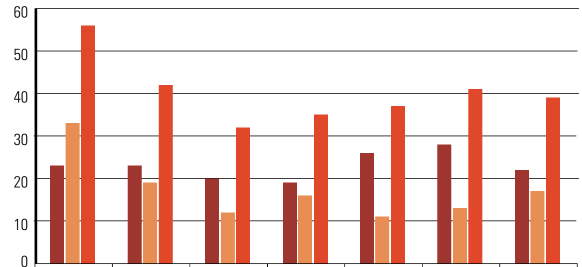
Inoperability was caused at OL2 during the second quarter of 2009 by the washing operations of the component cooling system heat exchangers, necessitated by their deteriorated capacity. The inoperability period of the last quarter mainly consisted of a fault in the position indicator of the control valve of the blowdown line of the steam system. In other respects, the periods of inoperability due to faults have been very short.

Number of failures of Tech Spec components causing immediate operation restriction, Olkiluoto NPP



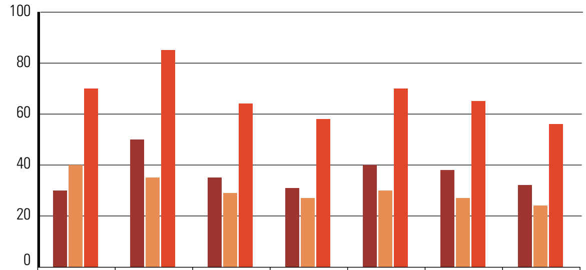
	2003	2004	2005	2006	2007	2008	2009
OL1	7	27	15	12	14	10	10
OL2	7	16	17	11	19	14	7
OL1,2	14	43	32	23	33	24	17

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



	2003	2004	2005	2006	2007	2008	2009
OL1	23	23	20	19	26	28	22
OL2	33	19	12	16	11	13	17
OL1,2	56	42	32	35	37	41	39

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



	2003	2004	2005	2006	2007	2008	2009
OL1	30	50	35	31	40	38	32
OL2	40	35	29	27	30	27	24
OL1,2	70	85	64	58	70	65	56

A.I.1b Maintenance of components subject to the Technical Specifications

Definition

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

Source of data

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

Purpose of the indicator

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

Responsible units/persons

Organisations and Operations (OKA),
resident inspectors
Pauli Kopiloff (Loviisa nuclear power plant)
Jarmo Konsi (Olkiluoto nuclear power plant)

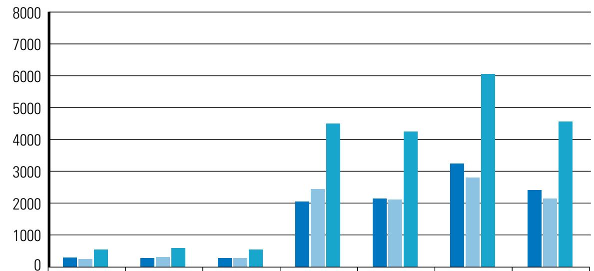
Interpretation of the indicator

Loviisa

A new IT system was commissioned at the power plant in 2006. The indicator was improved in conjunction with the IT system revision. The annual maintenance operations also included the work for such components covered by Tech Specs to which no operating restriction applied. The preventive maintenance figures include, according to the information system's classification, the scheduled maintenance, in-service inspection, periodic testing and condition monitoring for components, as well as inspection/shift rounds. Similarly, repair work figures include overhauls and repairs of component failures. 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 four years.

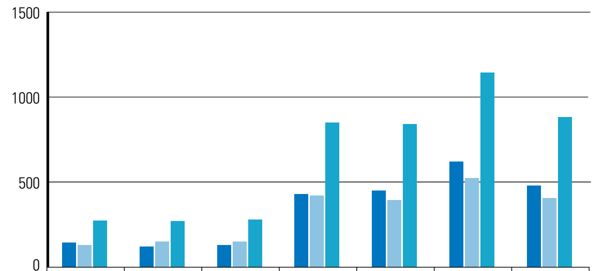
When considering the variation in the volume of failure repairs and particularly in the number of preventive maintenance works, the scheduling of various annual maintenance works (fuel replacement outage, 4 year annual maintenance, brief annual maintenance, 8 year annual maintenance) included in the maintenance strategy during a four

Volume of annual maintenance works of Tech Spec components, Loviisa NPP



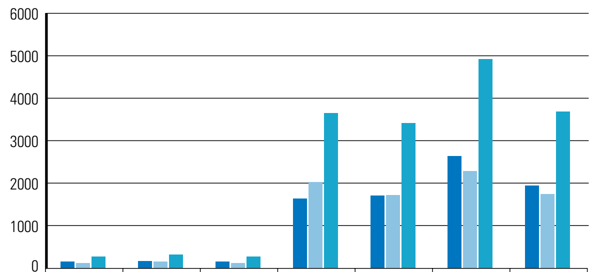
	2003	2004	2005	2006	2007	2008	2009
LO1	293	282	277	2057	2148	3250	2416
LO2	243	303	269	2444	2105	2807	2148
LO1,2	536	585	546	4501	4253	6057	4564

Number of annual failure repair works of Tech Spec components, Loviisa NPP



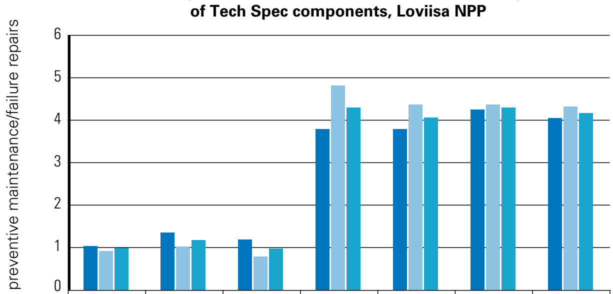
	2003	2004	2005	2006	2007	2008	2009
LO1	144	120	127	429	448	619	478
LO2	127	150	150	421	393	524	404
LO1,2	271	270	277	850	841	1143	882

Number of annual preventive maintenance works of Tech Spec components, Loviisa NPP



	2003	2004	2005	2006	2007	2008	2009
LO1	149	162	150	1628	1700	2631	1938
LO2	116	153	119	2023	1712	2283	1744
LO1,2	265	315	269	3651	3412	4914	3682

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



	2003	2004	2005	2006	2007	2008	2009
LO1	1.03	1.35	1.18	3.79	3.79	4.25	4.05
LO2	0.91	1.02	0.79	4.81	4.36	4.36	4.32
LO1,2	0.98	1.17	0.97	4.30	4.06	4.30	4.17

year cycle should be considered as this can have a significant impact on the annual figures. Short refuelling outages were implemented at the Loviisa plant units in 2009. Consequently, there was a significant reduction in the maintenance work figures related to components covered by the Tech Specs.

Judging by the data behind the indicator, 2009 was not markedly different from the previous years as concerns preventive maintenance. The ratio of preventive maintenance work to fault repairs was 4.18 in 2009, having been 4.30 in 2008. The large proportion of preventive maintenance work reflects the chosen maintenance strategy that allows keeping the number of faults and their consequences at a reasonable level.

The stability of the indicator values, with changes being mainly attributable to variation due to the scheduling of annual maintenance, may be regarded as an indication of a functional maintenance strategy.

Interpretation of the indicator

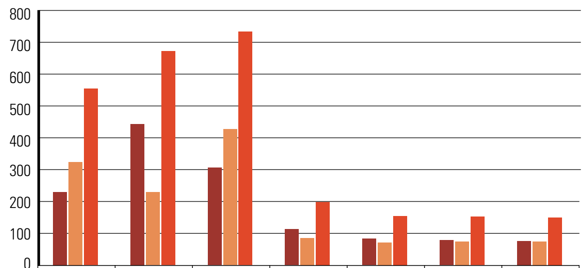
Olkiluoto

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 as of 1 January 2006, the data is not comparable with the figures for earlier years. Class 3 data (systems subject to the Technical Specifications (Tech Specs)) has been removed from the work order classification, since the Class 3 category covers all systems specified in the Tech Specs. However, nowhere near all of these systems are subject to restrictions set out in the Tech Specs. Thus this indicator is used to monitor the ratio of the number of preventive maintenance works causing unavailability of components to the number of failure repairs.

The number of maintenance works causing inoperability of components, included in the indicator, has been decreasing since 2006 due to the decreasing number of fault repairs. The amount of work causing unavailability of components included in the so-called preventive maintenance packages, carried out for OL2 in the first part of the year and for OL1 in the latter part of the year, dropped approximately 30% in 2007 compared to 2006. The figure for 2009 was almost the same as in 2007 and 2008.

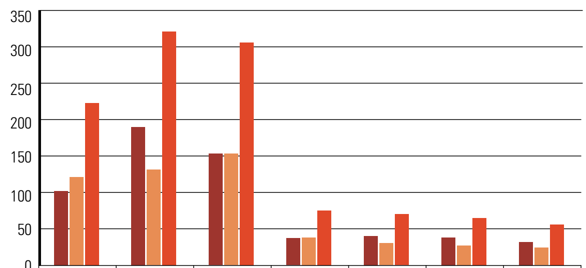
The total number of fault repairs due to occurrences of inoperability has been on the decline since 2006 while the total number of preventive

Volume of annual maintenance works of Tech Spec components, Olkiluoto NPP



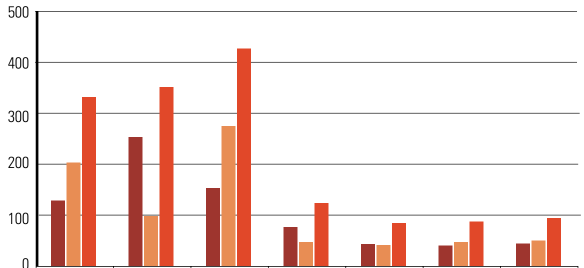
	2003	2004	2005	2006	2007	2008	2009
OL1	230	443	306	113	83	78	76
OL2	324	229	427	85	71	74	74
OL1,2	554	672	733	198	154	152	150

Number of annual failure repair works of Tech Spec components, Olkiluoto NPP



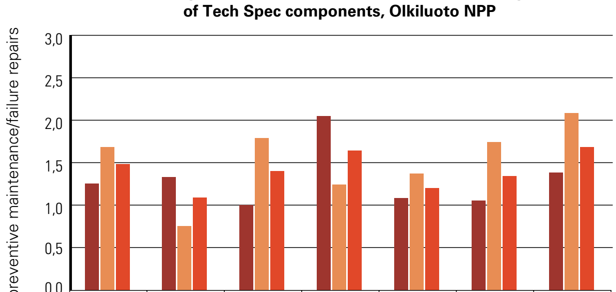
	2003	2004	2005	2006	2007	2008	2009
OL1	102	190	153	37	40	38	32
OL2	121	131	153	38	30	27	24
OL1,2	223	321	306	75	70	65	56

Number of annual preventive maintenance works of Tech Spec components, Olkiluoto NPP



	2003	2004	2005	2006	2007	2008	2009
OL1	128	253	153	76	43	40	44
OL2	203	98	274	47	41	47	50
OL1,2	331	351	427	123	84	87	94

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



	2003	2004	2005	2006	2007	2008	2009
OL1	1.25	1.33	1.00	2.05	1.08	1.05	1.38
OL2	1.68	0.75	1.79	1.24	1.37	1.74	2.08
OL1,2	1.48	1.09	1.40	1.64	1.20	1.34	1.68

maintenance operations has increased during the last three years.

The ratio of preventive maintenance work to fault repairs was 1.20 in 2007 and 1.33 in 2008. In 2008, the ratio was 1.68.

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.

A.I.1c Repair time of components subject to the Technical Specifications

Definition

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

Source of data

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

Purpose of the indicator

The indicator shows how quickly failed Tech Spec components are repaired in relation to the repair time allowed in the Tech Specs. The indicator is used to assess the strategy, resources and effectiveness of plant maintenance.

Responsible units/persons

Organisations and Operations (OKA),
resident inspectors
Pauli Kopiloff (Loviisa nuclear power plant)
Jarmo Konsi (Olkiluoto nuclear power plant)

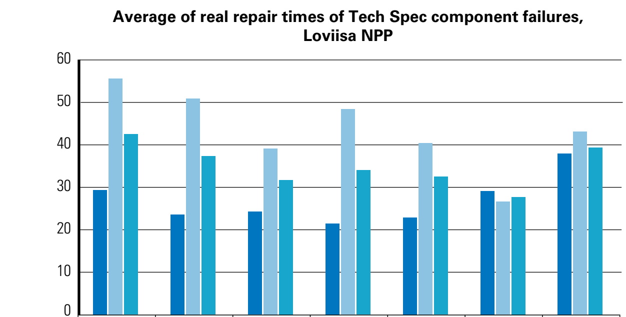
Interpretation of the indicator

Loviisa

The Technical Specifications define the maximum allowed repair times for components based on the components' safety significance. The times vary between 4 hours and 21 days. In addition to the allotted time, the principle is that the failures of Tech Spec components are to be repaired without undue delay.

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

The average repair times of failures causing unavailability of components have remained stable at the Loviisa plant for several years. In 2009, the average repair time at the plant units was 39.4 hours while the average for the four preceding years was 31.5 hours. The average repair time of Tech Spec component failures that had an allowed repair time of 72 hours or less was 25.4 hours at LO1 and 21.7 hours at LO2 in 2009.



	2003	2004	2005	2006	2007	2008	2009
LO1	29.4	23.6	24.3	21.5	22.9	29.1	38.0
LO2	55.6	50.9	39.1	48.4	40.4	26.6	43.1
LO1,2	42.5	37.3	31.7	34.0	32.5	27.7	39.4

Interpretation of the indicator

Olkiluoto

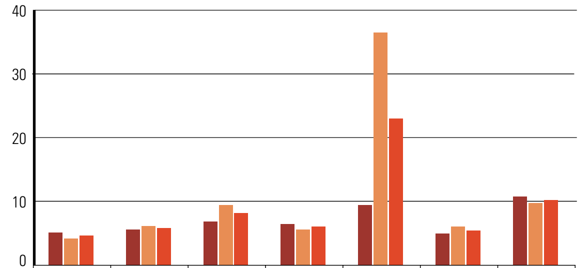
The indicator is used to monitor the repair times of components subject to the Technical Specifications. The repair time allowed in the Technical Specifications is usually 30 days for faults concerning one subsystem and three days for faults concerning two subsystems. Depending on the system and the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

Over a longer period, the average repair time has varied between five to eight 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 2009, the average repair time of failures causing inoperability of components defined in the Technical Specifications was approximately 10 hours for both plant units. This meant a two-fold increase from the previous year. For both plant units, the increase was due to a failure in a single device. At both plant units, the fault was in the position indication of the control valve of the steam system blowdown line.

On the basis of the 2009 indicators and the data behind them, the plant's maintenance operations meet the requirements.

Average of real repair times of Tech Spec component failures, Olkiluoto NPP



	2003	2004	2005	2006	2007	2008	2009
OL1	5.1	5.5	6.8	6.4	9.4	4.9	10.7
OL2	4.1	6.1	9.4	5.5	36.5	6.0	9.7
OL1,2	4.6	5.8	8.1	6.0	23.0	5.4	10.2

A.I.1d Common cause failures

Definition

As the indicator, the number of common cause failures of components or systems defined in the Tech Specs 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

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

Interpretation of the indicator

Loviisa

In 2009, no safety-significant common cause failures were identified at the Loviisa power plant. However, common cause failures were identified among others in the trigger valves of the fire-fighting area sprinkler system where throttles of the wrong size were found in an inspection following a failed test, and in the fuel levels in the emergency diesel generators' fuel tanks. The events are described in more detail in Section 4.1.2 and Appendix 3.

Olkiluoto

One common cause failure was identified at Olkiluoto in components covered by Tech Specs. Damages were found in the planetary gears of the actuators used for opening and closing the outer isolation valves of steam lines. The event is described in more detail in Section 4.2.3 and Appendix 3.

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

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

Interpretation of the indicator

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

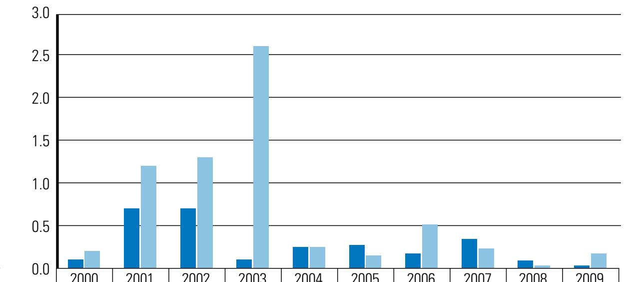
Loviisa

There were few production losses due to component failures in Loviisa during 2009. No reactor trips took place; instead, all faults were rectified when operating at low load. At Loviisa 1 all and at Loviisa 2 two-thirds of the faults were related to main coolant pumps. At Loviisa 1, the faults were individual occurrences of main coolant pump failures. At Loviisa 2, all faults occurred in the same main coolant pump: first there was a leak in the motor cooling water hose that was rectified, and after that, there was an oil leak from the motor. The diagnosis and repair of this fault took three days in all.

Olkiluoto

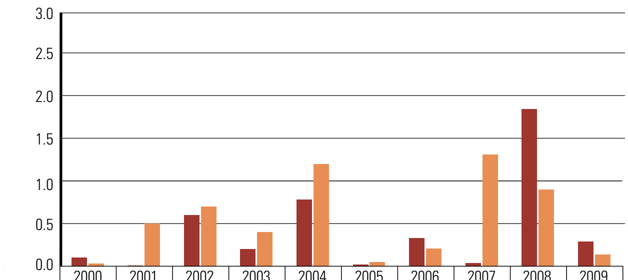
There were very few production losses due to component failures in 2009. At Olkiluoto 1 about one-third and at Olkiluoto 2 about two-thirds of them were caused by faults in the actuators of outer isolation valves in the steam lines. Half of the production losses due to component failures at Olkiluoto 1 were caused by a fault in the position indication of the blowdown system control valve. The reactor had to be shut down on 14 November 2009 for repairing this fault.

Loss of power production due to failures, Loviisa NPP



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
LO1	0.10	0.70	0.70	0.10	0.25	0.27	0.17	0.34	0.09	0.03
LO2	0.20	1.20	1.30	2.60	0.25	0.15	0.51	0.23	0.03	0.17

Loss of power production due to failures, Olkiluoto NPP



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
OL1	0.10	0.01	0.60	0.20	0.78	0.02	0.33	0.04	1.84	0.29
OL2	0.03	0.50	0.70	0.40	1.20	0.05	0.21	1.31	0.90	0.14

A.I.2 Exemptions and deviations from the Technical Specifications

Definition

As indicators, the number of non-compliances with the Technical Specifications, 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 Tech Specs: compliance with the Tech Specs and identified situations during which it is necessary to deviate from them; of which conclusions can be made as regards the appropriateness of the Tech Specs.

Responsible unit/person

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

Interpretation of the indicator

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

Non-compliance with the Tech Specs 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 Technical Specifications. The objective is for no events with non-compliance to the Technical Specifications 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

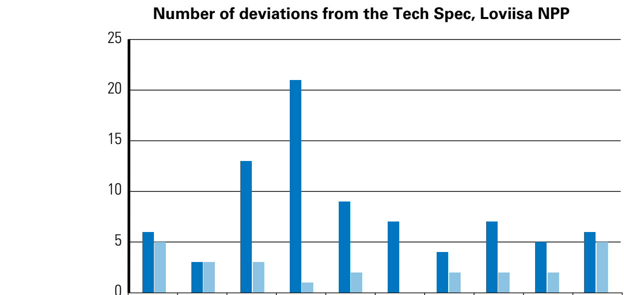
Exemptions

The number of exemptions was similar as in previous years. Eight exemptions are in line with the ten-year average. In addition, the plant has an average of two or three events in which operations are non-compliant with the Tech Specs.

In 2009, the power company applied for permission from STUK for seven planned deviations from the Technical Specifications. Two of these related to fault repairs, two to the change of mode of operations during fault repair in annual maintenance, and three to the I & C renewal. The two faults occurring during annual maintenance were to do with the position indicator of the ice condensing system door related to control of serious accidents at Loviisa 1 and the emergency diesel generator at Loviisa 2. The two other fault-related applications concerned additional time for finding the fault in the emergency generator at Loviisa 1 and additional isolation for rectifying the fault in the seawater pump while the plant was in power operation. STUK approved six applications because they had no significant impact on the safety of the plant or its environment. One of the applications was not approved by STUK, because the deviation application concerned I & C renewal related work which STUK had not approved yet.

Events non-compliant with the Tech Specs

In 2009, the number of events non-compliant with Tech Specs clearly exceeded the average of recent years (2). The Loviisa plant had five events during the year when the plant was not in a state compliant with the Technical Specifications. These involved ambiguous instructions regarding the fuel levels in a tank, failure to complete the periodic inspections during maintenance, erroneous isolations (two events) and incorrect actions in repairing a fault. The events were analysed and reported in special reports. The events were all cases of individual and inadvertent human errors. The events did not put nuclear or personal safety at risk.



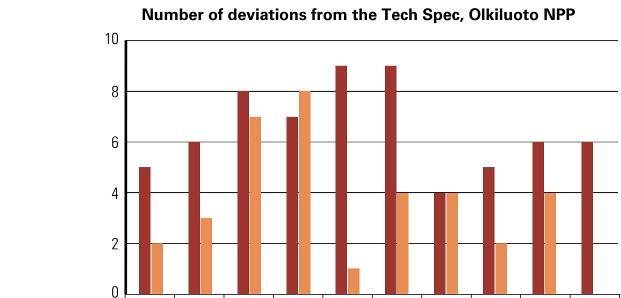
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Exemptions	6	3	13	21	9	7	4	7	5	6
Deviations	5	3	3	1	2	0	2	2	2	5

Olkiluoto

The number of events related to Technical Specifications does not deviate from the average. Based on the results of the last ten years, Olkiluoto nuclear power plant applies for STUK's approval for non-compliance with the Tech Specs six times per year on average. In addition, the plant has an average of four events in which operations are non-compliant with the Tech Specs. In 2004 and 2005, the number of exemptions was increased by work and installations related to the modernisation of OL1 and OL2 and the construction of OL3.

Exemptions

In 2009, the power company applied for permission from STUK for six planned deviations from the Technical Specifications. The applications concerned the postponement of leak tightness testing of the containment of Olkiluoto 2 from 2009 to 2011, the removal of protection from the fuel transfer machine of Olkiluoto 2 for repairs, the inoperability of radiation measurements monitoring the liquid waste drainage line for upgrading the equipment, the prevention of peaking in the radiation meters at the main steam line of Olkiluoto 2 and the possible deviation from the CPR margin of the reactor core for verifying the representative stability measurement. Since the planned deviations had no significant safety implications, STUK approved the applications apart from the postponement of the containment leak tightness test. This deviation was not topical yet because the Tech Specs also allow for performing the test in 2010.



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Exemptions	5	6	8	7	9	9	4	5	6	6
Deviations	2	3	7	8	1	4	4	2	4	0

Events non-compliant with the Tech Specs

In 2009, there were four situations at the Olkiluoto plant in which the Technical Specifications were violated. Two concerned the failure to carry out periodic radiation measurement testing, one with the withdrawal of a control rod during annual maintenance, and one with the start-up of a plant unit after annual maintenance while one containment isolation valve was inoperable.

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 Olkiluoto nuclear power plant are the containment vessel spray system (322), the auxiliary feed water system (327) and the emergency diesel generators (651–656). Those followed at Loviisa nuclear power plant are the high-pressure safety injection system (TJ), auxiliary feed water system (RL92/93, RL94/97) and the emergency diesel generators (EY).

Essentially, the ratio of a system's unavailability hours and its required availability hours is calculated as the indicator. Unavailability hours are the combined unavailability time of redundant sub-systems divided by the number of subsystems.

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

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

Source of data

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

Purpose of the indicator

The indicator indicates the unavailability of safety systems. The condition and status of safety systems and their development can be monitored by means of the indicator.

Responsible units/persons

Organisations and Operations (OKA),
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 no faults or events causing unavailability in 2009. The LO2 system had one fault, found in periodic tests, where the pump protection operated so that the pump could not be started. The faulty component turned out to be the pump power supply switch at the switchgear. This single fault caused an unavailability period of 233 hours for the other redundant part of the system. Replacement of the faulty switch, i.e. repair of the fault, took 16 hours and the estimated duration of unavailability before detecting the fault was 217 hours.

The unavailability of the high pressure safety injection systems was low in 2009, i.e. their condition and availability were good.

RL system

For LO1, the total unavailability time was 149 hours, 136 hours of which consisted of RL94 maintenance work performed during the annual outage. At LO1, the unavailability of the RL system during power operation amounted to 13 hours, 3 of which were due to repairs of valve faults. The failures were significant from the point of system operability. For LO2, the total unavailability time was 197 hours, which was exclusively caused by the annual maintenance of the RL97 system.

The unavailability of the auxiliary feed water systems was low in 2009, i.e. their condition and availability were good.

