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Regulatory control of nuclear safety in Finland

Annual report 2008

Erja Kainulainen (ed.)

Säteilyturvakeskus
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Radiation and Nuclear Safety Authority
STUK

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Management review

In 2008, Finnish nuclear power plants caused no danger to the plant environment or employees. Radioactive emissions into the environment were very low. For several years now, the collective doses of employees at both plants seem to be decreasing due to various development and modernisation projects, when normal annual variation according to the length and extent of the maintenance outage is taken into account.

However, some observations that were made during the operation year gave us a reminder of the constant vigilance and maintenance of competencies that are required to be able to maintain the appropriate safety level. These requirements apply to both plant operation and maintenance, and the replacement of old systems and equipment with new ones. No incidents requiring measures of the Radiation and Nuclear Safety Authority (STUK) occurred at Loviisa power plant, but the plant I&C modernisation that has been in progress for several years has been proceeding more slowly than was originally planned. This is due to the fact that proving the reliable operation of the systems utilising new technology has been even more difficult than was expected. At Olkiluoto, embrittlement by aging was detected in some emergency diesel seals. If allowed to continue, this could have prevented the start-up of several diesel generators at the same time. The seals in question were not included in the regular maintenance programme; instead, the problem was detected in connection with periodic start-up testing. A power failure also occurred at Olkiluoto, proving that changes carried out during the latest reactor power uprating did not result in the desired reliability of electrical systems. According to STUK's understanding, the operative decision-making in connection with these events did not comply with good operational procedures, and STUK had to set operational restrictions based on its own decision. As a result, Teollisuuden Voima Oyj (TVO) had its decision-making procedures and operational safety culture evaluated by external experts. The evaluators gave recommendations on measures to improve the situation, and TVO has implemented these measures.

To improve the safety of both plants that are currently operational, improvements were carried out to the operational procedures and plant structure. At the Loviisa power plant, a so-called risk-informed inspection programme was adopted for the in-service inspection of major pipework. In the new programme, particular attention is paid to the condition of the pipes at points where the susceptibility to breaks and the adverse consequences of a break are estimated to be highest. Adoption of a similar inspection practice is also being prepared at Olkiluoto. The reliability of inspections has also been improved by qualifying non-destructive examination methods for certain inspections to be carried out for a certain plant. Qualification methods have been developed in cooperation between power companies and inspection organisations for several years. STUK approved the main inspections of the Loviisa reactor pressure vessel as the first inspection qualified according to new international standards. Finnish nuclear power plants are European forerunners in the implementation of new inspection methods and programmes. Investments in the modernisation of systems and the plants continued in the manner established in the previous years. In the selection of the targets, probabilistic risk analysis was used; at Loviisa, the periodic safety review carried out in the previous year was also used. STUK will examine the periodic safety review of TVO in 2009. TVO carried out the review in 2008.

A generational shift is still in progress among the management and expert posts at both of the nuclear power plants. There are no difficulties in the recruitment of qualified and motivated young professionals, as the new nuclear power construction projects have strongly increased interest in the industry.

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.

STUK's work input in the regulatory control of each of the operating nuclear power plants was equivalent to approximately 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 regulation 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. 29.3 person-years were used for overseeing the design, component manufacturing and construction of the Olkiluoto 3 unit, which is slightly more than in previous years. The amount of work will continue to increase in 2009 and 2010, which will see a lot of component manufacturing and installation operations. 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 it has enabled operations to be increased according to actual needs.

Definite progress has been made in the construction of the new Olkiluoto plant unit, in both the smoothness and the quality of the construction work. Quality deviations have been fewer than before, and they have been repaired in an acceptable manner. The manufacture of Olkiluoto 3 structures and components according to the standards selected as benchmarks and the objectives set by the designers has succeeded better than before. Some components have had to be remanufactured or repaired, but no major problems in the realisation of quality objectives have been observed in the latter part of the year. The experiences of the regulation of construction and manufacture further emphasised the importance of comprehensive inspections as a means of ensuring the required quality. The inspection programme that has been active since the beginning of the construction project was used to monitor TVO's operations as the builder of Olkiluoto 3. Systematic inspections have proved to be a good tool for assessing the power company's ability to take on the responsibility for plant safety. To limit the delays caused by regulation work, operational methods were further developed on the basis of experience, and communication to organisations participating in the operations was improved. In addition, a few new inspectors were recruited for the areas with the largest increase in the workload.

Three new separate projects aimed at the construction of a nuclear power plant were in progress during the year. The projects proceeded from environmental impact assessment towards applying for a decision-in-principle. The environmental impact assessment was completed for TVO's Olkiluoto 4 and Fortum's Loviisa 3. Fennovoima also submitted a similar assessment report to the Ministry of Employment and the Economy. STUK reviewed the assessments, mainly with a view to ensuring comprehensiveness and the correctness of the information provided. An application for a decision-in-principle for Olkiluoto 4 was already submitted in the first half of the year, including five possible plant concepts. STUK began processing the application. The process includes the assessment of plant types and safety factors related to various plant locations. At the request of other power companies, and at their expense, two additional plant types were also included in the evaluations. The power companies announced that they will present these two plant types as alternatives in their future applications.

As a part of the preparation for the nuclear power plant projects mentioned above, STUK continued the preparation of new nuclear energy legislation in cooperation with the Ministry of Employment and the Economy. The new nuclear energy legislation and the related Government Decrees took effect during the year. Based on them, STUK will update its YVL Guides that include the detailed requirements for safety and safety control. According to the current schedule, the Guides will be updated to include the essential requirements needed for any invitations for tenders by spring 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 shafts. In 2008, the excavation work proceeded according to plan. STUK oversaw the work, preparing for the possibility that the tunnel and the shafts will, in due course, lead to the actual final disposal facility. In a few years, the final disposal project will proceed to the construction permit and implementation stage. To prepare for this, STUK continued the recruitment of inspectors representing various fields. The safety of final disposal will be primarily proved based on the reliability of the structures designed for the containment of radioactive substances, as well as information on the environmental conditions in which the structures will be expected to fill their purpose for a few hundred thousand years. These structures will consist of a gas-tight copper canister and surrounding bentonite clay. To be able to adequately prepare for the assessment of the long-term safety of the disposed waste, STUK requested statements from independent Finnish experts as well as an international expert team that directly supports safety control operations.

Preparation for exceptional radiation conditions is now well organised in Finland. The automatically alerting radiation monitoring network is reliable, very tolerant of individual equipment malfunctions and sufficiently dense. The joint actions by the authorities to control a fall-out situation have also been planned under STUK's leadership in a manner that provides an internationally-commended example for other countries, as well. The network required for measuring foods, composed of municipal and private laboratories, has been provided with new equipment, and the staff of these laboratories has been trained. Changes in the ownership and financing of the laboratories do, however, require new contract arrangements, which are now being processed together with the Finnish Food Safety Authority. As a new issue, the management of possible accident conditions, i.e. the cleaning of the fall-out area and the long-term protection of the population, has been examined in greater detail. A draft guide has been prepared for such conditions, the first of its kind in the world.

New experience was gained of nuclear materials regulation according to the amended nuclear non-proliferation treaty and, in particular, of the division of tasks between the IAEA, the EU and national regulatory authorities. STUK continues to make an active contribution towards finding an optimal task division between the parties concerned, and attempts to show the way to achieving well-functioning procedures ensuring an adequate level of confidence. The development of a model for the control of nuclear materials, suitable for the final disposal of spent nuclear fuel, continued in cooperation with the IAEA. The development must be continued simultaneously with the excavation of the tunnel leading into the final disposal facility.

Introduction

This report covers the regulatory control of nuclear safety in 2008, including 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. It constitutes the report on regulatory control in the field of nuclear energy, which the Radiation and Nuclear Safety Authority (STUK) is required to submit 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 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 a complete safety assessment of the nuclear facilities currently in operation or under construction. For the nuclear facilities in operation, the section describes plant operation, events during operation, annual maintenance, development of the plants and their safety, and observations made during monitoring. Data and observations gained during regulatory activities are reviewed with a focus on ensuring the safety functions of nuclear facilities and the integrity of structures and components. The 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 control. Summaries are also included for the regulation of the storage of spent nuclear fuel and the processing and storage of reactor waste. For the Olkiluoto 3 plant unit currently under construction, the report includes descriptions of the regulation of design, construction, manufacturing, installation and implementation preparations, as well as regulation of the operations of organisations participating in the construction project.

The nuclear safety indicator system is used to examine the efficiency and effects of the regulatory activities targeted at nuclear power plants. Appendices to the report include detailed data and conclusions related to the indicators (Appendix 1) and any significant operational events (Appendix 3).

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

The section concerning nuclear non-proliferation describes the nuclear non-proliferation control for Finnish nuclear facilities and final disposal of spent nuclear fuel, as well as measures required by the Additional Protocol of the Safeguards Agreement. Oversight of the nuclear test ban is also covered by the report.

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

Contents

1 Fundamentals of nuclear safety regulation

Regulatory oversight by STUK is based on the Nuclear Energy Act.

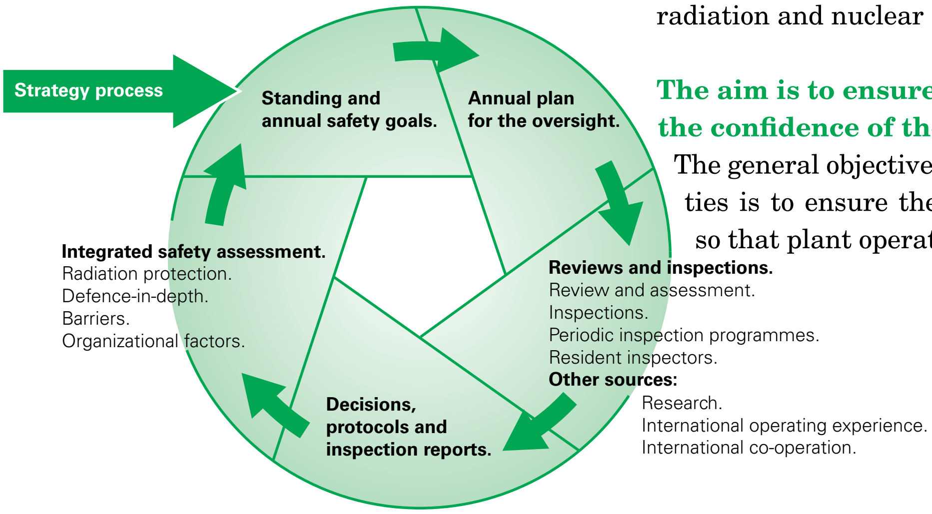
The Radiation and Nuclear Safety Authority (STUK) is responsible for the regulatory oversight of nuclear safety in Finland. Its responsibilities include the control of physical protection and emergency response, as well as the safeguards of nuclear materials necessary to prevent nuclear proliferation.

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 facilities, so that plant operation does not cause radiation



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.

Advisory Committee 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 Committee on Nuclear Safety. It is appointed by the Government and functions in conjunction with STUK. Its term of office is three years. The Advisory Committee was appointed on 1 October 2006, and its term of office ends on 30 September 2009.

The Chairman of the Committee is Professor Riitta Kyrki-Rajamäki (Lappeenranta University of Technology) and the Vice-Chairman is Rauno Rintamaa, Vice President, Business Solutions (VTT, Technical Research Centre of Finland). The members are Director Ulla Koivusaari (Pirkanmaa Regional Environment Centre), Managing Director Timo Okkonen (Inspecta Tarkastus Oy), Senior Researcher Ilona Lindholm (VTT), Branch Manager Runar Blomkvist (the Geological Survey of Finland) and Dr. Sc. (Tech.) Antti Vuorinen. Professor Jukka Laaksonen, Director General of STUK, is a permanent expert to the Committee.

The Committee has three divisions for preparatory work: a Reactor Safety Division and a Nuclear Waste Division, as well as an Emergency Preparedness and Nuclear Material Division. In addition to the Committee members proper, distinguished experts from various fields have been invited to the Divisions.

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.

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

Nuclear liability

The Nuclear Liability Act stipulates that users of nuclear energy must have acquired liability insurance, 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 2008, 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 2008, the average value of the SDR was 1.08 euro. As a result of international negotiations completed in 2004 concerning the renewal of the Paris/Brussels nuclear liability agreements, the 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.

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 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.

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.*

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 licenses and notifications, and that nuclear facilities and the related technologies are only utilised for peaceful purposes. The licensees are responsible for managing the nuclear materials in their possession, accounting for them and reporting the buildings included in the plant site, their use and other activities related 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 carried out by STUK alone or together with international inspectors.

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 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'.

The National Data Centre based on the Comprehensive Nuclear-Test-Ban Treaty ensures that Finland always has up-to-date information on any observations made in the global nuclear test ban monitoring system. The Centre specialises in monitoring radionuclides, and it analyses the gamma ray spectrums sent by measuring stations 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

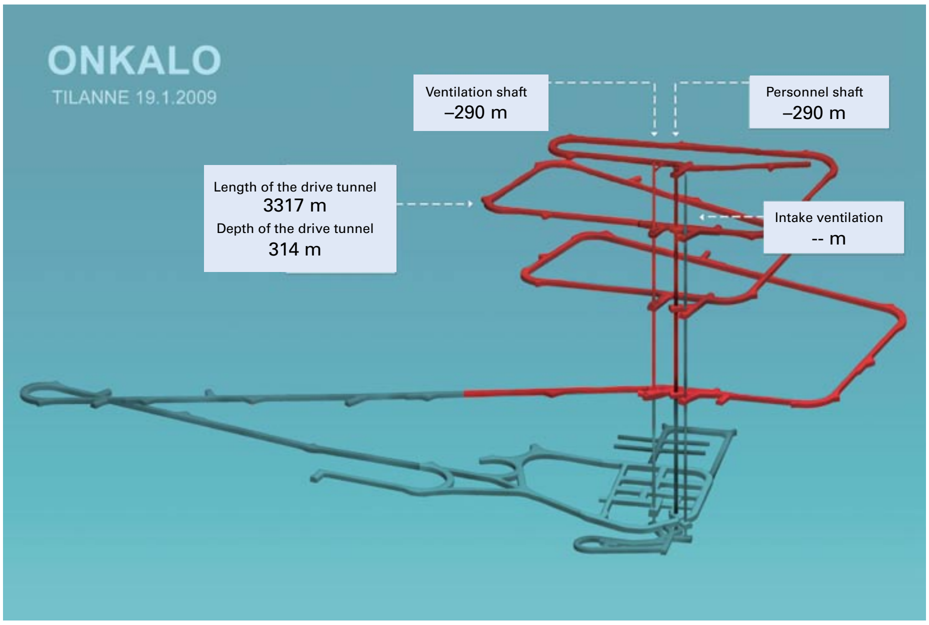


Figure 2. Plan of the underground rock characterisation facility (Onkalo) and status of the construction on 19 January 2009 (Posiva Oy).

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.

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 2008, the excavation of the drive tunnel had reached a depth of 300 m, and the length of the tunnel was 3,300 m. In addition, two shafts had been quarried using raise boring techniques to a depth of 290 m.

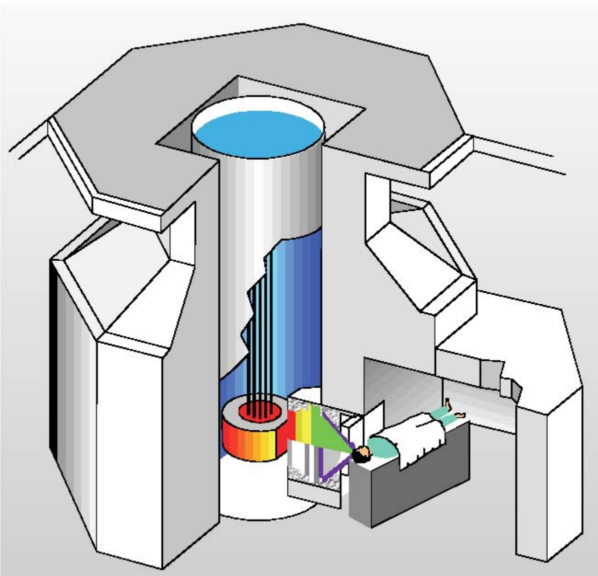


Figure 3. FiR 1 research reactor and the BNCT station.

FiR 1 research reactor

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

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

3 Development and implementation of legislation and regulations

Many years' work on legislation was concluded

STUK has participated in the process of preparing a total revision of nuclear legislation, headed by the Ministry of Employment and the Economy. The revision of the Nuclear Energy Act and its supplementary Government Decrees were completed in 2008:

- The Nuclear Energy Act was amended by two regulations, of which the one issued on 23 May 2008 (342/2008) concerns a partial revision of the Nuclear Energy Act, while the one issued on 14 November 2008 (725/2008) concerns the stipulations on sanctions.
- Government Decrees (732/2004) on amending the Nuclear Energy Act, on the safety of nuclear power plants (733/2008), on the security in the use of nuclear energy (734/2008), on emergency response arrangements at nuclear power plants (735/2008) and on the safety of the disposal of nuclear waste (736/2008) were issued on 27 November 2008 on the presentation of the Ministry of Employment and the Economy. The new Government Decrees superseded the Government Decisions issued in 1991 and 1999.

The compliance with the Finnish Constitution of the legislative level of the requirements was verified in conjunction with the revision of the Nuclear Energy Act 342/2008. At the same time, the regulations were brought up to date with regard to safety requirements. The stipulations on export control of dual-use items were transferred from nuclear energy legislation to the decree governing export controls.

Updates of YVL guides were prepared and implemented

STUK prepared the last updates of the YVL guides in their current form and issued decisions on their implementation. 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. 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.

Six YVL Guides were completed in 2008:

- YVL 1.4 Management systems for nuclear facilities, 9 January 2008
- YVL 1.15 Mechanical components and structures in nuclear installations. Construction inspection, 28 April 2008
- YVL 5.3 Nuclear facility valve units, 28 April 2008
- YVL 5.7 Nuclear facility pump units, 28 April 2008
- YVL 5.8 Hoisting and fuel handling operations at nuclear facilities, 26 September 2008
- YVL 8.2 Clearance of nuclear waste and decommissioned nuclear facilities, 18 February 2008.

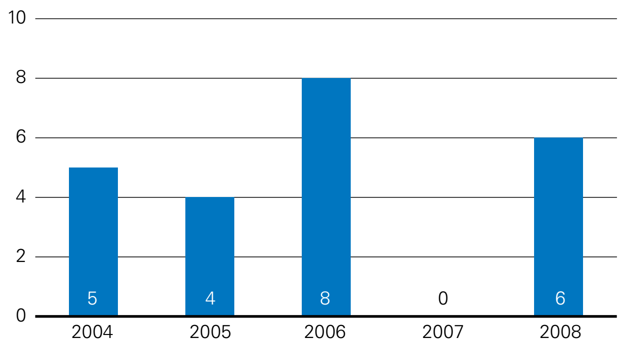


Figure 4. Number of yearly published YVL guides.

Table 1. Implementation decisions of YVL guides issued by STUK per nuclear facility in 2008.

Guide	Loviisa 1&2	Olkiluoto 1&2	Olkiluoto 3	Posiva	FiR 1 research reactor
YVL 1.4, Management systems for nuclear facilities, 9 Jan 2008	•	•		•	
YVL 8.2 Clearance of nuclear waste and decommissioned nuclear facilities, 18 Feb 2008	•	•		•	•

The Regulatory Guides on nuclear safety (YVL) will no longer be prepared in future years; instead, they will be published as STUK-YVL Guides in line with the overall revision of the guide system. The preparation of implementation decisions for YVL Guides will continue in 2009.

In its implementation decision for YVL 1.4, STUK stated, among other things, that the new guide must be applied as is to the operating phase activities of Olkiluoto 1 and Olkiluoto 2 and to the activities of Loviisa 1 and Loviisa 2, as well as to the construction phase of Onkalo, where applicable.

In its implementation decision for YVL 8.2, STUK stated, among other things, that the new guide must be applied as is to the operating phase activities of Olkiluoto 1 and Olkiluoto 2 and to the activities of VTT's FiR 1 research reactor and, with certain exceptions, to the activities of Loviisa 1 and Loviisa 2. In Loviisa, the operations will be brought in line with the YVL guide when the current project for revising the procedures of managing and measuring low- and intermediate-level waste is completed in 2010, and when the radiation protection instructions and Final Safety Analysis Report (FSAR) are updated. The guide requirements are not applicable to the operations of Posiva as yet.

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 guides 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 STUK-YVL guides completed by the end of 2011.

Working groups will be appointed to support STUK's experts in the preparation work of each new guide. In addition to STUK, the following organisations will be represented in the working groups: Teollisuuden Voima Oyj, Fortum Power and Heat Oy, Fennovoima Oy, Posiva Oy and VTT. 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. The follow-up group set up for the entire project, composed of representatives of the above organisations, convened twice in 2008.

Work continued in 2008 on preparing guides of the new type. The plan is to prepare a total of 38 of these new guides, half the number of current YVL Guides.

A General safety guides

A.1 Regulatory control of the safe use of nuclear energy
A.2 Structure and definitions applied in STUK-YVL guides

B Safety management of nuclear facilities

B.1 Siting of nuclear facilities
B.2 Management systems of nuclear facilities
B.3 Personnel of nuclear facilities
B.4 Construction of NPPs
B.5 Operation of NPPs
B.6 Risk management at NPPs
B.7 Modification management at nuclear facilities
B.8 Condition monitoring, maintenance and ageing management of nuclear facilities
B.9 Security arrangements at nuclear facilities
B.10 Emergency preparedness arrangements at nuclear facilities
B.11 Reporting by nuclear facilities
B.12 Operating experience feedback at nuclear facilities

C Plant and system design

C.1 Classification of systems, structures and equipment at nuclear facilities
C.2 Safety-classified systems
C.3 Nuclear fuel and reactor
C.4 Reactor coolant circuits of NPPs
C.5 Containments of NPPs
C.6 Internal and external threats to nuclear facilities
C.7 Fire protection at nuclear facilities
C.8 Safety assessment

D Radiation safety at nuclear facilities

D.1 Radiation protection of personnel at nuclear facilities
D.2 Control of environmental releases from nuclear facilities
D.3 Measurement of environmental releases from nuclear facilities
D.4 Structural radiation safety of nuclear facilities

E Nuclear materials and waste

E.1 Regulatory control of nuclear non-proliferation
E.2 Transport of nuclear materials and waste
E.3 Handling, storage and encapsulation of spent nuclear fuel
E.4 Handling and storage of low- and intermediate-level waste at, and decommissioning of, nuclear facilities
E.5 Final disposal of nuclear waste

F Structures and equipment of nuclear facilities

F.1 Manufacture and use of nuclear fuel
F.2 Mechanical components and structures of nuclear facilities, construction plan
F.3 Mechanical components and structures of nuclear facilities, regulatory control
F.4 Verification of strength of pressure equipment at nuclear facilities
F.5 Non-destructive testing at nuclear facilities
F.6 Buildings and structures of nuclear facilities
F.7 Electrical and I&C equipment of nuclear facilities

Figure 5. Structure of the STUK-YVL-guides.

4 Regulatory oversight of nuclear facilities and results in 2008

4.1 Loviisa nuclear power plant

4.1.1 Overall safety assessment of the Loviisa NPP

According to STUK's assessment, the Loviisa plant has been safe and it has been operated well.

The integrity of the radioactivity confinement barriers has remained good. The condition of release barriers has been inspected, and no significant signs of wear or faults were detected. The results of the tests show that the leak tightness of the containment and isolation valves has remained good. A fuel leak was observed at the Loviisa plant late in the year. The fuel leak was minor and the resulting radioactivity was contained in the primary circuit, which means that the leak had no implications for the radiation safety of the plant or its surroundings.

The plant has been operated systematically and in compliance with the Technical Specifications and guidelines, with two exceptions. The number of events was low and they had little significance for safety. The safety systems functioned as planned during the events. The safety significant finding related to the function of the safety systems was the jammed control rod at the end of annual maintenance work. When the control rod was being withdrawn from the core, its intermediate shaft hit a thermal barrier sleeve in the pressure vessel head. The sleeve had an indentation originating from the annual maintenance works. The indentation was repaired and, in the future, the sleeves will be inspected during annual maintenance. The condition of components and systems designed to prevent accidents and mitigate their consequences has remained good. No indications of deterioration in the condition of components were detected in in-service inspections or preventive maintenance. The number of component malfunctions has been low and their significance for safety small.

The accident risk at the Loviisa power plant has decreased, and risk factors have been eliminated by amending procedures and modifying the plant. Modification work was undertaken in 2008 to ensure the safety functions in case of a high-energy pipe rupture in the secondary circuit. The first phase of I&C systems modernisation was implemented during annual maintenance at Loviisa 1. No I&C modifications important to safety were carried out during the first phase.

The Loviisa plant employs an ageing management programme aimed at guiding the maintenance and plant modifications at the entire plant so that the plant can be operated safely throughout is lifetime. Investments have continued according to long-term plans.

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. Emergency preparedness at the Loviisa power plant complies with the requirements. Work has begun on revising the premises of the emergency response organisation at the Loviisa plant.

During 2008, STUK implemented guide YVL 1.4, which deals with management systems for nuclear facilities. In conjunction with the implementation decision of the guide, STUK made a comprehensive assessment of how the management system at the Loviisa power plant complies with the requirements of the new guide. On the basis of the assessment, the Loviisa power plant complies, in the main, with the requirements of the new guide, and the deviations identified in the implementation decision can be rectified so that the requirements of the new guide are met. The findings made during the year indicate that the Loviisa power plant must develop its follow-up of the implementation of open issues, the control of

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
Unclear testing instructions for the containment ice condenser door control system valves at Loviisa 1 and Loviisa 2	•	•	0
Absence of an uninterrupted power supply in a substation at the Loviisa plant		•	0
Incorrect simulations in the reactor protection system of Loviisa 2	•	•	1

procurement process and resource planning in order to reconcile line and project activities.

Human resource planning at the Loviisa power plant is based on a ten-year plan, which is subject to annual management review and updating. New personnel were recruited for the plant during 2008. The sufficiency of human resources requires continued attention with regard to duties crucial to nuclear safety, such as quality control, quality assurance, risk assessment and radiation protection. Resources must be invested in induction training of new personnel at the Loviisa plant. The implementation and organisation of training activities have been amended at the plant in order to meet the various challenges, including that of induction training.

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 currently up to date, and the document is sufficiently easy and clear to use. In 2008, two events took place at the plant during which the plant was not in compliance with the Technical Specifications. In one event, the valve test intervals were exceeded and in the other, incorrect simulations were detected in the reactor protection system. Neither event had any essential safety significance. The power company responded to both events by deciding to take corrective action in order to prevent similar events. The procedural flaws resulting in the incorrect simulation were so significant that the company decided to carry out a root cause analysis regarding the event.

The power company applied for permission from STUK for five planned deviations from the Technical Specifications. These were related to the repair of an equipment fault and tests or inspec-

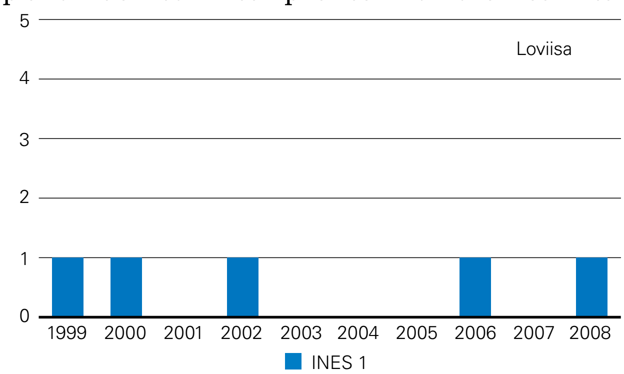


Figure 6. INES classified events at the Loviisa plant (INES Level 1 or higher).

Non-compliances with the Tech Specs

It was observed at the Loviisa plant *in July 2008 that the valves of the containment ice condenser door opening systems had been tested less frequently than required in the Technical Specifications of the plant. The reason for the omitted tests was a conflict between the Technical Specifications and the testing and procedure instructions observed at the plant.*

It was observed at Loviisa 2 *on 12 December 2008 that a simulation had been left in the reactor protection system indicating that three reactor coolant pumps were in operation. As a result of the simulation, the reactor protection system would not have been informed if these pumps had stopped and the reactor trip signal, triggered if four or more reactor coolant pumps had stopped, would not have been activated. The situation was non-compliant with the Technical Specifications. The simulations were immediately removed when the incorrect setup was detected.*

The events are described in more detail in Appendix 3.

tions and modification work in Loviisa's I&C facilities, storage, waste, and maintenance facilities. Since the planned deviations had no significant safety implications, STUK approved the applications (Appendix 1, indicator A.I.2).

STUK approved eight proposed changes to the Technical Specifications in 2008. These related to the chemistry of primary coolant, periodic testing intervals, modifications to the I&C system in Loviisa, replaced high-pressure safety injection pumps and other minor modifications.

Operation and operational events

No safety significant events took place in plant operation. Six events affected the production of the power plant.

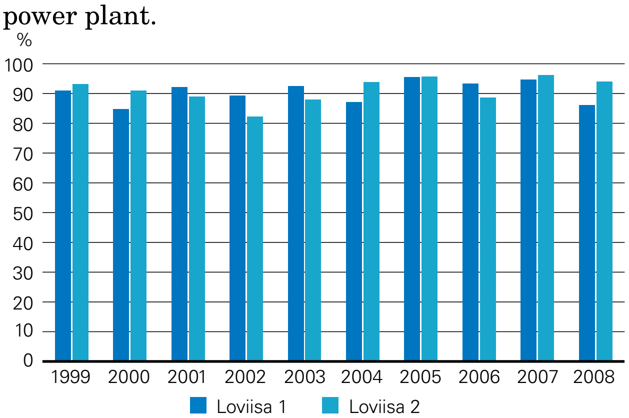


Figure 7. Load factors of the Loviisa plant units.

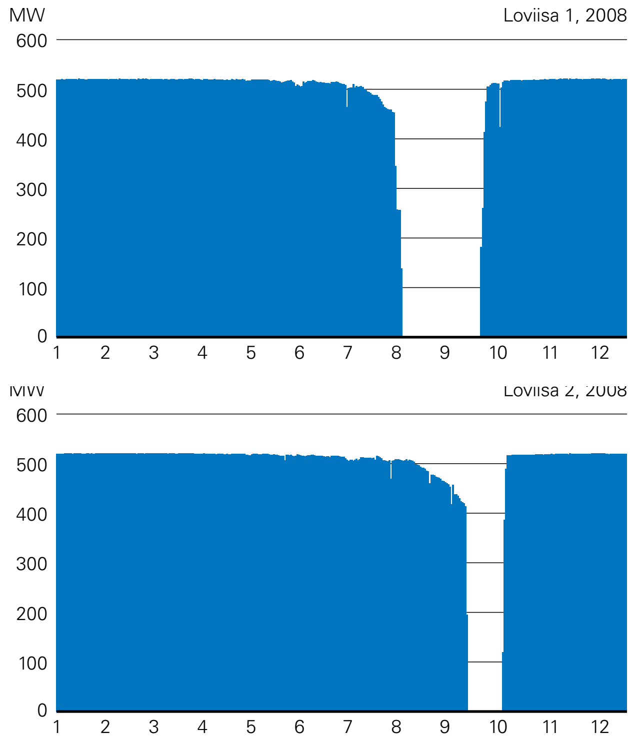


Figure 8. Daily average gross power of the Loviisa plant in 2008.

Operation and operational events

The Loviisa plant units operated reliably in 2008. The load factor of Loviisa 1 was 86% and that of Loviisa 2 was 93.9%.

Brief reductions in output capacity occurred at both plant units due to technical failures. The most significant of these events were the two faults occurring at Loviisa 1: the isolation of high-pressure pre-heaters due to a repair of the drains line, and the main coolant pump bearing replacement and repair of the motor oil leak. Production losses in nominal output caused by component malfunctions were low as a whole, 0.11% at Loviisa 1 and 0.03% at Loviisa 2. Production losses from component malfunctions over a longer time period are depicted by the indicators in Appendix 1 (indicator A.I.1g).

It was noted at Loviisa 1 *in conjunction with an inspection on 30 October 2008 that the power supply of one DC switchboard did not have the necessary battery backup. The 24 V DC switchboard left without a backup was part of the power supply system of the serious accident management system at Loviisa 1. Normally, the switchboard is supplied by the diesel-backed 400 V AC switchboard through rectifiers and backed up by a battery bank. It is probable that the fuses had been removed during preliminary maintenance work during the plant's annual maintenance in September, and had not been put back.*

The event is described in more detail in Appendix 3.

STUK's inspections within the the periodic inspection programme identified scope for improvement in different areas, including analysis and management of risks, implementation of modification work, plant cleanliness, storage of goods and signposting of storage areas. The power company initiated corrective actions.

In 2008, the risk caused by the detected component malfunctions, preventive maintenance and other events at the Loviisa plant was about 1.5% and about 2.4% 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 were slightly higher than in the previous year, but lower than the long-term averages. A few individual component malfunctions and the preventive maintenance of the redundant trains

Annual maintenance at Loviisa 1

A more extensive annual maintenance, carried out every four years, took place at Loviisa 1 from 9 August to 29 September 2008. The outage lasted 14 days longer than planned. The outage was extended, among other things, by the failure of the crane in the reactor hall. This slowed down the process of moving the inner parts of the reactor. Another significant delay was caused by problems in moving a control rod during the final stages of the annual maintenance when the reactor was being started up.

Extensive inspection and modification works were also carried out in addition to refuelling. They included extensive inspections of pipelines and pressure equipment, as well as internal inspections of the reactor pressure vessel. The latter requires removing all fuel from the reactor. In addition, the steel liner of the containment is subjected to a leak tightness test at four-year intervals. Its purpose is to test the leak tightness of the containment under the pressures prevailing in accident situations.

The largest modification work comprised the installation work of the first phase of the I&C system modernisation project (the LARA project) at the Loviisa plant and the commissioning of the control automation of reactor control rods. Modification work was also undertaken during annual maintenance in 2008 to ensure the safety functions in case of a high-energy pipe rupture in the secondary circuit (the SETU project). These modification operations included the replacement of a valve in the main steam manifold, the installation of restraints and jet shields for steam pipelines, as well as the modification of the minimum circulation line of the residual heat removal system. Other work with safety implications included the replacement of two high-pressure safety injection pumps and the duplication of steam generator blowout lines for two steam generators.