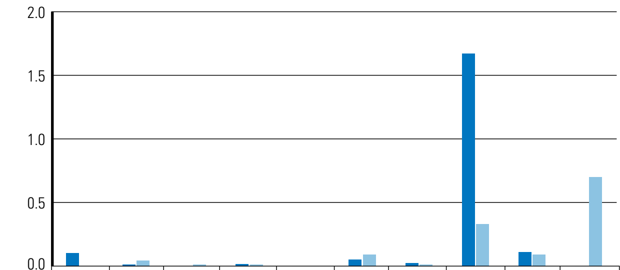
EY system

The unavailability of the emergency diesels (EY) increased in 2009 compared to the previous year's level, but still remained low, i.e. their availability was satisfactory.

In 2009, the total unavailability for all eight diesel generators was 852 hours, where the estimated total duration of unavailability before detecting the faults was 368 hours. There were 20 faults in all, of which 9 caused immediate operation restrictions while 11 caused operating restrictions from the beginning of the repair work. The failures detected were mainly caused by normal ageing of components and did not have any serious implications.

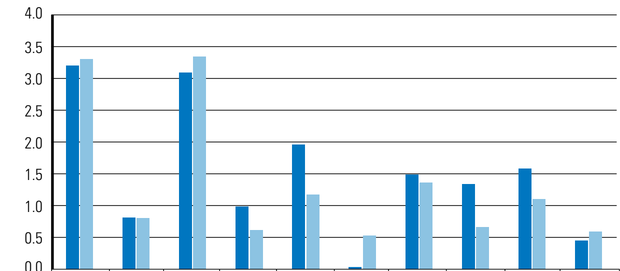
Based on the indicators and an assessment of the failures behind them, the condition of the emergency diesels can be regarded as good.

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



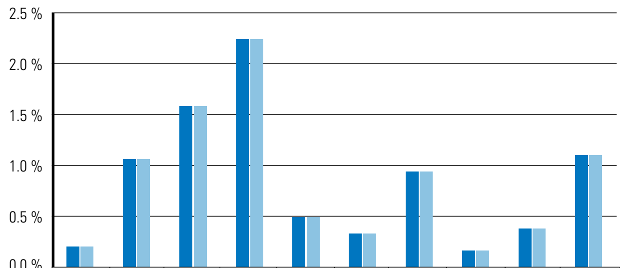
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
LO1	0.10	0.01	0.00	0.01	0.00	0.05	0.02	1.67	0.11	0.00
LO2	0.00	0.04	0.01	0.01	0.00	0.09	0.01	0.33	0.09	0.70

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



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
LO1	3.20	0.81	3.09	0.98	1.96	0.03	1.49	1.34	1.58	0.45
LO2	3.30	0.80	3.34	0.61	1.17	0.53	1.36	0.66	1.10	0.59

Unavailability of emergency diesel generators (EY), Loviisa NPP



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
LO1	0.20	1.06	1.58	2.24	0.49	0.33	0.94	0.16	0.38	1.10
LO2	0.20	1.06	1.58	2.24	0.49	0.33	0.94	0.16	0.38	1.10

Interpretation of the indicator

Olkiluoto

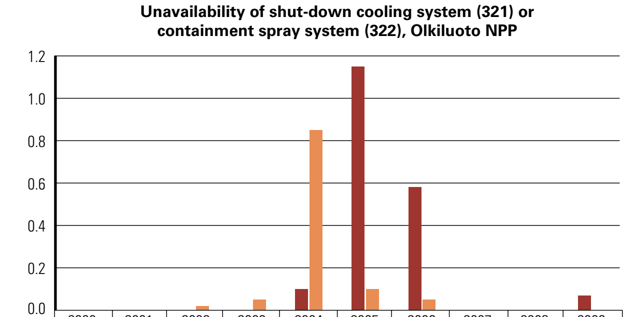
The unavailability times of the containment spray system have been decreasing since 2005. In 2007 and 2008, the unavailability was zero for both plant units, and almost zero in 2009.

The unavailability of the auxiliary feed water system increased significantly after 2004, when the unavailability was practically at zero. The increased unavailability of Olkiluoto 1 in 2006 was due to faults in the recirculation and safety valves in system 327. As corrective measures, the torque settings of the recirculation line's valve actuator motors were adjusted, and a separate safety valve testing line was installed for one of the lines leading to the reactor core in 2008. Testing lines will be 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.

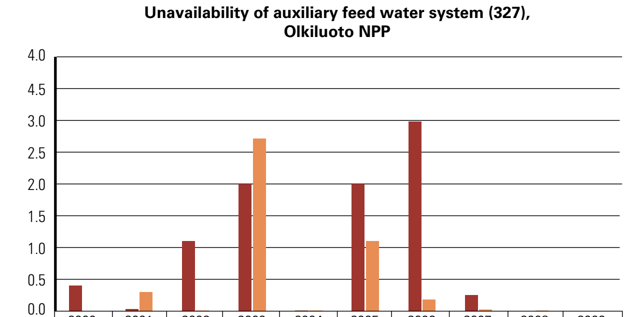
The unavailability of the diesel generators has decreased since 2004, and was very low in 2006 and 2007. In 2008, the value increased by nearly 95% compared to the previous year. The increase was due to latent faults in the compressed air motors of the diesels in both plant units. The diesel generator of one subsystem did not start in connection with a periodic test at OL1 plant unit on 28 May 2008. The failure was caused by a leak in the seals of both compressed air motors of the diesel engine. In inspections, similar leaks were found in the seals of the compressed air motors of several diesel generators in both plant units. Thus, the failure was a common cause failure endangering the availability of a Safety Class 2 system. The event was classified as an anomaly, rated as INES 1 according to the International Nuclear Event Scale. The compressed air motor seals for the diesel engines for both OL1 and OL2 were inspected and replaced in connection with the inspections. The diesel generators were isolated one subsystem at a time. The isolation time for each diesel was, however, short. The inspection and repairs were carried out swiftly.

In 2009, the unavailability of diesel engines decreased considerably from the 2008 figures.

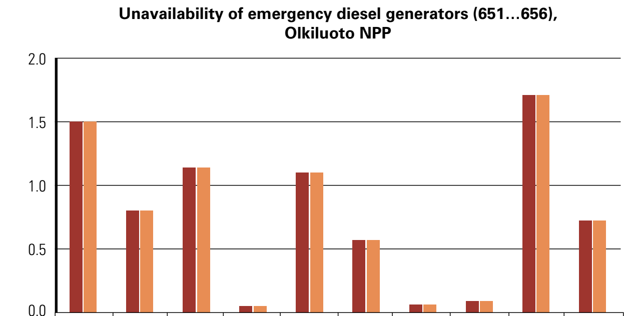
The condition of the containment spray system and the auxiliary feed water system has remained good. The increase in the unavailability of emergency diesels in 2008 was the result of starter motor failures that were caused by the exclusion of these motors from appropriate preventive maintenance. In 2009, the condition of the diesels remained relatively good.



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
OL1	0.00	0.00	0.00	0.00	0.10	1.15	0.58	0.00	0.00	0.07
OL2	0.00	0.00	0.02	0.05	0.85	0.10	0.05	0.00	0.00	0.00



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
OL1	0.40	0.03	1.10	2.00	0.01	2.00	2.98	0.25	0.00	0.00
OL2	0.00	0.30	0.01	2.71	0.01	1.10	0.18	0.02	0.01	0.00



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
OL1	1.50	0.80	1.14	0.05	1.10	0.57	0.06	0.09	1.71	0.72
OL2	1.50	0.80	1.14	0.05	1.10	0.57	0.06	0.09	1.71	0.72

A.I.4 Occupational radiation doses

Definition

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

Source of data

The data on collective radiation exposure is obtained from quarterly and annual reports. The data on individual radiation doses is obtained from the national dose register.

Purpose of the indicator

The indicators are used to control the radiation exposure of employees. In addition, compliance with the YVL Guide's calculated threshold for one plant unit's collective dose averaged over two successive years is followed. The threshold value, 2.5 manSv per one gigawatt of net electrical power, means a radiation dose of 1.22 manSv for one Loviisa plant unit and 2.15 manSv for one Olkiluoto plant unit. The collective radiation doses describe the success of the plant's ALARA programme. The average of the ten highest doses indicates how close to the 20 manSv dose limit the individual occupational doses at the plants are, at the same time indicating the effectiveness of the plant's radiation protection unit.

Responsible unit/person

Radiation protection (SÄT)
Antti Tynkkynen

Interpretation of the indicator

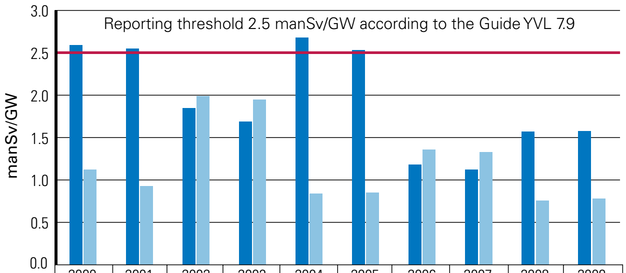
Loviisa

Most doses are incurred through work done during outages. Thus, outage duration and the amount of work having significance on radiation protection affect the yearly radiation doses. Both Loviisa plant units have major 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. In the previous years, major outages have been held in even years and normal outages in odd years. The effect of annual outages on collective doses can be clearly observed in the *Collective radiation dose, Loviisa* graph. In 2009, there was a refuelling outage in both Loviisa plant units. The time used for annual maintenance outages was short, and there were few operations with significance to radiation protection, which had the result that the total collective dose at Loviisa was lower than in the preceding year, second-lowest in the plant's history. The lowest collective dose ever was recorded in 2007.

The radiation doses for nuclear power plant workers were below the individual dose limits. The trend of the average for the ten highest doses has been a decreasing one for some years, and in 2009 the average was lower than ever. 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.

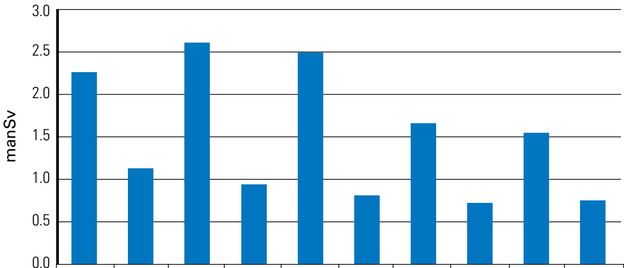
Furthermore, the threshold set for the collective occupational dose was not exceeded in 2009. If, at one plant unit, the collective occupational radiation dose average over two successive years exceeds 2.5 manSv per one GW of net electrical power, the utility is to report the causes of this to STUK, and any measures possibly required to improve radiation safety (Guide YVL 7.9).

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



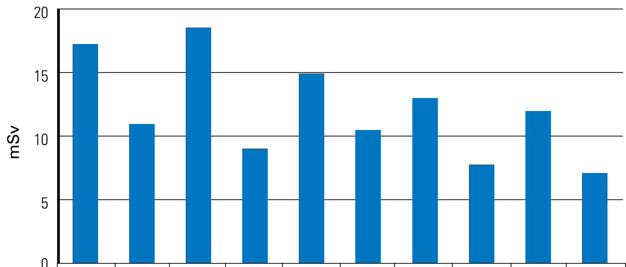
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
LO1	2.59	2.55	1.85	1.69	2.68	2.53	1.18	1.12	1.57	1.58
LO2	1.12	0.93	1.99	1.95	0.84	0.85	1.36	1.33	0.76	0.78

Collective occupational radiation dose (manSv), Loviisa NPP



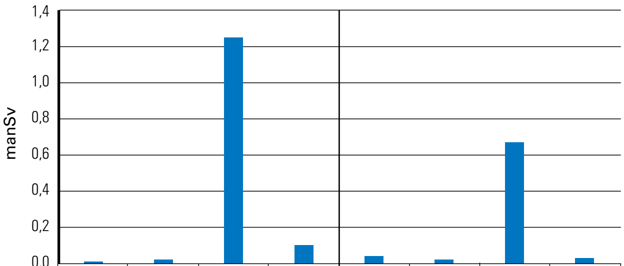
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
LO	2.26	1.13	2.61	0.94	2.49	0.81	1.66	0.72	1.55	0.75

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



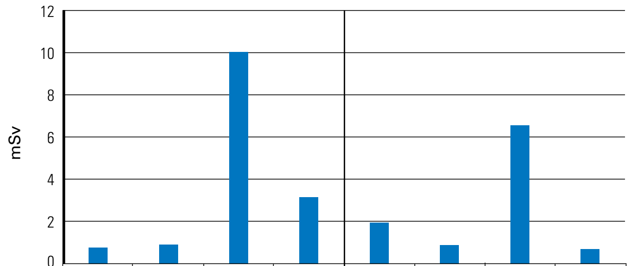
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
LO	17.25	10.94	18.54	9.01	14.93	10.48	13.00	7.76	11.99	7.11

Collective occupational radiation dose (manSv), Loviisa NPP



	I/08	II/08	III/08	IV/08	I/09	II/09	III/09	IV/09
LO	0.01	0.02	1.25	0.10	0.04	0.02	0.67	0.03

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



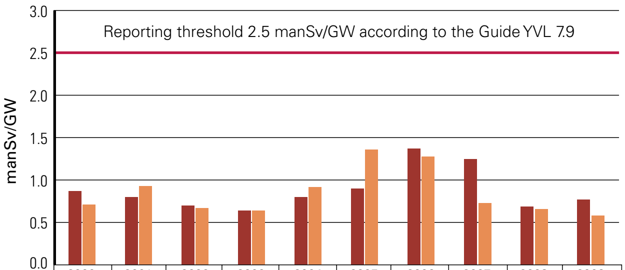
	I/08	II/08	III/08	IV/08	I/09	II/09	III/09	IV/09
LO	0.74	0.89	10.02	3.14	1.92	0.86	6.54	0.68

Interpretation of the indicator

Olkiluoto

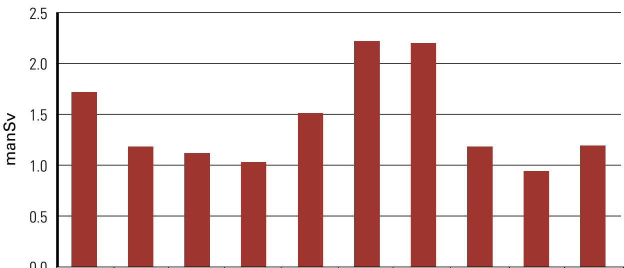
Most doses are incurred through work done during outages. Thus outage duration and the amount of work having significance on radiation protection affect the yearly radiation doses. The annual outages for the Olkiluoto power plant units are divided into two groups: the refuelling outages and the maintenance 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 2005 and 2006, the collective doses for the workers were high due to turbine work with considerable significance for radiation protection. In 2009, the collective dose in Olkiluoto was higher than in the previous year, but still lower than the average dose level of recent years, at the 2007 level. In addition, the average of the ten largest doses was higher than in the two previous years, but 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



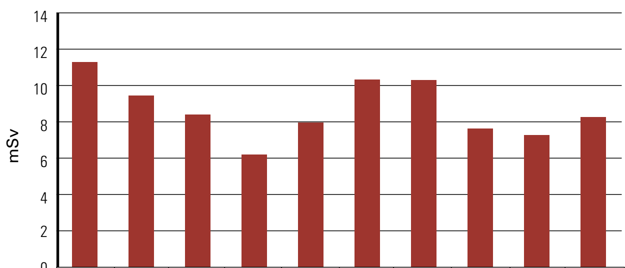
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
OL1	0.87	0.80	0.70	0.64	0.80	0.90	1.37	1.25	0.69	0.77
OL2	0.71	0.93	0.67	0.64	0.92	1.36	1.28	0.73	0.66	0.58

Collective occupational radiation dose (manSv), Olkiluoto NPP



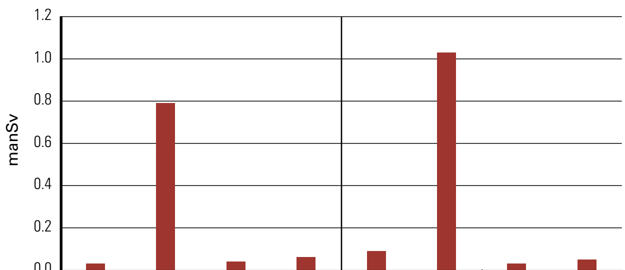
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
OL	1.72	1.18	1.12	1.03	1.51	2.22	2.20	1.18	0.94	1.19

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



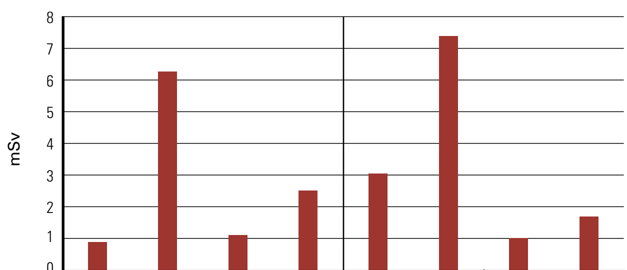
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
OL	11.30	9.45	8.41	6.20	7.96	10.32	10.30	7.63	7.275	8.27

Collective occupational radiation dose (manSv), Olkiluoto NPP



	I/08	II/08	III/08	IV/08	I/09	II/09	III/09	IV/09
OL	0.03	0.79	0.04	0.06	0.09	1.03	0.03	0.05

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



	I/08	II/08	III/08	IV/08	I/09	II/09	III/09	IV/09
OL	0.88	6.26	1.10	2.50	3.05	7.38	1.01	1.68

A.I.5 Radioactive releases

Definition

As the indicators, radioactive releases into the sea and the atmosphere (TBq) from the plant are monitored, as well as the calculated dose due to releases to the most exposed individual in the vicinity of the plant.

Source of data

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

Purpose of the indicator

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

Responsible unit/person

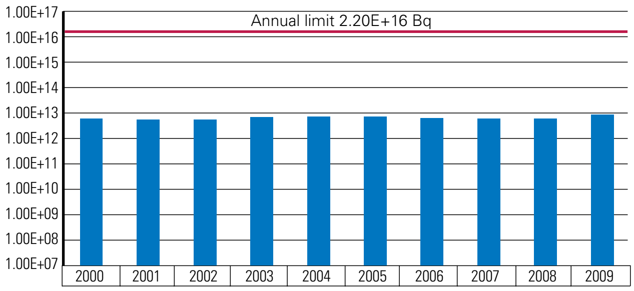
Radiation protection (SÄT), Antti Tynkkynen

A.I.5a Releases into the atmosphere

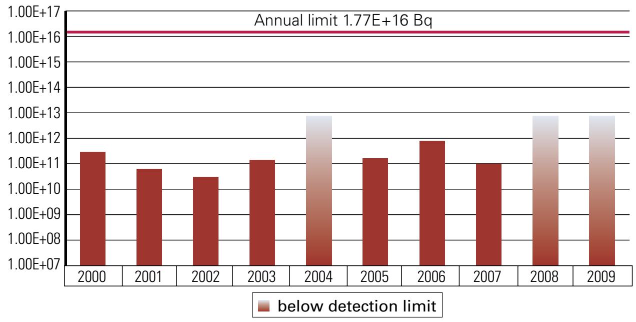
Interpretation of the indicator

Radioactive releases into the atmosphere from the Loviisa and Olkiluoto nuclear power plants were of the same magnitude as in previous years. In Loviisa, only the releases of iodine isotopes have been increasing. The iodine releases from Loviisa in 2009 were affected by the fuel leak occurring at the Loviisa 2 plant unit that released more iodine than usual to the environment. The total releases from Olkiluoto have decreased, and releases of noble gas activities remained below the detection limit for the second consecutive time. Emissions of radioactive substances into the environment from the Loviisa and Olkiluoto power plants were minor and remained clearly under the set emission limits.

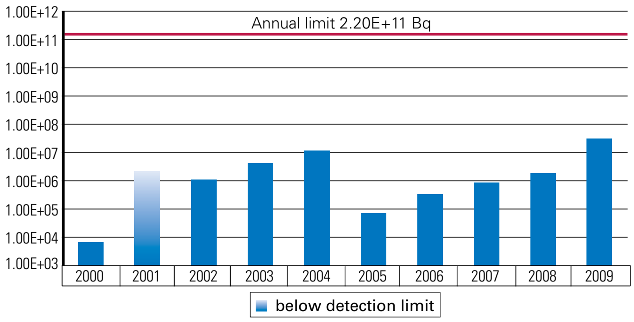
Noble gas releases (Bq $^{87}Kr_{eq}$), Loviisa NPP



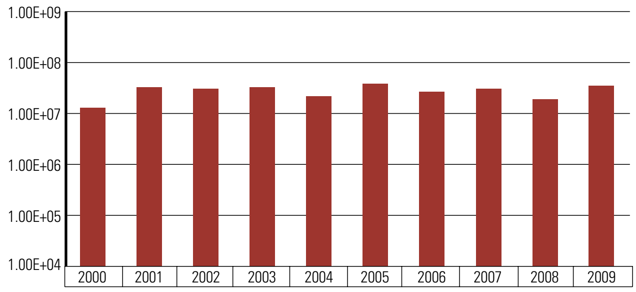
Noble gas releases (Bq $^{87}Kr_{eq}$), Olkiluoto NPP



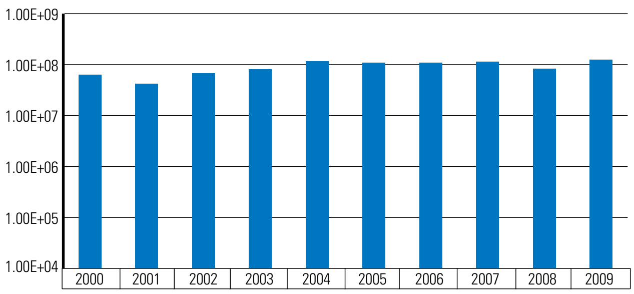
Iodine isotope releases to atmosphere (Bq $^{131}I_{eq}$), Loviisa NPP



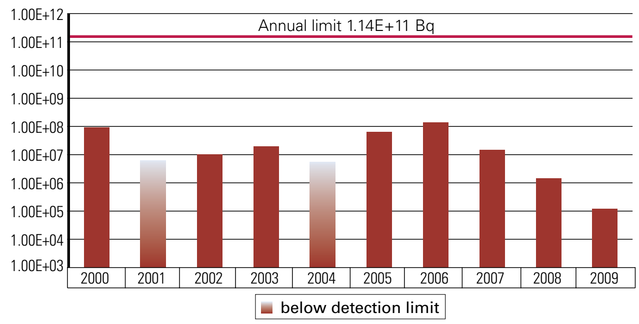
Aerosol releases to atmosphere (Bq), Olkiluoto NPP



Aerosol releases to atmosphere (Bq), Loviisa NPP



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

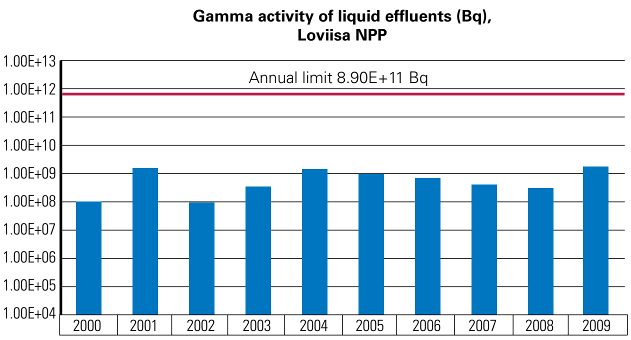


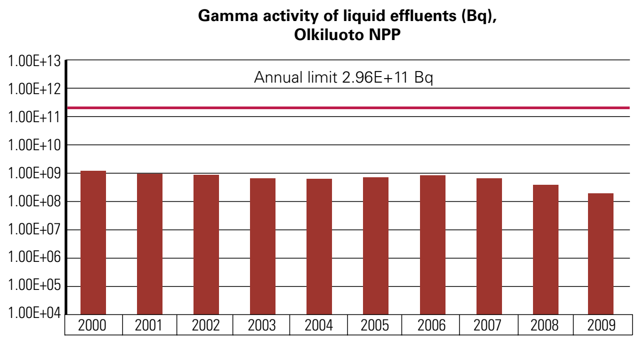
Gaseous fission products, noble gases and iodine isotopes originate in leaking fuel rods, in the minute amounts of uranium left on the outer surfaces of fuel cladding during fuel fabrication, and in reactor surface contamination from earlier fuel leaks. At both Loviisa and Olkiluoto, fuel leaks have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

A.I.5b Releases into the sea

Interpretation of the indicator

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



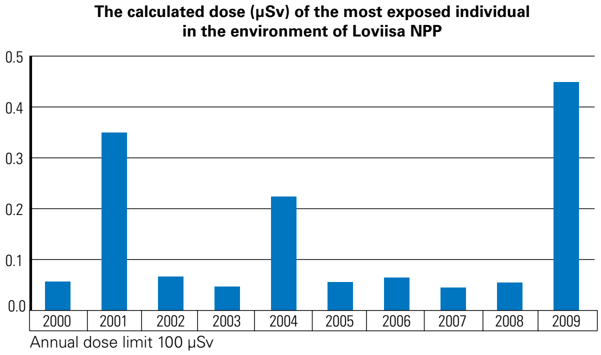


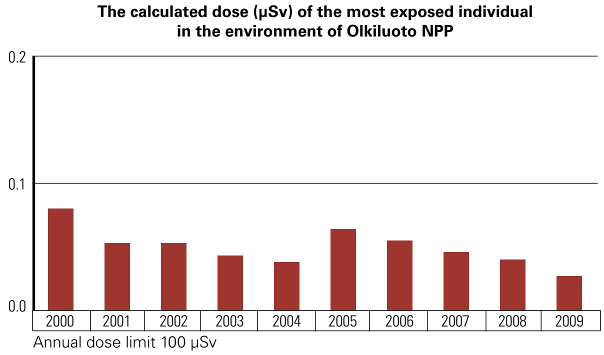
A.I.5c Population exposure

Interpretation of the indicator

The doses of the most exposed individual in the vicinity, calculated on the basis of releases from the plant, were below the set limit in Loviisa and Olkiluoto. As a result of the planned release of low-level evaporation waste to the sea in Loviisa, the dose of the most exposed individual in the vicinity of Loviisa was higher than usual. In Olkiluoto, the dose of the most exposed individual in the vicinity was the lowest in the plant's history.

For both plants, the calculated doses of the most exposed individual in the vicinity were less than 0.5% 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 euros are the confidential information of the utilities involved, and not to be published here. Furthermore, the scales of the Loviisa and Olkiluoto power plants' investment and modernisation diagrams are not mutually comparable.

Purpose of the indicator

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

Responsible unit/person

Organisations and Operations (OKA)
Tomi Koskiniemi

Interpretation of the indicator

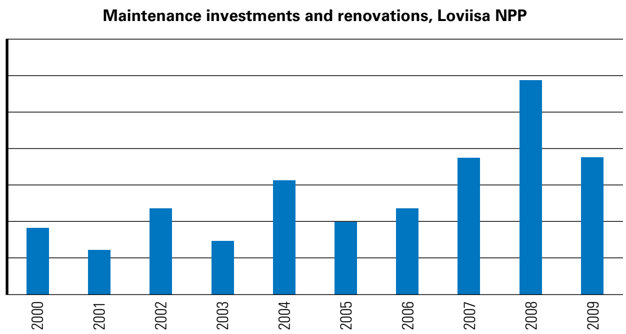
The variation in the indicator distinctly shows the investments related to power upgrades and modernisation projects of the plants. Both plants have paid much attention to life-cycle management, which also shows as continuous long-term investment plans. The renewal of the operation permit of the Loviisa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

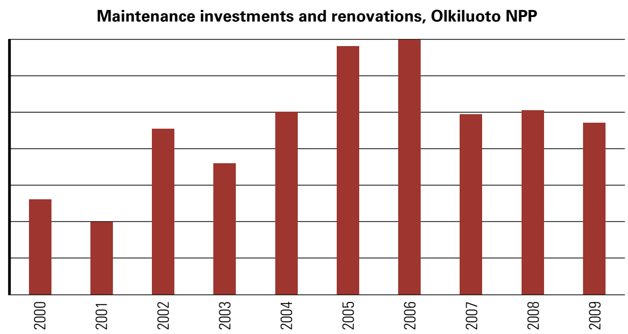
Loviisa

The increase in investments at the Loviisa power plant during 2007–2009 was due to the I & C modernisation project (LARA) that was by far the most significant single investment also in 2009. Other investments have remained at the previous years' level. Other investments in 2009 include the replacement of fuel racks with a denser design, the basic overhaul of waste, storage and decontamination facilities (VAJAKO), modernisation of the command centre used in potential emergencies, new boron analyzers for the primary circuit, replacement of wind generator stators, maintenance of the operability of the refuelling machine (LAMO), basic overhaul of the emergency diesels and generators, modernisation of the seawater inlet facility an improvement of the safety of secondary circuit (LARA/SETU), and an improvement project for the control of primary circuit pressure.

Olkiluoto

In 2009, the investments remained at the previous years' level in Olkiluoto. The largest investments included the expansion of storage and workshop facilities completed in 2009, replacement of valves in the residual heat removal system, replacement of extraction steam lines 3, replacement of rectifiers (SIMO), modernisation of the weather station and the still on-going projects for replacing the low pressure turbines and procuring new turbine generators for OL1 and OL2.





A.II Operational events

A.II.1 Number of events

Definition

As the indicators, the numbers of events reported in accordance with Guide YVL 1.5 are monitored. (Events warranting a special report, reactor trips and reports on operational events.)

Source of data

Data for the indicators is obtained from STUK's document administration system.

Purpose of the indicator

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

Responsible unit/person

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

Interpretation of the indicator

Loviisa

In the past year, six events warranting a special report (five of which were non-compliances with the Tech Specs, see section A.I.2) were observed. All events were classified as Class 0 on the international INES scale, and had little significance to safety.

The first event related to the momentary manual control during the repair of magnetic loads of the safety valve control valves of the pressurizers at Loviisa 2.

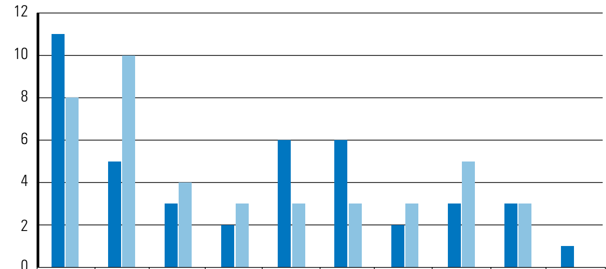
The second event was caused by a mistake made in the management of maintenance operations at Loviisa 1 that led to a momentary inoperability of both external containment spray system trains.

The third event concerned the level of fuel for the diesel generator in the electrical system for controlling serious reactor accidents; the fuel level in the tank had at times been too low because of discrepancies between the Tech Specs, testing instructions and alarms limits. The fourth event concerned an erroneous electrical isolation of the emergency feedwater control valve of Loviisa 2, done during the annual maintenance of Loviisa 1. The fifth event (the only one that was not in conflict with the Tech Specs) took place at Loviisa 2 when the control solenoid of a contactor in one emergency feedwater pump power supply unit overheated so that it had to be switched off and the plant fire brigade had to come and extinguish the fire. The sixth event concerned the periodic maintenance of flow meters of the emergency feedwater pumps common to both plant units. These were omitted during the 2009 annual maintenance.

There was only one reported operational transient where the reactor power was suddenly limited to 80% at Loviisa 1 when the triggered circuit breaker of the reverse rotation control device of the main coolant pump was being reset. The fault was rectified immediately.

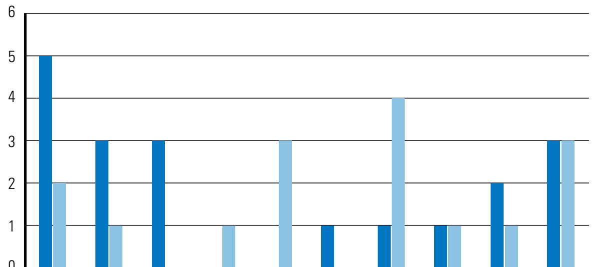
No reactor trips occurred in 2005–2009.

Number of operational transient reports, Loviisa NPP



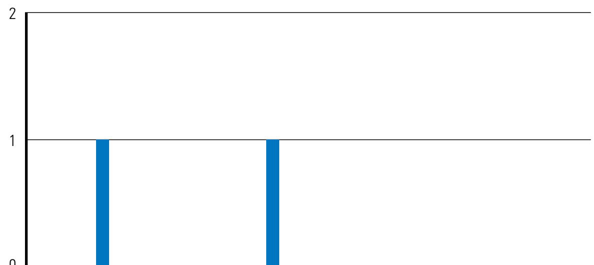
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
LO1	11	5	3	2	6	6	2	3	3	1
LO2	8	10	4	3	3	3	3	5	3	0

Number of Special Reports, Loviisa NPP



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
LO1	5	3	3	0	0	1	1	1	2	3
LO2	2	1	0	1	3	0	4	1	1	3

Number of reactor scrams, Loviisa NPP



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
LO1	0	1	0	0	1	0	0	0	0	0
LO2	0	0	0	0	0	0	0	0	0	0

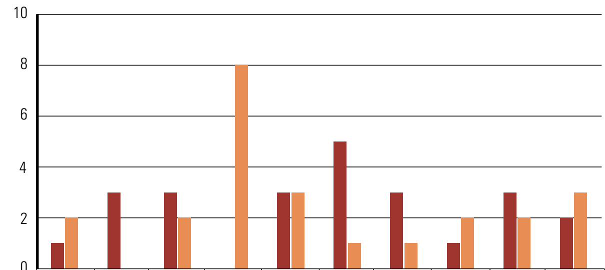
Olkiluoto

No reactor trips occurred in 2009. Based on the data from the last ten years, an average of one reactor trip per year occured at the Olkiluoto nuclear power plant. The number of reactor trips has decreased from the previous decade 1990–1999 when an average of four reactor trips occurred every year.

Based on data from the last ten years, the average number of annual events warranting a special report or a transient report is five. Hence, the number of events warranting a special report (five) and the number of reported transients (also five) in 2009 were of average level.

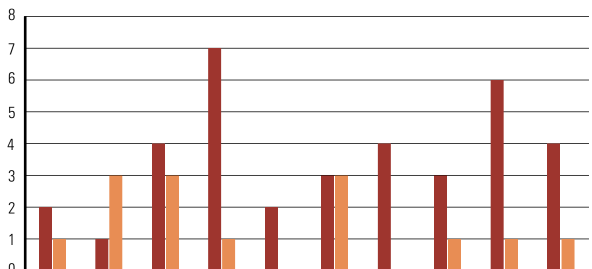
When considering the indicators, it must be noted that the number of reports does not give the correct conception of the division of events by plant unit since, for system technical reasons, the reports for both plant units have been entered for Olkiluoto 1. In 2009, one event warranting a transient report and two warranting a special report concerned both plant units.

Number of operational transient reports, Olkiluoto NPP



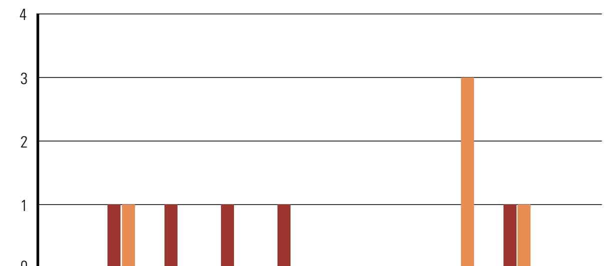
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
OL1	1	3	3	0	3	5	3	1	3	2
OL2	2	0	2	8	3	1	1	2	2	3

Number of Special Reports, Olkiluoto NPP



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
OL1	2	1	4	7	2	3	4	3	6	4
OL2	1	3	3	1	0	3	0	1	1	1

Number of reactor scrams, Olkiluoto NPP



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
OL1	0	1	1	1	1	0	0	0	1	0
OL2	0	1	0	0	0	0	0	3	1	0

A.II.2 Direct causes of events

Definition

As the indicators, the direct causes of events reported in accordance with Guide YVL 1.5 are followed. The causes of the events are divided into technical failures and erroneous operational and maintenance actions (non-technical, human errors).

Source of data

Data for the indicators are collected from special reports, reports on reactor trips and operational transient reports, and are entered into an event follow-up table maintained by OKA.

Purpose of the indicator

The indicator is used to follow the division of the causes of reported events into technical and non-technical causes. "Non-technical causes" denote failures caused by erroneous operational and maintenance actions. The indicator may be indicative of an organisation's operation.

Responsible unit/person

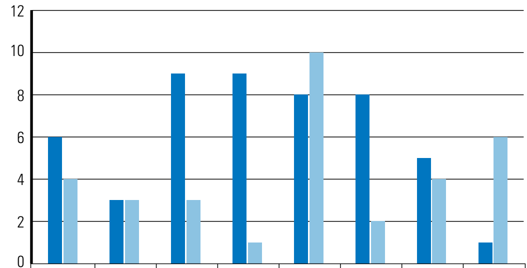
Organisations and Operations (OKA)
Suvi Ristonmaa and Tomi Koskiniemi

Interpretation of the indicator

The indicators do not give cause for any particular conclusions concerning either utility.

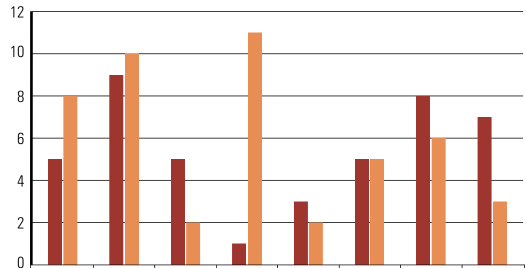
Both technical and non-technical causes can be identified behind many events. In such cases, classification is done based on the most significant cause of the event.

Direct causes of events, Loviisa NPP



	2002	2003	2004	2005	2006	2007	2008	2009
LO, Technical	6	3	9	9	8	8	5	1
LO, Human	4	3	3	1	10	2	4	6

Direct causes of events, Olkiluoto NPP



	2002	2003	2004	2005	2006	2007	2008	2009
OL, Technical	5	9	5	1	3	5	8	7
OL, Human	8	10	2	11	2	5	6	3

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 Tech Specs are in category 1, if they can be utilised for this indicator. Non-compliances with the Tech Specs are also dealt with under indicator A.I.2.

N.B.! Calculations for the Loviisa plant are based on a somewhat outdated internal-initiating-event model, making them indicative only of a trend.

Source of data

Data for the calculation of the indicators is collected from utility reports and applications for exemptions.

Purpose of the indicator

The indicator is used to follow the risk-significance of component unavailability and to assess risk-significant initiating events and planned unavailability. Special attention is paid to recurring events, CCFs, simultaneously occurring failures and human errors. Another objective of the event analysis is to systematically identify signs of a deteriorating organisational and safety culture.

Responsible unit/person

Risk assessment (RIS), Jorma Rantakivi
(PSA computation)
Organisations and Operations (OKA)
(failure data)

Interpretation of the indicator

Loviisa

A brief description of the significant events is given below:

Loviisa 1:

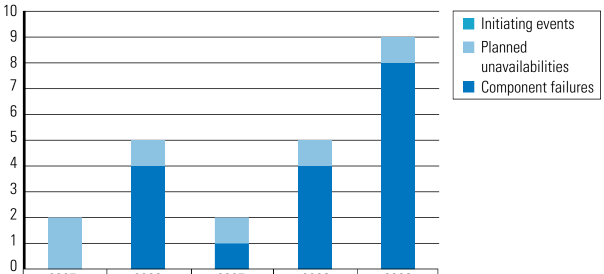
1) Component failure: One of the two cooling devices (B2) in the cooling system UV25 of the instrument facilities of the control room building failed (faulty thermistor relay). The duration of faulty state was approximately 18 days. CCDP = 4.8E-7.
2) Component failure: One of the two cooling devices (B3) in the cooling system UV25 of the instrument facilities of the control room building failed (valve UV25S219 leaky). The duration of faulty state was approximately 5 days. CCDP = 1.6E-7.
3) Component failure: One of the two cooling devices (B2) in the cooling system UV25 of the instrument facilities of the control room building failed (base of compressor 1V1962 disintegrates). The duration of faulty state was approximately 9 days. CCDP = 2.5E-7.
4) Component failure: A diesel generator (EY01) did not start during a test drive. The diesel engine remained faulty for approximately 16 days. CCDP = 1.9E-7.
5) Component failure: The inlet damper of redundancy 2 of the control room building instrument facilities air conditioning system UV20 and all room outlet dampers (redundancy 2) were faulty. Cooling device UV25B02 was also faulty. The duration of faulty state was approximately 11.5 days. CCDP = 5.9E-7.
6) Component failure: The inlet damper of redundancy 2 of the control room building instrument facilities air conditioning system UV20 and all room outlet dampers (redundancy 2) were faulty. Redundancy 1 of UV20 was also faulty because blower UV20D01 was faulty. Cooling device UV25B02 was also faulty. The duration of faulty state was approximately 3 days. CCDP = 3.5E-6.
7) Component failure: The inlet and exhaust blowers of the control room building instrument facilities air conditioning system UV20 were faulty. The duration of faulty state was approximately 2 days. CCDP = 1.3E-7.

8) Component failure: The inlet damper of redundancy 2 of the control room building instrument facilities air conditioning system UV20 and all room outlet dampers (redundancy 2) were faulty. The duration of faulty state was approximately 4.5 days. CCDP = 1.2E-7.
9) Preventive maintenance: The preventive maintenance of auxiliary feed water system RL97 during LO2 revision increased the probability of a severe accident at LO1, as the auxiliary feed water systems RL 94/97 can also be connected to plant unit LO1. CCDP = 6.8E-7.

Loviisa 2:

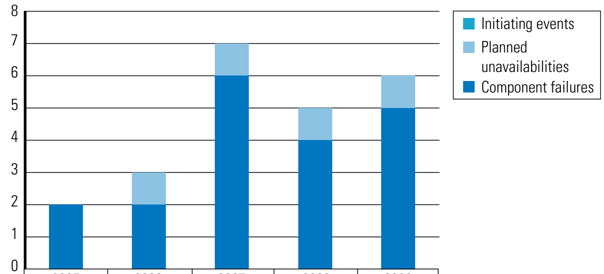
1) Component failure: Valve RL94S0050 connecting emergency feedwater pumps RL97 and RL94 (used when RL94 feeds RL97) was jammed. The valve had been jammed for approximately 15 days. CCDP = 1.0E-6.
2) Preventive maintenance: The preventive maintenance of auxiliary feed water system RL94 during LO1 revision increased the probability of a severe accident at LO1, as the auxiliary feed water systems RL 94/97 can be connected to either plant unit. CCDP = 8.7E-7.
3) Component failure: Diesel generator (EY02) faulty due to a fault in cooling blower UV52D0091. The diesel generator remained faulty for approximately 16 days. CCDP = 4.2E-7.
4) Component failure: Primary circuit emergency feedwater pump TJ11D01 tripped as a result of over-current when started during YZ24 testing.

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



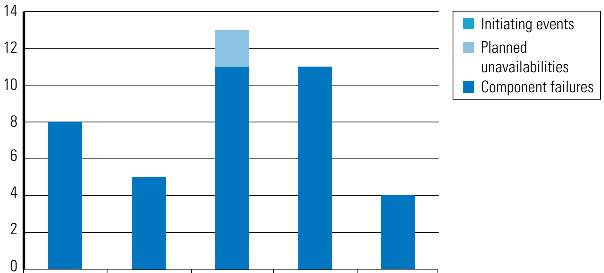
	2005	2006	2007	2008	2009
Initiating events	0	0	0	0	0
Planned unavailabilities	2	1	1	1	1
Component failures	0	4	1	4	8

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



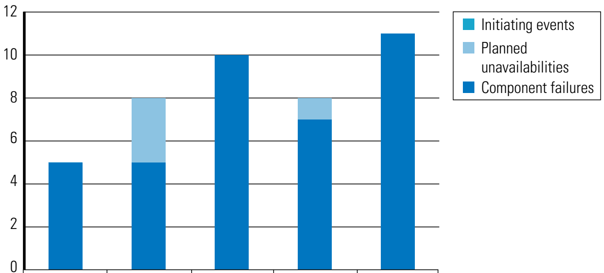
	2005	2006	2007	2008	2009
Initiating events	0	0	0	0	0
Planned unavailabilities	0	1	1	1	1
Component failures	2	2	6	4	5

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



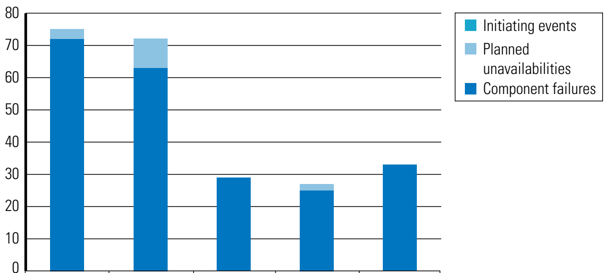
	2005	2006	2007	2008	2009
Initiating events	0	0	0	0	0
Planned unavailabilities	0	0	2	0	0
Component failures	8	5	11	11	4

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



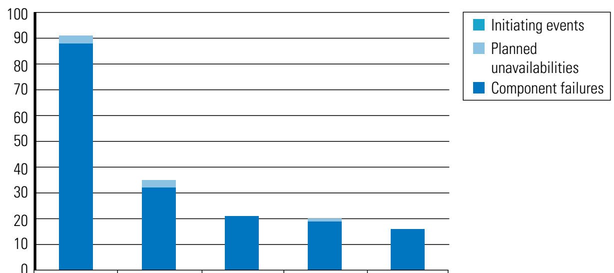
	2005	2006	2007	2008	2009
Initiating events	0	0	0	0	0
Planned unavailabilities	0	3	0	1	0
Component failures	5	5	10	7	11

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



	2005	2006	2007	2008	2009
Initiating events	0	0	0	0	0
Planned unavailabilities	3	9	0	2	0
Component failures	72	63	29	25	33

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



	2005	2006	2007	2008	2009
Initiating events	0	0	0	0	0
Planned unavailabilities	3	3	0	1	0
Component failures	88	32	21	19	16

The pump remained faulty for approximately 10 days. CCDP = 1.5E-7.

5) Component failure: Emergency feedwater system RL97 was faulty due to a fault in air conditioning inlet damper RL97S120. Tech Specs require this damper to be operable in order for RL97 to be operable. The damper remained faulty for approximately 23 days. The CCDP becomes 1.6E-6.
6) Component failure: Cooling device B2 in the cooling system UV46 of the instrument facilities of the control room building failed due to a failure of the starting card. The duration of faulty state was approximately 4 days. CCDP = 1.2E-7.

Loviisa experienced plenty of air conditioning faults last year. Attention must be paid to this in 2010. The other events can be considered part of normal nuclear power plant operation and did not call for any further actions by STUK.

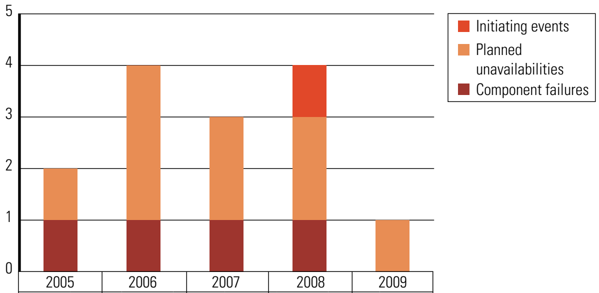
Olkiluoto

A brief description of the significant events is given below:

Olkiluoto1:

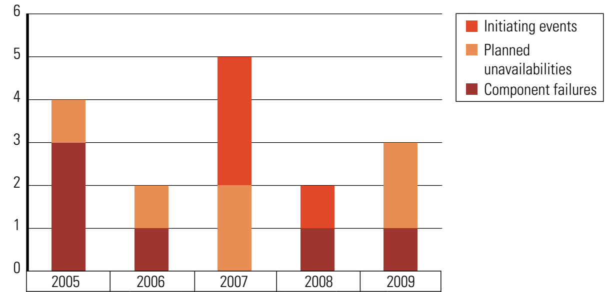
1) Preventive maintenance: The diesel package DIP-D took more than 4 days. CCDP = 1.0E-7.

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



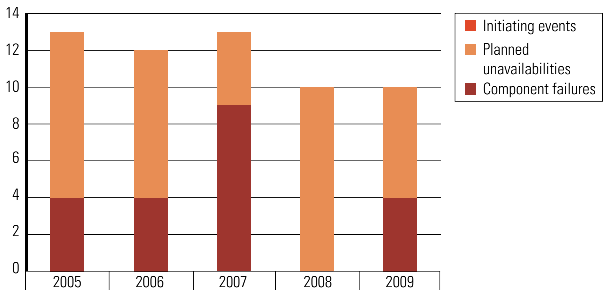
2005	2006	2007	2008	2009
0	0	0	1	0
1	3	2	2	1
1	1	1	1	0

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



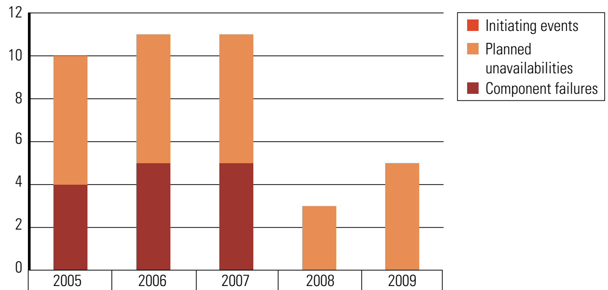
2005	2006	2007	2008	2009
0	0	3	1	0
1	1	2	0	2
3	1	0	1	1

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



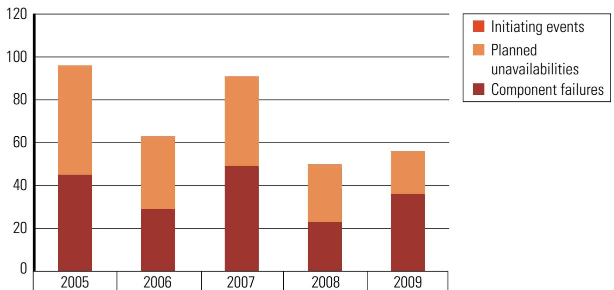
2005	2006	2007	2008	2009
0	0	0	0	0
9	8	4	10	6
4	4	9	0	4

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



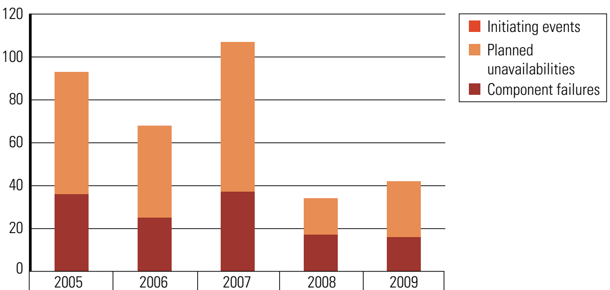
2005	2006	2007	2008	2009
0	0	0	0	0
6	6	6	3	5
4	5	5	0	0

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



2005	2006	2007	2008	2009
0	0	0	0	0
51	34	42	27	20
45	29	49	23	36

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



2005	2006	2007	2008	2009
0	0	0	0	0
57	43	70	17	26
36	25	37	17	16

Olkiluoto2:

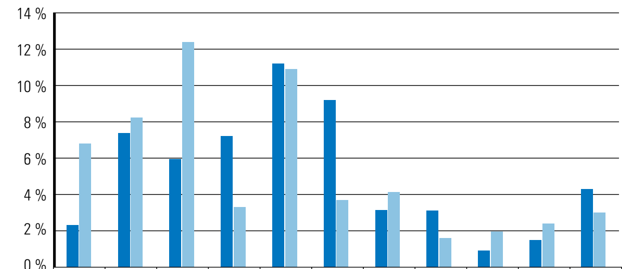
1) Preventive maintenance: The diesel package DIP-C took more than 6 days. CCDP = 1.5E-7.
2) Preventive maintenance: The diesel package DIP-D took more than 4 days. CCDP = 1.1E-7.
3) Component failure: Switch G201-S of diesel 653G201 opened during the diesel load test. The diesel generator remained faulty for approximately 14 days. CCDP = 1.5E-7.