The annual maintenance operations also included the repair of two penetration fittings on the reactor pressure vessel cover and the replacement of faulty bolts in the reactor support cage mantle plate. The significant modifications on the turbine side included the replacement of a generator stator and the modernisation of the high-pressure chamber of the turbine.

Annual maintenance at Loviisa 2

The short annual maintenance at Loviisa 2 was carried out between 20 September and 13 October 2008, taking some three days longer than planned.

The delay was caused by the repair of a fault in the isolation ball of the accumulator of the emergency core cooling system. Very few modification operations were carried out during the annual maintenance in addition to refuelling, most of them related to preparations for the upcoming modifications for the I&C system modernisation of the plant (the LARA project). Only the steam generators were subjected to extensive inspections.

of the auxiliary feed water system were the most significant in terms of accident risk.

Annual maintenance outages

The most important modification works carried out during annual maintenance were for I&C systems as part of the I&C modernisation process (LARA). STUK oversaw and inspected the implementation of modification work on site. STUK also oversaw other modification work and the progress of annual maintenance.

STUK raised the issue of training and familiarisation of the personnel of contractors participating in the annual maintenance and inspected the management and procurement of materials used in the work and their use on site. STUK also oversaw the procedure of valve line up.

On the basis of its oversight, STUK can state that the annual maintenance at the Loviisa power plant was well planned and safely implemented. The procedures developed to support operations and the training of contractors had been improved.

STUK used a total of 233 man-days for overseeing annual maintenance outages. In addition, one resident inspector 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 and the systems, equipment and structures implementing them.

A fault was detected in the operation of control rods used for shutting down the reactor in tests carried out at the end of the annual maintenance of Loviisa 1. The start-up of the plant was delayed when one control rod could not be totally withdrawn from the core when starting up the reactor. The cause of the fault was found to be an indentation on the thermal barrier sleeve in the pressure vessel head. The indentation was created during annual maintenance works. The intermediate shaft of the control rod hit the sleeve when the rod was being withdrawn. The indentation was repaired by pressing a special tool through the sleeve. Following the event, the instructions for start-up after annual maintenance were supplemented with instructions for a visual inspection of thermal barrier sleeves on the pressure vessel head.

The Loviisa power plant was requested to present an analysis of the impact of long undervoltage periods in the grid on the power plant's equipment. The request was based on the calculations made for the Oskarshamn power plant, referred to in Section 4.2.8 below. The analysis will be prepared during 2009. Similar analyses have been prepared before, and this new one is intended to study the current situation of plants.

4.1.4 Integrity of structures and equipment

No significant faults or signs of wear were detected during 2008 in the integrity of equipment and structures critical to plant safety. The follow-up and repair of earlier detected flaws in the integrity of structures continued during annual maintenance.

Corrosion protection sleeves on two control rod penetrations on the reactor pressure vessel of Loviisa 1 were replaced as a result of observations made in inspections carried out in 2004. Similar replacements were carried out at Loviisa 2 in 2006. Experience gained from VVER plants of the same type indicates that water between the corrosion protection sleeve and jacket tube may cause bulging of the protective sleeves. After the observations made in 2004, the condition of the protective sleeves was monitored by visual inspections during annual maintenance outages before finally replacing the sleeves. No bulging was observed in these inspections.

In earlier years, cracks have been detected in the seal slots of the flange faces of reactor pressure vessels. The deepest cracks have been repaired by welding. The inspections at Loviisa 1 indicated that the earlier detected fault indications have not grown. Two new indications were observed at Loviisa 2 by dye penetrant tests. The earlier detected fault indications have not grown. In addition, indentations in the seal face, caused by incorrect installation of the seal, were observed at Loviisa 2. The indentations were removed by grinding. Preparations were already made for grinding the seal face during the 2008 outages in Loviisa, but the decision was taken to continue monitoring the cracks as the indications had not changed. The current plan is to recondition the seal faces at Loviisa 1 in 2010 and at Loviisa 2 in 2012.

The steel liner of the containment is subjected to a leak tightness test at four-year intervals. The steel liner of Loviisa 1 was subjected to a leak tightness test during annual maintenance in 2008. For Loviisa 2, the leak tightness test of the steel liner was carried out in 2006. In addition, leak tightness tests have been made to containment isolation valves, personnel airlocks and containment penetrations. The results show that the leak tightness of the containment building has remained good.

The periodic inspections of registered pressure equipment were implemented according to plans for both plant units. In all, 95 inspections were carried out at Loviisa 1, 46 of them in STUK's inspection domain, while 31 inspections, most of them in the domain of the inspection organisation, were carried out at Loviisa 2. STUK supervised inspections of safety Class 3 and 4 at both plant units, as well as Class EYT (non-nuclear) pressure equipment performed by inspection organisations.

STUK carried out a total of 212 structural inspections and inspections of on-site repairs and modifications during the year, as well as three commissioning inspections.

Fuel

A fuel leak was observed at Loviisa 2 on 28 November 2008. The leak was detected as the activity of exhaust gases increased. Noble gas activity readings kept increasing until mid-December but have remained constant since then. Based on analysis it is estimated 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 constant measurement of the gamma activity of the reactor coolant and sampling by the laboratory. The safety significance of the one leaky rod is minor. Because of the fuel leak, all fuel bundles in the

Pressure equipment manufacturers and inspection and testing organisations

STUK approved, pursuant to the Nuclear Energy Act, three manufacturers of nuclear pressure vessels for the Loviisa plants on application by the Loviisa power plant of Fortum Power and Heat Oy.

In addition, STUK approved, on application by the Loviisa power plant of Fortum Power and Heat Oy and pursuant to the Nuclear Energy Act, three 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 Guide YVL 3.8.

reactor will be leak tested during the 2009 annual maintenance of Loviisa 2, and the leaky rod will be removed and encapsulated. The previous fuel leak in Loviisa occurred in 1999. Nearly ten years of operation without leaks is an indication of the good quality of fuel rods and commendable operation.

Fortum intends to introduce so-called second-generation fuel from TVEL (a Russian fuel supplier) in the autumn of 2009. The second-generation bundles have detachable fuel rods, and the fuel follower has detachable rods and a protective fuel channel. The amount of uranium in a fuel bundle is a few kilograms more, the uranium enrichment is slightly higher, and the bundle also has rods containing burnable poison. The increased amount of uranium improves fuel efficiency, and the burnable poison reduces the need to compensate reactivity with active boron control. This ensures retaining the safety of the reactor core in spite of the increased amount of uranium.

Qualification of ultrasonic inspection of the circumferential weld joints of reactor pressure vessels

The qualifications of inservice inspections of nuclear power plants are new, internationally developed practices for ensuring nuclear safety, and in Finland they are overseen by STUK. Qualification ensures that the inspection method can reliably detect any faults that may pose risks to nuclear safety.

In 2008, STUK approved the qualification of inspections of the circumferential weld joints of reactor pressure vessel. The qualified inspections are carried out from outside the pressure vessel using ultrasound techniques. A remote-controlled manipulator is used for the inspections.

All possible damage mechanisms of the welded joints in the reactor pressure vessel are identified to determine the input information of qualification. Of these, only the types of damage that must be detected in the inspections were selected as the targets of periodic inspections. The qualifications proved that the targets have been attained.

The qualification carried out was the first of its kind for remote-controlled US inspection of reactor pressure vessels where all parties, in particular those responsible for drawing up the inspection instructions, were Finnish. The qualification was also intended as a pilot qualification where Finnish qualification practices were developed and tested.

Risk-informed in-service inspection programme

A risk-informed inspection programme was introduced in Loviisa for the inservice inspections of safety-critical pipelines. The deployment of risk-informed inspection methods for targeting inspections has been developed in Finland by STUK, Fortum, FNS (Fortum Nuclear Services), TVO and VTT. The objective of risk-informed in-service inspection programmes is to allocate inspection resources to the targets that are most critical from the point of view of risk. Using this approach, it is possible to ensure that the current inspection objects are well-justified, identify new objects and omit certain less safety-critical objects from the existing inspection programme. Experts say that the programme is the most extensive risk-informed in-service inspection programme so far implemented in Europe.

4.1.5 Development of the plant and its safety

The first phase of modifications for the I&C modernisation were carried out at Loviisa 1

Fortum will upgrade the instrumentation and control systems of both plant units in Loviisa. The control rooms of the plant will also be modernised in stages. The power company has divided the modenisation process into four phases to be implemented during annual maintenance outages. The power company will complete the process during the annual maintenance outage of 2014.

During the first phase of the I&C modernisation, part of the I&C system controlling and limiting reactor power and its control room user interface were modernised during the annual maintenance outage at Loviisa 1.

The modernisation involves replacing the control, limitation, 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.

The reliability of I&C functions against internal and external threats 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 are also performing the installation work.

The inspections carried out by the power company and STUK indicate that the modifications were successful with the exception of one coupling error detected during plant start-up.

The modifications now made at Loviisa 1 will be repeated at Loviisa 2 in 2009. The second phase of the I&C modernisation will take place at Loviisa 1 in 2010.

Replacement of high-pressure safety injection system pumps

Two pumps in the high-pressure safety injection system of both plant units will be replaced with new types. The reason for changing the pump type is the poor availability of spare parts and an improvement in the functional reliability of the system. In 2004, STUK approved the power company's principal plan and time schedule for replacing the pumps. In line with the schedule, two pumps were replaced during the annual maintenance outage of Loviisa 1, one for both system redundancies, and the respective pipeline modifications were also carried out. The corresponding work was carried out at Loviisa 2 during the 2006 annual maintenance outage.

Waste volumes

The volume of low- and intermediate-level waste was 3,150 m³ at the end of 2008. The total increase of volume from 2007 is 90 m³. Approximately 57% of the waste has been finally disposed of.

The volume of spent nuclear fuel stored on-site at the Loviisa power plant at the end of 2008 was 3,769 assemblies (454 tU), an increase of 204 assemblies (26 tU).

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 evaporation residues generated at the power plant and the radioactive ion exchange resins from the purification filters. The power company initiated the commissioning phase of the solidification facility implementation project (LOKIT) during 2006 by carrying out system- and plant-level tests using inactive substances. Plant-level tests continued in 2008 using radioactive evaporation residues. The problems observed in earlier tests regarding tank level measurements have been solved and the measurements functioned reliably during the tests.

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

The inspections carried out within the periodic inspection programme on low- and intermediate-level 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. No significant issues with safety implications were observed in the inspections.

No events significant to plant or environmental safety were evident in the treatment, storage or final disposal of low- and intermediate-level waste ("operating waste") at the Loviisa power plant. The volume and activity of operating waste in relation to generated electrical power remained relatively low, compared with most other countries. The contributing factors include the high quality requirements for nuclear waste management and nuclear fuel, the planning of maintenance and repair operations, decontamination, component and process modifications, as well as waste monitoring and sorting, which enable some of the waste to be cleared from control. In 2008, quantities of maintenance waste below the activity limits and scrap metal were cleared from control at the power plant, with STUK's approval. The power plant employs efficient procedures for reducing the volume of waste subject to final disposal.

The waste processing facilities at the Loviisa power plant are cramped and impractical. The construction and reorganisation project for storage, waste and repair shop facilities (VAJAKO) will improve the facilities and equipment for waste processing. The maintenance of low- and intermediate-level waste will be improved by introducing centralised facilities for waste processing, activity determination and interim storage. The construction work under the project started in 2007, and is scheduled to be completed at the end of 2009. Towards the end of 2008, Fortum provided documents regarding integration of the new waste processing facilities with the controlled area. for STUK's inspection.

Statements under the Nuclear Energy Act and Degree

In compliance with section 74 of the Nuclear Energy Decree, Fortum submitted a report on the situation and progress plans for nuclear waste management and research, development and design activities (TKS activities) at the end of September. According to the statement issued by STUK in November, the action plans presented in the report comply with the principles set out in nuclear energy legislation and decisions by the Ministry of Employment and the Economy. The statement also set out certain areas for development.

STUK also 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 financial provision is based.

4.1.7 Organisational performance and quality management

Management and safety culture

In recent years, the Loviisa power plant has been actively seeking international evaluations of its safety and procedures in order to improve its own operations. STUK considers this to be a positive indication of the improved openness of the organisation, its search for good practice and commitment to long-term development work.

The IAEA carried out an OSART safety review at the Loviisa power plant in March 2007, and a follow-up review in July 2008. Following the review, the IAEA stated that some development actions have not been initiated and many are still in progress, although they have been appropriately started.

The responsible manager at the Loviisa power plant changed at the beginning of 2008. In addition, a restructuring of the unit responsible for safety at the Loviisa power plant took place, and new employees were recruited for the unit.

STUK inspected the planning process for the power plant operation, reward system and management steering in plant modification projects, in particular from the perspective of HR planning. The inspection of 2007 revealed that a lot of the issues that the plant had decided to rectify were still open. The inspection of 2008 revealed that the Loviisa plant had improved the follow-up of outstanding issues and the allocation of responsibilities, but that systematic development work was still called for.

STUK evaluated the planning process of the Loviisa power plant to be unambiguous and interactive. Planning of resources allocation between the line organisation, projects and development tasks was identified as a problem. The Loviisa plant has been forced to delay development project schedules, and this shows as, among other things, the large number of open issues. The reward system scheme adoptedn by the power plant was found to be useful, and it will support attaining the objectives when correctly targeted.

In recent years, the Loviisa power plant has acquired project expertise. STUK has found that scope for improvement exists in, *inter alia*, compliance with guidelines regarding modification projects and resource planning.

Functionality of the management system

In conjunction with the implementation decision of YVL 1.4, STUK made a comprehensive assessment of how the management system at the Loviisa power plant complies with the requirements of the new guide. On the basis of the assessment, the Loviisa power plant complies, in the main, with the requirements of the new guide, and the deviations identified in the implementation decision can be rectified so that the requirements of the new guide are met. Loviisa must implement the changes in its management system within five years. One of the most important new requirements in the said YVL Guide is one stating that the management system must be changed so that it is based on processes.

In 2008, STUK inspected the procurement activities and procedures for overseeing suppliers at the Loviisa power plant. The plant has specific procedures and instructions for procurement, but they have been deviated from in many cases. Internal control of procurement has been insufficient, and its safety implications have not been recognised in all respects. STUK required the power plant to submit a plan and time schedule for rectifying the subject issues. STUK will also follow up and assess the situation during future inspections.

Personnel resources and competence

STUK inspected the HR planning and training activities at the Loviisa power plant. The power plant has well-functioning, long-term HR planning procedures partly based on the practices of the Fortum Group. Human resource planning at the Loviisa power plant is based on a ten-year plan, which is subject to annual plant management review and updating. Dozens of new personnel have been recruited at the power plant during the year. STUK identified a need for HR development in, for example, quality control and assurance, risk assessment and radiation protection. The power company has initiated recruitment processes in order to improve the situation.

Following the inspection, STUK stated that the induction training of some new employees must be improved. A change has been initiated regarding training activities at the Loviisa power plant, with the objective of vesting the line organisation with the responsibility for competence development, while the Training Section supports the managers and trainers in the line organisation with their expertise. The training organisation has been strengthened with experts in behavioural science.

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 granted eight new trainee operator licences in 2008. STUK also approved 11 new NPP operators and renewed 28 operator licences.

4.1.8 Operational experience feedback

Following its inspection on operations, STUK stated that the Loviisa power plant must develop procedures to determine the corrective actions presented in disturbance reports. The power company has processed technical issues well, but there is scope for improvement in analysing human factors. The Loviisa power plant will develop its procedures and seek to improve the documentation on learning from operational experience feedback. Judging by the number of reports, there has been a slight increase in the occurrence of operational events. The power plant has continued the development of a root cause analysis method regarding events, initiated in 2007.

A more comprehensive screening of IRS reports was identified as a target for development in STUK's inspection in 2007 concerning international operational experience feedback and utilisation of experience. In its similar inspection carried out in 2008, STUK found that the processing of international operational experience reports had been improved at the Loviisa power plant. The number of reports processed has been increased through changes in screening methods and procedures, as well as by increasing resources. STUK noted that the processing of some reports had taken a long time and was still in progress. Therefore, there is still scope for development in the regular follow up of recommendations issued by the operational experience feedback team (KKR) and actions decided on their basis.

4.1.9 Radiation safety of the plant, personnel and environment

Occupational radiation safety

STUK carried out a radiation protection inspection according to the periodic inspection programme at the Loviisa plant, focusing on radiation measurements in particular. The inspection included monitoring of radiation in the environment, radiation measurements in plant premises, cleanliness measurements at employee exits and activity measurements of emissions. On the basis of the results, STUK requested a report regarding the recording of surface doses in the dose register and better instructions for radiation measurement at the premises. STUK also requested that the power company submit a plan to improve temperature conditions in spaces containing emission-measuring instruments, in line with the Technical Specifications.

STUK carried out radiation protection inspections during the annual maintenances of both plant units at Loviisa. The plant has developed, among other things, job-specific induction training, where certain employee categories were given special radiation protection training related to their duties. The signposting of radiation hazards has also been improved. In outage inspections, STUK assessed the situation regarding radiation work permits and the use of protective equipment and contamination monitoring, as well as the work of radiation protection supervisors and other employees in the controlled area. Positive developments had taken place at the Loviisa plant in how radiation protection aspects are taken into account in different phases of planning and work.

Radiation doses

The collective occupational radiation dose was 1.13 manSv at Loviisa 1, and 0.43 manSv at Loviisa 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

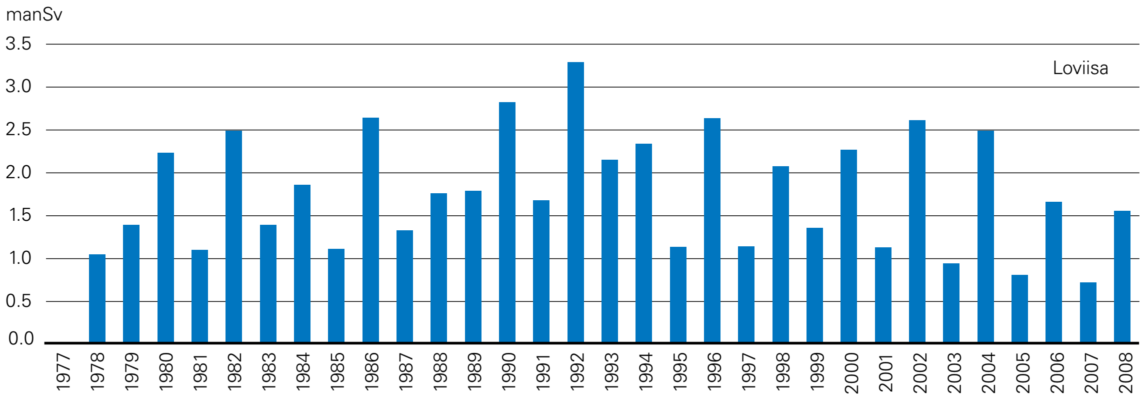


Figure 9. Collective occupational doses since the start of operation of the Loviisa nuclear power plant.

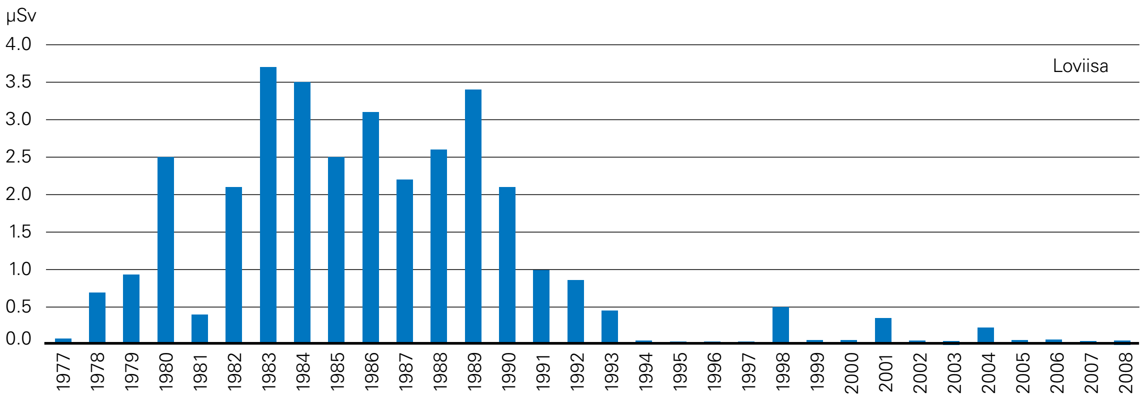


Figure 10. Annual radiation doses to the critical groups since the start of operation of the Loviisa nuclear power plant. Over the recent years, the doses to the critical groups has remained below one percent of the set limit, 0.1 milliSv.

of 1.22 manSv per Loviisa plant unit. This value was not exceeded at either plant unit. The collective dose of Loviisa plant units was smaller than average, even though a major annual maintenance (carried out at four-year intervals) took place at Loviisa 1. The collective occupational dose at the Loviisa units was of the same order of magnitude as the average level of PWRs in OECD countries. Taking into account the extent of annual maintenance work, the radiation doses have steadily decreased from 2001.

The annual collective radiation dose mainly accumulates in operations performed during annual maintenance outages. The collective radiation dose due to operations during the outage at Loviisa 1 was 1.09 manSv, while the highest individual radiation dose incurred during the outage amounted to 11.45 mSv. The collective radiation dose due to operations during the annual maintenance outage at Loviisa 2 was 0.39 manSv, while the highest individual radiation dose incurred during the outage amounted to 5.02 mSv. The highest radiation dose incurred during the outages at both plant units was 13.46 mSv.

The individual radiation dose distribution of workers at the Loviisa and Olkiluoto nuclear power plants in 2008 is given in Appendix 2.

Radioactive releases and environmental radiation monitoring

STUK has 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 dispersion of any atmospheric releases. A meeting was organised regarding the issue in 2008 between STUK, the Finnish Meteorological Institute and the power company.

STUK has approved the operating programme for environmental radiation monitoring in the surroundings of the Loviisa NPP for 2008–2011. The changes in the programme compared with the previous issue were related to, *inter alia*, the use of reference samples, measurements of the water treatment plant sludge and the interpretation of measurement results on carbon-14 nuclides.

Radioactive releases into the environment from the Loviisa nuclear power plant were well below authorised annual limits in 2008. Releases of radioactive noble gases into the air were approximately 5.5 TBq, which is approximately 0.03% of the authorised limit. The releases of radioactive noble gases were dominated by argon-41, i.e. the activation product of argon-40, in the air space between the reactor pressure vessel and the main concrete shield. The releases of radioactive iodine isotopes into the air were about 1.7 MBq, i.e. approximately 0.0008% of the authorised limit. The emissions through the vent stack also included radioactive particulate matter amounting to 82 MBq, tritium amounting to 0.3 TBq and carbon-14 amounting to approximately 0.3 TBq.

Table 3. Radioactive nuclides originating from the Loviisa plant detected in environmental samples in 2008. The number of the samples where the nuclides were detected is shown in parenthesis.

Sample	Observed nuclides
Air	Mn-54 (1), Co-58 (1), Co-60 (7), Nb-95 (1), Zr-95 (1), Ag-110m (3), Sb-124 (1)
Aquatic plants	Cr-51 (1), Mn-54 (1), Co-58 (3), Co-60 (5), Ag-110m (5), Sb-124 (3)
Sediment	Co-58 (1), Co-60 (3), Ag-110m (3), Sb-124 (1)
Seawater	H-3 (5)

The tritium content of liquid effluents released into the sea, 17 TBq, was less than 12% of the release limit. The total activity of other nuclides released into the sea was about 0.3 GBq, which is less than 0.04% of the plant specific release limit.

The calculated radiation dose of the most exposed individual in the vicinity of the plant was about 0.06 µSv per annum, i.e. less than 0.1% of the set limit (Appendix 1, indicator A.I.5c). The average person living in Finland receives an equivalent radiation dose from natural and cosmic radiation sources in about 15 minutes.

A total of 292 samples were collected and analysed from the terrestrial and aquatic environment surrounding the Loviisa power plant during 2008. External background radiation and the 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 samples. The amounts are so small that they are insignificant in terms of people's radiation exposure.

4.1.10 Emergency preparedness

STUK oversees the preparedness of the organisations operating nuclear power plants to act in abnormal situations. Such abnormal situations did not occur at the Loviisa power plant in 2008. The emergency response arrangements at the Loviisa power plant fulfil the key requirements; this was established during emergency response inspections as part of the periodic inspection programme. The objects of inspection included the re-organisation of premises and operational capabilities of the emergency response organisation during the re-organisation of premises, back-up of connections used for plant data transfer during emergency situations, as well as the training of the renewed emergency response organisation of the plant and personnel allocated to its related support functions. The premises available through the re-organisation of the emergency response centre will be better utilised, and equipment and accessories in the premises will be upgraded. The emergency exercise of the Loviisa power plant was postponed until 2009, and it will be arranged in the rebuilt emergency response centre premises.

The Loviisa power plant, STUK and Eastern Uusimaa Fire and Rescue Services maintain preparedness for the eventuality of a nuclear accident in Loviisa. The targets for development include the determination of the danger area in co-operation with the Meteorological Institute and measurement patrolling in emergency situations.

4.2 Olkiluoto nuclear power plant units 1 and 2

4.2.1 Overall safety assessment of Olkiluoto 1 and Olkiluoto 2

The key indicators describing the production of the Olkiluoto plant were customarily high for 2008, but exceptional events with safety impacts (anomalies according to INES classification) did take place at the plant. Scope of the condition monitoring of plant equipment and structures was found to be deficient with respect to certain equipment and structures. However, the events did not put plant employees or the environment at risk.

The radioactivity confinement barriers have remained intact. No fuel leaks were observed at the plant during 2008; this indicates, among other things, that the management of loose parts has improved. Signs of wear caused by operation were observed in pipeline inspections. The most significant cases of wear were repaired by replacing parts of the pipelines. Other areas where wear was observed were placed under closer monitoring in the future. The results of tests show that the leak tightness of the containment and isolation valves has remained good.

Plant has been operated systematically and in compliance with the Technical Specifications and guidelines, with four exceptions. Several anomalies with safety impact took place at the Olkiluoto 1 and Olkiluoto 2 plants during 2008. These include the blockage of a seawater intake opening due to frazil ice formation with consequences for plant cooling, the reduced reliability of emergency power supply due to faults in diesel generator starter motors, the consequences caused to plant electrical systems by a voltage peak caused by the voltage regulator of the generator, and the deteriorated leak tightness of safety critical rooms. The events did not cause a risk to the surrounding environment, but as the events involved phenomena typical of common cause failures of safety system equipment, the reliability of safety functions was consequently compromised. The common factor in the events is the fact that modification work carried out earlier at the plant contributed to all of them. The power company had not identified all factors affecting modification work during planning, nor was the work carried out with sufficient care. The events have shown how important it is to fully understand the design basis and to document everything in an unambiguous manner. The events are described in more detail in Appendix 3 to the Report.

The Olkiluoto plant employs an ageing management programme aimed at guiding the inspection, maintenance and modification operations at the plant so that the plant can be operated safely throughout is lifetime. During inspection of the internals of reactor pressure vessel, cracks were detected in the steam dryer and in the lifting lugs of the moderator tank. The cracks were small, and they are not expected to grow very quickly. The growth of these cracks will be monitored during future annual maintenance outages, and the need for repairs will be determined on the basis of this monitoring. No safety significant plant modifications were carried out at the Olkiluoto plant during 2008.

Plant operation did not cause a radiation hazard to the workers, the population or environment. Occupational radiation doses and radioactive releases into the environment were low and clearly below the prescribed limits. Thanks to the new steam dryers, the radiation levels in the turbine plant have decreased back to 1998 levels. This has also reduced the occupational radiation doses of turbine plant workers. Emergency preparedness at the Olkiluoto power plant is in compliance with requirements. The functionality of the emergency response was tested during an emergency exercise organised in early December.

During 2008, TVO has continued the process of developing management and the safety culture by communicating safety objectives to the personnel on different occasions, and by increasing the number of task-specific kick off meetings in order to identify risks and ensure safety. TVO has initiated a manager/supervisor training programme in order to highlight issues related to safety culture with supervisors and employees. Following the events of 2008, STUK required TVO to prepare an analysis of the causes of the events and the contributing organisational factors. The analysis was completed in late 2008, and TVO has decided on actions to develop its operations.

STUK implemented YVL 1.4, which deals with management systems for nuclear facilities. In conjunction with the implementation decision of the guide, STUK made a comprehensive assessment of how the management system at the Olkiluoto pow-

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-compliances with the Technical Specifications	Special report	INES rating
Control rod operation in non-compliance with Technical Specifications at Olkiluoto 1	•	•	1
Omission of weekly noble gas sampling from the vent stack at Olkiluoto 1	•	•	
Failures of seals in the pneumatic starter motors of diesel generators at Olkiluoto 1 and 2		•	1
Reactor trip at Olkiluoto 1 as a result of a generator voltage regulator failure		•	1
Failure of the outer isolation valve of the RPV head cooling spray system at Olkiluoto 2	•	•	0
Deficient leaktightness of of piping penetrations at Olkiluoto 1 and 2		•	1
Omission of periodic testing of the radiation measurement systems at Olkiluoto 1	•	•	1

er plant complies with the requirements of the new guide. On the basis of its assessment, STUK found that the Olkiluoto power plant in the main fulfils the requirements of the new YVL Guide. TVO has drawn up a plan for fulfilling all the requirements of the Guide.

TVO also prepared procedures on HR planning during 2008. The fact that several key persons have duties and responsibilities regarding both the existing plant units and the unit under construction poses a challenge to TVO's competence and the sufficiency of its resources. The power company has continued recruiting new personnel in preparation for a generation change. In its inspections, STUK has raised the issue of number of personnel at TVO and the importance of avoiding employee burnout. TVO has developed its procedures for, *inter alia*, controlling fatigue and monitoring the accumulation of working hours during annual maintenance operations.

The operating licence for the Olkiluoto 1 and 2 NPP units is valid until 31 December 2018. According to the licence conditions, the licensee carried out an interim safety assessment at Olkiluoto NPP before the end of 2008 and submitted the reports to STUK for review. The purpose of the assessment prepared by the licensee is to ensure that the plant has been operated safely during the past period and that the licensee is aware of the status of plant safety and its development during the remaining licence period. STUK will inspect TVO's assessment during 2009.

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 the work for developing the Technical Specifications in order to improve their clarity and ease of use. The development plan was submitted to STUK for inspection as part of the periodic safety review.

In the course of the year, the following four events took place during which the plant was not in compliance with the Technical Specifications (Appendix 1, indicator A.I.2):

- During annual maintenance at Olkiluoto 1, one control rod was drivenwithdrawn from the reactor core without written instructions in order to replace the shield tube of the neutron flux detector.
- Olkiluoto 2 was started up following annual maintenance, even though one containment isolation valve was inoperable.

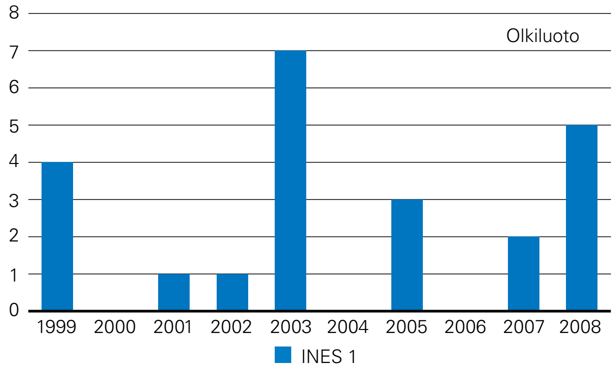


Figure 11. INES classified events at the Olkiluoto plant (INES Level 1 or higher).

Events non-compliant with the Tech Specs

During annual maintenance, one control rod at Olkiluoto 1 *was withdrawn from the reactor in non-complince with the Technical Specifications, without written instructions..The protective tubes of measuring sensors were replaced in the annual maintenance, and the work required the control rods adjacent to each protective tube out of the reactor core. There were no fuel bundles next to the control rod, so the event did not compromise the reactor's criticality safety.*

One round of noble gas sampling was omitted at Olkiluoto 1 *during the period 19 to 25 May 2008. This is a gas sample that is collected at the vent stack and analysed in the laboratory. The reports on atmospheric emissions of noble gases by the power plant are based on these measurements. The Technical Specifications require samples to be taken weekly in all operational states of the power plant. The event was caused by human error.*

During a leak tightness test carried out during annual maintenance of Olkiluoto 2 *the result for the outer isolation valve of the reactor pressure vessel head cooling spray system exceeded the leak limit set out in the Technical Specifications of the plant. The leak tightness test was repeated after repair, and the result exceeded the so-called attention criteria. According to the Technical Specifications, the valve should have been repaired so that the attention criteria were not exceeded. The plant unit was started up following annual maintenance, even though the isolation valve was inoperable. The error was discovered by STUK on 11 August 2008 when inspecting the leak tightness test results of isolation valves. After the observation, the inner isolation valve was prevented from opening as required by the Technical Specifications, and the faulty valve will be replaced during the next annual maintenance in 2009. The fact that the leak of the isolation valve exceeds the attention criteria is of no consequence, because the closed inner valve would prevent any leaks through the line.*

Periodic tests of the radiation measurement system of the exhaust gas system, the radiation measurement system of the vent stack and the waste water activity meters were omitted at Olkiluoto 1 *in September 2008. The equipment of the radiation measurement system of the exhaust gas system of Olkiluoto 1 was renovated during annual maintenance in 2008. Changes were also made to the periodic test schedule at that time. This conjunction led to the measurements taken in September at 11 measurement points being incorrectly recorded in the preventive maintenance system as year 2009 measurements instead of 2008. The Technical Specifications require that the measurements are taken at three-month intervals. The measurements were operable in the periodic test carried out after the observation, so the event had no safety significance.*

The events are described in more detail in Appendix 3.

- One weekly sampling related to release control of radioactive substances was omitted at Olkiluoto 1 during annual maintenance.
- Some periodic tests of radiation monitoring equipment were omitted in September at Olkiluoto 1.

The events and observations had no safety significance, but they showed that there is scope for im-

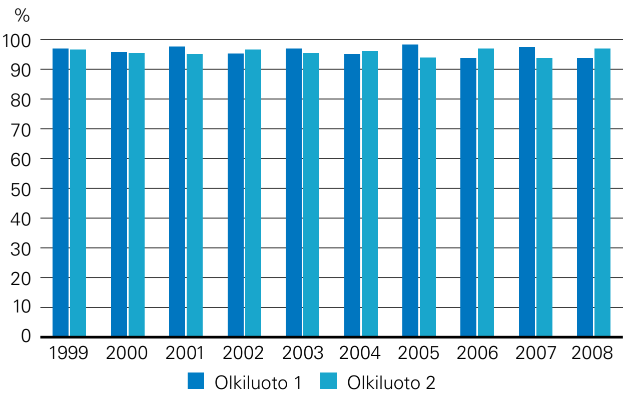


Figure 12. Load factors of the Olkiluoto plant units.