The risk caused by events in Olkiluoto consisted of three diesel maintenance packages of long duration and one latent diesel fault. The analysed events are considered to be part of normal nuclear power plant operation and did not give rise to any further measures by STUK.

The combined total CCDP of all three categories divided by the probability of a severe accident gives an overview of the risk-significance of operational events. To facilitate analysis, risk calculation is based on conservative assumptions and simplifications, which materially weakens the applicability of the results for trend monitoring. If the risk-significance remains at the target level on average for several years, the annual fluctuation does not warrant particular attention.

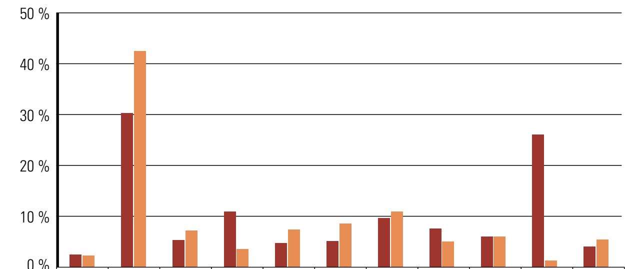
The risk due to operational events at the Loviisa plants would seem to have increased slightly in 2009 compared to previous years, but it still remains lower than during the early years of the decade. The risk due to operational events at the Olkiluoto plants has remained at the average level of previous years.

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



	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
LO1	2.30	7.39	5.96	7.20	11.21	9.20	3.15	3.10	0.90	1.50	4.30
LO2	6.80	8.23	12.39	3.30	10.90	3.70	4.14	1.60	1.95	2.40	3.00

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



	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
OL1	2.47	30.30	5.28	10.90	4.68	5.10	9.64	7.60	6.00	26.10	4.00
OL2	2.26	42.50	7.17	3.50	7.39	8.60	10.95	5.00	6.00	1.30	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 (PSA computation)
Organisations and Operations (OKA) (failure data)

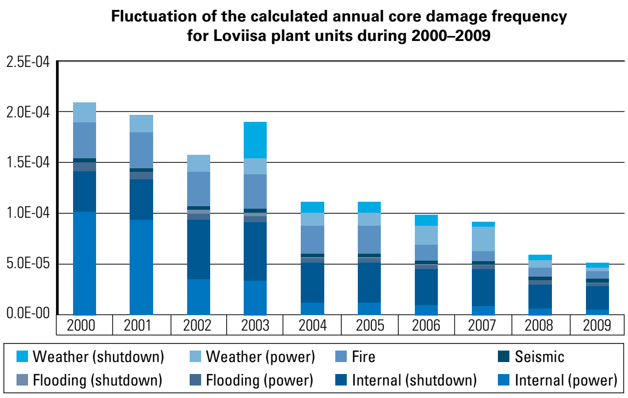
Interpretation of the indicator

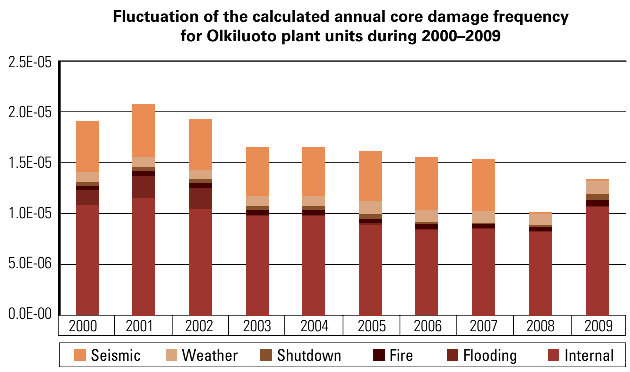
When assessing the indicator, it must be remembered that it is affected by both the development of the power plant and the development of analyses and the calculation model. Plant modifications and changes in methods, carried out to remove risk factors, will decrease the indicator value. An increase of the indicator value may be due to the model being extended to new event groups, or the identification of new risk factors. In addition, developing more detailed models or obtaining more detailed basic data may change risk estimates in either direction. For example, the increase in the Loviisa indicator in 2003 was due to the analysis being extended to cover exceptionally harsh weather conditions and oil accidents at sea during a refuelling outage. In the following year, the indicator value decreased, partly as a result of a more detailed analysis of these factors.

Loviisa power plant's accident risk has continued to decrease over the last ten years, and new risk factors discovered as the scope of the risk analysis has been extended, have been efficiently removed. The indicator decreased in 2007 due to the new seawater line completed during the period. The new line allows for the alternative intake of seawater from the outlet channel to cool the plant in shutdown operation. The change will decrease risks in situations where algae, frazil ice, or an oil release endanger the availability of seawater through the conventional route. The decrease of the indicator in 2008 results from more detailed analyses performed in conjunction with the renewing of the operating licence, as well as changes at the plant planned to be carried out earlier or in connection with the licence renewal. Such changes include: the I & C modernisation project, 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 a high-energy leak in instrumentation facilities.

For the Loviisa power plant, the most important factors affecting the overall accident risk include internal plant events during outages (such as the falling of heavy loads or a power surge caused by the sudden dilution of the boron used to adjust reactor operation), fire, a high level of seawater during power operation and oil releases during a refuelling outage.

The indicator for the Olkiluoto plant decreased approximately 30% in 2008 compared to 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. In 2009, the indicator for the Olkiluoto power plant increased because the new analyses indicated that the reactor cleaning system can no longer be utilised as the ultimate means of residual heat removal. For the Olkiluoto power plant, the most important factors affecting the overall accident risk include internal events during power operation (component failures and pipe ruptures leading to an operational transient).





A.II.5 Number of fire alarms

Definition

As the indicators, the number of fire alarms and actual fires are followed.

Source of data

Data for the indicators is collected from the power companies. The licensees submit the data needed for the indicator to the person responsible for the indicator at STUK.

Purpose of the indicator

The indicator is used to follow the effectiveness of fire protection at the nuclear power plants.

Responsible unit/person

Civil Engineering and Fire Protection (RAK)
Heikki Saarikoski

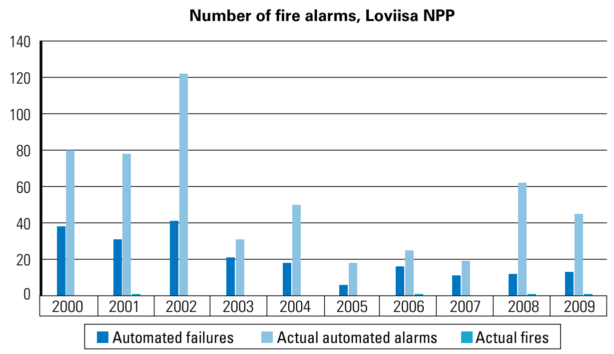
Interpretation of the indicator

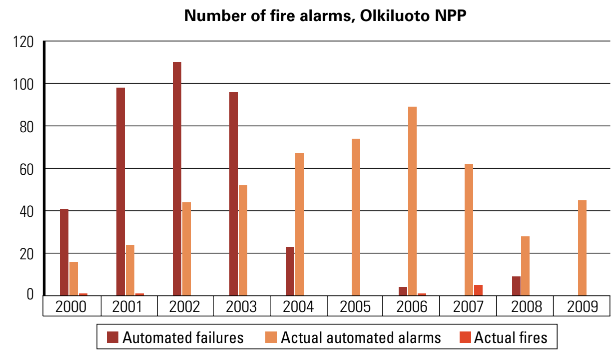
At the Loviisa power plant, one event classified as a fire occurred in 2009. A fire started in one switchboard cabinet in the electrical facility of the Loviisa 2 control room building. The plant fire brigade quickly put it out using carbon dioxide extinguishers. The fire did not put the safety of Loviisa 2 at risk. In addition, there were two events classified as fires in the terrain outside the plant perimeters. The frequency of faults in the fire detector alarms of the Loviisa power plants remained in 2009 at the same level as in 2008, but there were fewer genuine fire alarms during the year, partly because of less work done in annual maintenance and completion of the construction work of the new I & C buildings.

No events classified as fires occurred in the Olkiluoto plant area (OL1/2) in 2009. Outside the plant area, however, three events classified as fires occurred, two on the Olkiluoto 3 site and one in the accommodation village. The fire events were of a minor nature (OL3: fires in an industrial vacuum cleaner and switchgear cabinet, and fire in a range hood in the accommodation village). No fire detection system failures were observed at the Olkiluoto power plant in 2009. The situation was the same as in 2008. The 26 component faults shown in the table are failures of the sprinkler system, indicated by the fire alarm system. These failures did not, however, cause inoperability of the sprinkler system. The number of genuine alarms raised by the fire detection systems has increased from 2008. This may be partly due to the repair and modification work carried out in 2009 during plant operation.

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

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





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. As the indicator for the Loviisa plant, the activity level of the primary coolant calculated as I-131 equivalent concentrations, as well as the maximum activity as the sum of iodine isotopes, were followed until the end of 2006. Late in 2006, the Technical Specifications limit concerning the iodine activities in primary coolant was defined as an I-131 activity concentration, instead of the sum of iodine isotopes used until then. At the same time, I-131 activity concentrations were adopted for the monitoring of the maximum activity level. Loviisa power plant delivered the values for I-131 activity concentrations retrospectively from 1997–2006.

The maximum activity concentration of I-131 during depressurisation while entering shutdown or after a reactor trip, 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 shutdown situations also describe the success of the shutdown concerning radiation protection.

Responsible unit/person

Reactor and Safety Systems (REA)
Kirsti Tossavainen

A.III.1a Primary coolant activity

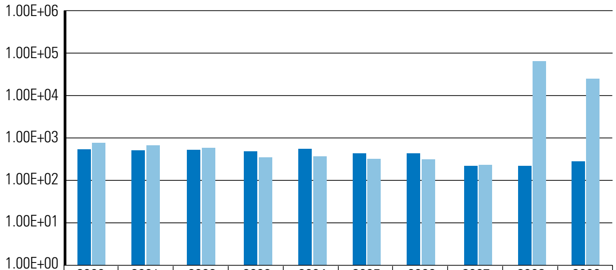
Interpretation of indicators (Loviisa)

Loviisa 2 had leaking fuel in 2009. An increase of activity had been detected on 28 November 2008 in the gases released from the process systems. The activity concentration of the iodine isotopes in the primary coolant and the gaseous fission products dissolved into the primary coolant also increased. On 1 December 2008, the observation was confirmed as a fuel leak. After the initial phases of the leak, the activity concentrations stabilised and the fuel leak remained small. One leaking fuel assembly was found in the search carried out during the annual maintenance outage and was removed from the reactor.

The limit set in the Tech Specs for the I-131 concentration in primary coolant was exceeded when the plant unit was shut down for the annual maintenance outage. The limit was only exceeded for a short time. The sample from which the activity concentration exceeding the Tech Specs limit was analysed was taken during plant operation mode (start-up operation) where the Tech Specs limit applies. By the time the result of the analysis was available, the plant unit had moved to another operating mode (hot standby) for which no limit has been set in the Tech Specs regarding the concentration of I-131 activity. The higher-than-normal I-131 activity concentration of primary coolant is also reflected in the maximum I-131 activity concentration during plant unit shutdown. After shutdown, the I-131 activity concentration rapidly decreased. During the operating cycle started after the annual maintenance and after removal of the leaking fuel bundle from the reactor, the I-131 activity of primary coolant was almost at the level preceding the fuel leak.

A minor fuel leak was observed at Loviisa 1 on 20 October 2009. The fuel leak had not caused a significant change in the I-131 activity concentration of primary coolant by the end of 2009.

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



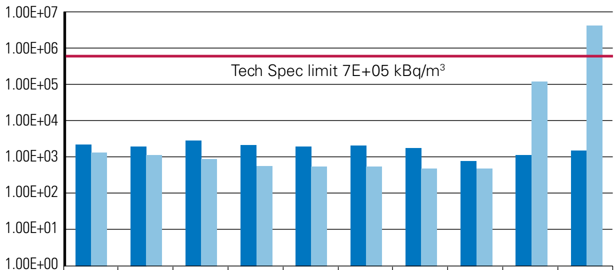
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
LO1	4.82E+02	4.45E+02	4.71E+02	4.32E+02	5.01E+02	3.89E+02	3.91E+02	1.90E+02	2.00E+02	2.60E+02
LO2	7.19E+02	6.40E+02	5.74E+02	3.22E+02	3.39E+02	2.91E+02	2.72E+02	2.10E+02	4.90E+04	2.40E+04

The indicator shows that the fuel integrity of both Loviisa 1 and Loviisa 2 was impaired due to minor fuel leaks.

Interpretation of indicators (Olkiluoto)

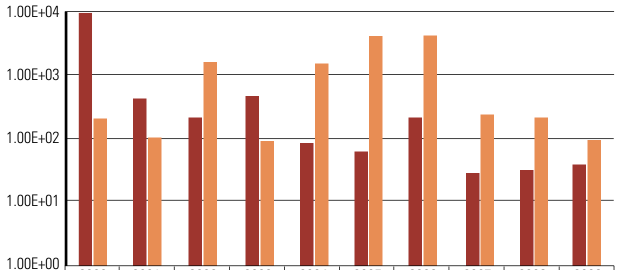
The Olkiluoto plant units had no leaking fuel in 2009. The I-131 activity concentrations during operation at Olkiluoto 1 have remained the same as in previous years. The concentrations at Olkiluoto 2 are on a downward trend, both during operation and shutdown. Based on the indicator, fuel integrity has been good at the Olkiluoto plant units in 2009.

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



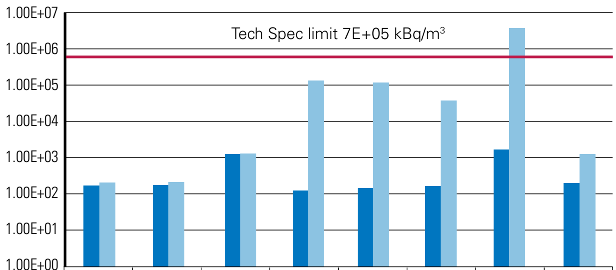
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
LO1	2.40E+03	2.10E+03	3.00E+03	2.30E+03	2.10E+03	2.20E+03	1.90E+03	8.10E+02	1.20E+03	1.54E+03
LO2	1.40E+03	1.20E+03	9.30E+02	6.00E+02	5.80E+02	5.90E+02	5.20E+02	5.00E+02	1.30E+05	3.85E+06

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



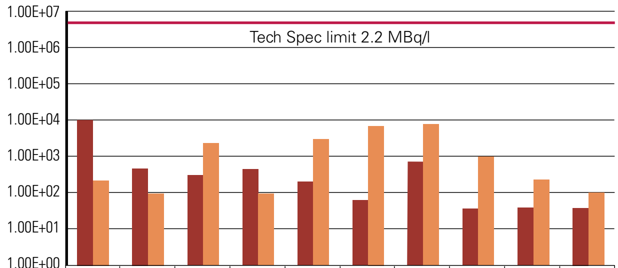
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
OL1	9.00E+03	4.00E+02	2.00E+02	4.30E+02	8.20E+01	5.80E+01	2.00E+02	2.70E+01	3.00E+01	3.50E+01
OL2	2.00E+02	1.00E+02	1.50E+03	9.00E+01	1.49E+03	4.00E+03	4.00E+03	2.30E+02	2.10E+02	9.10E+01

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



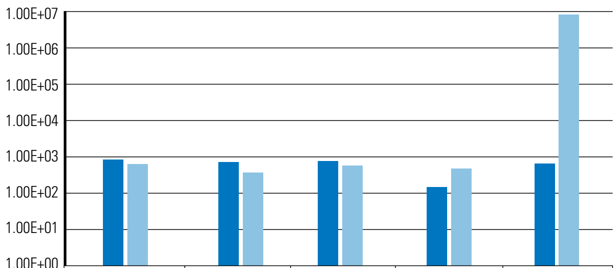
	I/08	II/08	III/08	IV/08	I/09	II/09	III/09	IV/09
LO1	1.60E+02	1.70E+02	1.20E+03	1.20E+02	1.40E+02	1.61E+02	1.54E+03	1.89E+02
LO2	2.00E+02	2.10E+02	1.30E+03	1.30E+05	1.20E+05	3.75E+04	3.85E+06	1.16E+03

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



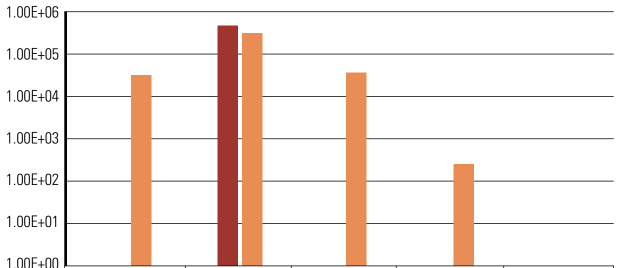
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
OL1	8.98E+03	4.42E+02	2.90E+02	4.30E+02	1.90E+02	5.90E+01	6.90E+02	3.50E+01	3.70E+01	3.60E+01
OL2	2.14E+02	9.88E+01	2.37E+03	9.10E+01	3.12E+03	6.52E+03	7.03E+03	9.99E+02	2.30E+02	1.00E+02

Fuel integrity:
Iodine (I-131) maximum activity concentration of primary coolant (kBq/m³) during shutdown or after reactor scram, Loviisa NPP



	2005	2006	2007	2008	2009
LO1	6.38E+02	5.48E+02	5.70E+02	1.40E+02	4.80E+02
LO2	5.09E+02	2.93E+02	4.40E+02	4.30E+02	6.40E+06

Fuel integrity:
Iodine (I-131) maximum activity concentration of primary coolant (kBq/m³) during shutdown or after reactor scram, Olkiluoto NPP



	2005	2006	2007	2008	2009
OL1	0.00E+00	3.60E+05	0.00E+00	0.00E+00	0.00E+00
OL2	3.44E+04	3.08E+05	3.70E+04	2.52E+02	0.00E+00

A.III.1b Number of leaking fuel bundles

Interpretation of indicators (Loviisa)

A minor fuel leak was detected at Loviisa 2 late in 2008. The leaking fuel bundle was removed from the reactor during the 2009 annual maintenance outage. A minor fuel leak was observed at Loviisa 1 in October after the annual maintenance outage. The leaking fuel will be removed from the reactor in the 2010 annual maintenance outage at the latest. The previous fuel leak occurred at the Loviisa plant in 1999.

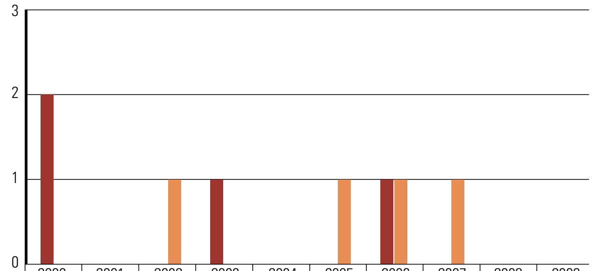
Interpretation of indicators (Olkiluoto)

In 2009, Olkiluoto plant units had no leaking fuel. The last leaking fuel bundle was removed from the reactor of Olkiluoto 1 in the annual maintenance outage of 2006 and from the reactor of Olkiluoto 2 in the outage of 2007.

Number of leaking fuel bundles removed from the reactor, Loviisa NPP

	2000	2001	1002	2003	2004	2005	2006	2007	2008	2009
LO1	0	0	0	0	0	0	0	0	0	0
LO2	0	0	0	0	0	0	0	0	0	1

Number of leaking fuel bundles removed from the reactor, Olkiluoto NPP



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
OL1	2	0	0	1	0	0	1	0	0	0
OL2	0	0	1	0	0	1	1	1	0	0

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 utilities, depicting the effectiveness of water chemistry control in the secondary circuits of PWRs and in the reactor circuits of BWRs. The indicator for Olkiluoto is the international index used by the plant. 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. 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 new index has been used as an indicator since 2002. 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 values during power operation.
- The maximum chloride concentration of the steam generator blowdown (Loviisa) and the reactor water (Olkiluoto) during operation compared with the Tech Spec limit in the monitoring period. At the Olkiluoto plant, the maximum sulphate content of reactor water on even, steady-state operation is followed as well.
- Corrosion products released from the surfaces of the reactor circuit and the secondary circuit into the coolant. For the Loviisa plant, the iron concentration of the primary coolant and the secondary circuit 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 power companies use several other parameters to monitor the plant units' water chemistry conditions.

Responsible units/persons

Reactor and Safety Systems (REA)
Kirsti Tossavainen

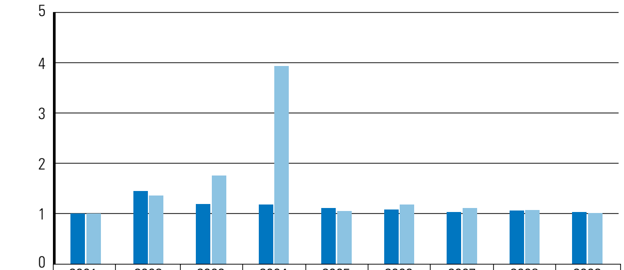
Interpretation of indicators (Loviisa)

The iron content in the primary coolant and the chloride content in the steam generator blowdown have complied with the license holder's guidelines. There was one brief period when the guide value (< 10 µg/l) set by the power company for the iron content of secondary coolant was exceeded at Loviisa 1. At Loviisa 2, the iron content of secondary coolant has complied with the guide value at all times. The iron and chloride concentrations monitored in STUK's indicator system refer to values measured during operation. The concentrations of cobalt-60 activity are monitored during shutdown. They did not deviate from previous years' values. The chemistry index of both Loviisa plant units has remained at almost the best possible value.

The water chemistry of primary coolant was modified at both Loviisa plant units in 2008. The objective of the modification was to achieve the high temperature pH (300 °C) already at the beginning of the operating cycle and to keep it stable throughout the cycle. The purpose of optimising the high temperature pH is to minimise the corrosion of materials in the primary circuit and the deposition of corrosion products on the surfaces of fuel rods and the primary circuit. The corrosion products may become activated in the reactor core and as they migrate and become deposited on the primary circuit surfaces, cause radiation exposure to employees, for example, during maintenance work. The power company has assessed the impacts of the modification on the chemical conditions and activity content in the primary coolant as well as on the surface contamination, the radiation levels present in the plant and the oxidation of the fuel cladding. Final conclusions cannot be drawn on the basis of one operating cycle alone. However, no cause for making modifications to the current water chemistry has been found. No significant changes took place regarding the indicator "Maximum values of iron concentration in primary coolant during power operation" monitored by STUK as an indicator of primary circuit corrosion.

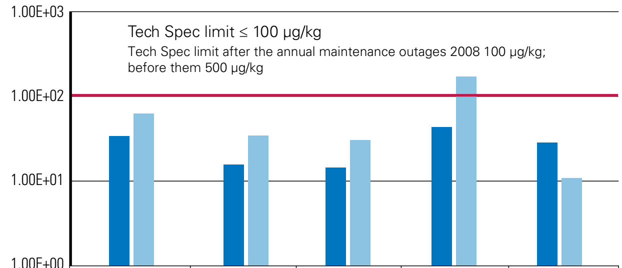
Based on the water chemistry indicators, the primary circuit integrity of Loviisa plant units has remained good.