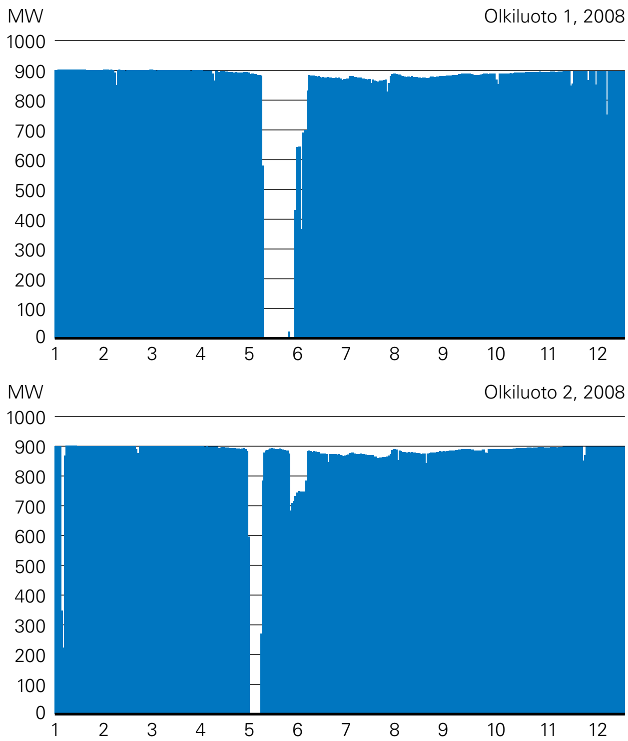


Figure 13. Daily average gross power of the Olkiluoto plant in 2008.

provement in the procedures of the power company. The power company initiated the necessary actions. The events are described in more detail in Appendix 3 to the Report.

The power company applied for permission from STUK for six planned deviations from the Technical Specifications (Appendix 1, indicator A.I.2). One was to do with replacing the battery bank of Olkiluoto 2 during power operation, one with investigating an incident in reactor vessel water level measurement at Olkiluoto 2, and three with disconnection of the power supply for the duration of excavation work and Olkiluoto3-related work in order to ensure safety at work. One application for permission is for opening an isolation valve at Olkiluoto 2 during the next shutdown. Since the planned deviations had no safety significance, STUK approved the applications.

Operation and operational events

The load factor of Olkiluoto 1 was 93.7%, while that of Olkiluoto 2 was 96.9%. The annual maintenance outages caused the most significant reductions in the load factor: the outage at Olkiluoto 1 lasted for 18.5 days, while that of Olkiluoto 2 lasted for 17 days. The losses in gross energy output due to operational transients and component malfunctions were 1.8% at Olkiluoto 1 and 0.9% at Olkiluoto 2.

***A reactor trip occurred at Olkiluoto 2** on 5 January 2008 following rapid generation of ice in the sea. The event was preceded by the rapid cooling down of seawater. The frazil ice formed as a result of this cooling blocked the circulating water screening filters and weakened the flow of seawater used as coolant in the plant. As a result, a turbine trip occurred at the plant unit, leading to a reactor trip. A similar phenomenon occurred at the plant in the mid-90s.*

***One of the diesel generators at Olkiluoto 1 did not start** in connection with the reactor protection system testing carried out during the start-up after annual maintenance on 28 May 2008. Damage in the seals of both pneumatic starter motors was found to be the cause of the failure. Further investigations by the power company revealed that at Olkiluoto 1, five of eight seals were damaged. At Olkiluoto 2, one of eight seals was damaged. Replacement of seals is not included in the maintenance programme of the pneumatic starter motors, leading to the embrittlement of the seals due to aging and the lubrication oil mixed with the air.*

***A reactor trip occurred at Olkiluoto 1** as a result of a transient in the generator voltage regulator on 30 May 2008. The generator voltage at the plant unit began to increase as a result of an incorrect function in the new voltage regulator installed during the annual maintenance. The overvoltage peak caused by the opening of a plant breaker shut down all six reactor coolant pumps. The direct power supply from flywheel generators was interrupted when part of the control electronics of the reactor coolant pumps and flywheels was damaged. Consequently, there was a momentary transient in fuel cooling. After the event, the power of Olkiluoto 2 was also reduced to about 80% for the duration of diagnosing and rectifying the fault, because a similar incident at full power could lead to damage in the fuel cladding as the cooling flow is disturbed. When the reactor coolant pumps were replaced in the 90s, it was not realised that overvoltage may, in certain situations, cut off the direct power supply from the flywheel generators to the reactor coolant pumps. At Olkiluoto 1 and Olkiluoto 2, uncontrolled stoppage of reactor coolant pumps caused by overvoltage has temporarily been prevented by modifying the protective relay functions in the auxiliary power supply network. In addition, the power company amended the plant operating instructions.*

***STUK noticed that the penetrations of pipes that led through the walls of emergency cooling system pump rooms at the Olkiluoto NPP, the so-called H rooms, had not been appropriately sealed.** These pump rooms must be watertight. The water from the containment condensation pool might leak into the rooms in certain pipe rupture situations. If the water further escapes from the room, the removal of residual heat from the reactor would be at risk because the cooling water would be lost. Since the H rooms are also separate fire compartments, the integrity of fire compartmentation was also doubtful. At Olkiluoto 1 and 2, 33 and 11 penetrations were repaired, respectively. The pipeline penetrations have been modified during plant operation. Since the purpose and design basis of penetrations had not been recognised by the power company, the penetrations had been modified so that they no longer served their purpose.*

The events are described in more detail in Appendix 3.

TVO submitted seven amendment proposals of the Technical Specifications to STUK for approval, concerning issues such as periodic testing, fire protection and weather instrumentation. STUK approved three amendment proposals as received, and one was returned for further preparatory work so that its justification could be stated in more detail. Three amendment proposals were approved in part, and updated proposals were requested for approval for the parts needing further specifications.

Operation and operational events

Several events related to the functioning of safety systems took place at Olkiluoto 1 and Olkiluoto 2 during the years 2007–2008. The events did not cause a risk to the surrounding environment, but as the events involved phenomena typical of common cause failures, the reliability of safety functions was consequently compromised. Earlier observed phenomena can also be identified in the events. The common factor in the events is the fact that modification work carried out earlier at the plant contributed to all of them. The power company had not identified all factors affecting modification work during planning, nor was the work carried out with care. The events have also shown how important it is to fully understand the design basis and to document everything in an unambiguous manner.

In 2008, the Olkiluoto power plant reported seven anomalies. The power company prepared a separate root cause analysis for one of the events. In addition, TVO submitted five other event reports to STUK.

In 2008, the risk caused by the detected component malfunctions, preventive maintenance and other events at Olkiluoto 1 plant was 26.1 %, and at Olkiluoto 2 plant 1.3 % of the expected value of the annual accident risk calculated using the plant's risk model. The high value for Olkiluoto 1 is mainly due to the common cause failure of diesel generators which alone accounts for 18.7%, and for the preventive maintenance of diesel generators, which took a long time and accounted for 3.8%. The value for Olkiluoto 1 is about five times the long-term average. The value for Olkiluoto 2 is clearly below the long-term average. Two reactor trips also occurred in Olkiluoto. The reactor trips and common cause failure of the diesel generators have resulted in modifications, either to the plant or to the maintenance procedures. The other events are considered to be part of normal nuclear power plant operation, and they did not give rise to any further measures by STUK.

Annual maintenance at Olkiluoto 2

The refuelling outage at Olkiluoto 2 took place between 4 May and 12 May 2008, a period of approximately eight days. One quarter of the fuel was replaced with fresh bundles. No major maintenance or modification took place.

Repairs related to operational transients occurring during the previous operating cycle were carried out during annual maintenance. These included the replacement of scram valves with serviced ones, the inspections of screws in the vacuum breaker valves of the relief system (as two of them had become loose earlier), as well as maintenance of a reactor coolant pump and inspection of the device preventing rotation in the wrong direction.

The disorder in the measurement of the reactor water level at Olkiluoto 2 has caused problems when running the reactor to a shutdown state. For example, a reactor trip was triggered on 21 May 2007 when the reactor was being shut down for annual maintenance. TVO has assessed that the malfunction is caused by water boiling in the water level detection impulse tube. During the annual maintenance of 2008, a test was carried out to establish if the malfunction can be prevented by cooling the impulse tubes. In the test, the impulse tube of one measurement channel was cooled using a temporary arrangement and pressurized air. The results were promising and TVO is contemplating further action on that basis. During the shutdown of 2009, cooling will be ensured by removing some of the insulation.

A link from the new gas turbine plant to the plant unit was connected at Olkiluoto. Commissioning tests were run at the end of the annual maintenance operation. The link will improve plant safety because it helps to secure the power supply of the plant. The gas turbine plant would provide the plant with electricity in a situation where the connection to the national grid is lost and the emergency generators fail to operate.

Annual maintenance at Olkiluoto 1

The maintenance outage at Olkiluoto 1 took place between 13 May and 6 June 2008, a period of approximately 18½ days. The outage lasted about five days longer than planned. The delay was attributable to the jamming of a fresh fuel bundle inserted into the reactor core on 23 May 2008, as well as the reactor trip resulting from voltage regulator malfunction on 30 May 2008 and the subsequent repairs.

No major modifications were made to the plant during annual maintenance. One valve in the cooling system of the shutdown reactor was replaced, the radiation measurement instruments of the exhaust gas system were replaced with new ones, sections of the extraction steam system pipelines were replaced, two low-pressure turbines were opened and inspected, the generator exciter was modernised and the voltage regulator replaced.

Annual maintenance outages

Based on its oversight, STUK stated that annual maintenance was safely implemented at the Olkiluoto 1 and Olkiluoto 2 units. However, several anomalies occurred during the annual maintenance of Olkiluoto 1.

STUK used a total of 189 man-days for the oversight of annual maintenance outages. In addition, two resident inspectors worked regularly on site.

4.2.3 Ensuring plant safety functions

In 2008, the reliability of the plant's safety functions were primary called into question by phenomena related to electrical systems. In Olkiluoto, a voltage peak caused by an operational transient in the voltage regulator caused a momentary disturbance in fuel cooling (a more detailed description of the incident is in Appendix 3). The event did not cause a hazard to the environment, but it revealed a significant flaw in the overvoltage protection of the electrical systems at the plant. At Olkiluoto 1 and Olkiluoto 2, the uncontrolled trips of reactor coolant pumps caused by overvoltage are temporarily prevented by modifying the protective relay functions in the auxiliary power supply network. In addition, the power company amended the plant operating instructions.

In Sweden, an analysis was carried out, concentrating in particular on the effects of voltage drops of long duration on the pump motors in safety systems. Similar studies were initiated in Finland. Similar analyses have been carried out before, and these new ones are intended to study the current situation of the plants.

In Sweden, cracks were detected in the shafts of control rods required for reactor shutdown. The possible presence of fractures was also investigated in Finland, but similar fractures are very unlikely in Olkiluoto because the stresses are smaller, due to structural differences. At Olkiluoto 1 and Olkiluoto 2, ten control rod shafts replaced during the previous annual maintenance were inspected, and no fractures were found.

The events in Sweden and analyses consequently carried out in Finland are discussed in more detail in conjunction with the oversight of operational experience feedback in Section 4.2.8.

4.2.4 Integrity of structures and equipment

The start-up of Olkiluoto 1 after annual maintenance was delayed when one fresh fuel bundle loaded in the reactor jammed in its position on 23 May 2008. Inspection revealed that the bundle movements were prevented by an instrumentation lance that had come loose from the core lattice. A video recording showed that the lance came loose when the adjacent fuel bundle was being moved into position. The event extended the duration of annual maintenance by about 24 hours. The jammed fuel bundle and the bundle in the symmetrical position were replaced. TVO submitted the amendments made to reactor core design and fuel behaviour analysis to STUK for approval.

Significant signs of wear were detected at two points of the pipelines when their operational condition was inspected at Olkiluoto 1. One was repaired by replacing the worn length of pipe. The other point of wear was not repaired because analyses indicated it to be unnecessary. The signs of wear will be inspected during future annual maintenance outages and repairs will be made if the wear advances.

Cracks were detected in the steam dryer panels during inspection of the reactor pressure vessel internals at Olkiluoto 2. The dryer had been in use during the periods 2005–2006 and 2007–2008. On the basis of its investigations, TVO decided to continue using the steam dryer because the fractures were not deemed relevant to plant safety or the operation of the dryer. STUK approved the use of the dryer in line with TVO's proposal.

One new fracture of about 20 mm depth was detected in the inspection of lifting lugs on the moderator tank cover located over the reactor core of Olkiluoto 2. STUK approved TVO's proposal, according to which the development of the fracture will be monitored during future years, and decisions on repairs will be taken on the basis of the monitoring results. Earlier, in 2003–2005, three fractures had been detected in the same lug, and they were not repaired. The fractures have been monitored, and they have not advanced.

The reactor containment is subjected to a leak tightness test three times during a 12-year period. The reactor containment of Olkiluoto 1 was subjected to a leak tightness test during annual maintenance in 2008. For Olkiluoto 2, the leak tightness test of the containment was last carried out in 2005. In addition, leak tightness tests have been made on containment isolation valves, personnel airlocks and containment penetrations. The results show that the leak tightness of the containment buildings has remained good. Stretch measurements of structures and a survey of fractures in the containment indicate that no changes have taken place in the structures. During the leak tightness tests, stretching did not exceed the elastic zone, and new fractures were not created. The structures are in good condition.

A total of 70 pressure vessel inspections were carried out at Olkiluoto 1, of which 20 in the inspection domain of STUK, while nine inspections were carried out at Olkiluoto 2 in the domain of the inspection organisation.

STUK carried out a total of 203 structural inspections and inspections of on-site repairs and modifications during the year, as well as three commissioning inspections.

Fuel

TVO submitted to STUK for approval the pre-inspection documentation of Areva's Atrium 10XM trial lot fuel bundles, scheduled for loading in the reactor in spring 2009. The number of fuel rods per bundle has been increased and the diameter of the rods has been correspondingly reduced. Partial length rods have been introduced in these bundles, and the bundle length has slightly increased.

Pressure equipment manufacturers and inspection and testing organisations

A total of 34 nuclear pressure equipment manufacturers were approved for the Olkiluoto plant (plant units Olkiluoto 1, 2 and 3). STUK approved 22 testing organisations to carry out tests related to the manufacture of mechanical equipment and structures for the Olkiluoto plants. 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 scope of operation of the earlier approved inspection unit for the Olkiluoto plants, "Teollisuuden Voima Oy's inspection organisation", was extended to include the assessment of suitability and approval regarding the design and manufacture of mechanical equipment and structures of the nuclear facilities of Posiva Oy.

Risk-informed in-service inspection programme

Preparations have been made this year in Olkiluoto for a risk-informed in-service inspection programme concerning safety-critical pipelines. The risk classification of pipes has been completed. They will be used to draw up a detailed risk-informed inspection programme. The deployment of risk-informed inspection methods for targeting inspections has been developed in Finland by STUK, Fortum, FNS (Fortum Nuclear Services), TVO and VTT. The objective of risk-informed in-service inspection programmes is to allocate the inspection resources to the targets that are most critical from the point of risk. Using this approach, it is possible to ensure that the current inspection objects are well-justified, identify new objects and omit certain less safety-critical objects from the existing inspection programme. Experts say that the Olkiluoto inspection programme will be the most extensive risk-informed periodic inspection programme so far implemented in Europe, equivalent to the programme already implemented in Loviisa.

4.2.5 Development of the plant and its safety

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 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 past period and that the licensee is aware of the status of plant safety and its development during the remaining licence period. TVO already began preparations for the periodic safety review a few years after the current operating licence was granted. During 2008, TVO continued carrying out the review and drew up the reports to be submitted to STUK. TVO has discussed the scope and content of the documentation to be submitted in meetings organised with STUK during the past year. TVO sent the reports related to the periodic safety review to STUK for inspection on 31 December 2008. STUK will review TVO's assessment during 2009.

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

No significant events in terms of plant or environmental safety were evident in the treatment, storage or final disposal of low- and intermediate-level waste ("operating waste") at the Olkiluoto power plant. The volume and activity of operating waste in relation to generated electrical power remained relatively low compared with most other countries. The contributing factors include the high quality requirements for nuclear waste management and nuclear fuel, the planning of maintenance and repair operations, decontamination, component and process modifications, as well as waste monitoring and sorting, which enable some of the waste to be cleared from control. In 2008, maintenance waste below the activity limits was taken to the local landfill for burial, waste oil delivered to Ekokem Oy, and recyclable scrap metal and some reusable components 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 2008 was 6,984 assemblies (1,225 tU, tonnes of original uranium), an increase of 234 assemblies (41 tU) in 2008.*
>
> *The volume of low- and intermediate-level waste at the Olkiluoto power plant was 6,240 m³ at the end of 2008. The total increase in volume from 2007 is 115 m³. Approximately 80% of the waste has been finally disposed of.*

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

Statements under the Nuclear Energy Act and Degree

In compliance with section 74 of the Nuclear Energy Decree, TVO submitted a report on the situation of nuclear waste management and the situation of and progress plans for research, development and design activities (TKS activities) at the end of September. According to the statement issued by STUK in November, the action plans presented in the report comply with the principles set out in nuclear energy legislation and decisions by the Ministry of Employment and the Economy. The statement recommended that Posiva should better define the focus of overall planning of research work carried out in the underground research facility (Onkalo) so that a systematic approach in research work can be ensured, together with the possibility of utilising the results in the further design of Onkalo and the comprehensive utilisation of the research results achieved in Onkalo.

STUK also 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 Economy. In its statement, STUK assessed the technical plans and cost estimates on which the financial provision is based. STUK considered the planned nuclear waste management activities to be acceptable for use as a basis for making financial preparations.

4.2.7 Organisational performance and quality management

Management and safety culture

During 2008, TVO continued developing the management and safety culture. Safety objectives have been discussed in several training sessions organised both for TVO's own and external personnel. The number of task-specific kick-off meetings has been consciously increased in order to identify risks and ensure safety. In 2008, TVO initiated its new manager training programme and introduced the "one hour per week" procedure whereby the manager communicates safety objectives, shows his/her commitment to safety and maintains an interactive dialogue with his/her staff.

TVO's decision-making in conjunction with the incidents and events occurring during the 2008 annual maintenance outage did not in all respects meet STUK's expectations regarding a good safety culture. Consequently, STUK required TVO to have an analysis prepared of the causes of the events and the contributing organisational factors. The analysis was completed in late 2008, and the power company presented its results to STUK during an inspection of safety management. STUK will use the analysis as the basis for following up the implementation of the decided actions during inspections in 2009.

At TVO the responsible managers of both the plants in operation and the one under construction changed, and a new office in charge of annual maintenance outages was established in the production department. A new CEO was appointed for TVO during 2008. Several key employees of TVO have responsibilities both in the organisations of plants in operation and the plant under construction.

Functionality of the management system

In the implementation decision of YVL 1.4, STUK decided that the management system of TVO complies, in its relevant parts, with the requirements of the new guide. STUK required TVO to draw up a plan for developing the management system with respect to the issues identified for improvement in the assessment.

TVO has developed its supplier assessment procedures during 2008. It was noted during the inspection by STUK that TVO must further develop the assessment procedures and train personnel for and improve its commitment to the supplier assessment procedures.

STUK inspected the internal audit and management review practices of TVO and requested, following the inspections, that TVO provide STUK with a detailed account of the objects to be audited and the development needs of the auditing programme. It was found in the inspection that TVO is in the process of developing the content of management reviews to better cover issues related to nuclear and radiation safety.

Personnel resources and competence

TVO recruited several new employees during 2008. With the recruitments, TVO is seeking to prepare for the generation change in progress in the nuclear power business. TVO prepared procedural instructions on strategic HR planning during 2008.

In its inspections, STUK has raised the issue of number of personnel at TVO and the management of working hours accumulation during annual maintenance operations. STUK is under the impression that the workload of certain key persons has increased because TVO deploys its personnel for the needs of both the units in operation and the one under construction. TVO has trained and instructed managers, supervisors and operating personnel on the importance of fatigue management. In its 2008 inspection, STUK stressed that TVO must communicate to its personnel in conjunction with annual maintenance how important it is to maintain alertness in safety-critical duties. TVO has introduced a more efficient system for managing working hours in conjunction with annual maintenance. This procedure is intended to ensure that the length of individual working shifts does not exceed 13 hours.

The methods for assessing the effectiveness of training were developed at TVO during 2008 by, among other things, more clearly defining the objectives of training. TVO operates a data system designed for competence management. It has been systematically developed during the past few years through co-operation between training experts and managers.

In an inspection carried out in 2008, STUK assessed how operational events are taken into account in the training of TVO personnel. Following the inspection, STUK stated that operational events are systematically discussed in personnel training sessions.

STUK participated in examinations of shift personnel where the operators working in the control

Control rod problems experienced at Oskarshamn 3 and Forsmark 3

It was noticed during the annual maintenance at the Oskarshamn power plant in Sweden that one control rod was out of alignment. Closer examination revealed that the shaft of the control rod had broken and that similar points on many other control rods displayed cracks caused by thermal fatigue. Following the observation, Forsmark 3, the sister plant of Oskarshamn 3, was shut down for inspections, and similar faults were also detected there. SSM, the Swedish nuclear and radiation safety authority, immediately informed STUK of these observations. In October, STUK asked TVO to report whether a similar phenomenon is possible at Olkiluoto and whether the event gives rise to any actions at the power plant.

At Olkiluoto 1 and Olkiluoto 2, ten control rod shafts replaced during the previous annual maintenance were inspected, and no fractures were found. The root cause of the phenomenon is thought to be thermal fatigue at the spot where the flow rinsing the control rod drive mechanisms meets the main circulation flow inside the reactor. At Oskarshamn 3 and Forsmark 3, the temperature difference of these two flows is more than 200 degrees, while it is only about 140 degrees at the Olkiluoto plants that are older than these two Swedish plant units. This fact, together with the differences in the routing of flows and structures of control rods, reduce the probability of a similar phenomenon at the Olkiluoto plants. The inspections at Olkiluoto will continue during the annual maintenance of 2009 when TVO will inspect control rods used in the reactor during the operating cycle 2008–2009.

Oskarshamn 3 and Forsmark 3 were started up at the beginning of January 2009 when all control rods in the reactors had been checked and the fractured ones replaced. According to the press release issued by the Swedish utility Vattenfall, about 25 per cent of the control rods in the reactor of Forsmark 3 had fractures or indications of fractures. The plant units may be operated until the 2009 annual maintenance outages. The plants must devise a solution to prevent similar problems in the future.

Plant operation in different undervoltage situations

The work of analysing the electrical systems disturbance which occurred at Forsmark 1 on 25 July 2006 has continued in Sweden. The analyses carried out at the Oskarshamn power plant revealed that the dimensioning of the pump motors of the plant's safety systems is not adequate to cope with all foreseeable transients in the national grid. The problematic scenario was found to be one where the grid voltage drops slowly and a malfunction prevents the plant breaker to disconnect the plant from the national grid. In such a situation it is possible that the pump motors of safety systems will overheat because of the undervoltage before their power supply is switched over from the national grid to the diesel generators. Investigations were made at the NPPs in operation in Finland. Consequently, the operation instructions for electrical disturbnce situations at the Olkiluoto 1 and 2 were supplemented as the first measure. More detailed investigations regarding the capability of electrical motors to withstand long periods of undervoltage are in progress at both the Loviisa and Olkiluoto power plants. The investigations will be completed during 2009. Similar analyses have been carried out before, and these new ones are intended to establish the current situation of the plants.

The modifications to the battery-backed UPS system equipment at the Olkiluoto plants, initiated following the Forsmark event, were continued. New type of overvoltage-limiting devices were fitted to part of the plant's UPS systems. They are scheduled for installation in all redundant systems by the end of 2010.

rooms show that they are conversant with all salient matters related to plant operation and safety. During 2008, STUK approved seven new NPP operators. In addition, STUK approved the renewal of 27 operator licences.

4.2.8 Operational experience feedback

A more comprehensive screening of IRS reports was identified as a target for development in the inspection of 2007 concerning international operational experience feedback and the utilisation of experience. The preliminary screening of international operational experience feedback reports (WANO, IRS, NRC) is being carried out by ERFATOM, an organisation responsible for the exchange of information on experience between Nordic owners of BWR reactors. One member of ERFATOM is KSU (Kärnkraftsäkerhet och Utbildning AB), a training centre that is part of the Vattenfall Group. The screening criteria do not necessarily correspond to the needs of Olkiluoto 3. During the 2008 inspection, the representatives of TVO assured the inspectors that the experience related to pressurized water plants is also conveyed through ERFATOM, because there are plenty of reports concerning them coming through WANO. Individual events at pressurized water plants are also discussed at the Olkiluoto plant, albeit that this varies from one person to the next. It was found during the inspections that the follow-up of corrective actions has improved following the introduction of the operational experience database (OPEX) at the plant. STUK identified areas in need of development regarding general awareness of the OECD/NEA databases and their more extensive utilisation in order to improve safety.

4.2.9 Radiation safety of the plant, personnel and environment

Occupational radiation safety

STUK inspected the radiation measurement process at the Olkiluoto plant. The inspection included monitoring of radiation in the environment, measurements in plant premises, cleanliness measurements at employee exits and activity measurements of emissions. On the basis of the results, STUK requested, among other things, more detailed instructions for radiation measurements in

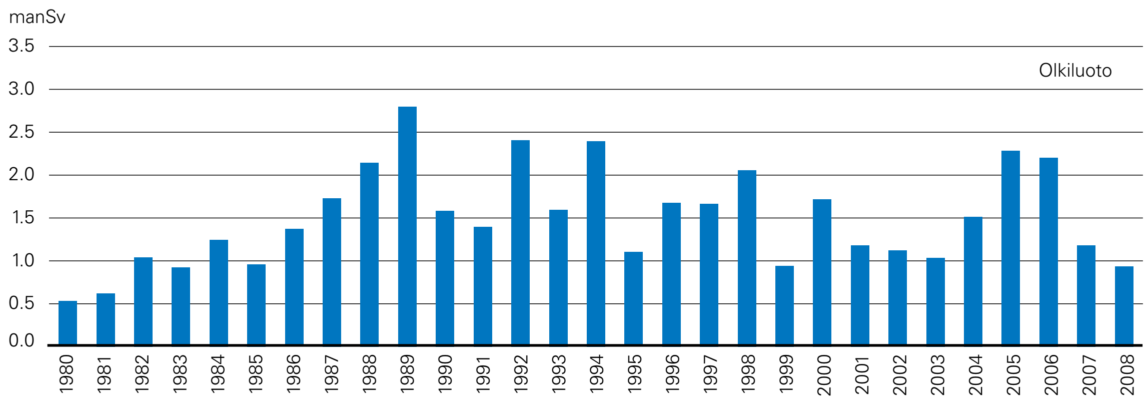


Figure 14. Collective occupational doses since the start of operation of the Olkiluoto units 1 and 2.

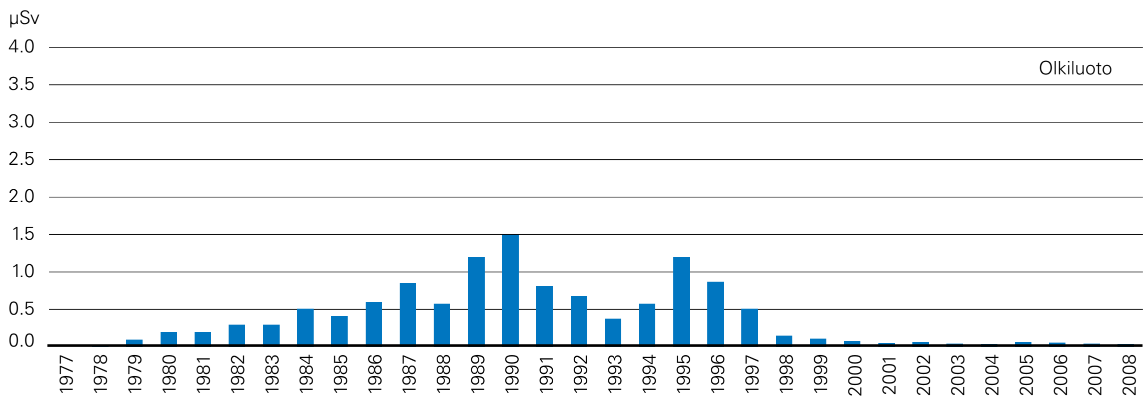


Figure 15. Annual radiation doses to the critical groups since the start of operation of the Olkiluoto units 1 and 2. Over the recent years, the doses to the critical groups has remained below one percent of the set limit, 0.1 milliSv.

rooms and bringing the instructions up to date.

STUK carried out radiation protection inspections during the annual maintenances of both plant units in Olkiluoto. In the inspections, STUK assessed the situation regarding radiation work permits and the use of protective equipment and contamination monitoring, as well as the work of radiation protection supervisors and other employees in the controlled area. STUK found that contamination monitoring in Olkiluoto is comprehensive. Thanks to the monitoring, the premises in the controlled areas of the plant were kept clean, which also helped keep the number of personnel monitor alarms low during the annual maintenance operations.

Radiation doses

The aggregate (collective) occupational radiation dose was 0.73 manSv at Olkiluoto 1 and 0.21 manSv at Olkiluoto 2. The annual maintenance outage at Olkiluoto 1 was normal in terms of the number of personnel and amount of work involved, while a refuelling outage took place at Olkiluoto 2. According to STUK guidelines, the threshold for one plant unit's collective dose averaged over two successive years is 2.10 manSv. This value was not exceeded at either plant unit. The collective radiation dose at Olkiluoto 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 of workers at Olkiluoto 1 during the outage was 0.61 manSv, while the corresponding figure for Olkiluoto 2 was 0.16 manSv. As a result of replacing steam dryers in 2006 (Olkiluoto 1) and 2007 (Olkiluoto 2), radiation levels in the turbine halls continued to decrease. The radiation levels in the turbine hall are proportional to the moisture content of the steam in the steam pipes and the quantity of radioactive substances it carries. 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 doses incurred during the annual maintenance at Olkiluoto 1 and 2 were 2.4 mSv and 8.1 mSv, respectively. The largest individual radiation doses in Olkiluoto have been less than 10 mSv during 2007 and 2008. The individual radiation dose distribution of workers at the Olkiluoto and Loviisa nuclear power plants in 2008 is given in Appendix 2.

Table 5. Radioactive nuclides from the Olkiluoto power plant observed in the environmental samples of 2008. The number in brackets states the number of samples in which nuclides were found.

Sample	Detected nuclides (number of samples)
Aquatic plants	Co-60 (10), Mn-54 (1)
Sedimenting materials	Co-60 (7)
Fish	Co-60 (1)
Shellfish	Co-60 (1)
Seawater	H-3 (4)
Rain water	H-3 (2)

Radioactive releases and environmental radiation monitoring

The monitoring sensors in the weather mast at the Olkiluoto plant had to be replaced in 2008. The new measurement sensors are more versatile and accurate than the old ones. More comprehensive data is now available on the weather conditions around Olkiluoto, including the stability of air flows over time. This data is used for fallout calculations if an accident situation causes releases into the air. Software updates will be carried out for the weather station during 2009.

New, more accurate monitoring instruments were installed in the external radiation monitoring network of the Olkiluoto NPP surroundings. The installed instrumentation 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. The monitoring network has functioned well right from its commissioning. Three measurement stations will be installed in the vicinity of Olkiluoto 3 before the plant unit is completed.

STUK has approved the operating programme for environmental radiation monitoring in the surroundings of the Olkiluoto NPP for 2008–2011. The changes in the programme compared with the previous issue were related to, *inter alia*, the use of reference samples and the interpretation of measurement results on carbon-14 nuclides.

Radioactive releases into the environment from the Olkiluoto nuclear power plant were well below authorised annual limits in 2008. No releases of radioactive noble gases into the environment were detected. Releases of radioactive iodine isotopes into the air were approximately 1.5 GBq, which is approximately 0.001% of the authorised limit. The emissions through the vent stack also included radioactive particulate matter amounting to 18 MBq, tritium amounting to 0.4 TBq and carbon-14 amounting to approximately 0.9 TBq.

The tritium content of liquid effluents released into the sea, 2.4 TBq, is approximately 13% of the annual release limit. The total activity of other radionuclides released into the sea was less than 0.4 GBq, which is about 0.1% of the plant specific release limit.

The calculated radiation dose of the most exposed individual in the vicinity of the plant was about 0.04 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 cosmic radiation sources in about 15 minutes.

A total of 300 samples were collected and analysed from the terrestrial and aquatic environment surrounding the Olkiluoto power plant during 2008. 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 samples. The amounts are so small that they are insignificant in terms of people's radiation exposure.

4.2.10 Emergency preparedness

STUK oversees the preparedness of the organisations operating nuclear power plants to act in abnormal situations. No such situations occurred at the Olkiluoto power plant in 2008. The inspection of emergency response arrangements at the Olkiluoto power plant covered, among other things, special training for the emergency response organisation of the Olkiluoto power plant, as well as training and evacuation 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 28 November 2008.

The licensee and public authorities have continued their co-operation. In 2008, an emergency and rescue operation exercise was carried out at the Olkiluoto power plant under the leadership of the Provincial State Office of Western Finland. STUK also trained its own activities in this operation. During the emergency exercises, the operation of organisations, functionality of instructions and use of emergency response premises are tested. STUK also separately assessed the licensee's emergency response arrangements during the exercise and commented on the observations at the plant.

4.3 Regulatory oversight of the construction of Olkiluoto 3

4.3.1 Overall safety assessment of Olkiluoto 3

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

The design of Olkiluoto 3 has improved in detail during the period. The plant vendor and power company still have scope for improvement in terms of submitting sufficiently detailed and unambiguous design documentation to STUK. At this stage of the project, this in particular applies to the design of I&C systems, which will be finally detailed when the design of the plant and its process systems has been completed. STUK brought up the need to develop design activities during inspections and meetings with the plant vendor and TVO, as well as during audits of the plant vendor's design activities, in which STUK participated. STUK inspected TVO's operations and assessed the processes TVO deploys to ensure the quality of design work. STUK required that flaws in the design work observed in the inspections be rectified. The simultaneous progress of design, equipment manufacture and construction poses a challenge to the project management and supervision activities of the plant vendor and TVO.

The manufacturers, the plant vendor and the power company supervised the manufacturing of the primary circuit components appropriately. The number of detected manufacturing defects reduced. The detected deviations have been repaired in accordance with the plans presented to STUK so that the original approval criteria are met. As a result of the supervision of the manufacturing and construction of other components, the power company and the plant vendor have found scope for improvement in their own operations and those of their subcontractors. Operational deficiencies have been dealt with at meetings between the plant vendor, the power company and STUK's project management, and in connection with the inspections of the periodic inspection programme during construction and construction inspections at the manufacturers' premises. The observations show that the systematic and timely control and inspection activities of the plant vendor, TVO and STUK are necessary at Olkiluoto 3 in order to ensure the fulfilment of quality requirements.

In the periodic inspection programme during construction, STUK inspected the operations of TVO in order to form an opinion on TVO's project management, resources, handling of safety issues and quality management, as well as the supporting functions. In its inspections in 2008, STUK paid attention to project management and the future phases of the project, such the commencement of installation work and preparations for actual operation of the plant. Following its inspections, STUK required TVO to develop its performance in several areas. Regarding project management by the power company, STUK required that the process of assessing compliance with requirements is made more specific by issuing further instructions. Further, STUK required that the information derived from non-conformances is processed statistically so that the results can be more specifically utilised in project management. Regarding quality management, STUK required that an analysis is carried out regardingon the project's process indicators of the projectand on the plant vendor's assessment of safety-critical functions. STUK carried out an ex-programme inspection on the safety culture at the construction site. The inspection was carried out because there were suggestions in the media that flaws in quality or safety may not be freely brought up at the site. STUK required TVO to develop the safety culture at the site and create a process for assessing the state of safety culture. TVO presented action plans concerning the development needs found in the inspections, and STUK followed up their implementation through inspections and oversight.

The assessment of the plant vendor by STUK is based on the assessment of performance in connection with oversight on the construction site and at component manufacturers' premises, reviews of the documents drawn up by the plant vendor, the review of the plant vendor's quality management system and plans and the review of the project manuals, as well as audits and interaction with the plant vendor. Co-ordinating the project schedule and design as well as construction pose challenges to the plant vendor, as does the attainment of strict quality objectives. STUK's experience shows that the plant vendor is prepared to repair the detected design and quality defects in accordance with the original quality requirements. The familiarisation, guidance and supervision of subcontractors at the construction site and manufacturing sites requires a systematic and active approach by the plant vendor, in particular when safety-critical equipment is being installed. The plant vendor and its subcontractors have also shown that they have learned from past experience, because the concrete casting and steel liner welding work has been executed better than at early stages of the project.

Based on the results of oversight, STUK is able to state, despite the modifications to the design and the observations made in construction and manufacturing, that the original safety and quality objectives for the plant can be achieved. So far, the plant vendor has been able to accommodate the modification requirements following the increasing degree of detail in design related to different areas of technology in its construction activities. The flaws detected during manufacture have been repaired so that the original quality criteria are met. The flaws in the work of different parties and in product quality have resulted in additional work to solve the problems. The additional work has had an impact on the progress of the project. STUK will continue project oversight according to the current policies. The focus area for 2009 is review and assessment of the I&C system and oversight of the prerequisites for commencing the installation phase.

4.3.2 Plant design

Transient and accident analyses

The power company submitted to STUK for review analyses that describe the operation of the plant in different transient and accident situations. The method descriptions and calculation parameters were also submitted to STUK to allow the analyses to be reviewed. The analyses supplied were related, among other things, to the operation of the plant in pipeline break situations of different magnitudes, and in a situation where the heat exchanger tube of the steam generator breaks, a scenario typical for pressurized water reactors. STUK was also provided with an analysis on the generation and behaviour of hydrogen in a situation where the reactor core melts during a so-called severe accident. The analyses are part of the final safety analysis, and they are based on the detailed design of the plant. The plant model forming the basis of analyses has been revised to correspond to the detailed design.

The analysis supplied to STUK regarding pipe break of the largest pipe in the primary circuit concerned a situation where the broken pipe and the pipe supplying emergency cooling water are adjacent to each other. In a situation like this, there is a risk that the emergency cooling water required for cooling the reactor core escapes directly into the adjacent broken pipe as a result of the created pressure difference, without cooling the fuel in the reactor. No similar analysis had been submitted to STUK earlier. The analysis indicated that in this situation, the flow of water to the reactor core is sufficient to cool the reactor so that the criteria for fuel rod damage is not exceeded. STUK had a similar analysis of a pipe break situation made at the stage of the construction licence application; it showed that the flow rate was sufficient to cool the fuel.

In 2007 STUK required that the power company make a closer analysis of the behaviour of the plant in a situation where one or more steam generator heat exchanger tubes have broken. The underlying reason for this requirement was the phenomenon observed in comparison analyses commissioned by STUK where a possibility existed for non-borated water from the secondary circuit to enter the primary circuit. Depending on the quantity of non-borated water, the situation may lead to a so-called criticality accident where the reactor power very quickly increases. Following the new analyses, the power company proposed changes to plant design and to instructions on accident management. The changes serve to prevent the possibility of non-borated water entering the reactor from the secondary circuit, thus eliminating the possibility of a criticality accident. As a result of the changes, radioactive emissions into the environment will slightly increase. However, the analyses and dose calculations carried out indicate that the activity of releases will only increase very marginally, while the dose values still remain clearly below the limits set for the accident situation in question. STUK approved the proposed changes because the overall impact on plant safety was positive.

STUK was provided with an analysis describing the behaviour of the plant in case of a breakage of medium-sized pipes associated with the primary circuit. The analysis had been calculated using a more detailed model than before. Following the new analysis, the plant vendor had noted that in the accident situation considered, the reactor must be cooled at a higher rate than previously thought, and consequently the plant vendor proposed changes in accident management. According to the power company, the higher rate of cooling prevents the fuel in the reactor from overheating and becoming damaged. STUK will inspect the submitted analysis and the proposed design changes during 2009.

Probabilistic risk analyses

In 2008, STUK assessed how the key design principles affecting plant safety are implemented in the detailed design documents of systems and structures. The inspections concentrated on the design documentation of safety systems, fire analyses and risk analyses of I&C systems and fuel handling systems. The objective was to ensure that appropriate measures have been taken in preparation for area events (such as fires and flooding on-site) 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 scope for improving the design was detected in the review conducted by STUK. Regarding the I&C system, STUK required a reliability assessment of the overall implementation of I&C systems.

An update of the PRA computer model was submitted to STUK for information. Of the documentation concerning risk analyses, STUK reviewed, the risk-informed regular inspection programme for Safety Class 2 piping, method description for flooding risk and the updated description of the use of PRA when drawing up the Technical Specifications. In addition, STUK received for review the method descriptions for fire analyses and human error, as well as analyses on the falling of heavy loads. Their review will continue in 2009.

Conceptual plant design

Of the conceptual design documentation of Olkiluoto 3, the power company submitted analyses and their updates on the protection of the plant against internal and external threats to STUK for review. The analyses showed that the earlier decided versityseparation principle allows the consequences of internal and external threats 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. STUK required the basis and starting parameters of the analysis to be specified in further detail and an assessment of the impact of loss of air conditioning at different temperatures. STUK did not receive an update of the analysis during 2008.

STUK reviewed the safety classification of the plant's systems, structures and equipment. In conjunction with the review, STUK approved the structure of the classification document and specified the level of detail at which the classification of components and structures must be presented in this document.

In 2008, the plant vendor continued submitting its studies of the behaviour of Olkiluoto 3 in exceptional voltage and frequency conditions that may be caused either by events in the external electricity grid or malfunctions in the plant's internal power supply systems. The start-up of the plant's own large pump motors may cause disturbances in the operation of other electrical equipment if such starting is not appropriately taken into account in the detailed design of electrical systems. The analyses are still pending.

STUK also reviewed the routing plan for electrical cabling in the plant. The plan showed the principals according to which the cables are routed, paying special attention to their potential defects such as short circuits, and to the protection and separation of cables.

Fire safety at the plant

STUK received for review the structural fire analyses, the purpose of which was to demonstrate that the plant structures will withstand the fire loads in fire compartments. In addition to the structural fire analyses, STUK received for review functional fire analyses showing the impacts of fires on the safety functions of the plant. These analyses are intended to prove that in case of a fire, the reactor can be shut down and the residual heat can be removed. STUK required more specific fire analyses and more complete analysis method descriptions, as well as an analysis of interfaces with the fire PRA method description.

STUK has earlier inspected the oil fire analysis of the main coolant pump. STUK commissioned VTT to carry out an independent reference analysis that included modelling the entire containment and a calculation of pressure change and its impact on the functioning of the containment. VTT's analyses also included sensitivity analyses, where an assumption was made of a fire involving a bigger amount of oil than that in the plant vendor's analysis. In the plant vendor's analysis, the estimate of the quantity of burning oil is based on the assumption that the oil collection solutions foreseen for oil leaks operate as designed. VTT's analysis indicated that if a large quantity of oil is burning, the plant's safety functions may be at risk. STUK required the power company to assess the functional capability of the motor fire extinguishing system in different fire scenarios. The power company must also indicate the rationale behind the quantities of oil used in the analyses presented, as well as the design bases for motor constructions that prevent oil leaks on the floor. STUK also required the power company to prepare an account of the consequential impacts of mechanical motor damage and the magnitude of oil leak in damage situations.

STUK commissioned VTT to carry out a study of the fire safety of the type of cable being installed in Olkiluoto 3. The study involved assessing the cable's tendency to catch fire and its fire properties. The tests run by VTT indicated that the tested cable catches fire more easily than the types tested earlier. The study will be continued and extended in 2009 to include the most common types of cable already delivered to Olkiluoto. STUK has earlier reviewed the fire analysis of the largest cable room and commissioned VTT to carry out a reference study with sensitivity analyses. The plant vendor's analysis found that a fire in the cable room is extinguished by itself because the oxygen content required for the combustion process decreases after the fire compartment is sealed off. The cable fire model earlier prepared by VTT and the simulations carried out will be updated following the new test results in 2009. The adequacy of fire-fighting arrangements will be reviewed on the basis of the updated simulations.

System design

STUK continued the review of the detailed design of process systems in 2008. The inspection concerned the I&C and electrical design of process systems. As the design progressed, the review was extended to include an assessment of whether process technological changes made in the design were acceptable.

Regarding I&C systems, STUK focused in particular on the acceptability of I&C architecture and the extent of pre-commissioning tests of the I&C systems. Late in the year, STUK received for review the updated plans of the power supply systems of the nuclear island and turbine island.

Instrumentation & Control is the key open issue in the plant's system design. In order to assess whether the I&C design for Olkiluoto 3 is acceptable, STUK required TVO to establish how independent the I&C systems designed for managing different operational and accident situations really are. The documentation earlier submitted to STUK indicates that there are data transfer links between different I&C systems, the significance of which for the independent operation of different systems has not been sufficiently justified. In addition, STUK wanted TVO to establish whether the data transfer links are so designed that the systems can carry out their functions even when the links are defective. In addition to these, STUK required a study to test the I&C as a complete system, as well a study of how data security has been taken into account in I&C design and during plant operation. Regarding the design of the protection system, STUK called into question the quality assurance of the design work because the third party employed by STUK found functional errors in the design of the protection system.

Several meetings were organised during 2008 to discuss the status of I&C issues. Design changes were presented to STUK, intended to eliminate dependencies between I&C systems. Late in the year, STUK received a description of the I&C architecture and its independence requirements. The review of this documentation will continue in 2009. STUK discussed the testing of I&C systems and data security with TVO and the plant vendor, but did not receive any documentation on them during 2008. The review will continue in 2009.

Radiation safety

The power company submitted the updated requirements specifications of radiation measurements and the documentation on the central computer system of radiation monitoring to STUK for approval. STUK approved the requirements specification and system description of the contamination monitoring system (personal and tool monitors and electronic dosimeters) supplied by the power company. As part of its review of process systems, STUK reviewed the requirements for radiation safety, such as radiation protection, equipment layout, accessibility and decontamination possibilities.

The power company sent to STUK for review reports related to the radiation classification of rooms, radiation doses of employees and taking the ALARA principle into account in design. STUK approved the room classification report and the employee dose report. The review of the ALARA report will continue in 2009.

Design of components and structures

STUK reviewed the plans regarding fuel design and manufacture. Following the review, STUK gave permission to procure material required to manufacture the fuel. Since not all plans regarding quality control during manufacture had been submitted to STUK yet, STUK did not give permission to commence manufacture.

STUK continued the review of detailed design for Safety Class 2 components and structures in 2008. The key objects of this review were the structural and construction plans of concrete and steel structures, as well as the construction plans of pressure vessels. For pressure equipment, STUK received, in particular, many documents concerning the isometrics, pipe supports 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 periodic inspections of pipelines. Another important documentation package was that related to the design and manufacture of valves. In addition to these, STUK reviewed the structural 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 analyses of the main components of the primary circuits commenced at STUK.

STUK's review brought up certain issues related to the design and implementation of components and structures. Regarding the design of safety injection pumps required in accident situations, STUK required TVO to provide an analysis to ensure that the pumps have sufficient suction head for reliable operation. STUK also required that the pumps be subjected to extensive tests.

STUK received for review documentation setting out the conditions in which the equipment must function in operational and accident situations. The conditions include temperature, pressure, radiation conditions and vibration caused by seismic events. STUK also required TVO to produce a study regarding how the ageing of components and structures is to be managed during the plant's planned service life of 60 years. The assessment of ageing management will continue in 2009.

Design modifications

STUK has required certain modifications to the plant design. The most important modifications required in 2008 related to I&C design; this issue was discussed under System design. The modifications required for other systems, structures and components were not so major.

The safety regarding criticality during refuelling was already assessed in 2007. STUK required TVO to modify the monitoring of the reactor or the design of fuel handling systems so that the criticality safety of the reactor can be ensured by technical solutions instead of administrative measures. Towards the end of 2008, STUK received documentation presenting the procedures for ensuring the criticality safety of the reactor. Part of these procedures was of administrative nature. The processing of this issue will continue in 2009.

Matters leading to structural modifications of the plant have surfaced as the construction work and detailed design of the plant progresses. In the course of pipeline design, the loads exerted by pipelines on their supporting structures have become more closely defined. In some cases, the loads have exceeded the earlier anticipated loads, and the design of penetrations, for example, has had to be modified. As a result of these observations, STUK required TVO to establish that the loads – which will possibly be further defined as the pipeline design work advances – have been adequately taken into account when designing the structures. In practice this means, among other things, that the walls must be strong enough to allow additional pipe supports to be fitted, if required.

4.3.3 Construction

Construction and on-site manufacture of steel lining

Construction oversight on site and in workshops focused on the manufacturing and installation of Safety Class 2 steel and concrete structures. STUK inspected the readiness to start the concreting of Safety Class 2 concrete structures and authorised the start of concrete casting. These concrete structures include the containment wall and its internal structures. Concrete casting has been successful from a technical point of view.

The welding and installation work of cylindrical sections of the containment steel lining continued at the factory in Poland and on site in Olkiluoto. The quality of welds was better than in 2007, but some parts of the welds still had to be repaired. The so-called biaxial tests on the durability of steel lining welds that began in 2007 were completed in 2008. The preliminary results of the tests indicate that the welds fulfil the requirements.

Fire on site

There was a fire on site in late July. The fire occurred in the space between the inner and outer containment. No injuries were sustained. The probable cause was a lamp that had tipped over and set the wooden worktop on fire. The fire was extinguished some four hours after it was detected. The fire-fighting efforts were slowed down by problems in identifying the location of the fire and in gaining access to it. As a result of the fire, some concrete became loose on the inner and outer concrete wall surfaces. In some places, enough concrete covering the steel reinforcement fell off that the steel rebars became visible. STUK inspected the location of the fire and the damage soon after the fire. The licensee provided STUK with a survey plan regarding the damage sustained by structures and components at the location of the fire. The inspections and tests carried out involved taking material samples of the affected structures. On the basis of the preliminary inspections and tests, STUK found that the concrete, steel reinforcements, penetrations in the fire area and other steel structures did not sustain significant damage in the fire. TVO and the plant vendor proposed improvements for fire safety on site. These included the construction of a temporary pipeline for fire-fighting water, stressing the dangers of hot work and the importance of house keeping on site to all persons working on site, and increasing the on-site resources required for ensuring fire safety. The concrete surfaces had not been repaired by the end of 2008.

Concrete reinforcement welds on site

Doubts were raised in the media during August 2008 that the quality of welds and supervision of welding work for concrete reinforcement steel and anchoring plates were not up to the required standard. These doubts were expressed, *inter alia*, on certain TV programs broadcast by the Finnish Broadcasting Company and in comments made by Greenpeace. Part of the subject welds on reinforcement steel rebars and anchoring plates were so-called installation welds, while part of them were so-called load-bearing welds. Load-bearing welds are used to increase the strength of the structure, and they are important to the safety of structures that affect nuclear safety.

STUK has supervised and inspected all significant load-bearing safety significant welds, and on this basis, it was able to state that the allegations made in public were untrue. Load-bearing welds were made in safety significant concrete structures from April 2008 onwards. The welding procedures had been appropriately drawn up, qualified and approved before the welds were made. The load-bearing welds have been subjected to the required tests to demonstrate their durability. The welding of the subject welds was supervised and the welds were inspected by qualified welding experts of the contractor, plant vendor and licensee. STUK inspected the compliance with requirements of the load-bearing welds before permission was given to cast concrete on the subject structures.

The purpose of installation welds is to ensure the reinforcement steel and anchoring components remaining on the surface of the concrete structure in place during the concrete casting process. Since these welds are insignificant to the strength of the structure, they have no safety significance for the structure. This is why STUK neither supervises nor inspects the installation welds in detail. The contractors responsible for construction work, the plant vendor and the licensee are responsible for ensuring that the installation welds are appropriate and that they are duly inspected. STUK ensured that the completed installation welds in safety-critical structures had been inspected by the contractor, plant vendor and the licensee before STUK gave permission to start the casting of concrete. The accounts submitted to STUK and the inspections carried out indicate that procedures had been available for installation welds as well before starting the work, and the installation welding work was only carried out by qualified welders. No movements of reinforcement steel or anchoring plates was observed during the casting process or in inspections after it, which also allows the conclusion that the installation welds were also made sufficiently well.

The building contractor had no qualified weld coordinator appointed during the period November 2007 – April 2008. However, this was insignificant from a safety point of view because the load-bearing welds made in April were supervised by the plant vendor's qualified welding coordinator, together with the building contractor's welding coordinator undergoing the qualification process. In April, the building contractor managed to appoint trained welding coordinators who fulfilled the qualification requirements.

Raising quality and safety issues on site

Suspicions were also voiced in the public in August 2008 suggesting that problems, safety issues or quality defects cannot be brought up on the construction site. In order to investigate the situation, STUK interviewed employees on site. Following the inspection, it was found that it would be beneficial to have more open and effective communications on site.

Different interpretations existed on confidentiality rules applied on site. Language barrier also created misunderstandings and made it more difficult to raise quality or safety issues. STUK required the licensee to ensure that language barriers can no longer hinder the attainment of safety and quality objectives. It was further required that the confidentiality rules are correctly understood, so that they will not prevent people from openly bringing up problems and flaws on the construction site. The licensee was also required to ensure that the employees know several alternative ways and routes of reporting any problems or defects in safety or quality they may encounter.

STUK has approved TVO's plans for evaluating and developing the safety culture on site. STUK will follow up the implementation and effectiveness of these actions during 2009 in conjunction with its own inspections.

4.3.4 Manufacture

Manufacture of main components

The control of component manufacturing activities continued to focus on inspections of the main components. STUK's inspectors supervised the manufacturing of the reactor pressure vessel at the factory of Mitsubishi Heavy Industries in Japan and the manufacturing of steam generators at the plant vendor's factory in St. Marcel in France by regular monthly visits. The manufacture of other components, such as the pressuriser and reactor coolant pipes, was also supervised in connection with the visits. The manufacturing of the reactor coolant pumps and the control rod drive mechanisms was supervised by regular visits to the plant vendor's factory in Jeumont, France. The manufacturing of the internals of the reactor pressure vessel was supervised at Skoda's Pelzen factory in the Czech Republic, and the manufacturing of the steel liner ensuring the leak tightness of the containment was supervised at Energomontaz Polnoc Gdynia's premises. 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.

The first primary circuit components were completed during 2008. The manufacture of the reactor pressure vessel was completed in Japan. STUK carried out a final inspection of the vessel. Following the final inspection, the pressure vessel was approved for shipping to Olkiluoto. The reactor pressure vessel was put in temporary storage in Olkiluoto in late 2008. STUK investigated the interim storage of the pressure vessel in Olkiluoto and the storage conditions before the vessel arrived Olkiluoto. A total of four steam generators will be manufactured, and the first one was subjected to a successful pressure test at the end of 2008.

Some items requiring repair have still been observed in connection with the manufacture of main components (e.g. welding and manufacturing defects). Welds have been repaired in accordance with approved repair plans, and the original quality requirements have been met. With certain items, the plant vendor decided to remanufacture them. The most significant of such items were the bending pipe sections of the primary circuit, located between the steam generator and the reactor coolant pump.

During 2008, the plant vendor completed all new forged parts of the reactor coolant pipe for the cold and hot legs of the reactor coolant circuit. Following changes in the manufacturing method, the grain size of the material in the new pipes is more homogenous than in the earlier pipes that were rejected. Although there still are sections in the new pipes where the grain size exceeds the requirements, all pipes were successfully tested using ultrasonic method. STUK will assess the significance of the deviations regarding grain size when STUK has received final results for all pipes and the licensee has made its own assessment.

Manufacture of other equipment

The manufacture of parts for the containment steel liner was completed in Poland in late 2008. Defects were still observed in the manufacture. The steel plates had small areas of pit corrosion because the plates had been stored without appropriate protection, so that the plates on the top of the stack were unprotected. STUK commissioned an external expert to provide an assessment of the significance of the corroded spots. The assessment was that the corroded spots are small and as such unimportant for the steel lining. The surface of the sealing plate was ground smooth in the areas were corrosion was present. In conjunction with its inspection visit in September 2008, STUK noted that parts were welded together using welding instructions intended for a different safety class. Consequently, the decision was taken to suspend welding work until the confusion regarding welding procedures has been cleared up. It was noted in conjunction with a follow-up inspection by STUK regarding the manufacturer's performance that the manufacturing work had continued in spite of the suspension order. The welds made using incorrect welding procedures intended for another safety class were inspected using X-ray, and no welding faults were detected. All parts of the steel liner, with the exception of the containment top dome, have been delivered to Olkiluoto.

During 2008, STUK oversaw and inspected, besides the main components and containment steel lining, the manufacture of Safety Class 2 pipelines, tanks, heat exchangers, pumps, valves and steel structures as well. In particular, the oversight and inspections of pipeline manufacture involved a lot of work for STUK due to the large number of different pipelines. STUK has maintained a permanent oversight at the German factory manufacturing piping prefabricates. The prefabrication of pipelines was also supervised at the Olkiluoto harbour. STUK also controlled and inspected the manufacture of fuel handling equipment and the containment's polar crane.

In addition to overseeing the manufacture of pressure equipment and steel structures, STUK oversaw and inspected the manufacture of emergency diesel generators. In conjunction with one inspection visit, STUK noted scope for improvement in the manufacturing process and its documentation, such as loose bolt joints, deviations regarding the extent of non-destructive examination of shafts, and a machining error in a shaft. During the follow-up inspection regarding the said observations, STUK noted that the manufacturer had continued assembling the uninspected shaft without subjecting it to the earlier required non-destructive examinations. STUK insisted that the generator be disassembled so that the shaft can be examined to the extent earlier required. STUK asked for explanatory accounts regarding the observed deviations and discussed the quality of manufacture of safety class 2 equipment and the coverage of TVO's own supervision.

STUK's construction inspections, intended to ensure that the manufacture of components complies with requirements, revealed need of improvement because in some cases the inspections could not be carried out as planned. The most significant deficiencies of performance were flaws in the equipment manufacturing documentation presented to STUK for structural inspections, and the instances where the equipment scheduled for inspection by STUK had already been packed, so that the visual inspection — forming part of the structural inspection — could not be carried out. STUK required TVO and the plant vendor to ensure before the inspections that the prerequisites for construction inspection are present.

Two instances of equipment damage took place late in the year. One emergency diesel generator fell off its transport pallet. Further, the lifting mechanism of the reactor pressure vessel was damaged when a beam used in moving it failed. No significant injuries were sustained in these events. The plant vendor and TVO are investigating the damage incurred. A report on the damages or their repairs will be submitted to STUK during 2009.

4.3.5 Installation work

The installation of equipment significant to nuclear safety has only just begun. During 2008, only some pipelines and tanks were installed at the plant. Discussions aimed at ensuring the prerequisites for installation took place with TVO. In addition, STUK participated in an on-site audit of the plant vendor's installation activities. The installation of equipment significant to nuclear safety will commence during 2009.

4.3.6 Commissioning

TVO sent STUK a plan of TVO's operating organisation during the operating phase of Olkiluoto 3. The training of operating personnel for the plant continued during 2008. STUK reviewed the training programme as part of the periodic inspection programme during construction. No significant areas in need of improvement were revealed in the review.

STUK received for approval the general plan for commissioning the plant, presenting, among other things, the administrative principles and a general description of the trial operation of the plant.

During trial operation, the functionality of design solutions of the plant is to be verified, and that the operation of the plant is compliant with requirements. STUK required the plan to be further specified in detail. STUK will continue reviewing it. In addition to the commissioning plan, STUK received instructions on the commissioning of components and commissioning plans of systems. Since the system design has not been approved in all its parts, STUK did not start the reviewing commissioning plans. STUK participated in training on plant commissioning, organised by TVO.

STUK also had discussions with TVO and the plant vendor regarding the content of Technical Specifications – required for operating the plant – and of other operating instructions, as well as the prerequisites and schedules of applying for the operating licence. STUK participated in training on the use of the Technical Specifications, organised by TVO.

4.3.7 Organisation and quality management

STUK evaluated the performance of organisations participating in the Olkiluoto 3 project by carrying out inspections, through on-site oversight, by participating in supplier audits carried out by TVO and by reviewing documents supplied by TVO. The flow of information is of vital importance for the quality management of the Olkiluoto 3 project. However, the flow of information poses a particular challenge in this network of different companies, because there are such a large number of parties, they operate guided by different national and industrial cultures, and each has its own financial interests affected by time-related pressures.

Several significant changes took place in the management of the Olkiluoto 3 project in 2008 as the Project Director and the Manager of Nuclear Safety Office, *inter alia*, left the company. However, successors were appointed for them from within the project organisation, and the contents of the project management process of TVO did not change as a result of these organisational changes.

TVO has increased its resources for reviewing plant design documents and performed an extensive audit of the design activities of the plant vendor for the Olkiluoto 3 project and its subcontractors. The quality of plant design documents sent to STUK has improved, but there was further scope for improvement in their contents. Commonly found deficiencies in the documentation included using imprecise expressions in the definition of design requirements, references to wrong reference documents and ignoring or responding superficially to STUK's requirements. The documentation of I&C was in particular need of improvement. With certain items of documentation, TVO's reviews have not addressed all different areas of technology. The actions taken as a result of these are described in Section 4.3.2.

In 2008, positive developments took place with regard to construction activities. The quality of construction plans submitted to STUK for review improved, and the construction inspections became more fluent than before. There is still scope for development in the flow of information between TVO, the plant vendor and subcontractors. A few incidents came to light on the construction site where surface laying, casting or welding work had been continued without TVO's approval.

The reporting and processing of non-conformances was often slow and prevented inspections, particularly on the construction site. TVO and the plant vendor have agreed upon common rules of engagement in order to make the reporting and processing of non-conformances more efficient in construction activities and manufacturing operations. TVO has an efficient process for processing non-conformances, involving systematic classification of non-conformances. However, TVO does not utilise, in a traceable manner, its extensive non-conformance statistics for decision-making. STUK continues to stress the importance of reporting, processing and utilising non-conformances to all project parties.

The problems with requirement management in the Olkiluoto 3 projects are most clearly evidenced in equipment manufacture. Several audits carried out in the course of the year have revealed that the requirements of YVL Guides have not been conveyed to the manufacturers. TVO does not have a comprehensive requirement management system either for keeping track of official requirements, for example. Since the requests for construction inspections are received on a tight schedule, the inspectors have to prepare for end of manufacturing inspections at short notice. STUK is not aware of any cases where the above problems in requirement management would have resulted in a failure to meet the required standard for a certain item.

The problems with requirement management in the Olkiluoto 3 projects have also been reflected in the installation phase. In some cases, TVO has approved the commencement of equipment installations even though STUK's requirements regarding the equipment had not been fulfilled. 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 will be one of the focus areas of regulatory control by STUK in 2009.

4.4 Preparation for new projects

Assessment of environmental impact of the planned nuclear facilities

STUK submitted its statement regarding the environmental impact assessment report of TVO's nuclear power plant project to the Ministry of Employment and the Economy on 22 April 2008. Among other things, STUK pointed out that the radiation impact of accidents and civil protection measures were rather briefly addressed in the report.

STUK submitted its statement regarding the environmental impact assessment report of Fortum's Loviisa 3 NPP project to the Ministry of Employment and the Economy on 13 June 2008. In its statement, STUK raised the issue of the impact of cooling water on the eutrophication of the discharge area as it was assessed in the report.

STUK submitted its statement regarding the environmental impact assessment report by Fennovoima Oy to the Ministry of Employment and the Economy on 22 December 2008. In its statement, STUK required that the report be supplemented with an assessment of the impact of radiation exposure following a serious accident. In addition, STUK issued statements to the municipalities and regional councils that are preparing changes in the regional plans, local plans and local detailed plans required by the Fennovoima project regarding the proposed amendments required in the Simo and Pyhäjoki nuclear facility locations. In its statements, STUK emphasised that all substantial population concentrations within a 5 km perimeter must be included in the protective zone.

STUK also prepared a statement to the Ministry of Employment and the Economy regarding an EIA Report by Posiva where the impact of expanding the final disposal facility to accommodate the fuel from the seventh NPP unit was assessed.

Feasibility studies of planned nuclear power plants

The power companies Teollisuuden Voima Oyj, Fortum Oy and Fennovoima Oy have been making plans to build new NPP units. In compliance with section 55 of the Nuclear Energy Act, the companies have asked STUK to review the plans they have drawn up and to provide preliminary instructions on the matters that should be taken into account in such plans regarding safety, as well as security and emergency response arrangements. STUK has participated in feasibility study meetings at the power companies where the fulfilment of Finnish nuclear safety requirements in different power plant alternatives has been discussed.

TVO submitted the application for a decision-in-principle regarding the new Olkiluoto 4 power plant unit to the Government on 24 April 2008. At the same time, TVO sent the documentation for all power plant alternatives to STUK, as required in section 2.2 of YVL 1.1. STUK initiated the work to prepare the preliminary safety assessment and, having studied the documentation, stated that the submitted documentation was not sufficient in all respects, nor was it balanced considering all power plant alternatives. On 19 September 2008, STUK sent TVO a request for supplementary information regarding the licensee's and the plant vendor's organisation and quality management, as well as specific questions pertaining to power plant technology. TVO answered STUK's additional questions on 27 November 2008 and supplemented the documentation on 22 December 2008.

In its safety assessment STUK must 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.

The safety assessment work performed by STUK has been organised into a separate oversight project.

In 2008, STUK also made preparations for a preliminary safety assessment and statement to the Ministry of Employment and the Economy regarding Posiva's application for a decision-in-principle related to the expansion of the final disposal facility to accommodate the fuel from the Olkiluoto 4 unit.

4.5 FiR 1 research reactor

The FiR research reactor continued to operate in 2008 as in previous years.

There were no exceptional events affecting safety, and occupational radiation doses and radioactive releases into the environment were clearly below the set limits.

In 2008, it was possible to give two radiation treatments per week to patients, and the treatments were in the main given accordingly. 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 2008, VTT reviewed, among other things, the preparedness manual of the research reactor and sent the necessary changes in contact details to STUK for information and inclusion in its emergency response instructions.

STUK carried out inspections on the operational safety, physical protection and emergency preparedness, nuclear safeguards and radiation protection of the FiR 1 reactor. During the inspections, STUK made remarks on, among other things, the spare parts service of the reactor control system and organisation of user support.

The personnel and training plan drawn up on the key duties of the FiR 1 reactor operating staff concerns the training and transfers of the production manager, the persons responsible for security, nuclear material issues and emergency response, as well as fire and radiation protection duties. A new person looking after emergency response arrangements was approved in 2008. In addition, another new staff member started work as a radiation protection manager at the FiR 1 reactor.

In 2008, STUK approved the results of the operator hearing organised for the FiR 1 reactor. Following the approval, three reactor operators received their licences.

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 of the reactor is valid until the end of 2011.

5 Regulatory control of the spent nuclear fuel disposal project

5.1 Spent nuclear fuel disposal project

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

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

In 2008, the final disposal project and the related oversight activities by STUK were at stage 2, the "research construction stage". The regulatory control activities of STUK have been reorganised and further developed in line with the STUK's strategy and operating plan in the area of nuclear waste management..

In 2000, the Government issued the decision-in-principle referred to in the Nuclear Energy Act stating that the disposal of spent nuclear fuel in the bedrock at Olkiluoto is in line with the overall good of society. Parliament ratified the decision in May 2001. The decision-in-principle states that the spent nuclear fuel disposal project may proceed to the construction of underground research facilities and more detailed investigation. This statement 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 referred to in the decision-in-principle is designed to form a part of the final disposal facility to be constructed later.

In addition to the construction of research facilities, the decision-in-principle specifically mentions more detailed investigation; in other words, the Government and Parliament have required that research, development and design activities should be continued in order to specify the safety case further.

The actions taken by Posiva Oy, the applicant for the decision-in-principle, to implement the decision are governed by the Nuclear Energy Act and fall under STUK's regulatory control. In 2008, the final disposal project progressed in accordance with the decision-in-principle. During the reported year, regulatory control of the project focused on the following areas:

- Posiva's management system;
- construction of the research facility (regulatory control of Onkalo);
- the R&D and design activities to further specify the safety case for final disposal (R&D and design review); and
- nuclear non-proliferation monitoring of the research facility (non-proliferation monitoring).