Integrity of the secondary circuit: Chemistry index, Loviisa NPP



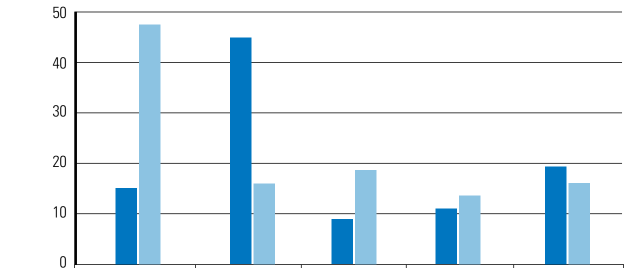
	2001	2002	2003	2004	2005	2006	2007	2008	2009
LO1	1.00	1.45	1.19	1.18	1.11	1.08	1.03	1.06	1.03
LO2	1.00	1.36	1.76	3.93	1.05	1.18	1.11	1.07	1.01

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



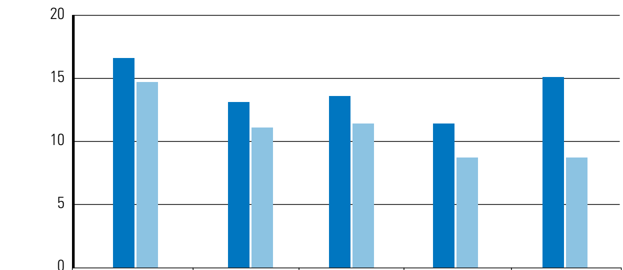
	2005	2006	2007	2008	2009
LO1	3.33E+01	1.84E+01	1.43E+01	3.64E+01	2.90E+01
LO2	5.28E+01	3.73E+01	3.19E+01	2.10E+02	1.14E+01

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



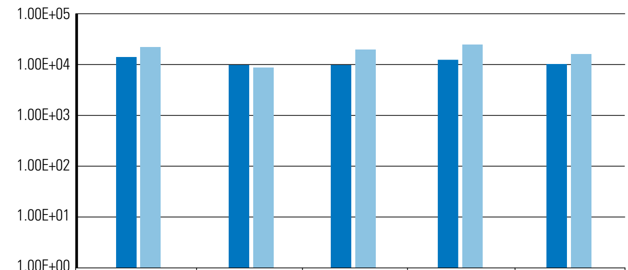
	2005	2006	2007	2008	2009
LO1	15.1	44.9	8.9	11.0	19.4
LO2	47.5	16.0	18.7	13.6	16.1

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



	2005	2006	2007	2008	2009
LO1	16.6	13.1	13.6	11.4	15.1
LO2	14.7	11.1	11.4	8.7	8.7

Integrity of primary circuit: Maximum cobalt-60 activity concentration (kBq/m³) in primary coolant during shutdown or after reactor scram, Loviisa NPP



	2005	2006	2007	2008	2009
LO1	1.50E+04	9.60E+03	1.09E+04	1.29E+04	1.03E+04
LO2	2.30E+04	9.00E+03	2.30E+04	2.40E+04	1.71E+04

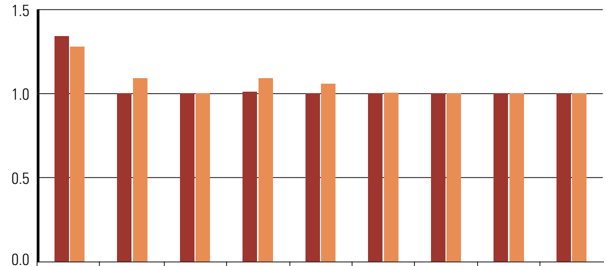
Interpretation of indicators (Olkiluoto)

The sulphate and chloride concentrations in reactor water and the iron concentration in reactor feedwater have complied with the license holder's target values apart from one brief incident where the target value for sulphate concentration (< 5 µg/l) was exceeded. The chemistry index has remained steady at the best possible value (1).

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

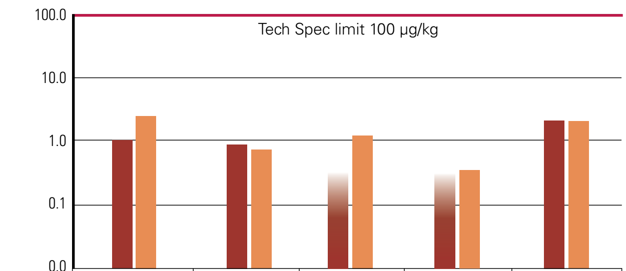
Based on the water chemistry indicators, the primary circuit integrity of Olkiluoto plant units has remained good.

Integrity of primary circuit: Chemistry index, Olkiluoto NPP



	2001	2002	2003	2004	2005	2006	2007	2008	2009
OL1	1.34	1.00	1.00	1.01	1.00	1.00	1.00	1.00	1.00
OL2	1.28	1.09	1.00	1.09	1.06	1.00	1.00	1.00	1.00

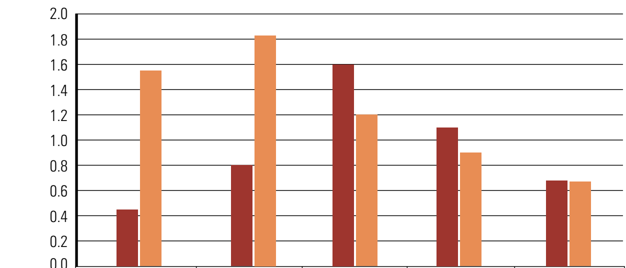
Integrity of primary circuit: Corrosive impurities; Maximum chloride concentration in primary coolant (µg/kg) in power operation, Olkiluoto NPP



	2005	2006	2007	2008	2009
OL1	1.0	0.9	0.5	0.5	2.1
OL2	2.5	0.8	1.2	0.6	2.0

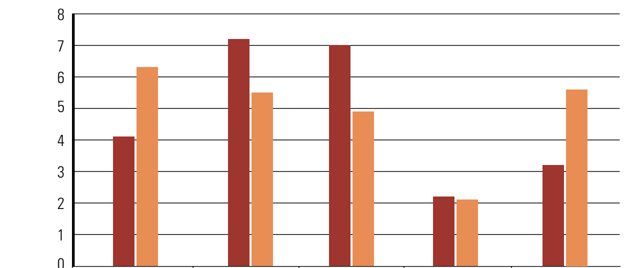
below detection limit

Integrity of primary circuit: Corrosion products; Maximum iron concentration in reactor feed water (µg/l), Olkiluoto NPP



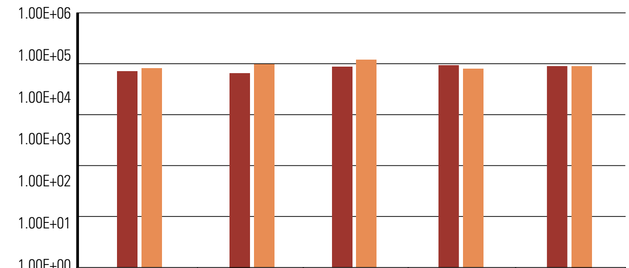
	2005	2006	2007	2008	2009
OL1	0.45	0.80	1.60	1.10	0.68
OL2	1.55	1.83	1.20	0.90	0.67

Integrity of primary circuit: Corrosion products; Maximum sulphate concentration in primary coolant (µg/l) in power operation, Olkiluoto NPP



	2005	2006	2007	2008	2009
OL1	4.1	7.2	7.0	2.2	3.2
OL2	6.3	5.5	4.9	2.1	5.6

Integrity of primary circuit: Corrosion products; Maximum cobalt-60 activity concentration (kBq/m³) in primary coolant during shutdown or after reactor scram, Olkiluoto NPP



	2005	2006	2007	2008	2009
OL1	6.24E+04	5.70E+04	7.08E+04	8.34E+04	7.83E+04
OL2	7.63E+04	9.67E+04	1.46E+05	7.01E+04	7.54E+04

A.III.2b Primary circuit leakages (Olkiluoto)

Definition

The indicators below are used to follow identified and unidentified primary circuit leakages at the Olkiluoto plant units:

- Total volume (m³) of identified (from containment to collection tank 352 T1 of the controlled leakage drain system) and unidentified (total volume of leakages into the sump of the controlled floor drainage system, 345 T33) containment internal leakages during the operating cycle.

- Highest daily containment internal leakage volume during the operating cycle in relation to the allowed leakage volume in the Tech Specs (outflow water volume of water condensing in the air coolers of the containment cooling system 725/Tech Specs 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

Organisations and Operations (OKA)
Jarmo Konsi

Interpretation of the indicator

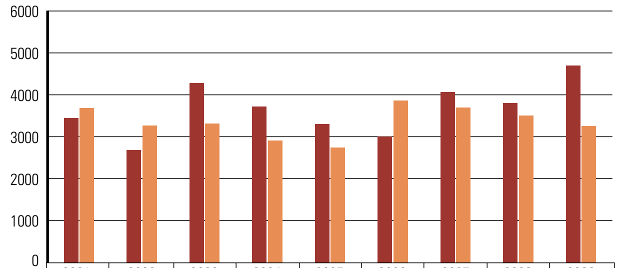
One of the purposes of controlled leakage drain system 352 is to collect seal box leakages from valves, pumps and other such components. The drains from the seal boxes of the valves within the containment are equipped with temperature sensors to locate any leaks. Temperature sensors installed on the drains above the main lines will detect any leakage in the specific line. Other methods must then be used to locate the actual leaking object. During the operating cycle of 2008–2009, the number of leaks identified in the containment has decreased at OL2, continuing the trend of last four operating cycles. In contrast, the number of identified leaks at OL2 increased to some extent compared to the previous operating cycle. No single reason has been found for the increasing trend.

At the lowest point of the containment drywell, there is the drain water pit T33, which collects the drain water from the containment drywell floor drains and any leakage from the control rod actuator seals. The number of unidentified primary circuit leaks occurring during the operating cycle of 2008–2009 increased somewhat at both plant units, having been very small during the previous operating cycle. One reason for the number of leaks increasing was due to small valve seal leaks inside both plant unit containments.

One of the purposes of containment gas cooling system 725 is to remove moisture from the containment atmosphere. Moisture may originate from steam leaking from the primary circuit. In the operating cycle of 2008–2009, the containment's largest internal daily leak volume's ratio to the maximum allowable volume, as specified in the Technical Specifications, continued to be low for both plant units although there was some increase from the previous cycle's figures. This was the sixth consequent operating cycle with very few leaks from the primary circuit to the containment atmosphere.

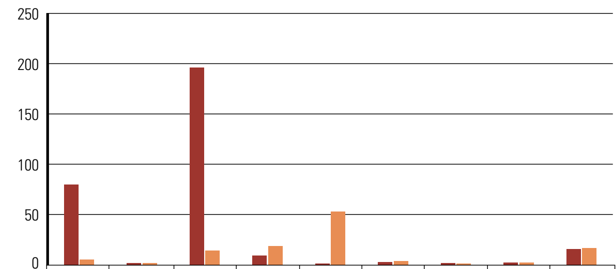
The primary circuit has been relatively leak-proof in the 2008–2009 operating cycle.

Identified leakages of primary circuit (352T1, m³), Olkiluoto NPP



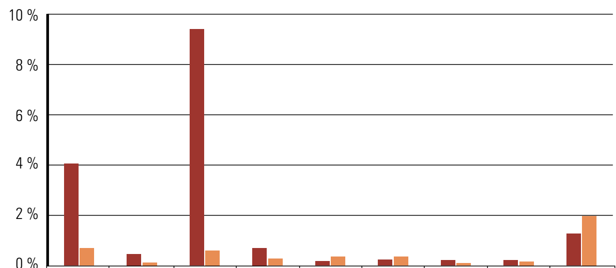
	2001	2002	2003	2004	2005	2006	2007	2008	2009
OL1	3443	2678	2481	3716	3300	3004	4058	3805	4697
OL2	3677	3262	3307	2908	2741	3862	3696	3502	3252

Unidentified leakages of primary circuit (345T33, m³), Olkiluoto NPP



	2001	2002	2003	2004	2005	2006	2007	2008	2009
OL1	79.6	1.8	196.0	9.2	1.1	2.5	1.6	2.2	15.5
OL2	5.4	1.8	14.0	18.6	53.0	3.8	1.3	2.0	16.5

The maximum unidentified leakage in ratio to the Tech Spec limit, Olkiluoto NPP



	2001	2002	2003	2004	2005	2006	2007	2008	2009
OL1	4.05	0.46	9.40	0.70	0.18	0.23	0.21	0.21	1.27
OL2	0.69	0.12	0.60	0.27	0.35	0.35	0.09	0.1	1.97

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. In Loviisa, the combined leakage rate is comprised of the leakage test results of personnel airlocks, the material airlock, the cable penetrations of inspection equipment, the containment maintenance ventilation systems (TL23), the main steam piping (RA) and the feedwater system (RL) penetrations, as well as the seals of the blind-flanged penetrations of ice-filling pipes.

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

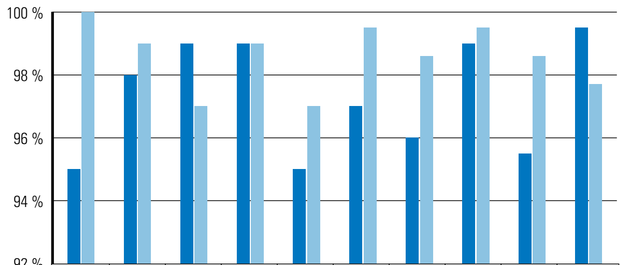
Interpretation of the indicator

Loviisa

The total as-found leakages of outer isolation valves have decreased at the Loviisa 1 plant unit and increased at the Loviisa 2 plant unit. The total as-found leakages at both plant units are still below the limit set in the Tech Specs. At Loviisa 1, the largest leaks came via two valves in the fuel pool cooling system (approximately 24%). At Loviisa 2, the largest leak came via the valve in the cooling system of the ice condensation system (approximately 26%).

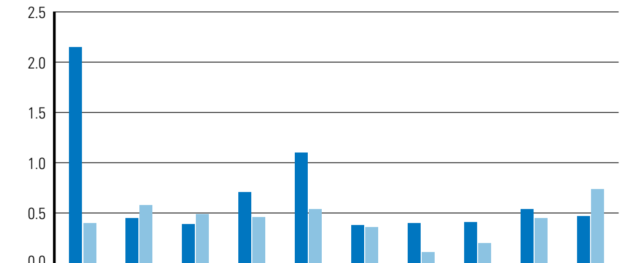
The percentage of isolation valves which passed the leakage test at the first attempt has remained high.

Isolation valves passing the leakage test at the first attempt, Loviisa NPP



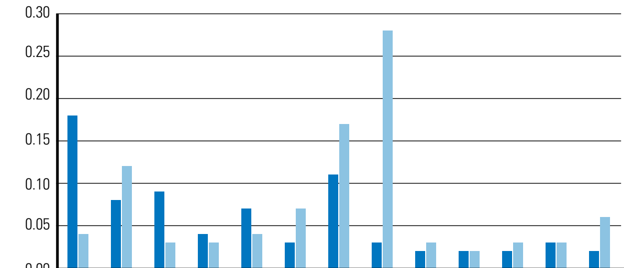
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
LO1	95.00	98.00	99.00	99.00	95.00	97.00	96.00	99.00	95.50	99.50
LO2	100.00	99.00	97.00	99.00	97.00	99.50	98.60	99.50	98.60	97.70

The overall as-found leakage of outer isolation valves compared with the highest allowed overall leakage of outer isolation valves, Loviisa NPP



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
LO1	2.15	0.45	0.39	0.71	1.10	0.38	0.40	0.41	0.54	0.47
LO2	0.40	0.58	0.49	0.46	0.54	0.36	0.11	0.20	0.45	0.74

Combined leak rate of containment penetrations and air locks compared to the leak limit, Loviisa NPP



	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
LO1	0.18	0.08	0.09	0.04	0.07	0.03	0.11	0.03	0.02	0.02	0.02	0.03	0.02
LO2	0.04	0.12	0.03	0.03	0.04	0.07	0.17	0.28	0.03	0.02	0.03	0.03	0.06

The overall as-found leakage of containment penetrations, which at Loviisa includes the leakage test results for the personnel airlock, the emergency personnel airlock, the material airlock, the reactor pit, inward relief valves, cable penetrations and bellow seals (RA, RL, TL23), was small at both plant units.

Olkiluoto

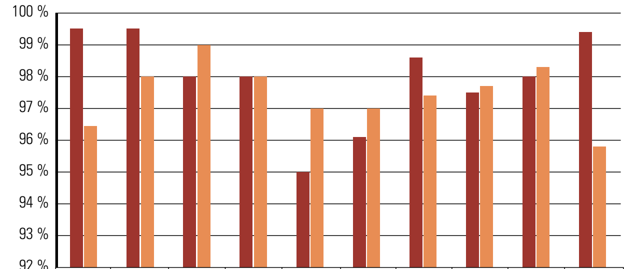
The total as-found leakages of outer isolation valves at the Olkiluoto 1 plant unit exceeded the limit set in Tech Specs and were also bigger than in 2008. About 85% of the total is caused by a single leaking valve of the reactor pressure vessel. The leak was caused by poor alignment of the valve seat cone. This was also the largest single leak measured. After repairs, the total leakage met the requirements of the Technical Specifications.

The total as-found leakages of outer isolation valves at the Olkiluoto 2 plant unit exceeded the limit set in Tech Specs and were also bigger than in 2008. About 56% of the total is caused by a single leaking valve of the reactor pressure vessel cover spraying system. This valve is normally open and closes when the containment isolation signal is received. The isolation valve fitted in the line inside the containment did not leak. The subject valve has leaked in many different years. The leak was caused by rocking of the valve disc. The leaky valve has been replaced. In other respects, the total of as-found leakages was made up of minor leaks in several outer isolation valves. After repairs, the total leakage met the requirements of the Technical Specifications.

The percentage of isolation valves that passed the leak tightness test at first attempt has remained high for both plant units.

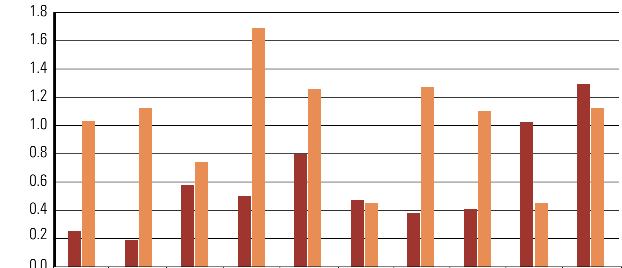
The total as-found leakage rate of containment penetrations, in which TVO includes leakages in the upper and lower personnel airlocks, the maintenance dome and the containment dome, has remained small for both plant units.

Isolation valves passing the leakage test at the first attempt, Olkiluoto NPP



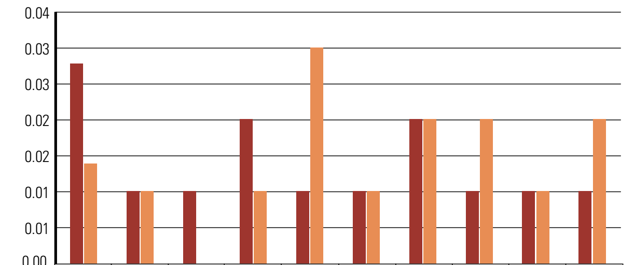
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
OL1	99.51	99.51	98.00	98.00	95.00	96.10	98.60	97.50	98.00	99.40
OL2	96.45	98.00	99.00	98.00	97.00	97.00	97.40	97.70	98.30	95.80

The overall as-found leakage of outer isolation valves compared with the highest allowed overall leakage of outer isolation valves, Olkiluoto NPP



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
OL1	0.25	0.19	0.58	0.50	0.80	0.47	0.38	0.41	1.02	1.29
OL2	1.03	1.12	0.74	1.69	1.26	0.45	1.27	1.10	0.45	1.12

Combined leak rate of containment penetrations and air locks compared to the leak limit, Olkiluoto NPP



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
OL1	0.03	0.01	0.01	0.02	0.01	0.01	0.02	0.01	0.01	0.01
OL2	0.01	0.01	0.00	0.01	0.03	0.01	0.02	0.02	0.01	0.02

APPENDIX 2 Occupational radiation dose distribution at Loviisa and Olkiluoto nuclear power plants in 2009

According to the Radiation Decree, the annual effective dose from radiation work for a worker must not exceed 50 mSv while the average over any period of five years must remain below 20 mSv.

The highest individual dose incurred at Finnish nuclear power plants was 13.5 mSv. This dose was accumulated from work at the Loviisa nuclear power plant. The highest individual dose for a Finnish nuclear power plant worker in the five-year period from 2005 to 2009 was 54.6 mSv. The dose was accumulated at Loviisa and Olkiluoto, as well as at Swedish nuclear power plants.

dose range (mSv)	number of persons by dose		
	Loviisa	Olkiluoto	total*
< 0.1	782	1107	1863
0.1–0.49	167	581	767
0.5–0.99	95	245	346
1.00–1.99	117	228	369
2.00–2.99	60	63	142
3.00–3.99	38	30	90
4.00–4.99	15	18	34
5.00–5.99	13	9	29
6.00–6.99	3	15	28
7.00–7.99	3	6	16
8.00–8.99	2	2	9
9.00–9.99	0	3	7
10.00–10.99	–	0	4
11.00–11.99	–	–	0
12.00–14.99	–	–	–
15.00–24.99	–	–	–
> 25	–	–	–

* 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

Oil leak in the reactor coolant pump

At Loviisa 2, a leak was detected on 9 January 2009 in the cooling water hose leading to the oil cooler of the reactor coolant pump motor. The fault was repaired by stopping the pump and replacing the hose connector. After the water leak was repaired, the motor generated an oil leak, and in all, 4.5 litres of oil had to be added during the week (the total oil volume is 20 litres).

The reactor coolant pump was stopped again for repairs on 17 January 2009, and the reactor power was reduced to 82%. The impurities found in the motor oil channel were removed and the hoses inspected, after which the pump was started and the plant power was ramped up towards 100%. The oil level kept decreasing, and a total of about four litres of fresh oil was added. Despite that, the plant power was increased. The oil leaking out of the pump began to generate fumes when it came into contact with hot surfaces, an indication of an obvious risk of fire. The plant power was reduced and the pump was stopped on the morning of 18 January 2009. After which, one broken pipe in the oil mist suction device was replaced and another one straightened. The repairs were completed on 19 January 2009. After this, the pump was started and the plant power increased again.

STUK wanted to review how the accident risk caused by the oil leak had been assessed at the plant and how the decisions regarding pump repairs were made. The review included interviewing the persons involved in the event in order to ascertain that the plant had been in a safe state and the actions taken had been appropriate. The result of the inspection was that plant safety was not at risk, but the procedures and decision-making contained elements of ambiguity. Decision-making under difficult circumstances, management of changes in the situation, and supervision and oversight of work are areas in need of further development at the Loviisa plant. The results of the inspection were discussed with the employees and management of the NPP. The Loviisa plant carried out a root cause analysis regarding the event.

Loss of magnetic loads of the pilot valves of pressurizer safety valves at Loviisa 2

At Loviisa 2, the power supply to the magnetic loads of the pilot valves of both safety valves of the pressurizer blowdown line was lost in conjunction with a repair operation on 21 January 2009. The interruption in power supply occurred when the circuit breaker protecting the power supply tripped after a tool fell on it.

The pressurizer safety valves prevent the pressure in the primary circuit from rising in a transient situation. The purpose of the magnetic loads was to ensure the leak-tightness of the pilot valves and to ensure the operation of the pilot valve (to control the safety valve) at the correct pressure. The actual operation of the pilot valve is based on spring loading.

After the circuit breaker had tripped, the plant assessed the operability of the valves and took the line, with an emphasis on safety, that the valves are inoperable. The Technical Specifications require that the plant must be shut down in this situation. The plant began repairing the fault and preparing for a shutdown.

Some time after the fault occurred, more steam than normal started flowing into the blowdown tank and the temperatures at the leak lines of the safety valve pilot valves started to rise. In order to prevent the unnecessary opening of the safety valve, the decision was taken at the plant to switch the magnetic loads to manual control. This caused a common cause failure of the safety valves, and the valves would not have automatically opened at the normal opening pressure. The generation of overpressure and opening of the safety valves is unlikely at a plant of the Loviisa type. It would have been possible to cancel manual control if required. Manual control was switched on for 16 minutes until the circuit breaker was replaced and the power supply of the solenoids restored.

STUK is of the opinion that the overpressure protection of the plant was momentarily brought to an inoperable state contrary to the Technical Specifications by switching the magnetic loads of the pilot valves to manual control. On the other hand, the opening of a safety valve and in particular its erroneous jamming to the open position will result in a leak of the primary circuit and consequently a major load on the reactor pressure vessel. This was a case of a decision-making situation based on consideration, with conflicting safety implications that the instructions did not fully support.

Fortum has submitted a special report on the matter, with a proposal for corrective actions to be taken in the matter. The markings on and instructions for manual controls of power supplies have been made less ambiguous. Further modifications will also be made on manual controls in conjunction with the upcoming I & C modernisation project. The instructions for decision-making will be further developed.

Incorrect flow rate readings for the vent stack at Loviisa 1

In April 2009, it was detected that one of the two flow meters at the Loviisa plant unit vent stack for exhaust air had become faulty. The fault had occurred in February 2009, but it was not detected immediately because the trends in air flow readings were not monitored as a matter of routine, nor were there any alarms set for minimum flow or faults. The observations made in conjunction with repairing the flow sensor indicated that the sensor had given readings that were too low even before it failed. Test measurements taken in the flow channel at Loviisa 1 indicated a flow rate of 55 m^3/s while the sensor had given a reading of 42 m^3/s just before its failure. The said 55 m^3/s is actually also the theoretical nominal flow rate at the vent stack of the plant.

The central air exhaust channel for the air conditioning and gas processing systems in the radiation control area of the Loviisa power plant is the vent stack that has two separate flow channels for the plant units. The exhaust air flowing in the vent stack channel has a flow measurement system with redundancy, and the measured data from one of them is used as the basis for determining the total air volume to be used for emission calculations. In this case, the vent stack flow meter used for emission calculations did not operate as expected. The radiation measurement monitors constantly monitoring radioactivity as well as the sampling and analysis of radioactive emissions operated as planned.

The incorrect reading of the flow rate sensor has resulted in a smaller amount of radioactive material released being reported from Loviisa 1 ever since 2006, proportionally to the error in measurements. Compared to the total emissions of the entire plant, the releases of activity from the plant unit have been reported as five per cent too low since 2006. Since the releases of radioactive materials into the environment have been very small, the flow rate measurement error has not affected the radiation exposure of local inhabitants. The Government has set 0.1 millisieverts per year as the limit for radiation doses received by individual inhabitants in the vicinity of the plant as a result of normal operation of the NPPs. The radiation dose caused by the Loviisa NPP to inhabitants in the vicinity has during recent years been less than one per cent of the set limit.

As corrective actions, changes will be made at the Loviisa power plant to the testing and inspection instructions for flow rate sensors. In addition, alarms have been set for the minimum flow rate readings so that any faults in the sensors could be better detected. The Loviisa power plant supplied STUK with a revised report of airborne releases in 2009.

Inoperability of the external containment spray system at Loviisa 1

A mistake was made at Loviisa 1 in the management of maintenance operations that led to a momentary inoperability of both external containment spray system trains on 28 April 2009.

The cooling fan of the switchgear supplying one of the two trains of the external containment spray system was isolated for periodic inspection. This was not a permissible action because the spraying pump motor of the other train was already being inspected at the time.

The external containment spray system is designed to prevent the slow generation of overpressure in the containment building during a serious accident and the uncontrolled release of radioactive substances to the environment that might consequently result. The increase in containment building pressure is prevented by spraying cooling water on it to condensate the steam inside the containment and to reduce its pressure.

The simultaneous maintenance operations on the spray system should have been spotted in the inspection and approval of maintenance work. The database software intended for monitoring maintenance operations at the Loviisa plant should help with this. The simultaneous operations on the same system were not spotted by the software because certain system information was missing. The situation was not identified in the night and morning shift meetings either. The inoperability of the system was detected later during the morning meeting of the operating unit.

The situation was rectified by discontinuing the periodic maintenance of the cooling fan and by restoring the operation of the isolated components. The spray pumps of the trains were inoperable for more than four hours.

According to the Technical Specifications, the trains may be simultaneously out of operation for three days. In addition, the Technical Specifications allow maintenance on the system during plant operation provided that the other train is operable. The event did not have a significant effect on the safety of the plant or its environment because a serious accident at the Loviisa plant is very unlikely and the inoperability of the system only lasted for a short while.

As the immediate corrective measure, the information in the work management program was checked and the missing data added. The safety inspection process of work orders has been amended so that the progress of simultaneous operations leading to a similar state of inoperability is prevented through work planning.

On the INES scale, the event is rated at level 0.

Low fuel levels in diesel generator fuel tanks

It was noticed at Loviisa 2 on 1 July 2009 in conjunction with testing the diesel generator that the fuel level in the tank was too low. The fuel level had already sunk below the minimum level in conjunction with the previous tests. This diesel generator backs up the power supply to the electrical system of the Serious Accidents Management (SAM) system. The fuel level was also checked in the respective tank at Loviisa 1 and was also found to be low.

When the event was reviewed, it was found that the testing instructions and the Technical Specifications had conflicting requirements. The Technical Specifications require that the tank must be at least half full (1,500 litres). The testing instructions specified the half height of the tank as the limit after which more fuel must be ordered. The alarm limit for the tank level was also set below the limit set by the Tech Specs. Therefore, the level of fuel in the tank had at times been non-compliant with the Tech Specs ever since the SAM system was introduced, i.e. the early 1990s.

The event only has minor safety implications because it is highly unlikely that these diesel generators actually would have to be operated for longer periods. 1,500 litres of fuel is enough for operating one diesel engine for about 11 to 21 hours, depending on the load. The volume of fuel giving rise to the event would only have reduced the operating time of the diesel generator by a few hours. The safety implications of the event are further mitigated by the fact that in a potential situation of needing more fuel, there would have been time to transfer it in a container from the tanks of other diesel generators or to connect the tanks of the SAM systems of Loviisa 1 and Loviisa 2.

As an immediate corrective measure, the fuel tanks of both diesel generators were filled up and their level measurements were checked. The operating and alarm limits were tested and the necessary modifications were made in conjunction with the periodic inspection.

Fuel measurements were modified so that instead of showing the shortfall, they now indicate the amount of fuel in the tank. The testing instructions were amended so that the limits for ordering and the minimum level specified by Tech Specs are now clearly marked with the ordering limit set above the Tech Specs limit. It was further ensured that a similar situation cannot arise with the other diesel generators.

Erroneous isolation of power supply to the control valve of the standby emergency feedwater line at Loviisa 2

During the annual maintenance of Loviisa 1 on 25 August 2009, the emergency feedwater system was disabled for planned maintenance and modification operations. In this conjunction, an erroneous isolation of power supply was carried out when the control valve of the emergency feedwater line of the operating steam generator of the Loviisa 2 unit was isolated instead of the motorized shutoff valve. The erroneous isolation was spotted immediately when the system operation was being restored after completing the work on 3 September 2009. The power supply isolated for the work was switched back on and the operability of the valve of Loviisa 2 was restored.

The motorized shutoff valve of Loviisa 1 had been closed during the work, but not electrically isolated. However, no significant risk to personnel, the process or electrical safety was caused due to the nature of the work.

The control valve of Loviisa 2 was closed and electrically isolated which means that it would not have opened when required. The control valve is required for pumping standby emergency feedwater to the steam generators for ensuring the removal of residual heat in a situation where the normal feedwater system and emergency feedwater system are not available. There are four similar feedwater lines, and analyses have shown that at least two of them have to operate for sufficient cooling of the reactor. As a result of the erroneous isolation, three operable feedwater lines were available.

The power outlets and fuses of the power supplies of valves in Loviisa 1 and Loviisa 2 relevant for the work are located on top of each other in the same substation. The markings for the electrical isolation at this substation were incorrect and referred to the power outlet and fuses of the wrong valve. Elsewhere, such as in the work order system and control room markings, the markings and actions were correctly referred.

In order to prevent a similar event from recurring, the event and issues learned from it were discussed with the electricians carrying out this type of work at the Loviisa plants.

The event had no significance to nuclear or radiation safety and was rated at level 0 on the INES scale.

Fire in the power supply unit of the emergency feedwater pump at Loviisa 2

The personnel of Loviisa 2 noticed during annual maintenance on 13 September 2009 that smoke was emerging from the 400 V switchgear supplying the safety system components. The electrical supply unit of the emergency feedwater pump was identified as the source of smoke. After that, the switchgear power was totally cut off and the fire was extinguished by the fire brigade.

The emergency feedwater pump whose power supply unit caught fire had been de-energized due to annual maintenance operations even before the fire occurred. Besides the actual operating power for the pump, the outlet unit also has an auxiliary power connection (220 VDC) for controlling the outlet unit components. When the type of the main switch changed in 2006, the outlet unit had been modified so that turning the main switch to position 0 would only cut off the main power, not the auxiliary power. The pump received a start command from the I & C system during annual maintenance of the plant. The contactor switching the power of the pump closed in the normal manner because the open main switch no longer switched off the auxiliary power of the outlet unit. Knowledge of a closed contactor would have stopped the CLOSE command but the open main switch prevented this information from being conveyed to the I & C system. The contactor solenoid is not designed for a 100% duty cycle which is why it overheated and started smoking.

The fire was caused by the wiring that allowed the contactor to be controlled so that it overheated. As an immediate measure, Fortum will amend the instructions for isolation work so that the auxiliary power supplies of outlet units are always switched off when the main power supply circuit is switched off. The wiring of outlet units was modified so that the possibility for this fault occurring is eliminated.

The event had little significance to safety because the reactor had been shut down for annual maintenance of the plant. However, had the emergency feedwater system been needed for cooling off the reactor, the redundant systems would still have been available.

Inoperability of the sprinkler system of the turbine lubrication oil tanks at Loviisa 2

It was found in conjunction with testing the sprinkler alarms of the turbine lubrication oil tank at Loviisa 2 that the regional sprinkler triggering valve does not trigger automatically or become reactivated after forced triggering. Because of this fault, local fire extinguishing at the lubrication oil tank would probably have failed to operate. The regional trigger valve was opened and the throttle of the trigger network was also inspected. The inspection revealed that the throttle diameter was 6 mm when it should have been 3 mm.

All regional trigger valves in the sprinkler system of the turbine lubrication oil tanks of Loviisa 2 were inspected, and three examples of throttles that were too large were found. The throttles were replaced and the systems were successfully tested. The equivalent valves at Loviisa 1 were inspected and tested immediately after the valves at Loviisa 2 had been repaired and tested. One valve had a throttle that was too large and was replaced with a smaller one.

The regional trigger valves were replaced in 2005 at both plant units. The design documentation specifies 3 mm as the throttle size. The pressure equipment associated with the system was inspected at the plant before commissioning the new components in line with the instructions applied at the Loviisa power plant. The other parts, such as the throttles, were not inspected at the plant. Instead, it was established in line with the instructions that the equipment supplier had inspected them in compliance with its own quality assurance procedures.

The alarms and operation of the sprinkler system for the turbine lubrication oil tank are tested twice a year: once during the annual maintenance and once during operation. A situation had occurred earlier at Loviisa 1 in conjunction with the replacement of regional trigger valves where one regional trigger valve of the sprinkler system for the turbine lubrication oil tank had failed to operate. In that instance, the valve was opened and the gasket set was replaced. The valve operated correctly when tested after the repair. The fault was thought to be caused by too little usage that had resulted in parts of the valve jamming. Apart from this case, the valves have operated correctly in spite of the wrong size throttles.

As a corrective measure, Fortum will assess the adequacy of its instructions regarding modification work. In addition, the testing frequency of alarms caused by the triggering of turbine sprinklers will be doubled from the present.

The event is of minor significance to safety because the different fire extinguishing systems and methods back up each other. In addition to local extinguishers, any fires in the lubricating oil tanks can be extinguished by using two water cannons of fixed installation and the fire hydrants in the turbine hall. There is a fixed installation of a general sprinkler system below the main level of the turbine hall which is designed for extinguishing any burning oil that is spilled from the oil tanks to the levels below. The operation of the general sprinkler system is independent of the sprinklers over the oil tanks.

Failure to carry out periodic maintenance on the flow meters of the emergency feedwater pumps

At Loviisa 1 and Loviisa 2, all flow rate measurement systems of emergency feedwater pumps were not calibrated. These calibrations are part of the preventive maintenance operations that are required by the Tech Specs and carried out every 12 months. The flow measurements verify that the pumps are operating at low water flow rates and protect the pump motors from overloading in different situations.

It was noticed at Loviisa 2 after annual maintenance that two flow meters had not been calibrated. The work had been incorrectly moved from the annual maintenance to be carried out during operation without taking the relevant requirements of the Tech Specs into account. The change had not been spotted in the inspection carried out at start-up.

When the event was investigated it transpired that three other flow meter calibrations had also been omitted at Loviisa 1 and Loviisa 2 in 2009 and 2007. These omissions occurred because the preventive maintenance operations had been coupled with inspections of the protective logic of emergency feedwater pumps which are only carried out at two-year intervals. This coupling of operations was to do with the introduction of the new work order and condition monitoring database (LOMAX) in 2006.

The plants have six flow metering units in all: two at Loviisa 1 and four at Loviisa 2. All calibrations were duly carried out in 2008. In conjunction with other tests, Fortum verified that the uncalibrated meters give correct readings. The calibrations will be next carried out during the 2010 annual maintenance. As corrective measures, the power company will review the Tech Specs and the preventive maintenance programmes and organise refresher training regarding the Tech Specs, contents of work orders and administration of work. During start-up, work postponed during the annual maintenance will be reviewed and the procedural instructions regarding the postponement of work will be made more specific.

The event is of minor significance to safety because in practice, the incorrect readings or inoperability of the pump flow meters would have been detected in tests that are carried out at the plant at regular intervals. The event was rated at level 0 on the international INES scale because it had no significance to nuclear or radiation safety.

Olkiluoto NPP

Stoppage of the pump of the shutdown service water system as a result of signal lamp failure at Olkiluoto 1

Periodic tests were carried out at Olkiluoto 1 on 5 January 2009. They involved starting a pump which had stopped as a result of the failure of a signal lamp in the pump control circuit that indicates that the pump is in operation. The significant issue here is that the failure of a signal lamp prevented the pump, a component more significant to safety, from operating. The pump is part of a system for pumping seawater to the plant for removing the residual heat from the reactor when the plant has been shut down (the shutdown service water system). The system consists of four identical and independent circuits. Each circuit has its own pump. The inoperability of one pump will not put the plant safety at risk.

The signal lamp had been in use since September 2008 when the glow discharge lamps in the control circuits of ten different pumps were replaced with LED signal lamps in conjunction with preventive maintenance operations. After the event, TVO analysed the causes for the fault and deliberated over whether this was a case of an individual component failure or could the same fault occur in the other LED signal lamps as well. As a precautionary measure, TVO decided to discontinue using these signal lamps on 8 January 2009. Similar pump tests are performed at four-week intervals, but this was the first occurrence of any faults.

TVO has initiated a project for replacing low-voltage switchgear (SIMO). The project involves separating the signal lamp voltage from the actual control circuit voltage into a totally separate circuit. The signal lamp voltage is generated from the main voltage of the switchgear using a dedicated power supply. The signal lamps will be of an LED type.

On the INES scale, the event is rated at level 1.

The Technical Specifications regarding the determination of thermal margins in the reactor are open to different interpretations

TVO noticed that the requirement in the Technical Specifications regarding the frequency at which the thermal margins in the reactor are to be determined has been formulated in a less than precise manner. The Tech Specs require that the margins are determined at over 60% power whenever the drive pattern of control rods has been changed. This requirement is not appropriate when, for example, operating at reduced power during periodic tests where the control rods are moved in while the main coolant pumps are operated using rev control and the control rods are moved through several drive patterns. In these situations, the margins have been determined before and after the change of power but not for each drive pattern during the change of power. The Tech Specs were revised so that the said procedure no longer is in formal conflict with the requirements of Tech Specs.

Inoperability of an isolation valve in the containment vessel spray system in a periodic test using an external diesel generator for power supply

The testing of isolation valve of the containment vessel spray system using a portable diesel generator could not be successfully done during the periodic tests carried out at Olkiluoto 1 on 23 March 2009. When the fault was investigated, it transpired that the contactor installation plates had been replaced during annual maintenance in 2008 for the switchgear outputs controlling this isolation valve and three other valves. In that modification operation, two separate connectors on top of each other had been incorrectly connected together. This erroneous construction would have prevented opening the valves when supplied by a portable diesel generator. A situation like that may arise for example when a total loss of AC power occurs. The error was not detected in the tests carried out in conjunction with the modification work. The fault was rectified on 23 March 2009.

These valves are located in the flooding line at the lower drywell of the reactor containment building and in the water lines of the containment building. During the operating phase, the valves are closed. In case of serious accident, the valves would be opened to fill the containment building with water. The valves can also be opened in a situation of total loss of AC power because power supply is backed up by battery banks that are capable of supplying power for at least a few hours. The continuous power supply can also be ensured by switching to a mobile diesel generator. If the valves had not been opened before switching over to the mobile diesel generators, they could not have been opened at all because of the error made in modification work. If an attempt to open the valves manually using a hand wheel would also have failed, the containment building could not have been filled with water when required.

On the INES scale, the event is rated at level 0.

Malfunctions of the outer isolation valves of main steam lines at Olkiluoto 1

At Olkiluoto 1, malfunctions were observed in the isolation valves of steam lines during tests carried out after annual maintenance. The malfunctions were caused by a gear in the actuator opening and closing the valve which had failed due to fatigue from its long history of use.

Olkiluoto 1 and Olkiluoto 2 both have four steam lines for conveying the steam generated in the reactor to the turbine plant. Each steam line has two isolation valves, one inside the containment wall and one on the outside. Their purpose is to close the steam lines in certain transient and accident situations, thus isolating the reactor and its containment building from the outside world so that radioactivity stays inside the containment building.

The damage was detected in the reduction gear between the motor and the actuator of the outer isolation valve at Olkiluoto 1. At worst, the damage could have prevented the closure of the outer isolation valve in a situation where the steam line had for some reason ruptured inside the containment building. In case of a pipe rupture outside the containment, both the inner and the outer isolation valves close automatically driven by steam pressure which means that in these situations both valves would have closed irrespective of the fault in the motor-driven actuator. During normal plant operation, the steam line isolation valves are open, and are only actuated in periodic tests carried out at two-month intervals.

All of these gears were replaced with new ones at Olkiluoto 1 and 2. Some of the gears removed showed early signs of cracks due to fatigue. The torque values applicable to the actuators have been reviewed following the event.

STUK required that TVO should establish the appropriate dimensioning of gear wheels and the reasons for the damages by the end of the year.

On the International Nuclear Event Scale (INES), the event was rated at level 1.

Jamming of the fuel transfer machine during transfers of spent fuel at Olkiluoto 2

At Olkiluoto 2, the refuelling machine developed a malfunction during annual maintenance when spent fuel was being transferred out of the reactor on 17 May 2009. The element of spent fuel had already been lifted completely out of the reactor when an excessive need for lifting force triggered the overload limiter of the refuelling machine and prevented the lifting operation from being continued.

It was found that the malfunction was caused by the compressed air hose of the refuelling machine jamming between the tubes of the telescopic mast of the refuelling machine which prevented the telescopic mast tubes from moving normally. TVO tried to remove the jammed compressed air hose by lifting and lowering the fuel assembly attached to the telescopic mast but failed to remove the hose. During the event, there was some uncertainty as to how much load the telescopic mast could carry which meant that there was a risk of parts of the mast falling, together with the fuel bundle attached to the gripping device, in the reactor core on top of other fuel elements. Because of this, TVO installed a special plate to the fuel transfer machine to support the jammed telescopic tubes. After the event, TVO analysed the durability of the telescopic mast with VTT. The results indicated that the telescopic tube could not have fallen on top of the fuel even if the securing plate had not been not installed.

STUK classified the event as an anomaly (INES level 1) due to the defects identified in fuel handling. The Technical Specifications prescribe that fuel may only be handled using a refuelling machine in full operating condition. The alarms generated by the refuelling machine were not appropriately reacted to during the early phases of the lifting operation, and fuel handling was continued even after the jamming of the compressed air hose between the telescopic mast tubes had been noticed. The risk of falling tubes was not taken into account during the early stages of the event, and fuel handling was continued using a faulty transfer machine without a comprehensive safety assessment of the situation.

The corrective actions taken following the event include installing a camera on the refuelling machine and making amendments to procedures and instructions. The needs for modernising and developing the transfer machines will be assessed taking this event into account.

Incorrect settings in the thermal relays of pump motors in the shutdown service water system

On 29 June 2009, TVO notified STUK of the incorrect settings detected in the thermal relays of electrical motors driving the pumps in the system required for residual heat removal. The pumps are part of a system pumping seawater to the plant for removing the residual heat from the reactor when the plant has been shut down (the shutdown service water system). At Olkiluoto 1, two pump motors and at Olkiluoto 2, one pump motor had wrong settings in the thermal overload relays. They were set for an operating voltage of 690 V when the nominal voltage of the supply bus was 660 V. TVO corrected the settings on 30 June by changing the thermal relay setting from 76 A to 81 A.

TVO had already detected the incorrect settings more than a year ago when these motors were replaced and the company carried out an operational assessment on the thermal relays as required by STUK. Incorrect settings were detected in four pumps in the tests carried out in conjunction with the assessment. One incorrect setting was corrected on 19 September 2008 when this pump outlet was replaced in conjunction with some modification work. The rest of the settings were corrected on 30 June 2009. The investigation also revealed that three motors only had the voltage 690 V (not 660 V) embossed on their plates, and two of them had wrong thermal relay settings. The plates were replaced with new ones showing the voltage 660 V.

The incorrect thermal relay settings would not have been significant in normal operating conditions but they would have resulted in the pumps stopping more easily than planned during undervoltage conditions. The probability of such undervoltage conditions is small, but this is a case of a systematic error in procedures because the thermal relay settings were incorrectly based on the new standard voltage of 690 V while the plant unit still used the smaller voltage (660 V) of the old standard as the nominal voltage. The significance of the event is amplified by the fact that a very long time elapsed between detecting the incorrect settings and taking the comprehensive corrective measures.

Actuator faults in the strainers of the seawater systems

The seawater system of Olkiluoto 1 and Olkiluoto 2 as well as the spent fuel interim storage of Olkiluoto plants have screens that are called strainers. They are used to remove the clams carried by seawater that might cause blockages in different components, such as heat exchangers.

The strainer has two actuators that operate the strainer and the rinsing valve (open-close). TVO replaced one faulty actuator during annual maintenance in May. The actuator removed from the component location was opened in September, and its planetary gear had signs of wear and tear that prevented its operation. Consequently, TVO decided to inspect more actuators in conjunction with the annual maintenance operations in progress at Olkiluoto 1. Two actuators at Olkiluoto 1 had only been in operation for one year so they were thought to be in good condition. The other ten actuators in use at Olkiluoto 1 and at the spent fuel storage were inspected during September–October. A fault was detected in the planetary gear of one actuator. It was of a different type than in the first faulty actuator and did not affect the operation of the device. The actuators of Olkiluoto 2 will be inspected and replaced with new ones during the preventive maintenance operations of spring 2010. Until then, their operation will be monitored with extra vigilance.

The actuator fault was not significant to safety because the strainers still let enough water through to cool the components important to safety.

APPENDIX 4 Licences and approvals in accordance with the Nuclear Energy Act in 2009

Teollisuuden Voima Oy

- C214/313, 26 February 2009. Transfer of samples made of depleted uranium to the Radiation and Nuclear Safety Authority. Valid until 31 December 2009.
- C214/314, 3 March 2009. Import of control rods from Sweden. Four rods weighing approximately 130 kg each. Valid until 31 December 2009.
- C214/315, 3 March 2009. Import of control rods from the United States. 14 rods weighing approximately 130 kg each. Valid until 31 December 2009.
- C821/97, 8 April 2009. Handover of waste oil (approximately 8.4 m^3) released from regulatory control to Ekokem Oy to be used as raw material for chainsaw chain oil. Valid until 31 December 2009.
- 1/C42214/2009, 10 September 2009. Import of nuclear fuel of Australian origin from Spain. 100 assemblies, a total of 17,700 kg (maximum) of low-enriched uranium. Valid until 31 December 2010. The licence was cancelled on 27 October 2009.
- 3/C42214/2009, 16 October 2009. Import of nuclear fuel with Euratom obligation code “S”, from Sweden. 10 assemblies, a total of 1,750 kg (maximum) of low-enriched uranium. Valid until 31 December 2010.
- 4/C42214/2009, 16 October 2009. Import of nuclear fuel with Euratom obligation code “S”, from Sweden. 108 assemblies, a total of 18,900 kg (maximum) of low-enriched uranium. Valid until 31 December 2010.
- 2/C42214/2009, 27 October 2009. Import of nuclear fuel with Euratom obligation code “S”, from Spain. 100 assemblies, a total of 17,700 kg (maximum) of low-enriched uranium. Valid until 31 December 2010.
- 5/C42214/2009, 19 November 2009. Import of fuel channels manufactured of a zirconium alloy from the EU, Japan or USA. A maximum total of 110,000 kg of zirconium (3,000 channels). Valid until 31 December 2020.
- 4/C46201/2009, 11 December 2009. Transport of two radiated fuel rods to Sweden. Valid until 31 March 2009.
- 6/C42214/2009, 16 December 2009. Export of spent nuclear fuel rods to Sweden. Two rods, 3.98 g. Valid until 31 March 2010.
- 7/C42214/2009, 16 December 2009. Import of computer software and its updates from Japan. Valid until 31 December 2018.

Fortum Power and Heat Oy

- A214/113, 13 January 2009. Import of equipment, related to I & C modernisation work at Loviisa 1 and 2, from Germany. Valid until 31 December 2009.
- A214/115, 3 March 2009. Loviisa 1 and 2; import of neutron flux sensors from Russia. A total of 10 ionisation chamber sensors. Valid until 31 December 2009.