5.1.1 Review of Posiva's management system

In 2007, Posiva submitted a description of quality management of the Onkalo construction work, as prescribed in section 35 of Nuclear Energy Act. The description consisted of Posiva's operations manual which includes the description of quality assurance in Onkalo. STUK reviewed the compliance of the management system against the requirements in Regulatory Guide YVL 1.4 as applied to the construction of Onkalo. The review by STUK indicated that, in the main, Posiva's management system fulfils the applicable requirements. The following areas were considered to need further development:

- in addition to nuclear safety, radiation safety must also be taken as the goal and basis of the management system and policy;
- the management system must better take into account the safety significance of different activities;
- a person must be appointed, for Onkalo construction work, with equivalent responsibility and duties as those of the responsible manager for construction of a nuclear facility;
- the structure of the quality manual must be made less ambiguous;
- the management of organisational changes must be improved;
- the training of suppliers and subcontractors must be developed so that it takes into account the objectives and goals of Posiva's management system and policy.

Posiva has developed its management system in line with STUK's requirements and submitted the materials for review by STUK in December 2008. STUK will review Posiva's updated operations manual in early 2009.

5.1.2 Regulatory control of the construction of research facility (regulatory control of Onkalo)

In 2008, an important part of regulatory control was the review and approval of plans describing the excavation works of tunnel phase 4 (access tunnel, from chainage 3,117 m to 4,340 m). As a whole, the control by STUK focussed on bedrock sealing, control of seepage waters that change the groundwater conditions and on the chemical and physical impact of excavation.

Overall safety assessment

The construction of Onkalo is proceeding in accordance with the overall schedule. In 2008, a significant water-conducting zone of fractured rock, HZ20, was penetrated. Sealing it using injection techniques delayed the excavation time schedule by some 1½ months.

In 2008, Posiva decided to change the extent of the construction of Onkalo so that the lower (–520 m) research level will not be implemented at this stage. STUK reviewed the matter from the point of the long-term safety implications of the change, and from the point of the Olkiluoto site investigations. Review of the matter will be completed in early 2009.

The construction of Onkalo may affect the long-term safety of disposal by changing the properties of the bedrock and groundwater surrounding the repository. The safe implementation of disposal activities requires that the systems are designed taking into account also operational safety aspects. The impact of the construction of Onkalo has been monitored by means of various measurements, and the limiting values, derived from long-term safety considerations, have not been exceeded. No factors compromising safety have been detected in the design and implementation of the structures and systems important to safety.

In 2008, STUK prepared a compilation of safety requirements applicable to Onkalo and of regulatory control of the planning and construction process of Onkalo. The practices deployed for Onkalo will create the basis for the requirements for, and regulatory control of, the underground disposal facility.

Regulatory control of design and construction

STUK controlled the construction of the underground research facility by reviewing Posiva's design documentation and performing inspections on the construction site.

STUK approved the updated classification document for Onkalo. Following recommendations by STUK, it had been supplemented with an assessment of safety implications, as well as diagrams and drawings showing the classification limits. In its review, STUK again highlighted the importance of ensuring that the safety classification is unambiguous and pointed out certain flaws in the drawings and diagrams describing systems.

STUK approved the requested plans by Posiva regarding the provision of documents related to the design and construction of Onkalo and the provision of information on the construction process. The plan for providing documents was updated in line with STUK's requirements to more comprehensively cover the following matters:

- organisational matters;
- the applicable regulations, odes and standards;
- the starting parameters used for planning and design;
- printed design documents;

- documents related to construction-related manufacture and as-built information;
- provision of information on time schedules and deviations.

These plans create a framework for STUK's regulatory control of the design, planning and construction of Onkalo.

The focal targets of regulatory control in 2008 were the design and plans regarding the excavation of tunnel phase 4. In reviewing them, STUK commented on the quality control in the construction work of Onkalo, the plans for penetrating the HZ20 rock fracture zone and the research programme supporting the planning and design of Onkalo. Approval of the plans for tunnel phase 4 was a prerequisite for continuing the construction Onkalo. At various stages of the review, STUK requested additional information on, among other things, the predicted locations and safety implications of rock structures, and the measures for ensuring setting of the injected cement. STUK continued monitoring the work aimed at ensuring the setting of injection cement by observing the tests carried out at Onkalo and by reviewing the test results.

STUK made regular inspections at the construction site, about twice a month depending on the progression of the construction work. Follow-up meetings were organised between STUK and Posiva about once a month regarding issues related to the construction and regulatory conrol of Onkalo. STUK also reviewed the geological mapping data on Onkalo's access tunnel between the chainages of 2,350 to 3,150 metres. The aim of the review is to ensure the sufficient scope and correctness of the survey data before the rock surfaces are clad with shotcrete.

Oversight of the organisation and procedures

The operation of the organisation overseeing the construction of Onkalo and the quality management process were reviewed as part of the audit of Posiva's management system. The construction inspection programme (RTO) provided the framework for the review of organisation and procedures.

STUK's regulatory control of Posiva's organisation comprised of inspections of the project management, the handling of safety issues and construction procedures. Based on the inspections, STUK required improvements in the instructions and procedures concerning the construction of the research facility, Examples of these are:

- deployment of the plan for compiling the as-built construction documentation of Onkalo during tunnel phase 4;
- update of the instructions for internal and external audits and development of the utilisation of overall assessments of audit results and the actual results;
- development of deviation procedures with regard to analysing their safety implications and causes, as well as with regard to closing the deviation cases;
- development of practices regarding the flow of information.

As a whole, the organisation and procedures of Posiva can be deemed to have improved considerably from the situation at the beginning of 2006, when Posiva assumed the responsibility for the Onkalo construction process in the capacity of the main contractor.

STUK also oversees Posiva's subcontractors based on the safety significance of their work. STUK observes their activities through inspections and in connection with document review, meetings, structural inspections of components and structures, and visits to the construction site and laboratories. STUK decides on its participation in the audits carried out by Posiva on its subcontractors each year on the basis of their respective importance to safety. In 2008, STUK participated in the audit of SK-Kaivin, a company performing the excavation work in Onkalo.

5.1.3 Regulatory control of research, development and design activities to further specify the safety case for final disposal (regulatory control of R&D and design)

The regulatory control of R&D and design activities comprises independent safety assessment of Posiva's activities and their results, forming an opinion of them and, as necessary, guidance and the formulation of requirements as well. STUK seeks to ensure that as good a result as possible is achieved with maximum certainty. This objective and ultimately the quality of Posiva's performance determine how STUK acts in terms of the regulatory control of R&D and design activities at any given time.

STUK's regulatory control comprise reviews of the current documentation for the safety case of the disposal facility, comparative analyses, identification of problematic safety issues and inspections of Posiva's and its subcontractors' management and quality systems. During 2008, STUK completed the process of reviewing of two extensive sets of documentation regarding disposal and initiated the review of two such set of documentation, to be continued in 2009. As background material, approximately one hundred research reports were also reviewed. Their main subjects were site confirmation investigation results and disposal technology.

Encapsulation and disposal technologies

The design of Posiva's encapsulation and disposal facilities has progressed based on long-term planning. The plans of the preliminary design stage were completed towards the end of 2006. The work on preparing draft plans for the disposal facility is currently in progress. The documents are scheduled to be completed by the end of 2009.

In early 2008, STUK completed the review of preliminary planning phase documents for the disposal facility. Most of the review work took place in 2007. The items under review included the design and construction of the repository, the systems monitoring how the construction of the repository affects the safety-significant properties of the bedrock, the encapsulation and disposal process, systems planning, safety classification of systems, the layout of the facilities, rock and concrete construction, fire compartmentalisation and fire safety, radiation protection design, radiation classification, radiation monitoring, the closing of the repository and waste processing. The plant description documentation was assessed applying the requirements set out for the construction licence application. It is therefore natural that the plans do not fulfil the requirements at this stage. The main observations made in STUK's review of Posiva's plant description were:

- Posiva's preliminary planning documentation did not display the methodical and systematic approach required when planning and designing a nuclear facility.
- The design requirements were not indicated in a clear and comprehensive manner, nor were the key design bases shown.
- Posiva had not described the design basis accidents nor the associated design requirements.
- Several comments were related to the system description of the plant
- Further issues raised included radiation protection issues in the design of the plant layout and taking into account functions potentially compromising the performance of technical barriers in plant design.

Posiva has continued the development work of waste canister manufacturing techniques in co-operation with SKB, the Swedish nuclear waste company. The electron beam welding tests for sealing the copper canister have continued in co-operation with Patria Aviation. Using the pierce-and-draw method, which is Posiva's responsibility, four copper canisters were manufactured in 2008. Cast iron inserts internal parts of the canisters were manufactured in 2008 as follows: insert of BWR type, two examples; insert of PWR type, three examples. During 2008, Posiva implemented the EB-DEMO project involving 12 welds and inspections of copper canister lids. The purpose of the EB-DEMO project was to establish how well Posiva is currently capable of manufacturing the copper canister components, sealing the canister off with electron beam welding and inspecting the canister components and the welded joint. Posiva has also continued the development of non-destructive testing methods for waste canister inspection in co-operation with BAM, VTT and SKB. In the BENTO programme, Posiva has identified the critical issues regarding the performance of bentonite buffer and is seeking to establish other issues related to it and to develop manufacturing and emplacement techniques as well as domestic expertise in the field. Posiva has made progress in the development of bentonite buffer and tunnel backfilling materials, and design reports will be issued on both during 2009.

Posiva has studied and developed, as the main alternative for the disposal of fuel, a solution where the disposal canisters are placed vertically in disposal holes. As the other alternative, Posiva has investigated the emplacement of disposal canisters horizontally in tunnels, the so-called KBS-

3H concept. Posiva has reported the main part of the development project for the KBS-3H concept, which was completed in 2007. On the basis of the results of the project, Posiva and SKB have decided to continue developing the alternative concept. STUK will review the KBS-3H reports during the latter half of 2008 and first half of 2009.

In 2008, STUK held two meetings with Posiva concerning the engineering barrier system where safety issues brought up by STUK were discussed. The discussion on safety issues was recorded on a follow-up list of EBS issues that was revised during 2007 and introduced at the beginning of 2008. In 2008, Posiva submitted two responses to the follow-up list regarding EBS safety issues. STUK updated the EBS issue list in June 2008 and will send the next update to Posiva in January 2009.

Safety-related issues regarding final disposal technology included the following:

- the design bases of the Engineered Barrier System (EBS);
- the design bases, manufacturing, inspection, properties and evolution of EBS components (disposal canisters, buffer and backfilling materials);
- issues related to the operating phase of the final disposal facility (such as emplacement of EBS components and QA/QC);
- the performancwe of EBS after the disposal facility has been closed, during the temperate climate phase, the assumed future ice age and the climatic conditions after it.

Site investigations

Posiva began investigations regarding the suitability of the disposal site in Olkiluoto after receiving the Government's decision-in-principle in 2001. The investigations continued in 2008, both above ground and in Onkalo, the underground research facility. Posiva drilled two new deep boreholes (OL-KR49 and OL-KR50) in the eastern part of the Olkiluoto research area. They were used for geological surveys, as well as for the geophysical and hydrological studies required for modelling. The fractures, rock type distribution and degree of deformation were studied with the help of two research excavations.

The monitoring programme in the Onkalo area carried out by Posiva, aimed at monitoring possible safety-significant changes the construction of Onkalo could cause in the bedrock (e.g. leaks of groundwater into Onkalo, excavation damage caused to intact rock, materials such as concrete, as well as fuel and lubricants of transport vehicles, introduced to Onkalo due to excavation and potentially harmful to long-term safety, and rock movement). In 2008, STUK reviewed the monitoring documents compiled by Posiva during 2006. The main observations made in the review were related to the implementation of the monitoring programme, the amendments made to the programme and the comparison of monitoring results with the conditions prevailing in Olkiluoto before the construction of Onkalo began.

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.

In its review of site investigations, STUK has identified issues, the safety significance of which were not adequately known at the time or which warrant further investigation or analysis due to safety reasons. These issues constitute a list of so-called open safety issues that is constantly updated as a result of Posiva's accumulating research data and STUK's inspection work. In its assessments, STUK relies on the support of a group of international experts in the field of geosciences.

STUK revised the list of safety issues early last year by further defining the classification of issues. The development work continued during the latter part of the year with the aim of focusing the resources to the most significant and urgent safety issues that need to be resolved during the construction licence phase, and it will also continue in 2009.

The safety issues related to site investigations were discussed in two meetings between Posiva and STUK's group of experts. The meetings also discussed developments in disposal site modelling, STUK's assessments regarding the evolution of the disposal site and the processes associated with it, the impact of the Onkalo construction work on the bedrock and Posiva' plans for studies to be carried out from Onkalo.

The currently topical safety issues are related, among others, to the following:

- the damage zone in the bedrock caused by excavation ;
- alteration and permafrost in the bedrock;
- hydrogeology and hydrogeochemistry; distribution of groundwater types at Olkiluoto;
- modelling of groundwater salinity;
- basic geologic parameters for modelling the transportation of radionuclides;
- chemical stability of the bedrock and the significance of dissolved gases and microbes in redox processes.

Oversight of the development of safety analysis and the safety case

In 2008, Posiva published a new plan regarding the compilation of the safety case. When updating the plan, Posiva has taken into account the recommendations by STUK on further specifying and developing it. STUK began reviewing the updated plan in late 2008 and expects to complete it in early 2009.

Posiva's safety case for the disposal facility, prepared in compliance with the new plan, will consist of a number of reports (Safety Case Portfolio) and materials that are updated every few years in an iterative process until final versions for license application are produced. The portfolio covers the following main documents:

- description of the disposal system (including a description of the disposal site, the plant and the EBS system);
- process report;
- formulation of scenarios (including a description of the evolution of disposal site and disposal facility);
- models and data;
- analysis of scenarios;
- complementary considerations;
- summary report.

The review of the disposal system in 2008 has been discussed above. Regarding the rest of the documentation, STUK has assessed the description of the evolution of the disposal site and facility, parts of the documentation concerning biosphere analyses and the documentation describing the physical and chemical processes of disposal.

Supported by a group of international experts, STUK carried out a safety assessment of the so-called Evolution Report (POSIVA 2006–05) and the associated documnentation, which describe the evolution of the disposal facility in three periods extending to 450,000 years in the future. In addition to normal operation, the documentation describes the evolution of faulty canisters under two different climatic scenarios. On the basis of its assessment, STUK took the view – at this stage of the final disposal project, when the safety case will be further developed as work progresses – that the report is sufficient and deploys the correct type of methodology. The assessment was carried out by comparing the evolution documentation with the standard required of the construction licence documentation to be submitted in 2012. Consequently, STUK is of the opinion that the documentation:

- does not always show sufficient grounds for its conclusions;
- requires more accurate qualitative analyses in its support;
- is missing an assessment of the total impact of safety functions;
- should better take into account the local conditions in Olkiluoto;
- must show that the phenomena leading to a weakening of the performance of the bentonite clay surrounding the disposal canisters will not compromise safety;
- needs a better rationale behind the evolution of climatic conditions;
- should not exclude the possibility of permafrost reaching the final disposal depth.

The climatic conditions, terrain formations, land usage, soil, terrestrial flora and fauna, as well as the sea, seabed and aquatic organisms in and around Olkiluoto, were discussed in the biosphere documentation (POSIVA 2007-02) submitted by Posiva to STUK. The documentation also presented conceptual ecosystem models for the terrestrial and aquatic environments. STUK reviewed the documentation, assisted by a group of external experts. The assessment focussed on evaluating the systematic approach and coverage of the report, as well as the possibility of utilising its results in justifying long-term safety.

In 2008, STUK initiated the review of the extensive documentation submitted by Posiva regarding the chemical and physical processes, characteristic features, events and other phenomena (so-called FEPs) of the final disposal facility for spent nuclear fuel (POSIVA 2007-12). The documentation presents the essential FEPs affecting long-term safety for the fuel, canisters, bentonite buffer, tunnel filling materials, tunnel sealing materials and the bedrock. The impact on the performance of the system is presented for different periods of time, and the main uncertainties associated with each phenomenon are also shown. An international assessment team consisting of ten members was used for the safety assessment. Most of the assessment work was completed during 2008, and STUK will finalise its assessment regarding the documentation during the first half of 2009.

Other safety research

Posiva's safety research is also based on long-term bilateral and multilateral collaboration projects. The majority of the bilateral research projects are included in the collaboration between Posiva and SKB. 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 participate. In addition, Posiva is participating in the international DECOVALEX project.

STUK considered Posiva's research collaboration in 2008 to be sufficiently extensive and of an adequately high standard. The collaboration with SKB was particularly extensive. In addition to technical and scientific benefits, international collaboration will increase openness concerning Posiva's activities among the scientific community; STUK considers this openness to have a significant impact by promoting safety and safety culture.

To the extent that Posiva has 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 by reviewing documents, in connection with meetings, construction inspections of components and structures, and construction site and laboratory rounds.

6 Regulatory control of nuclear non-proliferation

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

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

Safeguarding nuclear materials constitutes a requirement for the peaceful use of nuclear energy. Finland has in place a national system for nuclear material control, 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. IAEA safeguards are based on the Non-Proliferation Treaty and the Safeguards Agreement (INFCIRC/193) signed by non-nuclear weapon EU Member States, the European Atomic Energy Agency and the IAEA, as well as the Additional Protocol of the Safeguards Agreement (INFCIRC/193/Add.8). EU safeguards are based on the Euratom Treaty and Commission Regulation EURATOM 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.

To enable the IAEA to discover even secret nuclear programmes, the Nuclear Safeguards Agreement was supplemented with an Additional Protocol to extend the IAEA's rights to inspect and obtain information to cover the activities related to the nuclear fuel cycle in addition to nuclear materials. The Additional Protocol entered into force in the EU on 30 April 2004. The Additional Protocol entitles the IAEA to gather more information on activities in the nuclear field. States must notify the IAEA of nuclear facility sites, research and development projects related to the nuclear fuel cycle, as well as of the manufacture of certain, separately defined, components in the nuclear field and their export. 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 sector activities.

Combined, the regulatory control under the Nuclear Safeguards Agreement and that under the Additional Protocol constitute so-called Integrated Safeguards. In Integrated Safeguards, the IAEA performs fewer routine inspections, but it has the option of carrying out inspections giving either no notice at all or very short notice. This allows the IAEA to verify that the member country has no undisclosed activities related to the nuclear fuel cycle, and that the member country honours its obligations under the Nuclear Non-Proliferation Treaty. The IAEA's integrated control began in Finland on 15 October 2008. The efficient enforcement of the IAEA's Integrated Safeguards in Finland is made possible by the national control system maintained by STUK.

STUK applies its regulatory control of nuclear materials to both nuclear power plants and smaller holders of nuclear material

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

STUK inspects nuclear material holders and actors 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 safeguard manuals, and grants licences required by legislation. In addition, STUK is responsible for the activities associated with the accreditation of international inspectors.

Measurements and sampling are deployed to verify the correctness and completeness of reports submitted by facilities

The technical analysis methods applied in safeguards contribute to ensuring that nuclear materials and operations are in accordance with the notifications and that all operations are notified. STUK applies non-destructive methods and envi-

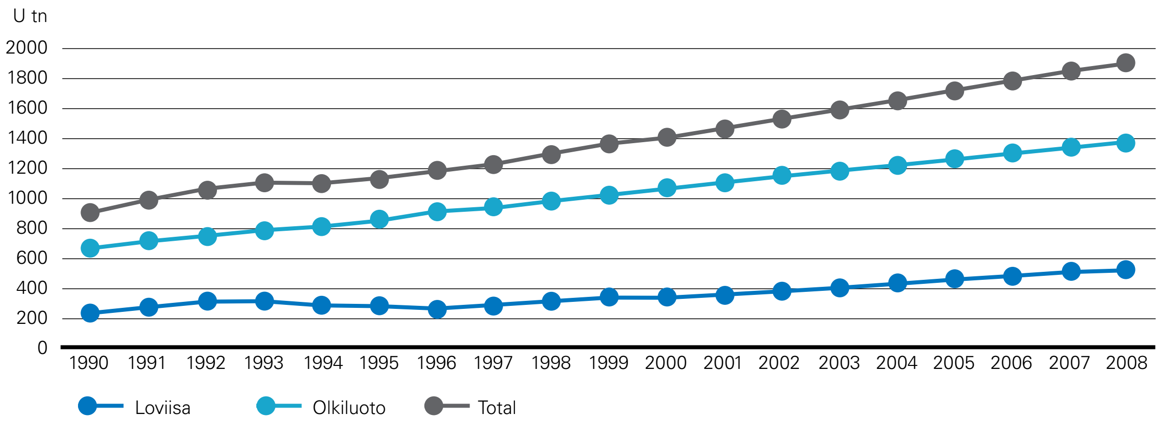


Figure 16. Amount of uranium in Finland.

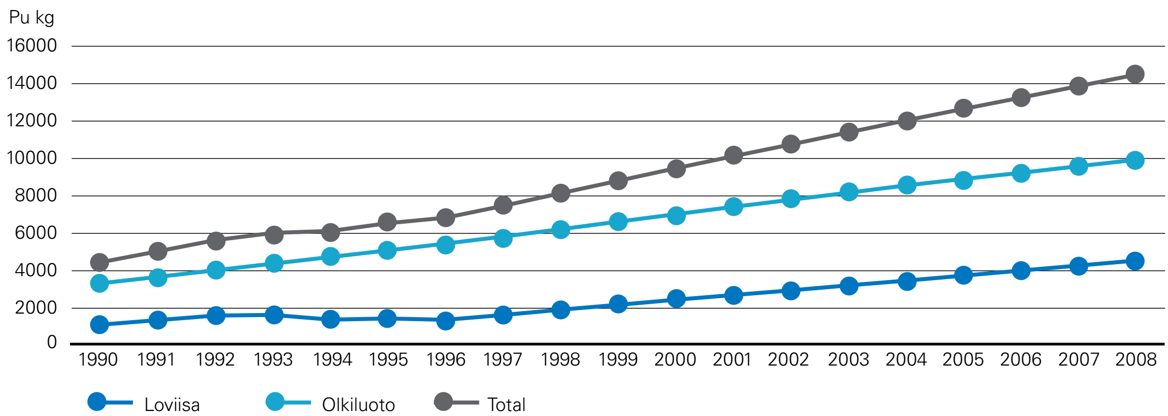


Figure 17. Amount of plutonium in Finland.

Table 6. Amounts of nuclear materials in Finland 31 December 2008.

Location	Natural uranium (kg)	Enriched uranium (kg)	Depleted uranium (kg)	Plutonium kg	Torium kg
Loviisa plant	–	510 970	–	4 550	–
Olkiluoto plant	–	1 377 955	–	9 933	–
VTT / FiR 1 research reactor	1 511	60	0,002	–	–
Other facililties	~ 2344	~ 1,7	~ 1694	~ 0	~ 5

ronmental sample analyses to verify that the information notified 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 by material category are shown in Figure 17. The licences granted by STUK pursuant to the Nuclear Energy Act are listed in Appendix 4.

STUK controls the transfer of nuclear products in co-operation with other public authorities

In order to prevent the proliferation of nuclear weapons and sensitive nuclear technology, STUK controls the transfer of nuclear products 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 imports and exports 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 include co-operation with Customs in investigating irregularities observed in radiation monitoring at the 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 Tracking Database (ITDB) maintained by the IAEA to keep records of observed irregularities regarding nuclear materials and radiation sources.

Regulatory control of the research facility for spent nuclear fuel produces data for the future licensing process of the disposal facility

STUK has obliged Posiva Oy, the company examining final disposal and its implementation, 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 operations relevant to nuclear safeguards exist in the final repository area. Another aim is to ensure that the IAEA and the European Commission can plan their future safeguards activities and inspection procedures to satisfy themselves of Finland's capability to implement adequate safeguards. The final disposal of nuclear fuel in an underground repository presents new challenges for safeguards planning and implementation, since, after encapsulation, nuclear material verification will be impossible.

6.2 Nuclear safeguards, activities and results in 2008

Licences and approvals

In 2008, STUK granted eight import licences for nuclear materials to TVO and three import licences to Fortum. An extension was granted to the export licence for uranium pellets held by VTT's FiR 1 research reactor. In addition, Platom Oy was granted a permit to hold documentary material.

STUK provided the Ministry of Employment and the Economy with a statement regarding one documentary material import licence application and the Ministry for Foreign Affairs with a statement regarding one documentary material export licence application.

STUK granted two transport licences for fresh nuclear fuel and approved four transport plans for such fuel. Fresh fuel was imported by Finnish nuclear power plants from Sweden, Spain and Russia.

STUK approved the responsible director of the Loviisa power plant and the director's deputy, the responsible director of the Olkiluoto power plant (Olkiluoto 1, Olkiluoto 2 and spent fuel storage) and the director's deputy, as well as the responsible director of the Olkiluoto 3 construction project. STUK approved the updated nuclear materials manual of the Loviisa plant, the person in charge of monitoring the international transports of TVO's nuclear material, as well as the update of Posiva's nuclear non-proliferation manual.

In 2008, STUK approved 20 new Euratom inspectors and 11 new IAEA inspectors to carry out inspections in Finland.

Monitoring pursuant to the Additional Protocol to the Safeguards Agreement

Declarations pertaining to Finland, required under the Additional Protocol, totalled 18 in 2008, 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. The IAEA paid one Complementary Access visit to Finland at 24 hours' notice, according to the Additional Protocol. The subject of the Complementary Access was research work carried out in the Laboratory of Radiochemistry at the University of Helsinki.

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. The IAEA notified Finland that the integrated control of nuclear materials will commence in Finland on 15 October 2008.

Inspections as part of regulatory control of nuclear materials

In 2008, STUK carried out a total of 31 nuclear materials inspections at nuclear power plants, including 12 in Loviisa and 18 in Olkiluoto. Of these, Euratom participated in 23 inspections, and the IAEA in 24. In 2008, STUK verified by non-destructive methods 41 spent fuel assemblies at the Olkiluoto power plant and 109 spent fuel assemblies at the Loviisa power plant during two measurement campaigns. One measurement campaign in Olkiluoto had to be interrupted and postponed until 2009 when the measurement instrument failed. In addition, STUK inspected the transport of fresh fuel to Olkiluoto and Loviisa in 2008. The records of international transport of nuclear fuel owned by TVO were inspected in 2008 with respect to the fuel consignments destined for the Olkiluoto NPPs.

In 2008 STUK, the IAEA and Euratom carried out one joint inspection of a nuclear material inventory of the FiR 1 research reactor operated by VTT. STUK verified 16 fresh fuel assemblies at VTT using non-destructive methods. In addition, STUK inspected other nuclear materials held by VTT, including graphite and control rods. Following the inspections, STUK required VTT to update the nuclear materials manual with regard to keeping records of and reporting other nuclear materials.

STUK carried out three periodic inspections of the Onkalo site under the nuclear non-proliferation agreement. The purpose of these inspections was to verify that the underground facilities correspond to what has been reported by Posiva. The IAEA participated in two inspections and Euratom in one inspection of Onkalo. The Swedish public authority SSM also sent observers to the inspections carried out by STUK. International organisations became more active in non-proliferation monitoring of the final disposal. The Commission issued a Material Balance Area code for the upcoming final disposal facility, and the IAEA made preparations for defining the design details of this new type of facility for its safeguards purposes. A planning meeting was organised with the IAEA and Commission in December regarding the implementation of safeguards.

Radiation control at the borders

Customs and STUK drew up a mutual co-operation agreement. Customs and STUK commenced a common project for revising technical equipment for radiation control at the borders. The project will be implemented in 2009–2014, and it includes equipment purchases, an update of common operational methods and instructions, as well as a training plan. STUK prepared a proposal for comments by other authorities for developing the exchange of information through the Illicit Tracking 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.

A special Preparatory Commission, which convenes in Vienna, is preparing for the Treaty's entry into force. All signatory states are represented in the Commission. The Provisional Technical Secretariat, whose tasks include constructing and maintaining the international monitoring system, operates in Vienna as well.

The National Data Centre (NDC), which is based on the CTBT and operates in conjunction with STUK, contributed to the work of the Preparatory Commission for the Comprehensive Nuclear-Test-Ban Treaty Organisation (CTBTO) in establishing a cost-effective NDC organisation that is functional from the Finnish perspective. The automatic analysis software used for the NDC's own routine monitoring analysed, on average, about 660 gamma spectra per day in 2008, which represents an increase of almost 10 % compared with the previous year. The increasing number of analyses is due to the fact that new stations are coming on-line in the CTBTO's network of monitoring stations. The network is almost complete now which means that fewer new stations will be established annually. Routine monitoring is facilitated by an alarm system transmitting data on unusual observations to NDC personnel. No abnormal activity levels in air relevant to the Treaty were observed by the NDC. The analysis server and database of the NDC were revised during 2008.

7 Safety research

The purpose of safety research is to ascertain that the authorities have adequate expertise available, including concerning unforeseeable issues affecting the safety of nuclear facilities. Publicly-funded 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. 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 2008 in January, and a corresponding statement on the KYT2010 programme in February.

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 control room, and the employment of probabilistic risk analysis in safety management and control. The funding of the SAFIR2010 research programme totalled €6.7 million in 2008, 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

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. The Ministry of Employment and the Economy provides information on the projects on its website at www.tem.fi.

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.

SAFIR2010 and their shares of the total funding are shown in Figure 18.

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 for aircraft impact are met.

In 2008, the Ministry of Employment and the Economy commissioned an international review of the KYT2010 programme. The review is available at the Ministry website (www.TEM.fi, *KYT 2010 Review Report, Publications of the Ministry of Employment and Economy, 2/2008*). In the review, the programme received both positive feedback

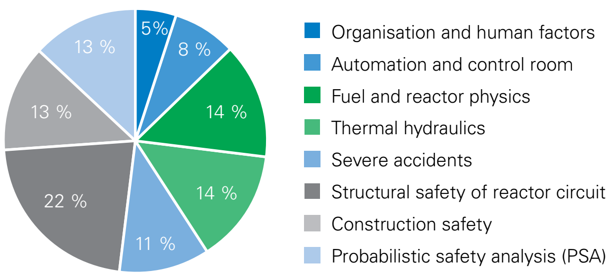


Figure 18. Research areas of SAFIR2010 programme and their shares of the total funding in 2008.

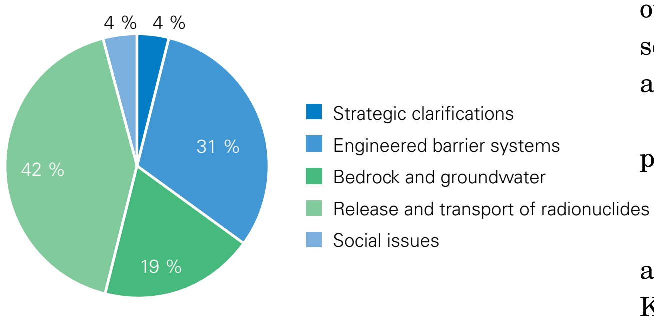


Figure 19. Research areas of KYT2010 programme and their shares of the total funding in 2008.

and recommendations and suggestions for further development of operations. The recommendations were mainly related to the operational methods of the programme. The development suggestions were related to the following areas:

- investigation of final disposal alternatives;
- national training for nuclear waste management;
- safety analysis methods;
- competence centre for nuclear waste management
- integration of R&D;
- more visible oversight of researchers and projects.

The steering group appointed committees to prepare development plans for each area of development. The goal is to have the development plans implemented by the end of the current programming period.

Twenty-eight applications were received for the KYT2010 programme for 2008, 20 of which were accepted. Twelve of them were new, while 16 continued the work carried out in the previous year. The KYT steering group gave its funding recommendations to the Ministry of Employment and the Economy, relying on the assessments of the supporting group regarding on the compatibility of each proposed project with the criteria set for the programme, and sorted the proposals by their merits. The total volume of the KYT2010 programme in 2008 was €1.5 million, and the studies mainly concentrated on the long-term safety issues of final disposal of nuclear fuel, such as technical barriers (6), bedrock and groundwater (5), and the release and transportation of radionuclides (8). In 2008, one social study was also included in the programme. Figure 19 shows the relative shares of these areas of the total funding. A total of 27 research project proposals were submitted for 2009, and the work of evaluating them is in progress.

The mid-term seminar of the KYT2010 research programme was held on 26 September 2008. The presentations focussed on the information produced in the projects under the programme, and almost all researchers taking part in the KYT programme during the period attended the seminar. The presentations are available at the website of the KYT2010 programme (http://www.ydinjatetutkimus.fi/tiedotteetmain.html). In the seminar, interim results were presented on various studies, including the methane production of bacteria present in the bedrock, the ecological risk assessment of final disposal in a forest ecosystem, the ageing of reinforced concrete structures, the deformation of nuclear waste canisters, and the thermo-hydro-mechanical modelling of bentonite during the thermal phase.

8 Enforcement of regulatory oversight of nuclear facilities

8.1 Review of documents

In all, 4,262 documents were submitted to STUK for review in 2008. Of these, 2,200 concerned the nuclear power plant under construction, and 121 were related to the final disposal of spent nuclear fuel. Document reviews totalling 3,850 were completed, including documents submitted in 2008, 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 86 days. The number of documents and their average review times in 2004–2008 are shown in Figure 20. Figures 21, 22 and 23 present the distribution of document review times for the different plant units.

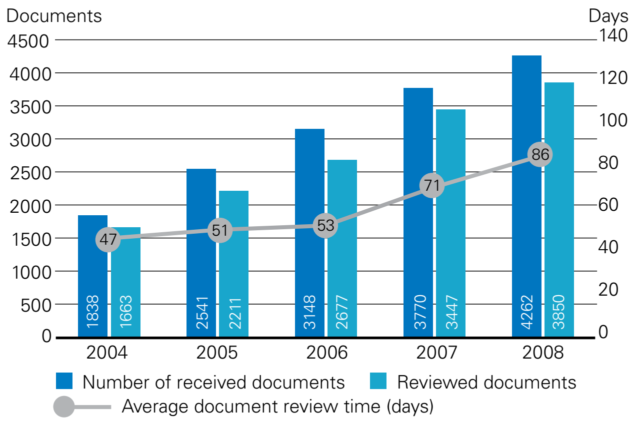


Figure 20. Number of documents received and reviewed as well as average document review time.

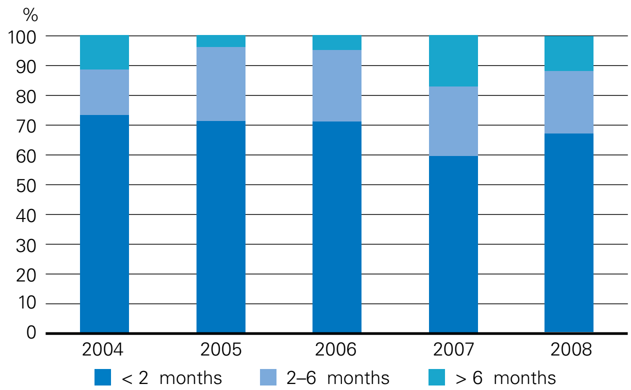


Figure 21. Distribution of time spent on preparing decisions on the Loviisa plant.

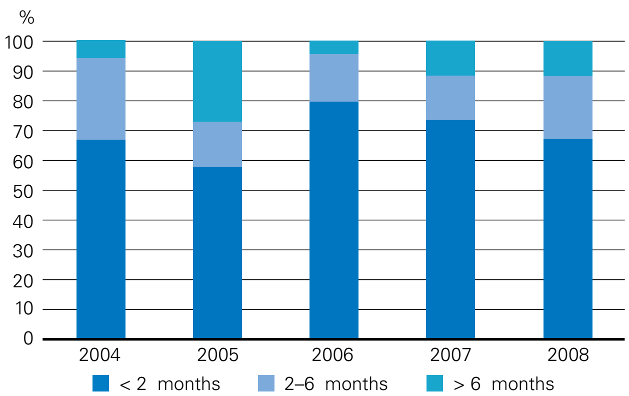


Figure 22. Distribution of time spent on preparing decisions on Olkiluoto plant units 1 and 2.

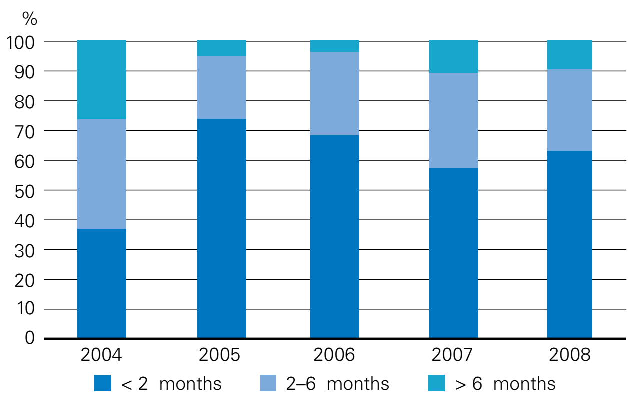


Figure 23. Distribution of time spent on preparing decisions on Olkiluoto plant unit 3.

8.2 Inspections on site and at suppliers' premises

Periodic inspection programmes

The 2008 periodic inspection programme (Appendix 5) was planned to include 21 inspections at the Loviisa plant and 22 at the Olkiluoto plant. During the year, it was found that STUK did not have the resources to carry out all of the inspections and, accordingly, it was decided to omit six inspections at the Loviisa plant and two at the Olkiluoto plant. One ex-programme inspection was carried out at the Loviisa plant. Its subject was maintenance training related to the I&C system revision. The findings of the inspections are presented in the chapters on regulatory oversight.

Inspection programme during the construction phase of Olkiluoto 3

In 2008, STUK carried out seven inspections of the Olkiluoto 3 construction inspection programme (Appendix 6). In addition, STUK assessed the safety culture on the construction site in a separate inspection.

Inspection programme during the construction phase of Onkalo

In 2008, STUK carried out eight scheduled inspections within the Onkalo construction inspection programme (Appendix 7). The findings of the inspections are presented in Section 5.1.2, discussing the regulatory oversight of Onkalo.

Other inspections on plant sites

A total of 1,031 inspections on site or at suppliers' premises were carried out in 2008 (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, 388 pertained to oversight of the plant under construction and 643 to that of the operating plants. Relevant documents are reviewed prior to on-site inspection.

The number of inspection days on site and at component manufacturers' premises totalled 2631. 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 270 inspection days outside normal working hours were spent at operating nuclear power plants, mostly during annual maintenance outages, as well as 89 inspection days at the plant under construction. The number of days spent on inspection has increased due to the inspections relating to the construction of the new nuclear power plant. Four resident inspectors worked at the Olkiluoto nuclear power plant. The Loviisa plant has one resident inspector. The number of on-site inspection days in 2004–2008 is shown in Figure 24.

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

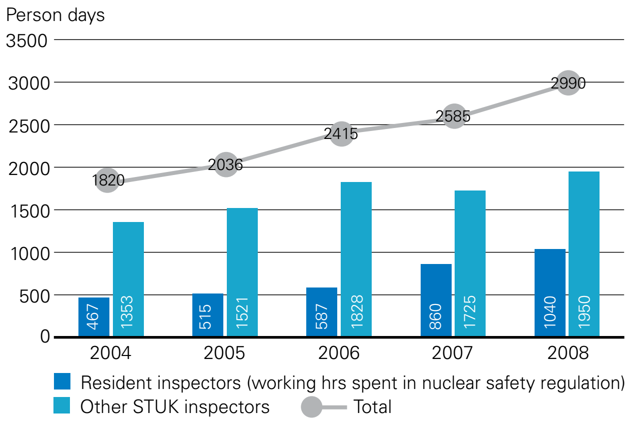


Figure 24. Number of inspection days onsite and at component manufacturers' premises.

of contracted services in relation to the number of working hours spent on each function.

In 2008, the costs of the regulatory oversight of nuclear safety subject to a charge were €14.0 million. The total costs of nuclear safety regulation were €15.4 million. Thus the share of activities subject to a charge was 90.6%.

The income from nuclear safety regulation in 2008 was €14.0 million. Of this, €2.3 million and €9.4 million came from the inspection and review of the Loviisa and Olkiluoto nuclear power plants, respectively. In addition to the operating plant units, the income from the Olkiluoto plant includes that derived from the regulatory oversight of the Olkiluoto 3 construction project. The income from the inspection and review of Posiva Oy's operations was €1.9 million. Figure 25 shows the annual costs from nuclear safety regulation in 2004–2008.

The time spent on the inspection and review of the Loviisa nuclear power plant was 11.5 person-years, i.e. 9.4% of the total working time of the nuclear regulatory personnel. For Olkiluoto nuclear power plant's operating units it was 10.6 person-years, which accounts for 8.7% of the total working time. In addition to the oversight of the operation of nuclear power plants, the figure includes nuclear material control. The time spent on inspection and review of Olkiluoto 3 was 29.3 person-years, i.e. 24.0% of the total working time. The time spent on nuclear waste management inspection and review was 7.8 person-years The time spent on international co-operation regarding regulatory oversight of nuclear safety was 5.1 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 26 shows the division of working hours of the personnel engaged in nuclear safety oversight (in person-years) by object of regulation in 2001–2008.

Where necessary, STUK commissions independent safety analyses and research in support of regulatory decision making. Figures 27 and 28 show the costs of nuclear safety research in 2004–2008. In addition to technical support projects, the pre-2005 figures also reflect the costs of national nuclear safety research. The costs for 2008 mostly

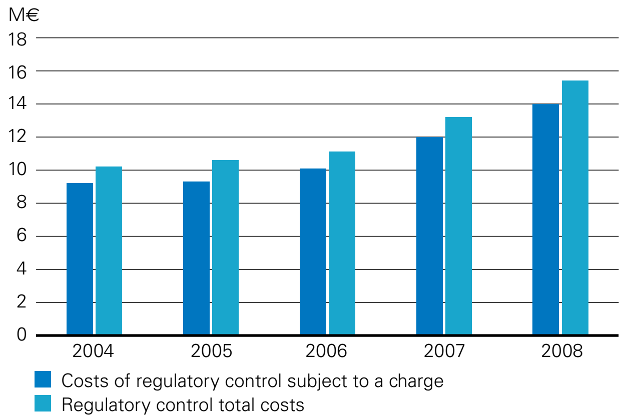


Figure 25. Income and costs of nuclear safety regulation.

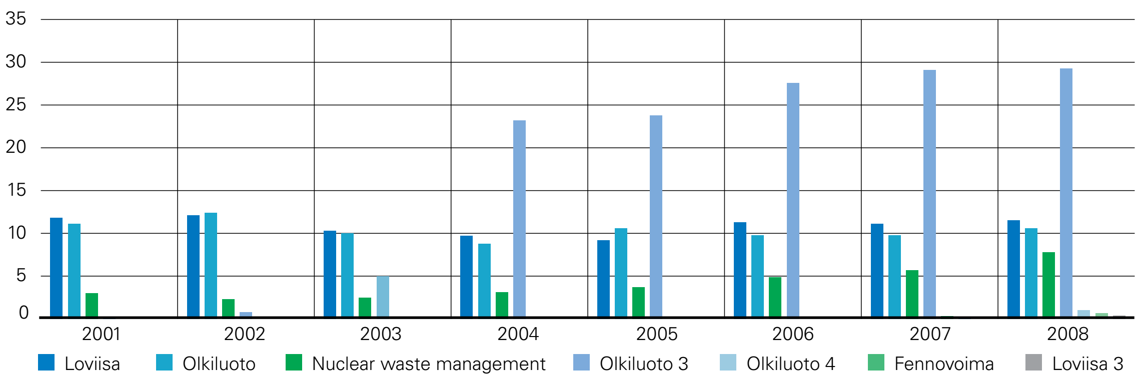


Figure 26. Distribution of working hours (person-years) of the regulatory personnel by subject of control in 2001–2008.

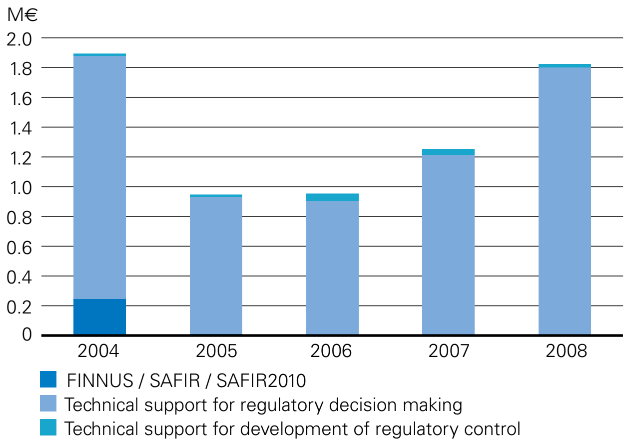


Figure 27. The costs of research and commissioned work pertaining to the safety of nuclear power plants.

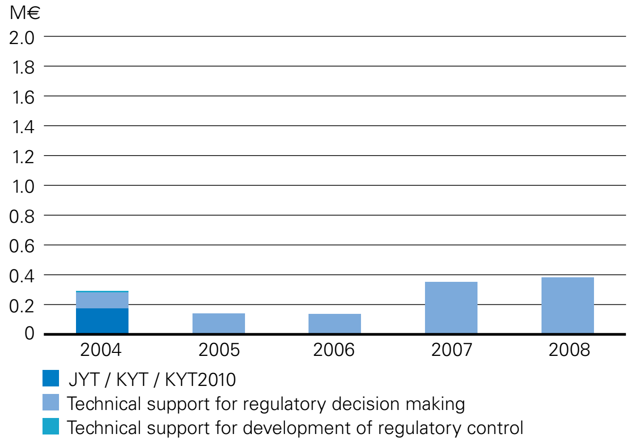


Figure 28. The costs of research and commissioned work pertaining to nuclear waste management and nuclear non-proliferation.

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

Duty area	2004	2005	2006	2007	2008
Basic operations subject to a charge	44.7	47.1	53.6	55.7	60.7
Basic operations not subject to a charge	5.1	7.2	5.7	6.1	6.3
Contracted services	5.1	3.3	3.0	2.2	2.2
Rule-making and support functions	22.7	27.5	28.8	30.3	31.5
Holidays and absences	16.9	16.9	20.0	19.1	21.1
Total	94.5	101.9	111.0	113.4	121.8

relate to reference analyses and independent assessments made for the plant unit under construction. Appendix 8 lists STUK-financed commissions completed in 2008.

The distribution of the annual working time of the nuclear regulatory personnel to duty areas is shown in Table 7. Figure 29 presents the distribution of working time spent on the main functions in 2004–2008.

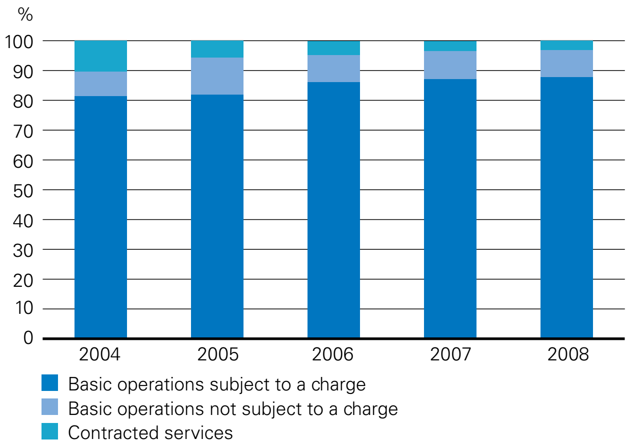


Figure 29. Working time spent on main functions.

9 Development of regulation

9.1 STUK's own development projects

Changes in procedures and the organisation updated in the quality manual

A total of 31 guidelines in the quality manual for nuclear safety regulation were updated, and two new nuclear waste regulation guidelines completed. The new guidelines apply to the regulation of nuclear facility decommissioning plans and provisions for the costs of nuclear waste management. 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.

Decentralised decision-making to ensure flexibility of operations

A new organisation was adopted at the Nuclear Reactor Regulation department in April 2008. The technology-specific offices responsible for inspections were grouped into three sections: Nuclear Facilities and Systems, Structures and Components, and Projects and Organisations, managed by Assistant Directors. The need for reorganisation was mostly due to the need to decentralise regulation-related decisions to several people. This way the regulation of current plant units and plant units under construction can be scheduled as accurately as possible. The change will also help prepare for possible new construction projects. Other objectives set for the reorganisation include better internal reporting, improved meeting practices, improving the internal communication of the department, and the efficient implementation of the regulation renewal.

Following the reorganisation, the Nuclear Reactor Regulation management group consists of the director, deputy directors and assistant directors of the department, as well as a staff representative at his or her own discretion and the development manager, when necessary. The management group meets every two weeks. In addition, actual operative issues within the scope of the department's oversight responsibilities are discussed at the OPERA meeting, established at the end of the year to replace the oversight meetings.

To assess the organisational change and the success of its objectives, a survey was launched in December. The survey consisted of interviews with the staff of the department. The assessment will be completed in the first quarter of 2009.

Development of final disposal project oversight

The operations of the nuclear waste section, reorganised in 2007, were further developed to meet the requirements set by the increasing number of regulatory control tasks and their increased complexity. Posiva Oy's project for the disposal of spent nuclear fuel, with ground-breaking work in geotechnics and geosciences in general as well as regarding safety functions, the engineered barrier system and safety analytics, is also a challenge for regulatory control. The Posiva organisation has been extended, and the volume of the safety-related materials it produces has rapidly increased in the recent years. The schedule until the construction license application at the end of 2012 is tight. Late in 2009 and during 2010, extensive reports concerning Posiva's preparedness to submit a construction licence application at that moment will be inspected. At the same time, the construction of the underground research facility, Onkalo, has progressed close to the disposal depth, approaching the disposal volume which is important for safety.

At the nuclear waste section, the development of the established prodedures of identification and processing of major safety issues with the disposal project was begun. Based on the preliminary safety assessment connected to the decision-in-principle concerning the disposal facility and the reviews of Posiva documents and materials carried to date, safety issues have been identified, and the dialogue with Posiva regarding resolving them recorded. The progress of the solving of these issues is regularly reviewed. Some issues must be solved before a construction license can be granted, but others may be discussed until the review of the operating licence application. In 2008, a process was launched to define the most important issues to be solved before the granting of a construction licence. The process also ensures that STUK focuses its inspections on essential issues.

A project to prepare for the review of the construction licence was initiated. The work is divided into four stages: definition of requirements, planning of the review process, preparation of the review organisation, and the detailed review plan. The review plan will be applied to the review of the construction licence application-related materials that Posiva will deliver to TEM and STUK in autumn 2009 (the documents required for the construction licence, listed in Section 32 of the Nuclear Energy Decree, and the documents submitted to STUK, listed in Section 35 of the Nuclear Energy Decree, as far as they have been drawn up, or as draft versions). The definition of requirements began in 2008.

As a result of the development begun in 2006, the full extent of Onkalo regulatory control according to planned procedures was achieved. The development of management system inspection, based on self-assessment practices used by the IAEA, among others, was completed and the first inspection was carried out in December 2008.

Development of communication competencies

A nuclear power plant communications project was launched to identify central areas for the improvement of communication and the need to develop communication skills at the Nuclear Reactor Regulation department. The department-wide development day focused on the success of communication in the past year. Discussions assessed the press releases drawn up in connection with nuclear facility events, and their handling in the media. Various issues concerning the oversight of nuclear power plants, raised by electronic media at their own initiative, were also assessed. In addition, the need to prepare basic messages on nuclear power plant regulation for all employees to use was discussed.

After the personnel gathering, it was decided that a survey should be carried out on the success of communication. A consultant was hired to carry out the survey. The consultant interviewed representatives of various interest groups, as well as STUK employees. Interviewees were asked to assess STUK's success in nuclear power plant-related communication and to give suggestions for improvements. The results of the survey will be complete early in 2009, after which the necessary improvements will begin.

Knowledge management project to transfer competencies and knowledge gained through experience

A significant part of the Nuclear Reactor Regulation staff will reach retirement age in the next few years. At the same time, the amount of regulation work has increased, and will continue to increase with new plant construction projects. In recent years, the number of staff has increased significantly, and it seems likely that more personnel will have to be recruited in the near future. There is a risk that major amounts of tacit knowledge gained through experience will be lost as inspectors retire.

The objective of the KM project is to develop knowledge management and related procedures in the Nuclear Reactor Regulation department. The project aims to ensure that employees learn from experience and improve the methods of recording and utilising experiences in the department. Tacit knowledge related to nuclear power plant events and difficult or prolonged decision-making situations will be gathered, and the distribution of tacit knowledge from retiring or otherwise-leaving experienced inspectors will be ensured. The project also aims to organise training to ensure that the tacit knowledge in the department reaches new employees and employees being moved to new positions, thus facilitating their inspection work.

The KM project on the decision-making procedures for difficult or prolonged nuclear plant situations and events was launched in autumn

2008 with two pilot projects, the first of which dealt with the decontamination of the Loviisa 2 primary circuit during the annual maintenance of 1994, the reasons leading to it and the post-processing of the event. The second pilot project concerned the failures of the control and stop valves in the Olkiluoto 2 low pressure turbine and the temporary change made to the turbine protection system in January 2002 as a result of these failures. Both event chains and the related decision-making were systematically analysed with the help of the basic principles and criteria described in the book ”Nuclear Regulatory Decision Making” published by OECD/NEA in 2005. These principles and criteria should be taken into account in all decision-making and be included in a unified decision-making process. Learner groups with seven members were established for both pilot projects, with meetings held three times in 2008.

Records management system enabling electronic processing of documents

The project to develop a comprehensive records management solution for STUK, spanning several years, continued. The aim is that the RM (Records Management) system supplied by Affecto-Genimap Oy will, in the future, replace STUK's current separate records systems and registers. The new system also makes possible internal digital records management (workflow) at STUK. The system preliminarily provides for electronic services to external clients. Introducing the records management solution also requires that STUK's earlier registry establishment plan (AMS) is reviewed and updated. In the latter part of the year, the functionality of the new system was assessed. Based on the assessment, it was decided that several features of the product would need to be improved before implementation. The development of a new, more advanced records management plan continued, with the aim of replacing the old registry establishment plan (AMS).

Electronic inspection records to improve data management

The department of Nuclear Reactor Regulation currently uses more than ten different inspection protocol forms. The manual procedures for these protocols in their current format do not allow optimal information management. In spring 2008, the requirement specification for an electronic records system was completed, and the project was opened for competitive bidding. Early in 2009, a consortium of Affecton Oyj and Avain Technologies Oy was selected as the system supplier. The project is in progress and will continue until 2010.

9.2 Renewal and human resources

Training was organised for inspectors concerning nuclear power plant systems and regulatory operations, for example. New STUK inspectors participated in a national training programme in the nuclear field (the YK course), which STUK organises together with other actors in the field. The fifth YK course consisted of 19 course days in six phases, three of which took place in spring 2008. Nine STUK employees participated in the YK5 course. In autumn 2008 the YK6 course began, again with nine STUK inspectors participating. The total number of participants was 60.

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

A master's thesis was completed in 2008 at the Nuclear Reactor Regulation department by Petteri Suikkanen on the use of comparative analysis in the research of how results yielded by thermohydraulic test equipment will transform to plant scale (STUK-TR 8, 2009). In his dissertation, Suikkanen examined how well test equipments of various scales that are built to represent the cooling circuit of a pressurised water reactor are able to depict the behaviour of an EPR plant in a situation in which the amount of coolant in the primary circuit changes. The research applied the APROS computer models of two pieces of testing equipment and the Olkiluoto 3 plant. Results calculated with the APROS model were compared to an experiment carried out using the PKL test equipment. It was found that the model repeats test results well, which increases the reliance on the APROS software's ability to calculate similar situations. The calculation results for the test equipment and the Olkiluoto 3 model were substantially similar. However, the detailed behaviour of a power plant cannot be directly deduced based on the results achieved using test equipment.

One inspector participated in the Nuclear Safeguards and Non-Proliferation course organised by ESARDA (European Safeguards Research and Development Association).

On average, 9.3 days per inspector in the field of nuclear waste and materials regulation and 7.2 days per inspector in the field of nuclear reactor regulation were spent on developing the expertise of STUK's nuclear safety experts in 2008.

Nine new inspectors were hired for nuclear reactor regulation in 2008. Five of the new inspectors specialise in the inspection of mechanical components, two in the field of I&C, one in construction technology and one in the inspection of risk analyses. In addition, employment contracts were signed with four inspectors who will begin their work in early 2009. Three new inspectors were recruited for nuclear waste regulation, one of whom started work in January 2009. Their areas of responsibility are the regulation of the rock excavation in the underground research facility, geological issues in the final disposal project, and the buffer material and barrier structures protecting the final disposal canister.

10 Emergency preparedness

In 2008, 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.

In 2008, a rescue operation exercise was organised at the Olkiluoto nuclear power plant. The purpose of the exercise was to practice and improve cooperation between the licensee and the authorities. Special focus was directed at the launch of the operation, assessment of the situation and the maintenance of the assessment, the correctness of the assessment, communication with the public and the media, as well as leadership responsibilities and leader relations. In addition to the power plant, more than 30 authority or expert organisations at central, regional and local level participated in the exercise.

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 Olkiluoto on 17 November 2008, and at Loviisa on 3 June 2008.

Part of the STUK emergency response organisation also participated in international preparedness exercises organised by the IAEA and the EU.

11 Communication

Discussion of the welding at the Olkiluoto 3 site

In 2008, STUK practiced frequent nuclear safety communication, releasing 19 press releases, among other things. The welding work and safety culture at the Olkiluoto 3 site raised much interest in the early autumn, and their control was explained in press releases, several interviews and a press briefing at the end of August.

Communication was also needed throughout the year on STUK's statements on the EIA reports of the TVO, Fortum and Fennovoima nuclear power plant projects. Of the municipalities involved in the Fennovoima project plans, Simo and Kristiinankaupunki also invited STUK experts to public meetings to give residents basic information on nuclear safety.

When May turned to June, STUK reported the disconnection of Olkiluoto 1 of the national grid during the start-up after annual maintenance. The failure and its repairs were described in three press releases. Releases were also published on two nuclear power plant events classified as INES 1 events. At Loviisa, a deficiency was detected in the reactor protection system, and at Olkiluoto, the pump facilities for the emergency cooling systems were not adequately sealed.

To increase the openness of operations, STUK began to publish any major decisions on the regulation of nuclear reactors on the Internet. The published decisions concern issues such as nuclear power plant licences, plant modifications with safety significance, changes in the organisation or responsible persons of licensees, and exceptional situations occurring at the plants. In addition to actual decision documents, preparation documents by STUK are also published to clarify the background of decisions.

STUK's Alara magazine directed a special focus towards nuclear safety issues, particularly in the fourth issue of the year. The articles included a discussion of the role of the authorities in the Loviisa I&C renewal, and estimation of the workload caused to STUK by the new nuclear power plant projects.

Nuclear safety experts gave presentations to various groups on questions of nuclear safety and the environmental impact of nuclear power plants.

12 International co-operation

International Nuclear Safety Convention

The International Nuclear Safety Convention requires that the states that have joined the Convention prepare reports every three years on how the requirements of the convention have been met. The reports are assessed at a joint meeting of the parties. In 2008, the parties met for the fourth time in a joint review meeting.

The International Nuclear Safety Convention review was held in Vienna in the spring. 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 found good practices, such as the modern legislation and the advanced regulatory body. Challenges were pointed out in the ageing management of the plants, the increasing need for skilled personnel, and the updating of safety regulations.

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 a report is presented every three years on how the obligations stated in the Convention are met. STUK was responsible for the preparation of Finland's report, and it was delivered to the IAEA, functioning as the secretariat of the Convention, according to the agreed schedule in autumn 2008. Corresponding reports were also presented in 2003 and 2005.

The report will be inspected at a large international convention in Vienna in spring 2009. The report has been prepared according to a new approach, with all the operators involved in Finnish waste management participating. The content of the report aims to provide a more extensive description of practical waste management work and official regulation activities. The report is available at the STUK website (http://www.stuk.fi/julkaisut/stuk-b/stuk-b96.html).

Cooperation within international organisations and with other countries

Participation in cooperation within international organisations in the fields of radiation and nuclear safety control, bilateral cooperation with various countries, participation in cooperation projects involving several countries, and presentations given at international meetings in 2008 are listed in Appendix 9.

APPENDIX 1 STUK's safety performance indicators for NPPs in 2008

Summary of the safety performance indicators for the 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 status of the plant and on any changes to the safety status. 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 indicator system divides nuclear safety into three sectors: 1) safety and quality culture, 2) operational events, and 3) structural integrity. These three sectors are divided into a total of 14 sub-areas to be interpreted (see the table below). 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 oversight of the area are considered. Indicators can also be used to monitor the efficiency and effectiveness of corrective measures. The information yielded by the indicators is also used when communicating nuclear safety.

STUK began the development of its own indicator system in 1995. In 2003, the nuclear safety indicators were first included in STUK's strategy and reported as part of the regulatory oversight of nuclear safety. Indicators monitor the implementation and success of the strategy. The following is a list of STUK's long-term safety objectives concerning nuclear power plants:

- No accidents or serious incidents occur at Finnish nuclear power plants.
- Releases of radioactive substances into the environment are minor and their calculated annual dose for a critical individual is less than 1% of the 100 µSv limit defined in Government Decision 395/1991.
- The radiation dose of each nuclear power plant employee is below the limit defined for individuals.

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	

- The collective radiation dose for all employees of a nuclear power plant remains low in international comparisons, staying below the maximum limit defined in Guide YVL 7.9 when figures from both nuclear power plants are included.
- Risks related to a nuclear power plant are managed to decrease or stabilise the accident risk at the plants.

Since 2006, indicator information has been managed in STUK's INDI (INdicator DIsplay) information system. In 2008, minor changes were made to the indicators. For example, the indicator describing the maintenance of plant documentation was discarded. 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.

Results for the safety performance indicators for the nuclear power plants in 2008

Loviisa NPP

Summary

The structural radioactivity confinement barriers are in good condition. Three safety significant events and some operational transients were reported relating to plant operation. Based on these events, procedures such as the plant modification management have been revised. Occupational radiation doses and releases into the environment remained low in 2008. The plant's load factors were high, and equipment failures only caused minor production losses. Long-term investments have been made in the improvement of the plant. In 2008, several projects with significance for nuclear safety were in progress, including the renewal of the I&C systems and the waste, storage and decontamination facilities. Plant maintenance has been appropriate. However, attention must still be paid to spare parts management and adequate human resources for maintenance operations. Below, the results of the nuclear safety indicators are described by indicator area.

Safety and quality culture

__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 currency of the plant documentation.

Plant maintenance was appropriate

The number of safety-significant component failures was small, and load factors were high. In 2008, Loviisa plant units had a total of eight component failures leading to production losses. The number of failures and the resulted production losses were low even compared to the previous years. No reactor trips occurred.

The plant's maintenance plan aims to keep the number and effects of failures at an acceptable level. In 2008, the number of component failures remained low and even decreased slightly compared to previous years. The power company applied for permission from STUK for five planned deviations from the Technical Specifications. These were related to the repair of a failed component, inspections, and the modification of Loviisa's I&C facilities, as well as its storage, waste material and workshop facilities. Since the planned deviations had no significant safety implications, STUK approved the applications.

Maintenance work includes both repairs and preventive maintenance. The total number of failures in 2008 was clearly lower than the average of the four previous years. No signs of aging can be detected in the indicators or the failure data behind the indicator, which proves that component life-cycle management and maintenance are successful.

The average repair times of failures causing unavailability of components have remained stable at the Loviisa plant for several years. In 2008, the average repair time for the plant units was 27.7 h, while the average of the four previous years was 33.9 h. In 2008, the average repair time of Tech Spec component failures that had an allowed repair time of 72 hours or less was 22.1 hours at Loviisa 1, and 27.8 hours at Loviisa 2.

On the basis of the 2008 indicators and the data behind them, it can be stated that the plant's maintenance operations meet the requirements. The plant must continue to pay attention to adequate resources and the management of operations so that faults are repaired without undue delay, even if the allowed repair time is long.

Plant safety systems were in good order

As in previous years, the high-pressure safety injection system (TJ), auxiliary feed water systems (RL92/93, 94/97) and emergency diesels (EY01-04) were in good condition. No safety-significant faults were detected in components, and any failures with minor safety significance were caused by normal aging of components.

Occupational radiation doses and releases into the environment remained low

In 2008, the 4-year annual maintenance took place at Loviisa 1, and a short annual maintenance at Loviisa 2. The time used for outages was long, and there was a high amount of work with significance for radiation protection, which resulted in a total collective dose that was higher than that of the previous year. Still, the collective dose was lower than in corresponding earlier years. The low dose accumulated during the 4-year maintenance can be explained by better targeting of non destructiveng inspections, the new inroduction training, and the improved planning and monitoring of radiation protection.

The radiation doses for nuclear power plant workers were below the personal dose limits. The trend for the average of the ten highest doses has been declining in recent years. In 2008, the average was higher than in the previous year, but still lower than the average dose level of recent years. Furthermore, the threshold set for the collective occupational dose was not exceeded in 2008.

Radioactive releases into the environment from the Loviisa nuclear power plant were small. They were well below the set limits.

Long-term investments in plant improvement

At the Loviisa power plant, special attention has been paid to life-cycle management. From 1997 to 2000, significant power upgrade and modernisation projects were carried out at the plant.

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 annual probability of a severe reactor accident calculated for the Loviisa plant units is small (approximately 6.0 x 10^{-5}). For the Loviisa power plant, the most significant factors affecting the overall accident risk include internal plant events during outages (such as falling of heavy loads or a power surge caused by sudden dilution of the boron used to adjust reactor operation), fire, high levels of seawater during power operation and oil releases into the sea in front of the Loviisa plant during refuelling outages.

At the Loviisa power plant, the most significant investment in 2008 was the I&C renewal. Other major investments in 2008 included the replacement of stators, the basic renovation of waste, storage and decontamination facilities, refuelling machine renovation, replacement of bolts in the reactor support cage, basic servicing of emergency diesels and generators, the improvement of secondary circuit safety, and the renewal of high pressure safety injection pumps.

Operational events

*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 the 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.

The number of events was low and their risk significance minor

The number of safety significant events has remained low at the Loviisa power plant. In 2008, three events were reported: vagueness of testing instructions concerning the containment ice condenser door control system valves at Loviisa 1 and Loviisa 2, the absence of an uninterrupted power supply in a substation at the Loviisa plant, and incorrect simulations in the reactor protection system of Loviisa 2. The events had no substantial safety significance. The power company responded to these events by deciding to take corrective action in order to prevent similar events. The procedural flaws resulting in the incorrect simulation were so significant that the power company decided to carry out a root cause analysis regarding the event. The analysis will be reviewed by STUK.

The number of operational transients affecting plant production has remained at a reasonable level since 2002. Five to nine transients have been reported annually. The number of failures and the resulting production losses were low compared to previous years, which also shows in the plant's load factors. No reactor trips occurred in 2005–2008. Reactor trips have been generally rare in Loviisa partly because there are two turbines; the reactor remains operational even if one turbine trips due to a transient.

The impact on the annual accident risk of unavailability resulting from component failures, preventive maintenance and other events was very low, rating about 1.5% at Loviisa 1 and about 2.4% at Loviisa 2. A few individual component failures and the preventive maintenance of the subsystems of the auxiliary feed water system were most significant in terms of risk.

Two events constituting non-compliance with the Technical Specifications occurred at the Loviisa plant: an incorrect testing interval in an instruction, and an incorrect simulation in the reactor protection system. The safety significance of the event concerning testing intervals was minor. The safety significance of the incorrect simulation was also low, but deficiencies in the procedure made it significant. The power company will prepare a root cause analysis on the event in 2009, and STUK will review the analysis.

Fire safety has remained stable

The fire safety of the Loviisa plant has remained at the same level. At the Loviisa power plant, one event classified as a fire occurred in 2008. When a pump of a drains system (RN) belonging to turbine systems of Loviisa 1 was being started up on 19 September 2008, the motor short-circuited, which caused a powerful arc flame and smoke in the pump motor. The smoke stopped without any measures beign taken. The plant's fire brigade inspected the target and the environment.

Even though the number of actual fires did not increase, correct alarms from detectors did increase. Detector alarms were mainly triggered by dust, smoke or humidity. The number of alarms is affected by factors such as the amount of maintenance work (in 2008, long annual maintenance outages, above-average workload and the construction of new I&C buildings), disconnection of detectors in an adequately large area, and more reliable operation of the fire detector system. At Loviisa power plant, detection system errors have remained at the previous years' level.

Structural integrity

__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, and 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.

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.

Radioactivity confinement barriers are in good condition

Based on the water chemistry indicators, the primary circuit integrity of Loviisa plant units has remained good. A minor fuel leak was detected at Loviisa 2 late in 2008. The leaking fuel bundle will be removed from the reactor in the 2009 annual maintenance outage at the latest. The previous fuel leak occurred at Loviisa in 1999.