Others

- Y214/170, 9 January 2009. Platom Oy; possession of data imported from the United States of America, to be used in the design of autoclaves. Valid until 31 December 2017.
- Y214/175, 24 January 2009. VTT; the extension of licence Y214/164 granted for export of uranium samples (2 uranium pellets and 2 crushed uranium samples) for research purposes to Germany, and to Sweden until 31 May 2009.

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.

Basic programme		Inspections in 2009	
		Loviisa 1 and 2	**Olkiluoto 1 and 2**
Management, management system and personnel			
A1	Management and safety culture	17.4.2009	14.1.2009
A2	Personnel resources and competence	2.6.2009 10.6.2009	2.–3.9.2009
A3	Functionality of the management system	30.11.–1.12.2009	5.–6.11.2009
Plant safety and its improvement			
B1	Assessment and improvement of safety	3.11.2009	
B2	Plant safety functions	16.6.2009	16.11.2009
B3	PSA and safety management		9.11.2009
B4	International operating experience feedback	23.11.2009	22.10.2009
Operational safety			
C1	Operation	23.2.2009 5.5.2009 7.5.2009 7.–8.12.2009	3.–4.2.2009 14.–15.4.2009 27.–28.8.2009 10.–11.11.2009
C2	Plant maintenance		
C3	Electrical and I&C systems	17.–18.11.2009	
C4	Mechanical engineering	24.11.2009	1.–2.6.2009
C5	Structures and buildings	18.11.2009	14.10.2009
C6	Information management and security		
C7	Chemistry	15.–16.4.2009	6.–7.10.2009
Personal and plant protection			
D1	Radiation protection	27.–28.10.2009	9.–10.3.2009
D2	Fire protection	17.3.2009	10.6.2009
D3	Emergency response	9.10.2009 14.10.2009	23.–24.6.2009 29.5.2009
D4	Security		
Nuclear waste and its storage			
E1	Reactor waste	3.–4.6.2009	21.–22.10.2009
E2	Final disposal facilities	14.12.2009	
Special items			
F1	LARA	19.5.2009	

APPENDIX 6 Periodic inspection programme during construction

The objective of the Olkiluoto 3 construction-time inspection programme is to verify that the operations required by the construction of the plant ensure a high quality implementation according to the approved plans and compliant with official regulations, without endangering the plant units operational within the plant site. The inspection programme assesses and oversees the licensee's operations in building the plant unit, implementation procedures in various technical areas, the licensee's expertise and use of that expertise, the handling of safety issues and the quality management and control. STUK prepares an inspection plan for Olkiluoto 3 every six months.

Subject of inspection	Time of inspection
Main functions	
Project management and the management of safety	3.–4.2.2009
Project quality management 1/2009	27.–28.4.2009
Development of safety culture on the site, follow-up inspection	27.8.2009
Work processes	
Quality assurance 1/2009: Supervision of installation	23.–25.2.2009
Chemistry	19.3.2009
Quality assurance: Supervision of installation, follow-up inspection	2.6.2009
Quality assurance, supervision of installation, follow-up inspection	21.8.2009
Preparations for commissioning	11.9.2009
Training of OL3 operating personnel	17.9.2009
Quality control of construction work	1.10.2009
Air conditioning systems	28.10.2009
I & C, Organisation and management of TVO's inspection activities	5.11.2009
Utilisation of PRA	19.11.2009
Radiation safety	10.–11.12.2009

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-A	Management system	
Planning and management		
ONP-B1	Project management and control	
ONP-B2	Safety management	26.–27.5.2009
ONP-B3	Project quality management	
ONP-B4	Planning and management of the research and monitoring programme	
ONP-B5	Design of Onkalo	3.–4.3.2009
Implementation		
ONP-C1	Site inspection and monitoring procedures	10.9.2009
ONP-C2	Drilling and modelling	6.8.2009
ONP-C3	Foreign substances	9.12.2009
ONP-C4	Excavation and EDZ	26.3.2009
ONP-C5	ONKALO in-flows	27.10.2009
ONP-C6	Monitoring and research methods	16.10.2009

APPENDIX 8 Commissions regarding the regulatory oversight of safety in nuclear power plants funded by STUK, completed in 2009

Reports supporting regulatory decision making

Olkiluoto 3

Fortum, Erik Westerlund: Statement regarding the document containing an update of documentation related to the instructions of SIAG Stahlblau Ruhland Gmbh & co. KG, the manufacturer of the reactor island for OL3

Fortum, Erik Westerlund: Statement regarding the document containing surface treatment instructions 1S-06-00028.136 for the SPC safety door (SC 3) of the OL3 safeguard building

VTT-M-00117-09; Heikki Keinänen: Inspection of the stress and resilience analyses of Safety Class 1 and 2 piping at the OL3 NPP

Pontek, Keijo Saloviin: Olkiluoto 3, Safeguard Building 4, design documentation from level +16.800 to level +21.000, inspection of design documentation

Pontek, Keijo Saloviin: Olkiluoto 3, Safeguard Building 1, design documentation from level +16.800 to level +21.000, inspection of design documentation

Pontek, Keijo Saloviin: Olkiluoto 3, structural plan of the cladding of JDH pools (JDH10, JDH40) in the Fuel Building

Pontek, Keijo Saloviin: Olkiluoto 3, Fuel Building, design documentation from level +14.100 to level +19.500, inspection of design documentation

Pontek, Keijo Saloviin: Olkiluoto 3, supplement to the structural plan of the cladding of KAA pools (KAA10–40) in the Safeguard Buildings

Space Systems Finland STUK-SSF-RP-003; Juha Jokipii, Timo Latvala: Audit report, Olkiluoto 3 reactor protection system

Pontek, Keijo Saloviin: Olkiluoto 3, Fuel Building, design documentation from level +14.100 to level +19.500, inspection of design documentation

Pontek, Keijo Saloviin: Olkiluoto 3, Safeguard Buildings 2 and 3, overall stability analyses, inspection of updated documents

Pontek, Keijo Saloviin: Olkiluoto 3, update to the structural plan (Batch 1) of the cladding of pools (30FAB01, 30FAB11 and 30FAB12) in the Fuel Building

Pontek, Keijo Saloviin: Olkiluoto 3, Reactor Building, update to the structural plan of the cladding of IRWST pool

Pontek, Keijo Saloviin: Olkiluoto 3, Safeguard Building 4, design documentation from level +16.800 to level +21.000, inspection of design documentation update

VTT, J. Mangs, S. Hostikka: preliminary research plan: Assessing fire safety of FRNC-cables for Olkiluoto 3, Paret 2B, further research on specific cable

Pontek, Keijo Saloviin: Olkiluoto 3, Safeguard Building 1, design documentation from level +16.800 to level +21.000, inspection of design documentation update

Fortum, Erik Westerlund: Olkiluoto 3, review of paint coating of steel liner assembly. 81-82

Pontek, Keijo Saloviin: Olkiluoto 3, inspection of the update to the structural plan of the cladding of pools (30FAE01, 30FAF01 and 30FAF02) in the Safeguard Building

Pontek, Keijo Saloviin: Olkiluoto 3, Fuel Building, design documentation from level +19.500 to level +26.300, inspection of design documentation

Pontek, Keijo Saloviin: Olkiluoto 3, inspection of design documentation for bedrock tunnels 37-38UQZ

VTT-M-00680-09-Rev2; Heikki Keinänen: OL3 NPP unit, Inspection of the stress and resilience analyses of Safety Class 1 and 2 piping

Pontek, Keijo Saloviin: Olkiluoto 3, Safeguard Buildings 2 and 3, design documentation from level +21.000 to level +26.800, inspection of design documentation

VTT-R-02489-09; Johan Mangs, S. Hostikka, A. Matala: Assessing fire safety of FRNC-cables of Olkiluoto 3 – Part 2

Pontek, Keijo Saloviin: Olkiluoto 3, Safeguard Buildings 1 and 4, design documentation from level +16.800 to level +21.000, inspection of design documentation

Pontek, Keijo Saloviin: Olkiluoto 3, Fuel Building, response to STUK decision G3920/151 regarding design documentation from level +14.500 to level +19.500 and design documentation from level +19.500 to level +26.300, inspection of design documentation

Pontek, Keijo Saloviin: Olkiluoto 3, Safeguard Building 1, design documentation from level +21.000 to level +24.700, inspection of design documentation

Pontek, Keijo Saloviin: Olkiluoto 3, Safeguard Buildings 2 and 3, design documentation from level +21.000 to level +26.800, inspection of supplement to design documentation

Pontek, Keijo Saloviin: Olkiluoto 3, Safeguard Building 4, design documentation from level +21.000 to level +24.700, inspection of design documentation

Pontek, Keijo Saloviin: Olkiluoto 3, Safeguard Buildings 2 and 3, design documentation from level +21.000 to level +26.800, inspection of update to design documentation

Pontek, Keijo Saloviin: Olkiluoto 3, Fuel Building, design documentation of internal structures of stairways 1 and 4 from level +14.500 to level +36.500, inspection of design documentation

VTT-R-04563-09; Antti Timperi, Markku Hänninen, Jarto Niemi, Arja Saarenheimo: OL3 loop analyses, pipe break at steam generator inlet nozzle

Pontek, Keijo Saloviin: Olkiluoto 3, Safeguard Building 1, design documentation from level +24.700 to level +29.300/+30.000, inspection of design documentation

VTT-R-04506-09; Antti Timperi, Kim Calonius, Markku Hänninen, Jarto Niemi, Arja Saarenheimo: OL3 Structural Integrity Study on Piping Penetration of Steam Line due to Pipe Breaks

VTT-M-05372-09, Rev. 0; Heikki Keinänen: OL3 NPP unit, inspection of the stress and resilience analyses of Safety Class 1 and 2 piping

VTT-M-05372-09, Rev. 0; Heikki Keinänen: OL3 NPP unit, inspection of the stress and resilience analyses of Safety Class 1 and 2 piping

Pontek, Keijo Saloviin: Olkiluoto 3, Safeguard Buildings 1 and 4, overall stability analyses, inspection of updated documents

Pontek, Keijo Saloviin: Olkiluoto 3, Fuel Building, update of design documentation from level +26.300 to level +32.200 and response to STUK decision 4/G43UFA/2009, inspection of documentation

Pontek, Keijo Saloviin: Olkiluoto 3, Safeguard Building 4, design documentation from level +29.300 to level +34.800/+36.000, inspection of design documentation

VTT-R-06181-09; Tuomo Sevón, Esko Pekkarinen: Transport of Debris to Olkiluoto 3 Core in a Loss of Coolant Accident

Pontek, Keijo Saloviin: Olkiluoto 3, inspection of the update to the structural plan of the cladding of pools (30FAE01, 30FAF01 and 30FAF02) in the Safeguard Building

Olkiluoto NPP

VTT-R-04881-09; Hanna Räty: Stoppage analysis of main coolant pumps of Olkiluoto 1 reactor using TRAB-3D computer software

VTT-R-06182-09; Tuomo Sevón, Risto Lautkaski: A Summary of Research on Steam Explosion Risk in Nuclear Power Plants

Loviisa NPP

VTT-R-08253-09; Seppo Hillberg: Stoppage of main coolant pump with the TRACE model of Loviisa 1

VTT-R-08267-09; Seppo Hillberg: Jamming of the turbine bypass valve with the TRACE model of Loviisa 1

VTT-R-08105-09; Seppo Hillberg, Pasi Inkinen, Malla Seppälä: TRACE model of Loviisa for accident analyses

Others

VTT-R-00015-09; Johan Mangs: VTT publications on fire safety of nuclear power plants

Finflo Report F-44; Timo Siikonen: Developments of the cavitation model of the Finflo code

VTT-R-02694; Topi Sikanen, Simo Hostikka, Jukka Vaari: Simulation of flame spread in cable room of Leningrad nuclear power plant

Avaplan Oy, Tuomas Mankamo: Conditional State-Dependent CCF Modeling in FinPRA

ÅF-Consult EXP-500; J. Saari, P. Heikkinen, P. Varpasuo, M. Malm, E. Turunen, K. Karkkulainen, O. Valtonen, M. Uski: Estimation of seismic hazard in territory of Finland

ÅF-Consult EXP-500/1; Attenuation curves of spectral acceleration for longitudinal and transversal components of the Saguenay and Newcastle datasets

APPENDIX 9 International co-operation of the Radiation and Nuclear Safety Authority in 2009

IAEA

IAEA working groups

- Board of Governors, participation through prepared addresses in meetings discussing the future operational strategy of the IAEA, Jukka Laaksonen (2 days, 2 meetings), Tero Varjoranta (2 days, 2 meetings), Esko Ruokola (1 day, 1 meeting) (A)
- INSAG, International Nuclear Safety Group – A group that assists the IAEA Director General in nuclear safety issues and issues instructions on the development of nuclear safety for Member States, Director General Jukka Laaksonen, Deputy Chairman (6 days, 2 meetings) (A)
- SAGSI, Standing Advisory Group for Safeguards Implementation – A group that assists the IAEA Director General in the control of nuclear materials and issues instructions on the development of nuclear materials control for Member States, Tero Varjoranta. (20 days, 4 meetings) (A)
- Expert groups preparing IAEA safety standards:
  - Safety Guide DS 424, Establishing a Safety Infrastructure for a National Nuclear Power Programme, Director General Jukka Laaksonen, Chairman (3 days, 1 meeting) (B3)
  - Safety Guide DS 367, Safety Classification of Structures, Systems and Components in Nuclear Power Plants, Keijo Valtonen (6 days, 3 meetings) (A)
  - Preparatory work for the Safety Requirement NS-R-2 Safety of NPPS, Timo Eurasto (5 days, 1 meeting) (A)
- CSS, Commission of Safety Standards – a body steering the preparatory work for IAEA's safety standards, Jukka Laaksonen (6 days, 2 meetings), Mari Andersin (1 day, 1 meeting), Lasse Reiman (3 days, 2 meetings) (A).
- NUSSC, Nuclear Safety Standards Committee, Pekka Salminen (6 days, 2 meetings) (A), Keijo Valtonen (1 day, 1 meeting) (A)
- IAEA/International Nuclear Event Scale (INES) system, Workshop on Train-the-trainers, meeting of national INES coordinators, Tomi Koskiniemi, Finland's contact person for INES, 22– 25 September 2009 (A)
- Technical meeting for the IAEA Nuclear Security Fundamentals recommendation, Paula Karhu (5 days, 1 meeting) (A)
- Meeting of national contact persons for IAEA's Illicit Trafficking database, Finland's contact person, chairing of one partial session, Paula Karhu (2 days, 1 meeting) (A)
- IAEA Steering Committee on Human Resources for Regulatory Bodies with NPPs, Kaisa Koskinen (7 days, 3 meetings) (A)
- Working group preparing guidelines for IAEA's OSART inspection to be carried out during the construction phase of nuclear facilities and the Safety Guide, Construction Activities at Nuclear Installations, Jouko Mononen (5 days, 1 meeting) (A)
- IAEA/Technical Meeting IGALL, Pentti Koutaniemi (3 days, 1 meeting) (A)
- WASSC, Waste Safety Standards Committee, Kaisa-Leena Hutri (a half-day meeting) (A)
- RASSC, Radiation Safety Standards Committee, Mika Markkanen (A)

Each item on the list bears a marking that shows how the participation was financed:

A All travelling costs were borne by STUK.
B1 The airfare was paid by the inviting party while the other travelling costs were borne by STUK.
B2 The airfare and accommodation were paid by the inviting party while the other travelling costs were borne by STUK.
B3 All travelling costs were borne by the inviting party while STUK paid the participant's salary.
C All travelling costs and the participant's salary were borne by the inviting party. The trip was made on the participant's own leisure time.

- ASTOR, Application of Safeguards to Geological Repositories, Elina Martikka and Olli Okko (2 days) (A)
- GEOSAF, International Project on Demonstrating the Safety of Geological Disposal, Ari Luukkonen (3 days, 1 meeting) (A)
- IAEA Early Notification and Assistance Conventions, meeting of the competent authority, Hannele Aaltonen (4 days, 1 meeting) (A)
- IAEA Action plan 2004–2009, strengthening of the international preparedness system, Hannele Aaltonen (15 days, 3 meetings) (A)
- IAEA Response Assistance Network (RANET), Anne Kiuru (5 days, 1 meeting) (A)
- Recommendations on Nuclear Security. Participation in the preparatory work in the capacity of an expert and representative of the State of Finland. Vienna, Austria, Harri Toivonen (10 days, 2 meetings) (A)
- EMRAS II (Environmental Modelling for Radiation Safety), Iisa Outola (3 days, 1 meeting) (A), Kai Hämäläinen (5 days, 1 meeting) (A)
- IAEA Regional Workshop on Combating Illicit Trafficking in Nuclear and other Radioactive Material, J. Rautjärvi (4 days) (B2).

IAEA's expert duties

- IRRS, International Regulatory Review Service, IAEA expert group to assess national nuclear safety regulation
  - Preparatory meeting for the audit of Japanese authority Nuclear and Industrial Safety Agency, 2–3 September 2009, Jukka Laaksonen, Deputy Team Leader (B3)
  - Preparatory meeting for the audit of British authority Health and Safety Executive's Nuclear Directorate, 4–13 October 2009, Jukka Laaksonen, Deputy Team Leader (B3)
  - Preparatory meeting for the audit of Russian authority Rostechnadzor 25–27 August 2009, Jukka Laaksonen, and the actual audit 5–27 November 2009, Jukka Laaksonen, Team Leader, Heikki Reponen, (B3)
  - Audit of the Canadian Nuclear Safety Commission (CNSC) 1–12 June 2009, Heikki Reponen (B3)
  - Audit of the Peruvian authority 9–30 April 2009, Ritva Bly (C)
  - Follow-up meeting of the audit of the French authority 28 March–3 April 2009 in Paris, Tero Varjoranta (B2)
  - First part of the audit of the Iranian authority 20–23 April 2009 in Vienna, Tero Varjoranta (B2)
- Meeting "To revise the Control of Medical Exposure Thematic Question Set of the IAEA Integrated Regulatory Review Service (IRRS)", 26–30 January 2009, Ritva Bly (C).
- RER9093 9002/Regional Coordination Meeting on Medical Exposure, 22–24 June 2009, Ritva Bly (C).
- RER9093 9005/Radiation protection in dentistry, 28–30 September 2009, Ritva Bly (C).
- The INES meeting to discuss the applicability of INES to overexposure of patients, Paris 4–6 February 2009, Eero Kettunen (A)
- Workshop on capacity building and strengthening of nuclear regulatory framework in connection to new nuclear activities, Bratislava, Slovakia, Janne Nevalainen, Pekka Välikangas, Keijo Valtonen (3 days) (C)
- IAEA's Operational Safety Review Team (OSART) inspection at the Oskarshamn NPP, Seija Suksi (16 days) (B2)
- Meeting of IAEA consultants "Generic Issues relevant to the Operation, Maintenance, and Upgrading of Protection and Control systems in Nuclear Power Plants", Heimo Takala (4 days) (A)
- Technical meeting on Regulatory Oversight of Licensees' Activities during Major NPP Projects, Kaisa Koskinen (5 days) (A)
- IAEA-Foratom Joint Workshop: Practical Implementations of IAEA Safety Standards on Management System, Kaisa Koskinen (3 days) (C)
- Regional Meeting on the Harmonisations of Licensing and Regulatory Capacity Building, Kaisa Koskinen (5 days) (C)
- Meeting organised by IAEA for potential new NPP countries, Lecturer Pentti Tiippana (3 days, 1 meeting) (A)
- Expert, IAEA Biodosimetry application in radiation emergencies – a manual, working group meeting 2–6 November 2009, Vienna, Carita Lindholm (A)
- RANET, IAEA's Response Assistance Network for radiation hazard situations. Anne Kiuru (5 days, 1 meeting) (A)
- IAEA Technical Meeting on Revisions of the BSS, Newest Recommendations on Health Ef-

fects from radon, The impact on Regulatory Requirements, 15–16 December 2009 Vienna, Mika Markkanen, Hannu Arvela (A)

- IAEA Technical Meeting on Uranium from Unconventional Resources 4–6 November 2009 Vienna, Tarja K. Ikäheimonen (A)
- Training organised by IAEA for authorities and operators of different countries: "State System of Accountancy and Control" with training organised in particular for Indonesian authorities 1–10 June 2009, Columbia, Missouri, USA, Tapani Honkamaa in the capacity of an expert (B3)

Other IAEA events

- Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management
  - Officers' Meeting, Tero Varjoranta (1 meeting) (A)
  - International audit meeting; Chairmanship of the Country Group Tero Varjoranta (11 days), Deputy Chairman of the Country Group, Kaisa-Leena Hutri, Country Coordinator (8 days), Risto Paltemaa (5 days), Jussi Heinonen (5 days), Mika Markkanen 10–22 May 2009 (A)

CTBTO

- Working Group B and meetings of the Expert Team on Radionuclides, Vienna, 16–27 February 2009 and 24–28 August 2009, Mikael Moring, Chairman of the Expert Team on Radionuclides (A)
- Evaluation-NDC Workshop, 18–23 May 2009, Beijing, China, Mikael Moring, Chairman of the meeting group (A)
- Laboratory Workshop, Seattle USA, 7 September 2009, Mikael Moring (B1)
- Meeting of the Technical Working Group B and meeting of the Expert Team on Radionuclides, 16–19 February 2009, Paula Karhu, member of the Finnish delegation (4 days, 2 meetings) (A)
- Working Group B and meetings of the Expert Team on Radionuclides, Tommi Renvall (A)
- Laboratory Workshop, FIL07, Tommi Renvall in the capacity of Head of Laboratory (A)

OECD/NEA

- **CNRA**, Committee on Nuclear Regulatory Activities, Petteri Tiippana (2 days, 1 meeting) (A), Lasse Reiman (2 days, 1 meeting), Kirsi Alm-Lytz (2 days, 1 meeting) (A)
  - WGOE, Working Group on Operating Experience workshop, (1 day), participation in the 5th meeting of the group with a prepared address, Seija Suksi (2 days) (A)
  - Sixth meeting of the operating experience working group of OECD/NEA/CNRA, Seija Suksi (3 days) and meeting of the Trending Methodology Working Group, Seija Suksi (1 day) (A)
  - WGRNR, Working Group on Regulating New Reactors, Pentti Tiippana (8 days, 2 meetings) (A)
- **CSNI**, Committee on the Safety of Nuclear Installations, Keijo Valtonen (4 days, 2 meetings), Lasse Reiman (2 days, 1 meeting) (A)
  - Programme Review Group of the SETH-2 Project, Eero Virtanen, Chairman (4 days, 2 meetings) (A)
  - WGAMA, Working Group on Analysis and Management Accidents 14–18 September 2009, Nina Lahtinen (4 days) (A)
  - Management Board of the PKL-2 Project, Eero Virtanen, Chairman (4 days, 2 meetings) (A)
  - Management Board of the ROSA Project, Eero Virtanen (4 days, 2 meetings) (A)
  - WGRisk Bureau, Reino Virolainen (2 days, 2 meetings) (A)
  - WGRisk, Working Group on Risk Assessment, Jorma Sandberg (3 days, 1 meeting) (A), Reino Virolainen (2 days, 2 meetings) (A)
  - WGHOF, Working Group on Human and Organisational Factors, Milka Holopainen 22–25 May 2009 (4 days) (A), Nina Koivula, (3 days, 1 meeting) (A)
  - Task Meeting of the WGHOF with Swiss authority ENSI, Milka Holopainen (2 days, 1 meeting) (A)
  - WGFS, Working Group on Fuel Safety, Risto Sairanen (1 meeting, 2 days) (A)
  - SCAP, Stress Corrosion Cracking and Cable Ageing Project, Rauli Keskinen (2 days, 1 meeting) (A)
  - DIDELSYS, Defence in Depth of Electrical Systems and Grid Interaction with nuclear power plants, Kim Wahlström (4 days, 2 meetings)

- IAGE, Working Group on Integrity and Ageing of Components and Structures, Sub-Group on the Integrity of Metal Components and Structures, Rauli Keskinen, (3 days, 2 meetings) (A)
- IAGE, Preparatory meeting for Missiles/IRIS 2010, Pekka Välikangas (2 days, 1 meeting) (A)
- IAGE, Concrete, Metal, Seismic, Missiles, Pekka Välikangas (5 days, 1 meeting) (A)
- COMPSIS, Exchange of Operating Experience Concerning Computer-based Systems Important to Safety, Steering Group, Heimo Takala (3 days, 1 meeting) (A)
- OECD NEA's WPNCS (Working Party on Nuclear Criticality Safety), Presentation on topical projects related to criticality safety in Finland and participation in the production of a manual on the subject. Riku Mattila, (1 day, 1 meeting) (A)
- OECD/NEA/CSNI research project, Meeting of the Program Review Group of the OECD THai project, Meeting of the Management Board of the OECD THai project, Minna Tuomainen, (3 days, 2 meetings) (A)

- **CRPPH**, Committee on Radiation protection and Public Health, Olli Vilkamo (3 days, 1 meeting) (A)
  - WPNEM, Working Party on Nuclear Emergency Matters, Hannele Aaltonen (6 days, 2 meetings) (A)
  - EGBAT, Expert Group on Best Available Technologies for Discharge Abatement from New Build of Nuclear Power Plants, Lauri Pöllänen (3 days, 1 meeting) (A)
  - ISOE, Information System on Occupational Exposure, ALARA symposium, Antti Tynkkynen (3 days, 1 meeting) (A)
  - HRP CCF Workshop, Heimo Takala (2 days, 1 meeting) (A)
  - OECD/NEA/NDC – PoW 2009–2010 – Activity 7.4 – Education, Training and Knowledge Management ad hoc expert group, Kaisa Koskinen (2 days, 1 meeting) (A)
- **RWMC**, Radioactive Waste Management Committee, Esko Ruokola (3 days, 1 meeting) (A)
  - RF, Regulators Forum, Esko Ruokola (1 meeting) (A)
  - IGSC, Integration Group for the Safety Case, Petri Jussila (3 days, 1 meeting) (A).