Leaks from the containment isolation valves, penetrations and personnel airlocks were minor for both plant units. Most of the isolation valves passed the leakage test at the first attempt, even though the overall as-found leakage has increased slightly since last year.

Olkiluoto NPP

Summary

At the Olkiluoto plant units, more safety-significant events occurred than in recent years, on average. The most important events in terms of safety were the common cause failure of diesel generator starter motors at both plant units, a reactor trip and unavailability of the electrical flywheel system of reactor coolant pumps ensuring proper cooling of fuel at Olkiluoto 1 due to a failure of a voltage regulator of the generator, and the reactor trip at Olkiluoto 2 in the beginning of January, when frazil ice blocked sea water screens.

In addition to these events, a major deficiency was detected in the plant safety structures. During the operating cycle, it was found that part of the pipe penetrations with significance for nuclear and fire safety were in poor condition. There were also deficiencies in the design basis of the penetrations.

The structural radioactivity confinement barriers for the Olkiluoto power plant are in good condition. The employees' radiation doses remained low, as in previous years. The load factors for the plant units were high, and failures only caused minor production losses, although the production losses caused by failures at both plant units were slightly more significant than in the previous year. Otherwise, life-cycle management and maintenance of the plants were appropriate.

Of major investments, 2008 saw the completion of the feed connection from the gas turbine plant to both plant units. Below, the results of the nuclear safety indicators are described by indicator area.

Safety and quality culture

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 currency of the plant documentation.*

Safety equipment has been well maintained

The number of defects in components subject to Technical Specifications has remained low since 2004. The indicators concerning failures and maintenance of components subject to the Technical Specifications show that the life-cycle management and maintenance operations of the plant are appropriate.

Maintenance work includes repair of defects and preventive maintenance. The amount of preventive maintenance varies from year to year based on the work chosen for outages and preventive maintenance packages. Based on the development of the amount of preventive maintenance work and fault repairs and the assessment of the work behind the figures, the maintenance strategy can be considered appropriate.

In 2008, the average repair time of failures causing unavailability of components subject to the Technical Specifications was swift for both plant units. Based on the 2008 indicators and the data behind them, the plant's maintenance operations can be considered successful.

Plant safety systems were in good condition

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

Occupational radiation doses and releases into the environment remained low

In 2008, the collective dose at Olkiluoto was the lowest since 1983. In addition, the average of the ten largest doses was clearly lower than in previous years. Emissions Releases of radioactive substances into the environment from the Olkiluoto power plant were minor and remained clearly under the set limits.

Long-term investments in plant life-cycle management

Significant investments have been made in the power upgrades and renewals of the plant units in 1997–2000 and in 2004–2006. The most significant accident risk factors for the Olkiluoto power plant include internal events during power operation (component failures and pipe ruptures leading to an operational transient) and relay failures caused by earthquakes deemed possible in Finland. The annual probability of a severe reactor accident calculated for both Olkiluoto plant units is very low (approximately 1.0×10^{-5}). Small improvements at the plant have caused a slight decrease in this indicator in recent years. Last year, the indicator value decreased clearly, due to a more detailed earthquake analysis and plant modifications. Component failures caused a slight increase in the production losses for Olkiluoto 2, compared to previous years.

Continuing major changes include the renewal of radiation measurement systems for both plant units, replacement of shutdown cooling system valves with a new valve type, replacement of DC power system batteries, repair of fine screening units in the sea water screening system, and the replacement of epoxy powder-coated circulating water pipes with ebonite pipes. A feed connection to both plant units was built from the new gas turbine plant. At the turbine plant, erosion repairs were carried out for the piping.

Operational events

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 the 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.

Safety-significant events and deficiencies affecting plant safety

At the Olkiluoto plant units, more safety-significant events occurred than in recent years, on average. The most important events in terms of safety were the common cause failure of diesel generator starter motors at both plant units, a reactor trip and unavailability of the electrical flywheel system of reactor coolant pumps ensuring proper cooling of fuel at Olkiluoto 1 due to a failure of a voltage regulator of the generator, and the reactor trip at Olkiluoto 2 in the beginning of January, when frazil ice blocked sea water screens.

In addition to these events, a major deficiency was detected in the plant safety structures. During the operating cycle, it was found that part of the pipe penetrations with significance for nuclear and fire safety were in poor condition. There were also deficiencies in the design basis of the penetrations.

Based on data from the last ten years, the average number of annual events warranting a special report or an operational transient report is five. The number of events warranting a special report in 2008 (seven) is higher than average. Five of these events occurred during annual maintenance. Due to these events, TVO had a safety culture assessment carried out in 2008.

The events reported in special reports and their immediate causes were very different, but contributory factors were to some extent similar. The common factors are related to the management of the state of the plant and design information, particularly in connection with changes. The same was also observed in 2007; then, TVO launched several development measures to ensure that components to be installed at the plant conform to the plans, and that their condition and instructions meet the requirements. The management of the design basis and plant condition must be further improved in the power company.

Operational activities conformed well to the Technical Specifications, even though deviations were slightly more common in 2008 than in the previous year. In 2008, TVO applied for STUK's approval for six deviations from the Technical Specifications. Three of these deviations concerned measures ensuring safety at work during the construction of Olkiluoto 3. STUK approved all applications.

Olkiluoto 1 experienced higher production losses from component failures in 2008 than in the previous years. Approximately 90% of production losses caused by failures resulted from a power restriction period lasting several days following a voltage regulator malfunction of the generator at the end of the annual outage on 30 May 2008. For Olkiluoto 2, production was affected by frazil ice in the beginning of January. As a result of the failure on 30 May at Olkiluoto 1, the flywheel generators of Olkiluoto 2 reactor coolant pumps were also found to be inoperable and, for approximately 11 days, the plant unit was brought to the 80–85% power level allowed by the fuel margins.

No events classified as fire occurred in the Olkiluoto 1 and Olkiluoto 2 area in 2008.

Events had significance for nuclear safety

Risks arising from operational activities were significantly above average in 2008 for Olkiluoto 1. The impact of unavailability resulting from component failures, preventive maintenance and other events on the annual accident risk was approximately 26% at Olkiluoto 1, and 1.3% at Olkiluoto 2. For Olkiluoto 2, the risk has remained at the same level as in previous years.

The risk arising from events at Olkiluoto 1 mainly consisted of the generator overvoltage leading to a reactor trip, and the common cause failure of diesel generators. The events will lead or have already led to changes in either the plant or operations.

Structural integrity

> ***Structural integrity*** *is assessed on the basis of the leak tightness of the multiple radioactivity confinement barriers – the fuel, the primary circuit, and the containment. The integrity must meet the set objectives, and 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.*
>
> *Water chemistry indicators are used to monitor and control the integrity of the primary circuit. 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.*

Radioactivity confinement barriers were in good working order

There were no essential changes in the indicators describing the integrity of the fuel or the primary circuit in 2008. Based on the indicators, the structural integrity of the barriers limiting the dispersion of radioactive substances has remained good.

Olkiluoto plant units had no leaking fuel in 2008, so the I-131 activity concentrations have remained the same or decreased. Similarly, the maximum activities resulting from shutdown of the plant have also shown a declining trend. Based on the indicator, fuel integrity has been good at Olkiluoto plant units. The water chemistry index, which yields an overview of the water chemistry conditions, was at the best possible level for both plant units.

The primary circuit has been leak-proof in the operating cycle 2007–2008. Identified and unidentified leaks from the primary circuit into the containment have remained small, and the ratio of the largest daily leak volume within the containment to the maximum leakage allowed in Technical Specifications was low for both plant units. This was the fifth consecutive operating cycle with hardly any leaks from the primary circuit into the containment atmosphere.

Leaks from the containment penetrations and personnel airlocks were minor for both plant units. Most of the isolation valves passed the leakage test at the first attempt. Leaks from the outer isolation valves of Olkiluoto 2 were minor. However, the sum of the leakage test results for the outer isolation valves of Olkiluoto 1 exceeded the limit specified in the Technical Specifications. More than half of the total leakage came from one valve. After repairs, the total leakage met the requirements of the Technical Specifications.

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 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)

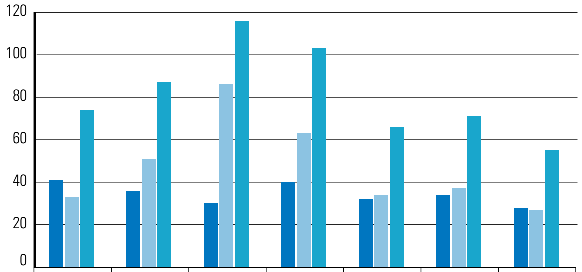
Interpretation of indicator

Loviisa

The total number of failures in equipment subject to Technical Specifications causing a restriction to plant use decreased from 194 in the previous year to 180 in 2008. The decrease was nearly identical for both plant units. The total number of failures in 2008 was clearly lower than the average of the four previous years, 229.

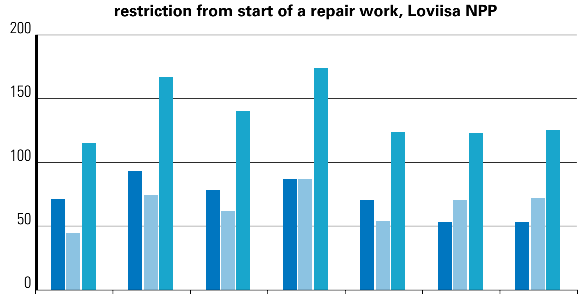
In recent years, the annual failure volumes have remained relatively stable; the variation therein is largely due to the random occurrence of failures which are difficult to predict, such occurrences being normal when the number of components is

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



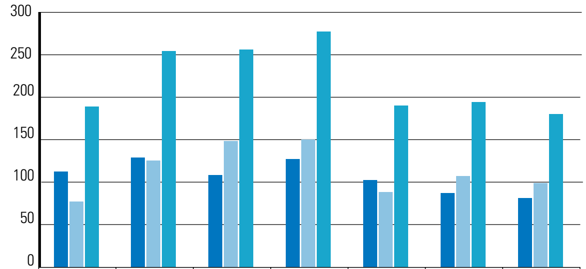
	2002	2003	2004	2005	2006	2007	2008
LO1	41	36	30	40	32	34	28
LO2	33	51	86	63	34	37	27
LO1,2	74	87	116	103	66	71	55

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



	2002	2003	2004	2005	2006	2007	2008
LO1	71	93	78	87	70	53	53
LO2	44	74	62	87	54	70	72
LO1,2	115	167	140	174	124	123	125

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



	2002	2003	2004	2005	2006	2007	2008
LO1	112	129	108	127	112	87	81
LO2	77	125	148	150	88	107	99
LO1,2	189	254	256	277	190	194	180

large. The number of failures causing operation restrictions decreased in 2008. This is good for the plant maintenance result, but no certain conclusions can be made about life-cycle management and the condition of the components based on these figures. Failure detection and anticipation have been continuously improved in plant maintenance operations at Loviisa, and components have been replaced. Due to these measures, the number of component failures with an effect on the safe operation of the plant has remained under control and continues to decrease.

Based on the above, it can be stated that the indicator or the failure data behind it do not show the potentially negative effects associated with the ageing of the facilities, which indicates functional component life-cycle management and successful maintenance.

Interpretation of indicator

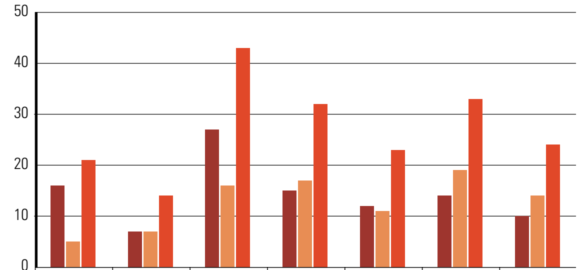
Olkiluoto

The number of failures occurring during power operation and causing the unavailability of components subject to Technical Specifications has been decreasing since 2004, with the exception of an increase occurring in 2007. In 2008, the number decreased to the level of 2006. Based on the number of failures, maintenance work has been successful.

The emergency diesel generator of one subsystem failed to start in the periodic test carried out in connection with the start-up of the 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. 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.

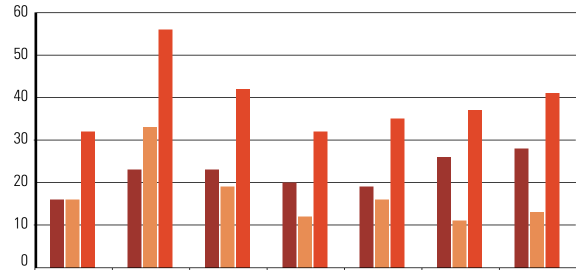
Capacity measurements of the plate heat exchanger of shutdown secondary cooling system 721 are regular. In 2007, several measurements indicated values below the required capacity for both plant units. In such cases, the heat exchanger was cleaned. In the second quarter of 2008, values still remained below the required capacity on several occasions, particularly for OL1. The necessary isolation then causes an operation restriction, and the cleaning of one heat exchanger takes nearly ten hours. The issue has been discussed with TVO representatives. TVO has changed the detergent used for cleaning the heat exchanger, and the cleaning results have improved significantly. For this reason, adding plates to the plate heat exchangers is not necessary at the moment.

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



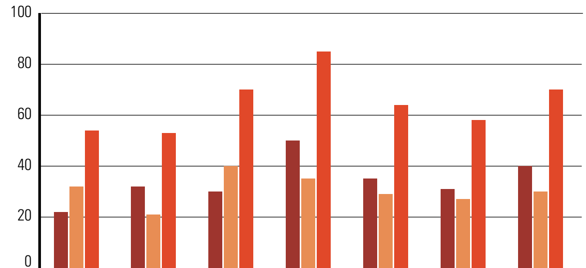
	2002	2003	2004	2005	2006	2007	2008
OL1	16	7	27	15	12	14	10
OL2	5	7	16	17	11	19	14
OL1,2	21	14	43	32	23	33	24

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



	2002	2003	2004	2005	2006	2007	2008
OL1	16	23	23	20	19	26	28
OL2	16	33	19	12	16	11	13
OL1,2	32	56	42	32	35	37	41

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



	2002	2003	2004	2005	2006	2007	2008
OL1	32	30	50	35	31	40	38
OL2	21	40	35	29	27	30	27
OL1,2	53	70	85	64	58	70	65

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.

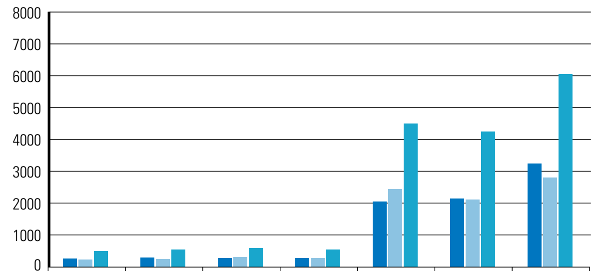
Purpose of indicator
The indicator describes the volumes of failure repairs and preventive maintenance and illustrates the condition of the plant and its maintenance strategy. The indicator is used to assess the maintenance strategy executed at the plant.

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

Interpretation of indicator

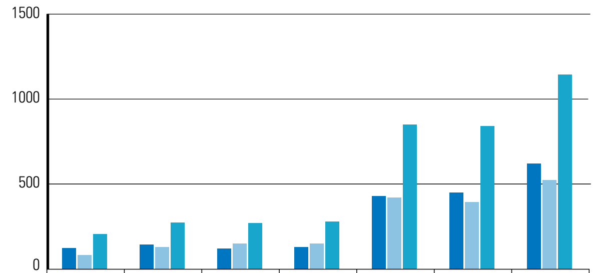
Loviisa
In 2006, the Loviisa power plant adopted the LOMAX information system, replacing the previous LOTI system. As a result, the scope of the indicator for the maintenance of components subject to the Technical Specifications has been extended so that future maintenance work will also include such work on Tech Spec components that did not cause an operation restriction. In connection with this period of change, changes and corrections have been made to the figures for 2006 and 2007, already presented earlier, to avoid future interpretation problems created by the information system change. Since 2006, 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 information system change and the extension and further specification of the scope of the figures described above, the maintenance figures for 2008 are only fully comparable for the last three years.

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



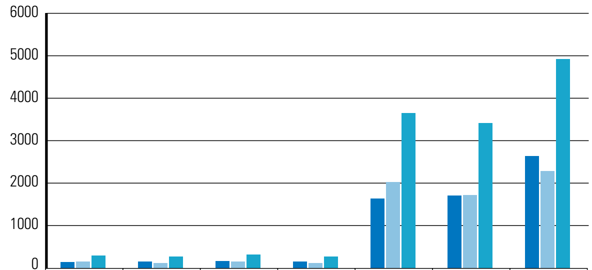
	2002	2003	2004	2005	2006	2007	2008
LO1	263	293	282	277	2057	2148	3250
LO2	228	243	303	269	2444	2105	2807
LO1,2	491	536	585	546	4501	4253	6057

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



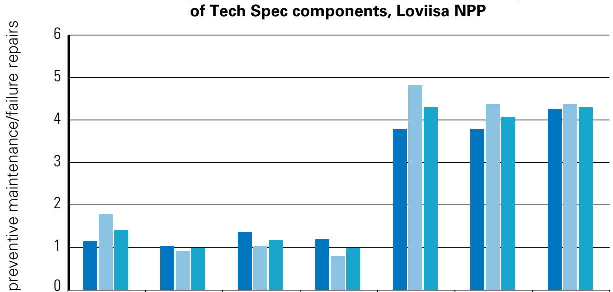
	2002	2003	2004	2005	2006	2007	2008
LO1	123	144	120	127	429	448	619
LO2	82	127	150	150	421	393	524
LO1,2	2205	271	270	277	850	841	1143

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



	2002	2003	2004	2005	2006	2007	2008
LO1	140	149	162	150	1628	1700	2631
LO2	146	116	153	119	2023	1712	2283
LO1,2	286	265	315	269	3651	3412	4914

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



	2002	2003	2004	2005	2006	2007	2008
LO1	1.14	1.03	1.35	1.18	3.79	3.79	4.25
LO2	1.78	0.91	1.02	0.79	4.81	4.36	4.36
LO1,2	1.40	0.98	1.17	0.97	4.30	4.06	4.30

When considering the variation found in the number of fault repairs and particularly of preventive maintenance measures, the many types of annual maintenance included in the maintenance strategy must be observed (refuelling outage, four-year annual maintenance, brief annual maintenance and eight-year annual maintenance). The four-year cycle may have a significant impact on the annual figures. In 2008, a major increase could be observed in the amount of maintenance work for equipment subject to Technical Specifications. The increase is mainly due to the annual maintenance cycles explained above.

Judging by the data behind the indicator, 2008 was not markedly different from the previous years as concerns preventive maintenance. The ratio of the number of preventive maintenance works to the number of fault repairs was 4.30 in 2008, compared to 4.06 in 2007. The relative increase in preventive maintenance operations reflects the selected maintenance strategy, the purpose of which is to keep the number of faults and the effects of faults at a tolerable level.

The stability of the indicator value, 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.

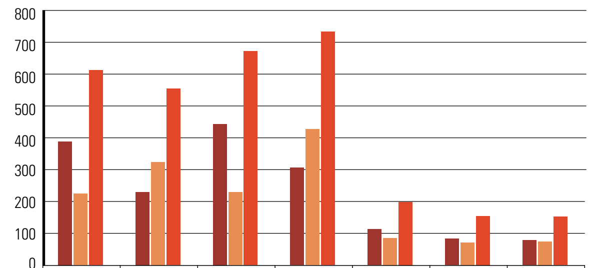
Interpretation of indicator

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 the 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.

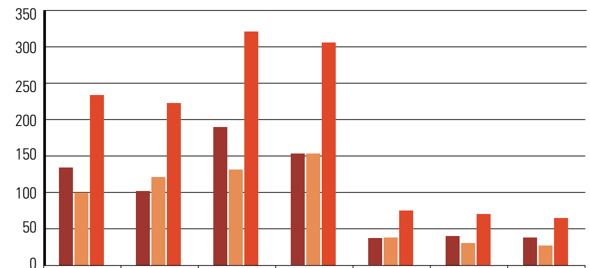
The number of maintenance works causing unavailability of components, included in the indicator, has been decreasing since 2006 due to the decreasing amount of fault repairs. The amount of work causing unavailability of components included in the so-called preventive maintenance packages,

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



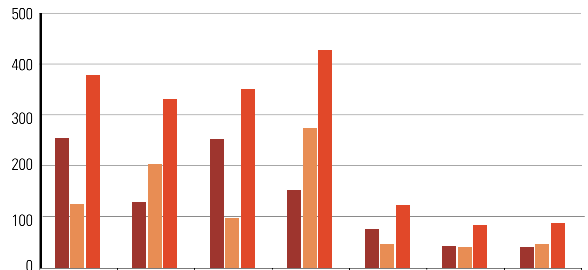
	2002	2003	2004	2005	2006	2007	2008
OL1	388	230	443	306	113	83	78
OL2	224	324	229	427	85	71	74
OL1,2	612	554	672	733	198	154	152

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



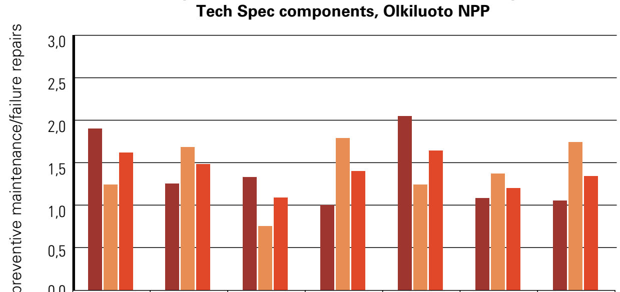
	2002	2003	2004	2005	2006	2007	2008
OL1	134	102	190	153	37	40	38
OL2	100	121	131	153	38	30	27
OL1,2	234	223	321	306	75	70	65

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



	2002	2003	2004	2005	2006	2007	2008
OL1	254	128	253	153	76	43	40
OL2	124	203	98	274	47	41	47
OL1,2	378	331	351	427	123	84	87

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



	2002	2003	2004	2005	2006	2007	2008
OL1	1.90	1.25	1.33	1.00	2.05	1.08	1.05
OL2	1.24	1.68	0.75	1.79	1.24	1.37	1.74
OL1,2	1.62	1.48	1.09	1.40	1.64	1.20	1.34

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 number for 2008 was nearly equal to that of 2007.

The ratio of preventive maintenance work to fault repairs was 1.64 in 2006 and 1.2 in 2007. In 2008, the ratio was 1.34.

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 unavailability. 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 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 indicator

Loviisa

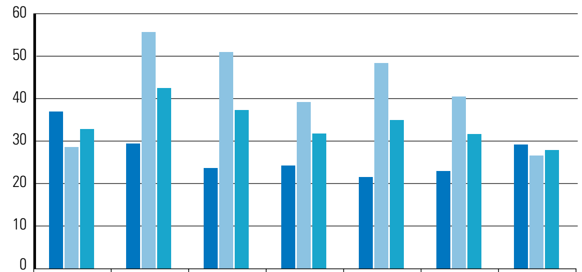
The Technical Specifications define the maximum allowed repair times for components based on the components' safety significance. The times vary between 4 hours and 21 days. Failures in Tech Spec components are to be repaired within the allotted time without undue delay.

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

The average repair times of failures causing unavailability of components have remained stable at the Loviisa plant for several years. In 2008, the average repair time for the plant units was 27.7 hours, while the average of the four previous years was 33.9. In 2008, the average repair time of Tech Spec component failures that had an allowed repair time of 72 hours or less was 22.1 hours at LO1 and 27.8 hours at LO2.

On the basis of the 2008 indicators and the data behind them, the plant's maintenance operations meet the requirements. The plant must continue to pay attention to adequate resources and the management of operations so that faults are repaired without undue delay, even if the allowed repair time is long.

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



	2002	2003	2004	2005	2006	2007	2008
LO1	36.9	29.4	23.6	24.3	21.5	22.9	29.1
LO2	28.6	55.6	50.9	39.1	48.4	40.4	26.6
LO1,2	32.8	42.5	37.3	31.7	35.0	31.7	27.9

Interpretation of indicator

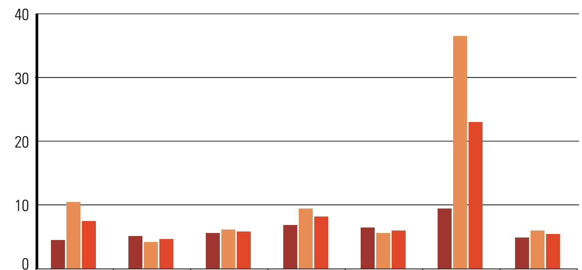
Olkiluoto

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.

In the long term, the average repair time has varied between 5 to 8 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 2008, the average repair time of failures causing unavailability of components defined in the Technical Specifications was low for both plant units, approximately 5.5 hours. On the basis of the 2008 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



	2002	2003	2004	2005	2006	2007	2008
OL1	12.4	4.4	5.1	5.5	6.8	6.4	9.4
OL2	10.4	4.1	6.1	9.4	5.5	36.5	6.0
OL1,2	7.4	4.6	5.8	8.1	6.0	23.0	5.4

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 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 indicator

Loviisa

In 2008, no safety-significant common cause failures were identified at the Loviisa power plant. The situation is good.

Olkiluoto

Two common cause failures were identified at Olkiluoto. The flywheel generators of reactor coolant pumps were found inoperable in connection with a voltage regulator failure at Olkiluoto 1 in May. The other common cause failure related to seal failures in the compressed air motors of diesel generators, also observed in May.

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 followed.

Source of data

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

Purpose of 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 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

In 2008, Loviisa plant units had a total of five failures leading to production losses. No reactor trips occurred. Failures caused the plant to go to low load, which allowed repair work. The number of failures and the resulting production losses were low compared to previous years. The figure itself has been at a good level since 2004, which also shows in the plant’s load factors.

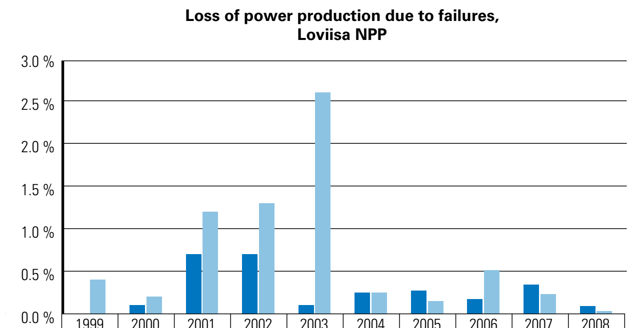
At Loviisa 1, there were two such failures: the leak in the drains line of the high-pressure heaters in June, and the oil leak in a reactor coolant pump motor in October. In connection with the latter, an N bearing was replaced in the pump motor. At Loviisa 2, the number of such failures was three: the dropping of a control rod due to a failure of a low-frequency transformer in May, a reactor coolant pump trip caused by a faulty differential pressure protection signal in July, and the opening of an SP50 generator breaker of the turbine generator caused by the faulted operation of a regulator.

Loviisa’s 2003 abnormal indicator value was caused by the replacement of the stator in one of the generators. The work took approximately 41 days and caused a production loss of 2.6%.

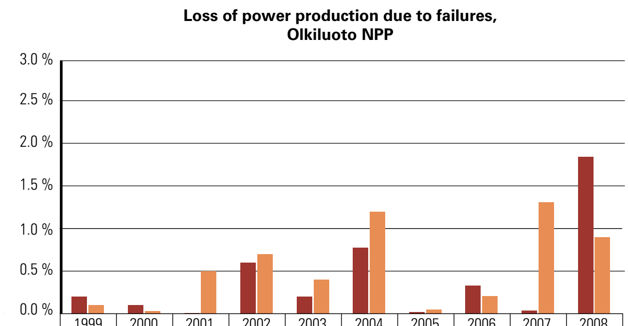
Olkiluoto

Olkiluoto 1 experienced higher production losses from component failures in 2008 than in the previous years. Approximately 90% of the production losses from component failures were caused by a voltage regulator failure at the end of the annual maintenance outage on 30 May 2008, the inoperability of the flywheel generators of the reactor coolant pumps observed in connected with the said failure, and the several days’ power restriction period following the inoperability.

At Olkiluoto 2, two major failures with an effect on production occurred. A reactor trip occurred at the beginning of January, when ice chips blocked circulating water band screens. The plant unit was disconnected from the national grid for approximately 19 hours to assess the situation and repair faults. As a result of the failure on 30 May at Olkiluoto 1, the flywheel generators of Olkiluoto 2 reactor coolant pumps were also found to be inoperable, and for approximately 11 days the plant unit was brought to the 80–85% power level allowed by the fuel margins.



	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
LO1	0.00	0.10	0.70	0.70	0.10	0.25	0.27	0.17	0.34	0.09
LO2	0.40	0.20	1.20	1.30	2.60	0.25	0.15	0.51	0.23	0.03



	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
OL1	0.20	0.10	0.01	0.60	0.20	0.78	0.02	0.33	0.04	1.84
OL2	0.10	0.03	0.50	0.70	0.40	1.20	0.05	0.21	1.31	0.90

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 followed.

Source of data

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

Purpose of 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 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 the report to STUK for decision.

Loviisa

Exemptions

STUK approved five exemptions in 2008. One application concerned repair of a component failure, one inspections, two the changes in Loviisa I&C facilities (LARA) and one the changes in the storage, waste and repair shop (VAJAKO) facilities. The number remained similar to that of the previous years. The number of failure-related exemptions decreased, which is good.

The large number of exemptions granted in 2003 can be explained by the replacement of the fixed measurement system (the MONU project); work related to this project required an exemption in any operating state.

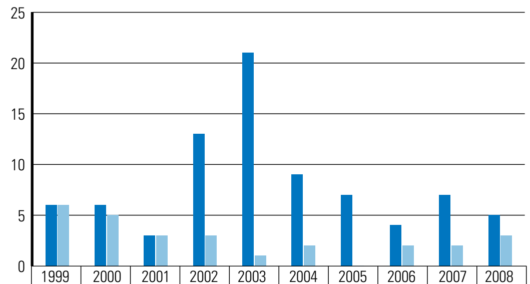
Non-compliances with the Tech Specs

The number of non-compliances with the Technical Specifications has remained low for Loviisa in recent years.

In 2008, two events occurred at the Loviisa plant resulting in non-compliance with the Technical Specifications. One of these concerned testing intervals, and the other incorrect simulation in the reactor protection system. The safety significance of the event concerning testing intervals was low but, as a result, actions to improve safety were initiated. The safety significance of the incorrect simulation was low, but deficiencies in the procedure made it significant. The power company will prepare a root cause analysis on the event in 2009, and STUK will inspect the analysis.

In addition, a third event was reported. The event concerned fuses that were missing from the severe accident power supply subsystem's second uninterrupted power supply system. This event was not interpreted as a non-compliance with the Technical Specifications. The Tech Specs requirement only applies to the SAM power supply, which was functional as a whole (both diesel generators and the batteries). The missing fuses were, however, against the spirit of the Tech Specs, according to which all components must be in working order. The safety significance of the event is minor.

Number of deviations from the Tech Spec, Loviisa NPP

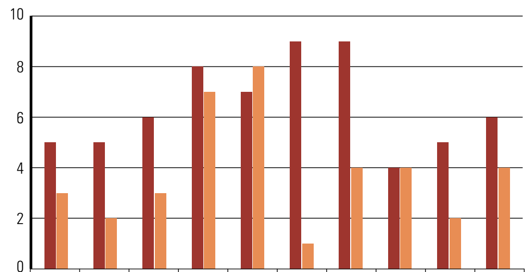


	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Exemptions	6	6	3	13	21	9	7	4	7	5
Deviations	6	5	3	3	1	2	0	2	2	3

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.

Number of deviations from the Tech Spec, Olkiluoto NPP



	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Exemptions	5	5	6	8	7	9	9	4	5	6
Deviations	3	2	3	7	8	1	4	4	2	4

Exemptions

In 2008, TVO applied for permission for six planned exemptions from the Technical Specifications. STUK approved all the applications. One was to do with replacing the battery bank of Olkiluoto 2 during power operation, one with investigating an incident in reactor level measurement at Olkiluoto 2, and three with the disconnection of the power supply for the duration of excavation work and Olkiluoto 3-related work in order to ensure safety at work. One application is for permission to open an isolation valve at Olkiluoto 2 during the next shutdown. In addition to these, STUK approved an extension for three permissions based on TVO's application.

Non-compliances with the Tech Specs

In 2008, there were four situations at the Olkiluoto plant in which the Technical Specifications were violated. Two were concerned with neglect 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 followed by the plant unit. The systems followed 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 utilities. Licensee representatives submit the necessary data to the relevant person in charge at STUK.

Purpose of 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 indicator

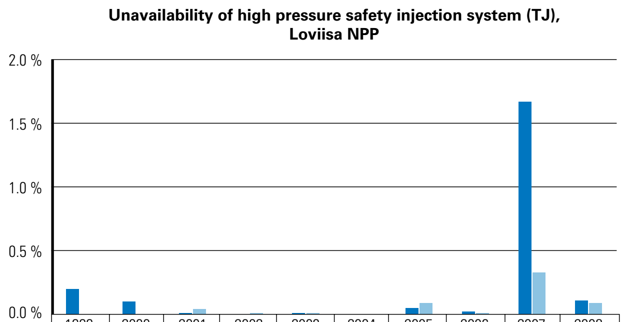
Loviisa

TJ system

The unavailability of the plant units' high pressure safety injection systems (TJ) returned to a normal low level from the peak value of 2007.

For LO1, the total unavailability time was 26 hours, consisting of the repairs of three failures of minor significance. For LO2, the unavailability time was 29 hours, caused by the replacement of a shaft seal in a TJ pump.

The unavailability of the high pressure safety injection systems was low in 2008, i.e. their condition and availability were good.



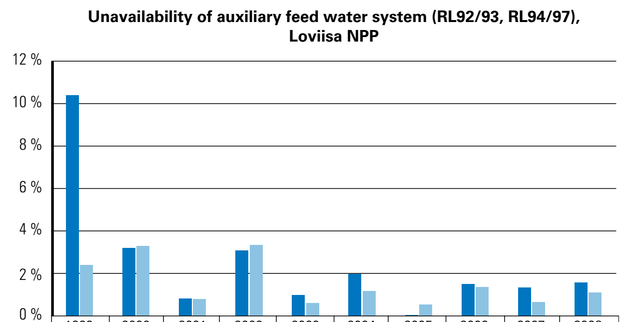
	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
LO1	0.20	0.10	0.01	0.00	0.01	0.00	0.05	0.02	1.67	0.11
LO2	0.00	0.00	0.04	0.01	0.01	0.00	0.09	0.01	0.33	0.09

RL system

In 2008, the unavailability of the auxiliary feed water systems remained at the previous years' level.