ICNIRP

- ICNIRP, International Committee on Non-Ionising Radiation Protection, Main committee, Kari Jokela (6 days, 2 meetings) (B3).

EU

- ENSREG, European Nuclear Safety Regulator's Group – Jukka Laaksonen (3 days, 3 meetings) (B1)
  - WG 2, Safety of the management of spent fuel and radioactive waste, Tero Varjoranta, Chairman (2 days, 2 meetings) (A)
- European Clearinghouse on Operational Experience Feedback – Director General Jukka Laaksonen, Chairman of the steering group (3 days, 2 meetings), Seija Suksi (3 days, 2 meetings) (A)
- ENSRA, European Nuclear Security Regulators Association, Ronnie Olander (2 days, 1 meeting) (A)
- Six-Country Information Exchange Meeting on Fire Safety, Jouko Marttila (3 days, 1 meeting) (A)
- EU Clearinghouse on NPP Operational Experience Feedback, Jukka Laaksonen, Chairman of the Technical Board (1 day) (A), Seija Suksi, Assistant to the Chairman and National Contact Person (1 day) (A)
- EU Clearinghouse on NPP Operational Experience Feedback, 2009 annual meeting of the Technical Board, Seija Suksi (1 day) (A)
- EU Clearinghouse, Juha Häikiö (1 day, 1 meeting) (A)
- Joint Research Centre Decommissioning and Waste Management Expert Group (JRC D & WM Expert Group), Risto Paltemaa (2 days, 1 meeting) (B2)
- EURATOM – Group of Experts Referred to in Article 31 of the Euratom Treaty, Eero Kettunen; Olli Vilkamo (B3)
  - Article 31 subgroup – Medical Exposures, Chairman Eero Kettunen (B3)
- EUTERP (European Training and Education in Radiation Protection Platform), Ritva Havukainen (A).
- EURADOS, European Dosimetry Group, Hannu Järvinen (A)
  - WG 9 Radiation protection in medicine, Hannu Järvinen, Chairman (A)
  - WG 2 Harmonisation of Individual Monitoring, Timo Ansaranta (A)

- EAN (European ALARA Network) Steering Group, Maaret Lehtinen (A)
- EURATOM – Group of Experts Referred to in Articles 35–36 of the Euratom Treaty, Raimo Mustonen, National Representative (B1)
- EURATOM – Consultative Committee Euratom – Fission, Expert Member (B1)
- Meetings of the European Regulators for Radiation Protection, Eero Kettunen (A)
- WG 1 Working group on Outside Workers & Dose Passports, Ritva Havukainen (A)
- WG 3 Working Group New Medical Techniques & Patient Release, Ritva Bly (A)
- WG 5 Working Group Stakeholder Involvement & Medical Practices, Eero Kettunen (A).
- EURADOS, European Dosimetry Group, WG3 (Environmental Radiation Monitoring), Kaj Vesterbacka (B3)
- EURANOS Rodos User's Group (RUG), Michael Ammann (A)
- High Level Group on Low Dose Risk Research, Member of the MELODI Mapping Group, Stuttgart, 28–29 September 2009, Virpi Launonen (A)
- EC, DG TREN, Nuclear safeguards regarding the disposal of spent nuclear fuel, Working Group meeting, Elina Martikka, Olli Okko and Marko Hämäläinen (1 day) (A)
- EC, DG TREN, Meeting with MS representatives on implementing Euratom Treaty Safeguards, Luxemburg 18–19 March 2009, Elina Martikka (B1) and Marko Hämäläinen (A)
- EC JRC, International Human Capital Development Workshop in Nuclear Safeguards, Ispra Italy, 2–4 September 2009, Elina Martikka (A)
- EU CBRN Task Force Concluding Meeting: Conference on Enhancing CBRN Security, 29–30 January 2009, Paula Karhu (2 days, 1 meeting) (B2).

Nordic cooperation

- Nordic Chefsmöte – Working Group for the Directors of Nordic nuclear and radiation safety authorities, Jukka Laaksonen (A)
- NKS Nuclear Safety Seminar, Olli Vilkamo (2 days, 1 meeting) (A)
- NORDFYS, Fysiskt skydd i Nordisk kärnteknisk verksamhet (Physical protection in the Nordic nuclear environment), Ronnie Olander (2 days, 1 meeting) (A)
- Advisory groups for the OECD Halden project's I & C and control room research, Harri Heimbürger (2 days, 1 meeting) (A)
- Meeting of the Management Group of Nordic Nuclear Research (NKS), Risto Sairanen (1 day, 1 meeting) (A)
- NKS, Nordisk kärnsäkerhetsforskning (Nordic Nuclear Research), Board of Directors, Raimo Mustonen, Member (A)
- Nordic Work Group on Emergency Preparedness (NEP), Hannele Aaltonen (4 days, 2 meetings), Anne Weltner (4 days, 2 meetings) (A)
- Training course for staff of Nordic Secondary Standard Dosimetry Laboratories, STUK 7–8 May 2009 (Antti Kosunen, Ilkka Jokelainen, Markku Tapiovaara, Teemu Siiskonen, Arvi Hakanen) (A)
- Evidence-based quality in radiographic imaging. Development of dose and image quality optimisation, syllabuses and web-based learning package. Teuvo Parviainen, Member of the Steering Group of the Nordic project (A)
- NKS-B; Measurement Strategy, Technology and Quality Assurance; GammaSem Working Group, Seppo Klemola (A)
- Nordic physicians responsible for preparedness to treat RN injuries, Wendla Paile (A)
- NORPLA, Cooperation group of Nordic radiation protection libraries and archives, Armi Länkelin. (A)
- Nordic meeting on lasers and IPL devices, Reijo Visuri (1 day) (A)
- Preparatory work for a statement on RF background radiation, 2 Nordic meetings, Tommi Toivonen (2 days) (A)
- Preparatory work for a statement regarding age recommendations on the use of solariums, teleconference, Reijo Visuri (1 day) (B3).

Other multinational working groups

- WENRA, Western European Nuclear Regulator's Association, Jukka Laaksonen (4 days, 2 meetings), Pentti Koutaniemi (2 days, 1 meeting), Kirsi Alm-Lytz (4 days, 2 meetings) (A)
  - WENRA/RHWG, Reactor Harmonization Working Group, Kirsi Alm-Lytz (8 days, 2 meetings), Lasse Reiman (4 days, 1 meeting)
  - WENRA-WGWD, Working Group for Waste and Decommissioning, Esko Ruokola, (2 meetings) (A)

- MDEP, Multinational Design Evaluation Programme – Cooperation project of 10 countries aimed at achieving global harmonization in the construction of new nuclear power plants,
  - Policy Group, Jukka Laaksonen (2 days, 2 meetings) (A)
  - MDEP STC, Meeting of the Technical Management Group, Lasse Reiman (9 days, 3 meetings) (A)
  - MDEP Safety Goals Expert Group, Lasse Reiman (5 days, 2 meetings) (A)
  - VICWG, Vendor Inspection Co-operation Working Group, Yrjö Hytönen 28 September–2 October 2009 (A), Martti Vilpas (2 days, 1 meeting) (A), Jouko Mononen (6 days, 2 meetings) (A)
  - Inspection of equipment manufacturer by VICWG; Audit of the operations of the Doosan engineering works in Busan, South Korea by the South Korean authority, Jouko Mononen (5 days) (A)
  - CSWG, Codes and Standards Working Group, Yrjö Hytönen (6 days, 2 meetings) (A)
- Joint IAEA / NEA Meeting of IRS National Coordinators to Exchange Experience on Recent Events in Nuclear Power Plants and Technical Committee Meeting of the IRS National Co-ordinators. Seija Suksi (4 days, 2 meetings), Erja Kainulainen (4 days, 2 meetings) (A)
- VVER-Forum, working group for the authorities of countries operating VVER plants, Jukka Laaksonen (3 days, 1 meeting), Timo Eurasto (3 days, 1 meeting) (A), Reino Virolainen (3 days, 1 meeting) (A)
  - VVER Forum PSA Working Group, Chairman Reino Virolainen (3 days, 1 meeting)
  - VVER Forum PSA Working Group, Comparison of the PSAs of VVER plants, WG Secterary Ilkka Niemelä (4 days, 1 meeting) (A)
  - VVER Forum WG on organisational issues, Chairman Timo Eurasto (4 days, 1 meeting) (A)
- ESREL 2009 + annual meeting of ESRA, Reino Virolainen (2 days, 2 meetings) (A)
- Carnegie Endowment Group for writing Nuclear Power Plant Export Code of Conduct, Jukka Laaksonen (8 days, 3 meetings) (B2)
- Board of Directors of the International Association for Probabilistic Safety Assessment and Management (IAPSAM), Reino Virolainen (3 days, 2 meetings) (B2)
- ICG-EAC, International Collaborative Group on Environmental Assisted Cracking, Yrjö Hytönen, 19–27 April 2009 (A)
- Annual international follow-up meeting on the risks of operational events – lecture on events in Finnish NPPs, Jorma Rantakivi (3 days, 1 meeting) (A)
- ESARDA 31st Annual Meeting, Elina Martikka, Olli Okko, Tapani Honkamaa, Mikael Moring, Marko Hämäläinen, Antero Kuusi and Harri Toivonen (3 days) (A)
- ESARDA, Integrated Safeguards Working Group, Anna Lahkola and Olli Okko (2 days, 1 meeting), Elina Martikka (1 day, 1 meeting) (A)
- ESARDA, Verification Technologies and Methodologies Working Group, Elina Martikka (1 day) (A)
- ESARDA, Containment and Surveillance Working Group, Elina Martikka (1 day) (A)
- 31st ESARDA ANNUAL MEETING Vilnius, Lithuania 26–28 May 2009, Juha Rautjärvi (2 days) (A)
- G-8 Nuclear Safety and Security Group. ITWG, International Technical Working Group to Counter Illicit Nuclear Trafficking, Antero Kuusi (2 days, 1 meeting) (A)
- European Pilot Group on Regulatory Review of the Safety Case for Geological Disposal of Radioactive Waste (EPS), Jussi Heinonen (subgroup 1) (3 days, 3 meetings), Risto Paltemaa (1 day, 1 meeting) (A)
- CBSS, Council of the Baltic Sea States, Expert Group for Nuclear and Radiation Safety, Raimo Mustonen, National Representative (A)
  - Participation in the meeting of the CBSS Expert Group on Nuclear and Radiation Safety (EGNRS), Juha Rautjärvi (2 days) (A)
- PROCORAD, Association for the Promotion of Quality Control in Radiotoxicological Analysis, Tarja Heikkinen (A)
- ICRM (International Committee for Radionuclide Metrology), Gamma Spectrometry Working Group, work on measurement standards for the activity parameters of ionizing radiation, Seppo Klemola (A)

- HELCOM-MORS, maintenance of the register for radioactive emissions into the Baltic Sea, Tarja K. Ikäheimonen, Iisa Outola, Vesa-Pekka Vartti (3 days, 1 meeting) (A)
- CBSS EGNRS (Council of Baltic Sea States), Working Group on Gamma Spectrometric Analysis, Tommi Renvall and Kaj Vesterbacka (meeting hosted by STUK)
- Statens Strålskyddsmyndighet: SSM Independent Expert Group on Health effects of Electromagnetic Fields, Anssi Auvinen (B3)
- EURAMET, the European Association of National Metrology Institutes, Antti Kosunen (A)
- ESOREX (European Study of Occupational Radiation Exposure), Maaret Lehtinen (member) (A).

Lectures given at training events

- MIT Nuclear Plant Safety Course, Cambridge Ma. USA, 23 June 2009, Jukka Laaksonen (B2)
- Nuclear Manager Training Course, St. Petersburg, 25 May 2009 Jukka Laaksonen (C)
- Elforsk Seminar – Competence needs in the Nuclear Industry, Kaisa Koskinen, 28 January 2009 (A)

Participation in international meetings in the capacity of a lecturer, panel member or session chairperson

- USNRC Regulatory Information Conference, Washington DC USA, 10–12 March 2009, Jukka Laaksonen (A)
- 2009 International Congress on Advances in Nuclear Power Plants, Tokyo, Japan, 11–12 May 2009, Jukka Laaksonen (B2)
- MDEP Workshop, Paris, France, 10–11 September 2009, Jukka Laaksonen, Lasse Reiman, Petteri Tiippana (A)
- IAEA Conference on Effective Nuclear Regulatory Systems, Cape Town, South Africa, 14–17 December 2009, Jukka Laaksonen, Jussi Heinonen (A)
- Workshop of the public authority forum of the NEA nuclear waste committee entitled "Towards Transparent, Proportionate and Deliverable Regulation for Geological Disposal", Tokyo 19–22 January 2009, Esko Ruokola, Risto Paltemaa (A)
- Pilot WS on Nuclear Forensics Analysis, JRC-ITU, Karlsruhe, Germany, 18–20 November 2009, Mikael Moring (C)
- Workshop organized by NNSA (USA) and MEXT(JPN), entitled "2nd International Meeting on Next Generation Safeguards", Tokaimura 26–28 October 2009, Tapani Honkamaa (A)
- INMM, Institute of Nuclear Material Management, 50th Annual Meeting, Tapani Honkamaa and Elina Martikka, Tucson, Arizona, USA, 12–16 July 2009 (A)
- IAEA Nuclear Security Symposium, Vienna, 30 March–3 April 2009, Paula Karhu (A)
- Workshop jointly organised by the IAEA and the EC Institute of Energy, Joint Research Centre in Petten for the public authorities of Eastern European counties and Russia regarding national operating experience procedures, event interpretation and analysis methods for operational events, Seija Suksi (5 days) (A)
- G8-NSSG-IAEA International Workshop on Nuclear Safety and Security Education and Training in Countries Embarking on or Expanding Nuclear Programmes, Bologna, in the capacity of an invited lecturer, Paula Karhu, 7–9 October 2009 (A)
- World Nuclear Harmonization Forum, Keijo Valtonen, 1–3 September 2009 (A)
- Eurosafe, Lasse Reiman, 2 November 2009 (A)
- Fortif, Lasse Reiman, 19 November 2009 (B1)
- Kärnteknik seminar, in the capacity of an invited lecturer, Martti Vilpas, 22–23 April 2009 (2 days) (B2)
- Eighth International Conference on Methods and Applications of Radioanalytical Chemistry (MARC VIII), 5–10 April 2009, Kona, Hawaii, USA. Tarja K. Ikäheimonen, Iisa Outola, Roy Pöllänen (A)
- 7th Symposium of CBRNE threats, meeting the future challenges (NBC2009), Jyväskylä, Finland 2009. Roy Pöllänen, Petri Smolander (A)
- Nuclear Security Expert Meeting on Nuclear Forensic Awareness and Development and Implementation of a National Response Plan, 14–16 October 2009, ITU, Karlsruhe, Germany. Kari Peräjärvi (A)

- CTBTO – International Scientific Studies, International Conference, 10–12 June 2009, Vienna, Austria. Kari Peräjärvi, Harri Toivonen (A)
- 31st ESARDA Annual meeting, 26–28 May 2009, Vilnius, Lithuania. Harri Toivonen (A)
- Nuclear Security Expert Meeting on Nuclear Forensic Awareness and Development and Implementation of a National Response Plan, 14–16 October 2009, ITU, Karlsruhe, Germany. Kari Peräjärvi (A)
- IGSE Workshop (Independent Group of Scientific Experts on the detection of clandestine nuclear weapons-usable materials production), 2–4 November 2009, Vienna, Austria. Jani Turunen (B2)
- GammaSem: Nordic seminar for users of gamma spectrometry 16–17 September 2009, Kjeller, Norway, Seppo Klemola (A)
- EURANOS Rodos User's Group (RUG), 22–23 June 2009, Madrid, Spain, Michael Ammann, Chairman (A)
- EURANOS concluding meeting, 24–26 June 2009, Madrid, Spain, Michael Ammann (A)
- Late health effects of ionizing radiation, 4–6 May 2009, Washington, USA, Carita Lindholm (B2)
- NKS-R and NKS-B Joint Summary Seminar, Stockholm, 26–27 March 2009, Carita Lindholm (B3)
- 1st International Radiation Proteomics Workshop 27–28 May 2009 (2 days), Munich, Germany, Reetta Nylund, scientific lecture (B3)
- US HUPO (Human Proteome Project) meeting on "Integrative Proteomics for the Future", 22–25 May 2009, San Diego, CA, USA, Dariusz Leszczynski (A)
- Guangbiao Professor duties in China 15 March–20 April 2009, Dariusz Leszczynski (B3)
- 5th International EMF Seminar in China; Co-Chair member of the Scientific Committee, Hangzhou, China, 17–19 April 2009; Invited speaker, Session Chair, Dariusz Leszczynski (B3)
- 1st International Radiation Proteomics Workshop 2009; co-organizer & member of the Scientific Committee, May 2009, Munich, Germany, Invited speaker, Session Chair Dariusz Leszczynski (B2)
- BioEM 2009: the Joint Meeting of Bioelectromagnetics Society (USA) and European BioElectromagnetics Association, 14–18 June 2009, Davos, Switzerland; Co-Chair Technical Program Committee, Session Moderator, Invited speaker, Dariusz Leszczynski (B2)
- U.S. Washington Conference on "Cell Phones and Health: Science and Public Policy Questions", 14–15 September, 2009, Washington, DC, USA; Member of Steering Committee, Session Chair, Invited speaker (opening lecture), Dariusz Leszczynski (B2)
- EU COST Action BM0704 meeting in Paris 3–5 November 2009, Dariusz Leszczynski (B3)
- Radon – DACH meeting, Capolago, Switzerland, 16–18 September 2009, Hannu Arvela, Olli Holmgren (A)
- Bioelectromagnetics Society (BEMS) Annual meeting, Davos, Switzerland, invited plenary lecture, Anssi Auvinen (B3)
- International Topical Conference on Po and Radioactive Pb isotopes, Sevilla, Spain 26–29 October 2009, Dina Solatie, Tuukka Turtiainen (A)
- Barents Sea Expedition (22 days), Ari-Pekka Leppänen (A)
- Seminar on gamma radiation measurements, organised by NKS GammaSem, NKS, Ari-Pekka Leppänen, Pertti Niskala (A)
- Meeting of the Nordic Working Group on UV and ozone, Pärnu, Estonia, Reijo Visuri, Lasse Ylianttila, (4 days) (A)
- BEMS conference, Davos, Switzerland, Sami Kännälä, Tim Toivo (8 days) (A).

Standardisation working groups

- CEN TC 351 Workshop on Radiation from construction products, 31 October 2009, Mika Markkanen (C)
- IEC/TC45/SC45A/Working Group A3, A8, preparation of nuclear power plant I & C standards, Harri Heimbürger, (1 day, 1 meeting) (A)
- Sub-committee WG4 (Radiological Measurements) of ISO Technical Committee TC147 (Water Quality), Pia Vesterbacka (A)
- IEC /TC61/MT16 UV Radiation WG (solariums), Reijo Visuri (2 day, 1 meeting) (A3)

Participation in foreign committees

- Advisory committee on nuclear safety to support the Swedish nuclear authority (SSM, Strålsäkerhetsmyndigheten), Lasse Reiman (4 days, 4 meetings) (B3)
- Advisory committee on nuclear safety in France (Groupe Permanent d'Experts pour les Réacteurs Nucléaires), Nina Lahtinen (7 days, 3 meetings) (A)
- Strålsäkerhetsmyndighetens (SSM) Nämd för Frågor on Radioaktivt Avfall och Använt Kärnbränsle, Advisory committee of the Swedish radiation and nuclear safety authority on radioactive substances and spent nuclear fuel, Tero Varjoranta (1 day, 1 member) (B1)
- Nuclear Safety Committee of Lithuania, Tero Varjoranta (1 day, 1 meeting) (B2)
- Bioelectromagnetics Society Board of Directors meeting in Zurich, Switzerland, 4–8 February 2009, Dariusz Leszczynski (B2)
- Annual Meeting of the American Society for Cell Biology, San Diego, CA, USA, 5–10 December 2009, Dariusz Leszczynski (A).

Bilateral cooperation between authorities

- STUK – Swedish Nuclear Safety Authority SSM: exchange of information on the work of public authorities and on the operational events at the Forsmark and Olkiluoto NPPs, Suvi Ristonmaa, Jukka Kupila (4 days, 2 meetings), Veli Riihinluoma (2 days, 1 meeting) (A)
- Meeting of public authorities at SSM; radiation safety of nuclear power plants, Olli Vilkamo, Veli Riihiluoma (1 day, 1 meeting) (A)
- Nordic meeting on dose monitoring, Olli Vilkamo, Veli Riihiluoma (2 days, 1 meeting) (A)
- ASN (France) Jukka Laaksonen (3 days), Pekka Välikangas (3 days), Jukka Myllymäki (3 days) (A)
- NRC (USA) Jukka Laaksonen (1 day), Risto Paltemaa (2 days), Petteri Tiippana, Lasse Kuosa (A)
- ENSI (Switzerland) Jukka Laaksonen (2 days) (A)
- Rostechandzor (Russia) Jukka Laaksonen (3 days) (A), Antero Kuusi (2 days) (A), Henri Niittymäki (4 days) (A)
- Bilateral meeting USA-Finland on Nuclear Security, Ronnie Olander (1 day, 1 meeting) (A)
- CNSC–STUK cooperation meeting; Civil engineering, Fire protection, Missiles, Pekka Välikangas (3 days, 1 meeting) (A)
- Swedish Nuclear and Radiation Safety Authority SSM (2 days), Swiss Nuclear and Radiation Safety Authority, Kirsi Alm-Lytz (1 day), Lasse Reiman (1 day) (bilateral meetings with the nuclear and radiation safety authorities in their countries and hosting in Olkiluoto)
- Visit of B. Hessu, Consultant for BMU, the Federal German Ministry for the Environment, Natural Conservation and Nuclear Safety (Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit) regarding pipe rupture criteria, Rauli Keskinen (1 day, 1 meeting)
- Attending the preparedness exercise of Rosatom, Moscow, Russia, Timo Eurasto (1 day) (A)
- BfS (Germany) Antti Kosunen, Teemu Siiskonen, Markku Tapiovaara (1 day) (A)
- BfS (Germany) Kaj Vesterbacka (3 day) (no travel expenses)
- Workshop on "International Emergency Preparedness and Crisis Communication" Sevastopol, Ukraine, 2–4 September 2009, Juha Rautjärvi (3 days) (B3)
- Program of the Summer School "Ukraine in global nuclear non-proliferation and arms control: political and technical dimensions", 5–10 July 2009, Odessa, Ukraine, Juha Rautjärvi (4 days) (B3).

Others

- Empire 2009 exercise on actions after the detonation of a dirty bomb, Albany, NY, USA, 2–4 June 2009, Hannele Aaltonen and Antero Kuusi (A)
- EU-27 Peer Review of nuclear waste management issues at STUK (5 days)

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

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

TechSpec
Technical Specifications, Operational Limits and Conditions

WANO
World Association of Nuclear Operators

WENRA
Western European Nuclear Regulators' Association

VVER (Vodo-Vodyanoi Energetichesky Reactor)
Russian pressurised water reactor; Loviisa 1 and Loviisa 2 are VVER-440 reactors

nuclear material
special fissionable material suitable for the creation of nuclear energy, such as uranium, thorium or plutonium

nuclear commodity (or: nuclear material)
nuclear material referred to above or another material referred to in Section 2, Paragraphs 4 and 5 of the Finnish Nuclear Energy Act (deuterium or graphite), device, system and information (Section 1, paragraph 8 of the Nuclear Energy Decree).

nuclear material accounting and control manual
manual to be used by an organisation in possession of nuclear commodities, describing the nuclear commodity safeguards and accounting system

nuclear non-proliferation manual
manual to be used by a future possessor of nuclear commodities, describing the measures to secure the requirements of nuclear safeguards

regulatory control of nuclear non-proliferation
monitoring operations to prevent the proliferation of nuclear weapons; operations consist of nuclear safeguards and the monitoring of the nuclear test ban

EIA procedure
Enviromental Safety Assessment

YVL Guides
STUK guides containing detailed requirements set for the safety of nuclear power plants. There's a large restructuring project going on, the new YVL Guides should replace old ones by the end of 2011. The last old style YVL Guides with number-only id's were issued in 2008.