For LO1, the total unavailability time was 479 hours, which was exclusively caused by the annual maintenance of RL84. For LO2, the total unavailability time was 362 hours, 297 hours of which were RL97 maintenance repairs performed during the annual outage. The total unavailability during LO2 power operation was 65 hours, resulting from the repairs of 4 failures. Of these, the most significant source of unavailability was the repair of the RL93D01 pump shaft's free end seal, taking 33 hours.

The unavailability of the auxiliary feed water systems was low in 2008, i.e. their condition and availability were good.



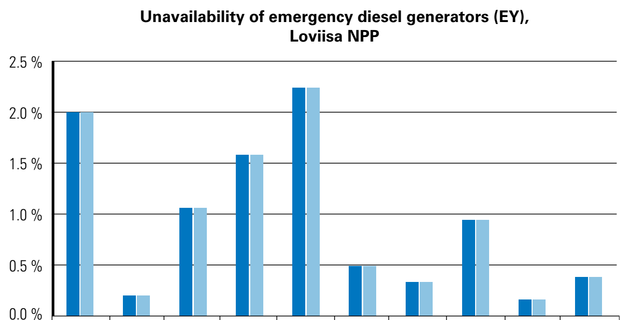
	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
LO1	10.40	3.20	0.81	3.09	0.98	1.96	0.03	1.49	1.34	1.58
LO2	2.40	3.30	0.80	3.34	0.61	1.17	0.53	1.36	0.66	1.10

EY system

The unavailability of the emergency diesels (EY) increased in 2008 compared to the previous year's level, but still remained low, i.e. their availability was good.

In 2008, the total unavailability for all eight diesel generators was 270 hours, consisting of the repair times of 16 failures. The failures were due to normal component ageing. The failures were not serious.

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



	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
LO1	2.00	0.20	1.06	1.58	2.24	0.49	0.33	0.94	0.16	0.38
LO2	2.00	0.20	1.06	1.58	2.24	0.49	0.33	0.94	0.16	0.38

Interpretation of indicator

Olkiluoto

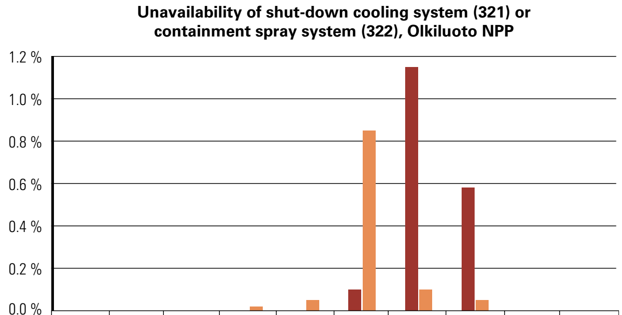
The unavailability times of the containment vessel spray system have been decreasing since 2005. In 2007 and 2008, the unavailability was zero for both plant units.

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 for other such OL1 and OL2 lines in 2009 and 2010. There were no significant failures in 2007 or 2008, and the unavailability of the auxiliary feed water system decreased to nearly zero for both plant units.

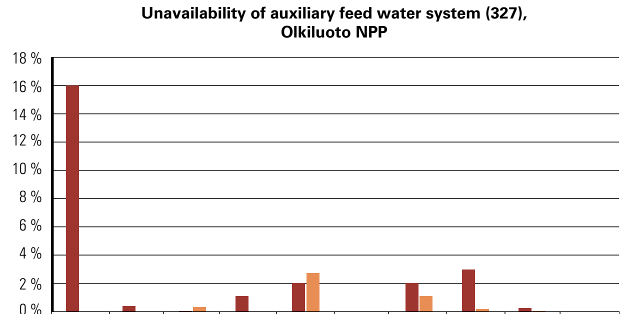
The unavailability of the diesel generators has decreased since 2004, and was very low in 2006 and 2007. In 2008, the value increased nearly 95% compared to the previous year.

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.

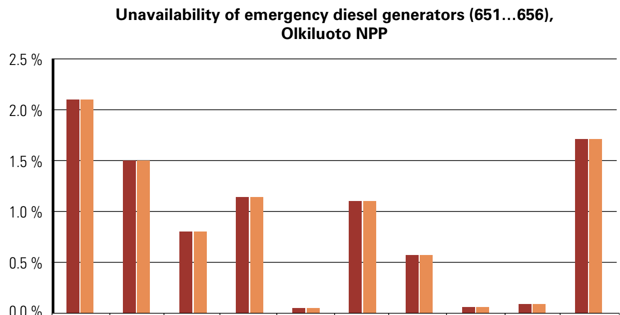
The condition of the containment spray system and the auxiliary feed water system has remained good. The increase in the unavailability of emergency diesels was a result of starter motor failures that were caused by the exclusion of these motors from appropriate preventive maintenance. In other regards,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



	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
OL1	0.00	0.00	0.00	0.00	0.00	0.10	1.15	0.58	0.00	0.00
OL2	0.00	0.00	0.00	0.02	0.05	0.85	0.10	0.05	0.00	0.00



	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
OL1	16.00	0.40	0.03	1.10	2.00	0.01	2.00	2.98	0.25	0.00
OL2	0.00	0.00	0.00	0.02	0.05	0.85	0.10	0.05	0.00	0.00



	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
OL1	2.10	1.50	0.80	1.14	0.05	1.10	0.57	0.06	0.09	1.71
OL2	2.10	1.50	0.80	1.14	0.05	1.10	0.57	0.06	0.09	1.71

A.I.4 Occupational radiation doses

Definition

As the indicators, collective radiation exposure by plant site and plant unit is followed, 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 personal radiation doses is obtained from the national dose register.

Purpose of indicator

The indicators are used to control the radiation exposure of employees. In addition, compliance with the YVL Guide's calculatory 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 mSv 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 indicator

Loviisa

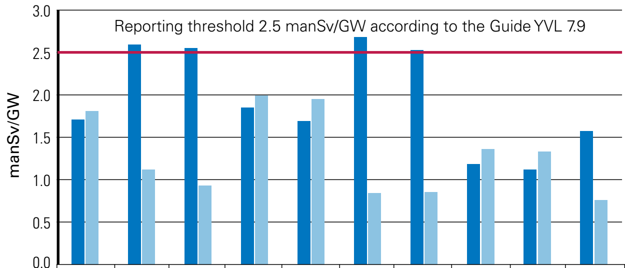
Most doses are incurred through work done during outages; thus outage duration and the amount of work having significance on radiation protection affect the yearly radiation doses. Both Loviisa plant units have major annual outages every four and eight years (the four-year annual maintenance and the 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 2008, a four-year annual maintenance took place at Loviisa 1, and a short annual maintenance at Loviisa 2. The time used for annual maintenance outages was long, and there was a high amount of work with significance for radiation protection, which resulted in a total collective dose that was higher than that of the previous year. Still, the collective dose was lower than in other similar major annual maintenance years. The low dose for the four-year maintenance can be explained by better targeting of materials inspections, the new induction training, and the improved planning and monitoring of radiation protection.

The radiation doses for nuclear power plant workers were below the personal dose limits. The trend for the average of the ten highest doses has been declining in recent years. In 2008, the average was higher than in the previous year, but still lower than the average dose level of recent years. The average for 2007 was the lowest of all time.

The Radiation Decree (1512/1991) stipulates that the effective dose for a worker from radiation work must not exceed the 20 mSv/year average over any period of five years, or 50 mSv in any one year.

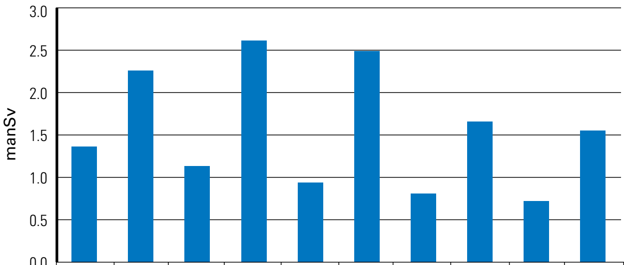
Furthermore, the threshold set for the collective occupational dose was not exceeded in 2008. If, at one plant unit, the collective occupational radiation dose average over two successive years exceeds 2.5 manSv per one GW of net electrical power, the utility is to report the causes of this to STUK, 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



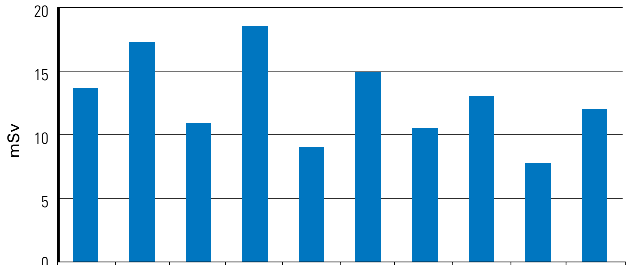
	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
LO1	1.71	2.59	2.55	1.85	1.69	2.68	2.53	1.18	1.12	1.57
LO2	1.81	1.12	0.93	1.99	1.95	0.84	0.85	1.36	1.33	0.76

Collective occupational radiation dose (manSv), Loviisa NPP



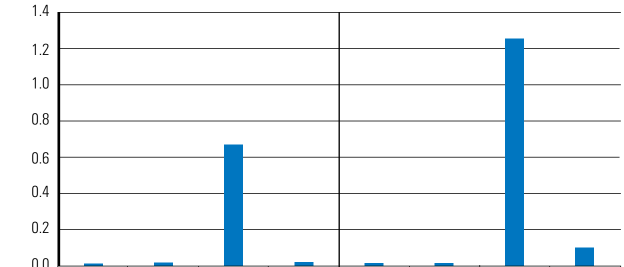
	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
LO	1.36	2.26	1.13	2.61	0.94	2.49	0.81	1.66	0.72	1.55

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



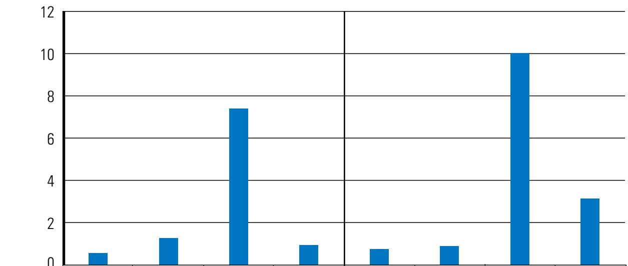
	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
LO	13.70	17.25	10.94	18.54	9.01	14.93	10.48	13.00	7.76	11.99

Collective dose (manSv) quarterly in 2005–2006, Loviisa NPP



	I/07	II/07	III/07	IV/07	I/08	II/08	III/08	IV/08
LO	0.012	0.019	0.670	0.021	0.015	0.016	1.255	0.100

Average of the ten highest doses (mSv) in 2005–2006, Loviisa NPP



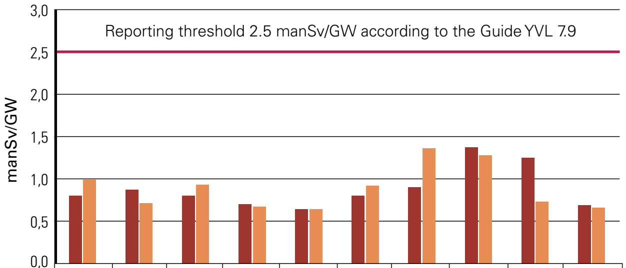
	I/07	II/07	III/07	IV/07	I/08	II/08	III/08	IV/08
LO	0.560	1.259	7.410	0.930	0.740	0.887	10.023	3.140

Interpretation of indicator

Olkiluoto

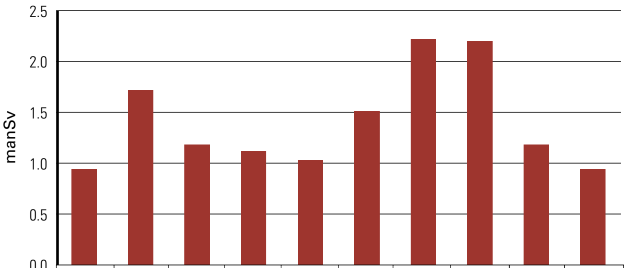
Most doses are incurred through work done during outages; thus outage duration and the amount of work having significance on radiation protection affect the yearly radiation doses. The annual outages for the Olkiluoto power plant units are divided into two groups: the refuelling outages and the maintenance 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 2008, the collective dose in Olkiluoto was the lowest since 1983. In addition, the average of the ten highest doses was decidedly lower than in the previous years, and the set dose limits (YVL Guide 7.9, the Radiation Decree 1512/1991) were not exceeded.

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



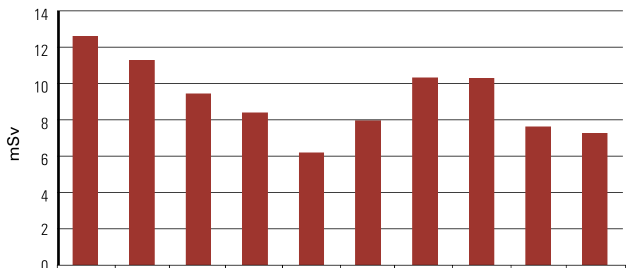
	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
OL1	0.80	0.87	0.80	0.70	0.64	0.80	0.90	1.37	1.25	0.69
OL2	0.99	0.71	0.93	0.67	0.64	0.92	1.36	1.28	0.73	0.66

Collective occupational radiation dose (manSv), Olkiluoto NPP



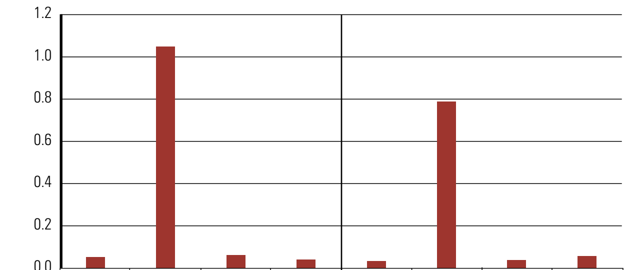
	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
OL	0.94	1.72	1.18	1.12	1.03	1.51	2.22	2.20	1.18	0.94

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



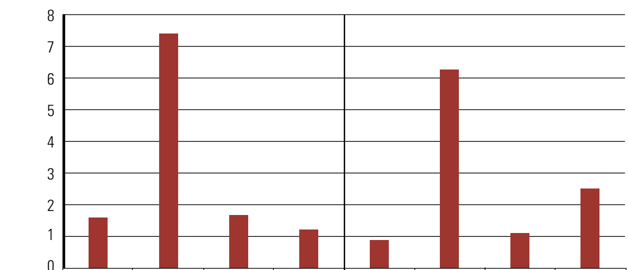
	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
OL	12.6	11.3	9.45	8.41	6.2	7.96	10.32	10.3	7.63	7.28

Collective dose (manSv) quarterly in 2005–2006, Olkiluoto NPP



	I/07	II/07	III/07	IV/07	I/08	II/08	III/08	IV/08
OL	0.052	1.048	0.060	0.039	0.032	0.788	0.037	0.056

Average of the ten highest doses (mSv) in 2005–2006, Olkiluoto NPP



	I/07	II/07	III/07	IV/07	I/08	II/08	III/08	IV/08
OL	1.590	7.395	1.670	1.205	0.875	6.255	1.095	2.500

A.I.5 Radioactive releases

Definition

As the indicators, radioactive releases into the sea and the atmosphere (TBq) from the plant are followed, 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 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

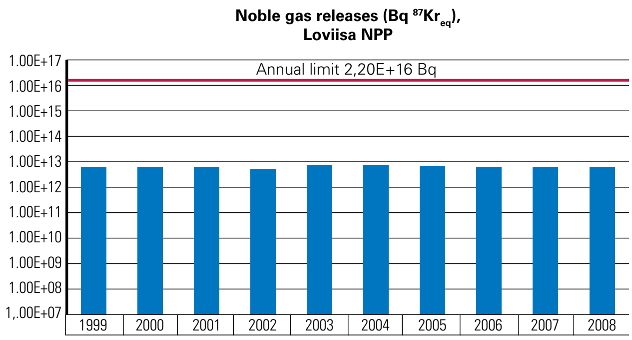
Radiation protection (SÄT), Antti Tynkkynen

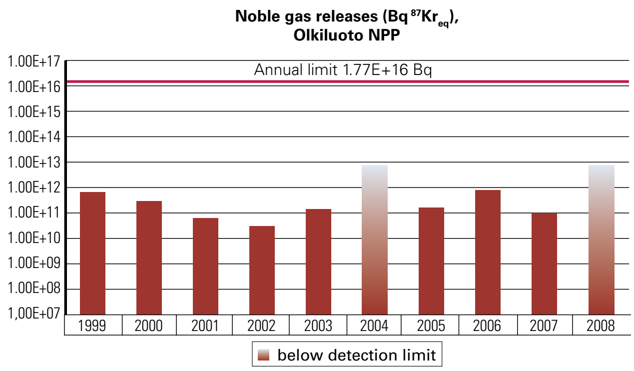
A.I.5a Releases into the atmosphere

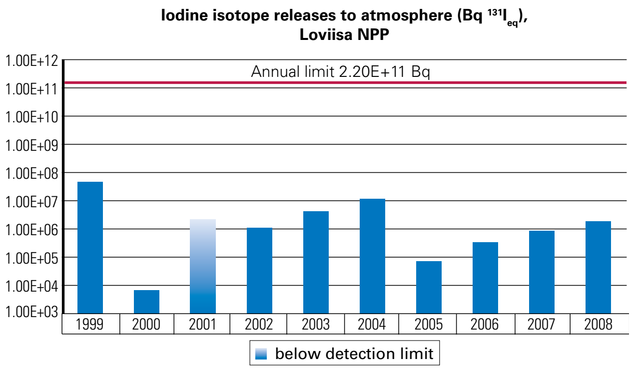
Interpretation of indicator

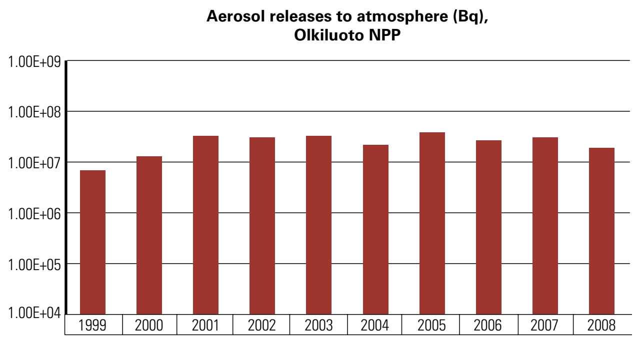
Radioactive releases into the atmosphere from the Loviisa and Olkiluoto nuclear power plants were of the same magnitude as in previous years. In Loviisa, only the releases of iodine isotopes saw a slight increase. The total releases from Olkiluoto have decreased, and releases of noble gas activities remained below the detection limit. Radioactive releases into the environment from the Loviisa and Olkiluoto nuclear power plants were small. They are well below the set limits.

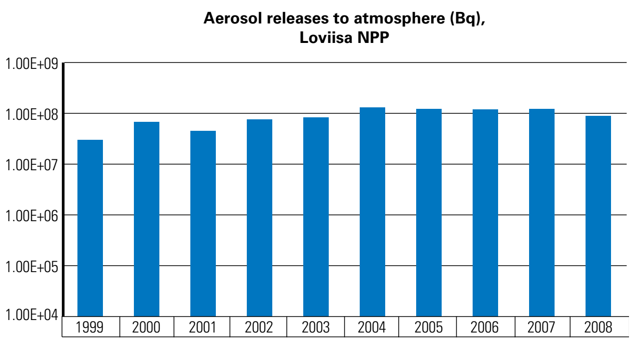
Gaseous fission products, noble gases and iodine isotopes originate in leaking fuel rods, in

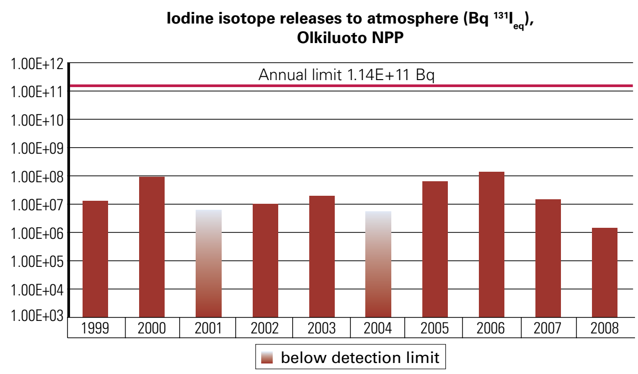










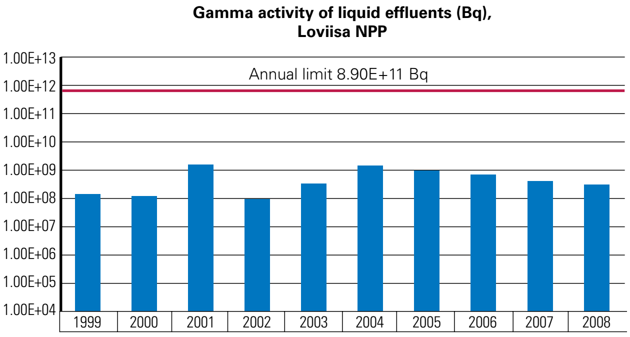


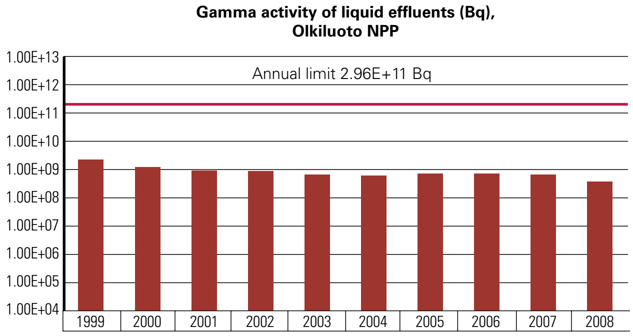
the minute amounts of uranium left on the outer surfaces of fuel cladding during fuel fabrication, and in reactor surface contamination from earlier fuel leaks. At both Loviisa and Olkiluoto, fuel leaks have been very small. The indicator A.III.1 describes fuel integrity. The noble gas releases from 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 indicator

The releases of radioactive substances with gamma activity have been decreasing since 2004, when the plant carried out a planned discharge of low-activity evaporation residue into the sea. The releases of substances with gamma activity into the sea from Olkiluoto have been decreasing in recent years, reaching their lowest value in 2008.



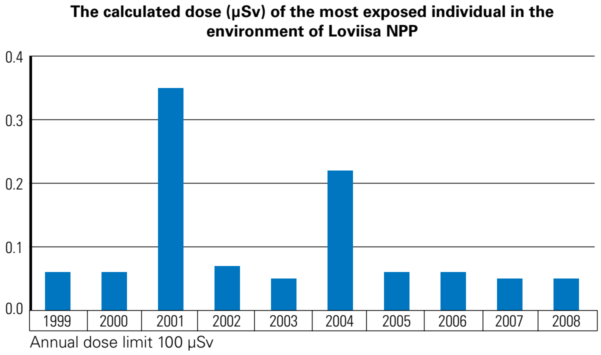


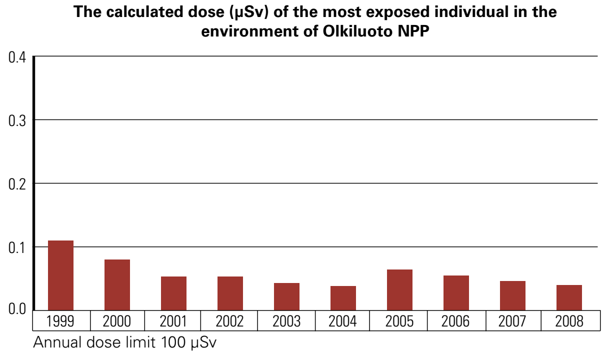
A.I.5c Population exposure

Interpretation of indicator

The calculated radiation dose for the most exposed individual in the vicinity of each power plant was of the same magnitude as in the previous years. The doses for the most exposed individual for both Loviisa and Olkiluoto were low in 2008. The Loviisa graph shows how the dose for the most exposed individual is affected by the controlled discharge of low-activity evaporation residues into the sea. The previous controlled discharge was made in 2004.

The calculated doses of the most exposed individual in the vicinity of both plants are less than 0.1% of the 100 microSv limit established in the Government Decision (395/1991).





A.I.6 Investments in facilities

Definition

Investments in plant maintenance and modifications in the current value of money adjusted by the building cost index.

Source of data

The licensee submits the necessary data directly to the person responsible for the indicator.

The indicator demonstrates the relative fluctuation of investments. The amounts given in euro are the confidential information of the utilities involved, and not to be published here. Furthermore, the scales of the Loviisa and Olkiluoto power plants' investment and modernisation diagrams are not mutually comparable.

Purpose of 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 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. At the moment, the situation is good at both plants.

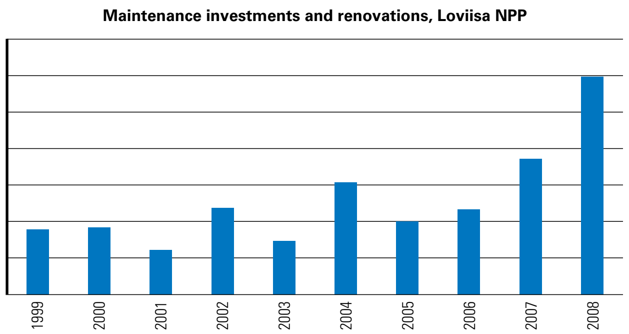
Loviisa

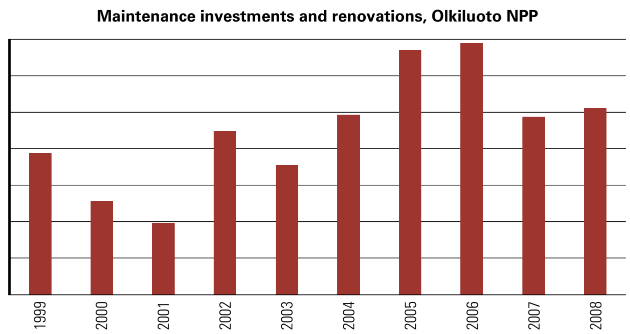
At the Loviisa power plant, the most significant investment in 2008 was the I&C renewal (LARA). LARA's share of the total investments was approximately 50% in 2007 and 2008. Other investments have remained at the previous years' level.

In addition to LARA, major investments in 2008 included the replacement of stators, the basic renovation of waste, storage and decontamination facilities, refuelling machine renovation (LAMO), replacement of bolts in the reactor support cage, basic servicing of emergency diesels and generators, the improvement of secondary circuit safety (LARA/SETU), and the renewal of high pressure safety injection pumps (TJ pumps).

Olkiluoto

The investments remained at the previous years' level in Olkiluoto in 2008. The largest investments include the gas turbine plant completed in 2008, the modernisation of the external radiation measuring system, and the continuing electricity production and aging management-related low pressure turbine renewal project and the acquisition of new generators in 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 followed. (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 (YTD).

Purpose of 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 indicator

Loviisa

The number of events warranting a special report has not changed markedly in the long term. The numbers have remained reasonably low. In the last year, three events warranting a special report (two of which were non-compliances with the Tech Specs, see section A.I.2) were observed.

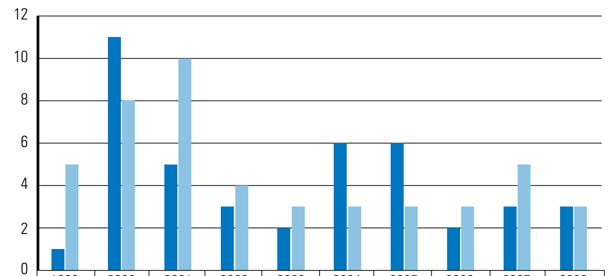
The first of these was related to differences specified for valve testing intervals in the Technical Specifications and in guides. The safety significance of the event was very minor. The second event concerned an incorrect simulation in the reactor protection system. The simulation would have prevented a reactor trip resulting from the stopping of four reactor coolant pumps. The safety significance of the incorrect simulation was low, but deficiencies in the procedure made the event significant. The power company will prepare a root cause analysis on the event in 2009, and STUK will inspect the analysis.

The third event concerned fuses that were missing from the severe accident power supply subsystem's second uninterrupted power supply system. The fuses had been absent since the annual maintenance of 2008. The safety significance of the event was very minor.

In the first case, corrective measures were targeted at the improvement of testing programmes and instructions, as well as cross-checking of the Tech Specs and improving the inspection procedures for the guidelines. For the second event, incorrect simulations were removed as an immediate corrective measure. Actual corrective measures will be defined in connection with the root cause analysis. For the event concerning the UPS fuses, corrective measures are targeted at developing record entries and more extensive inspections at plant start-up.

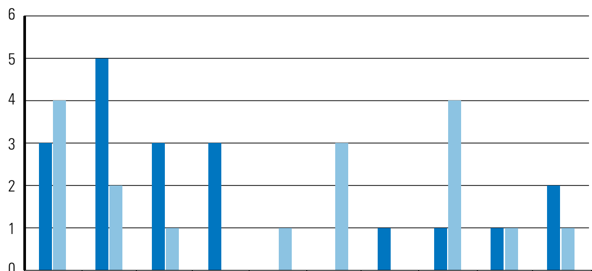
The number of reported operational transients has remained reasonably good since 2002, at between five and nine transients per year. At Loviisa 1, the transients concerned a short-circuit in a condensate pump motor at start-up, bypass of

Number of operational transient reports, Loviisa NPP



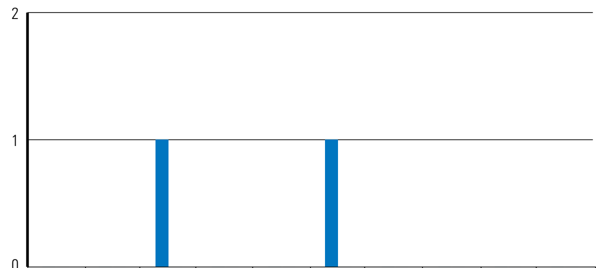
	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
LO1	1	11	5	3	2	6	6	2	3	3
LO2	5	8	10	4	3	3	3	3	5	3

Number of Special Reports, Loviisa NPP



	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
LO1	3	5	3	3	0	0	1	1	1	2
LO2	4	2	1	0	1	3	0	4	1	1

Number of reactor scrams, Loviisa NPP



	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
LO1	0	0	1	0	0	1	0	0	0	0
LO2	0	0	0	0	0	0	0	0	0	0

low pressure heaters, and the low pressure heater bypass and main coolant pump start-up problems observed in connection with the LARA main coolant pump shutdown test. At Loviisa 2, transients concerned the failure of one control rod, resulting in the rod's entry into the reactor, a spurious trip of a main coolant pump and a spurious opening of an excitation field breaker. The plant operated as planned during the transients.

The number of reactor trips has been low at Loviisa, partly due to the two turbines. These guarantee that if one turbine trips due to a malfunction or other cause, the reactor remains operational. No reactor trips occurred in 2005–2008.

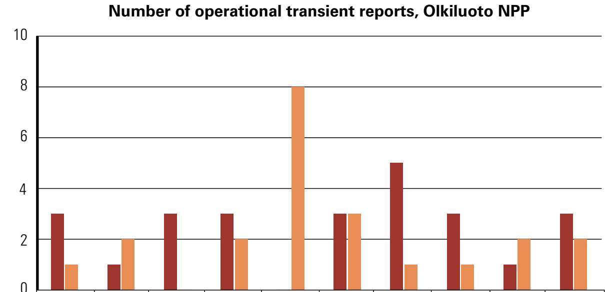
Olkiluoto

Based on the data from the last ten years, an average of one reactor trip per year occurs at Olkiluoto nuclear power plant. In 2008, two reactor trips occurred, one at both plant units. Seawater cooled rapidly in front of the Olkiluoto nuclear power plant on the morning of 5 January 2008. The ice chips created as a result of this cooling blocked the circulating water screening filters of Olkiluoto 2 and weakened the flow of the seawater used as coolant in the plant. As a result, a turbine trip occurred at the plant unit, leading to a reactor trip. Following an incorrect function in the new voltage regulator installed during the annual maintenance in 2008, generator voltage began to increase at the start-up of Olkiluoto 1 on 30 May 2008. Reactor power was 60%. The protective devices of the electrical network disconnected the generator and power plant's main connection to the national 400 kV grid. The back-up connection from the 110 kV grid connected automatically after two seconds to supply power to the plant systems. The overvoltage peak caused by the opening of a plant breaker shut down all six main coolant pumps circulating cooling water within the reactor pressure vessel, as well as the flywheels that were supposed to slow down the stopping of the pumps, and damaged parts of the control electronics of the main coolant pumps and flywheels. As a result of the transient, a turbine trip and partial reactor trip occurred at Olkiluoto 1, with an immediate reactor trip following as the actuator oil pumps of turbine valves stopped and the direct dumping of steam into the turbine condenser was prevented.

Based on the data from the last ten years, the average number of annual events warranting a special report or an operational transient report is five. The number of events warranting a special report in 2008 (seven) is higher than average. Five of these events occurred during annual maintenance. Due to the latest events, TVO had a safety culture assessment done in 2008. TVO presented the results of the assessment to STUK in the safety management A1 inspection in January 2009.

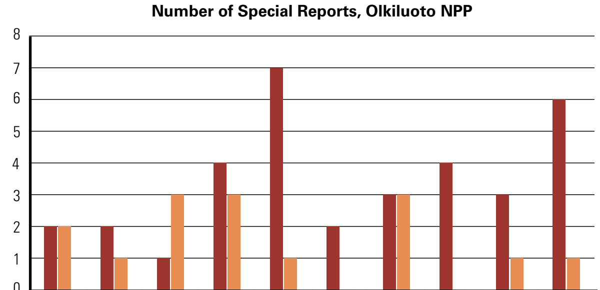
When considering the indicators, it must be noted that the number of reports does not give the correct conception of the division of events by plant unit since, for system technical reasons, the reports for both plant units have been entered for Olkiluoto 1. In 2008, one event warranting an operational transient report and two warranting a special report concerned both plant units.

Number of operational transient reports, Olkiluoto NPP



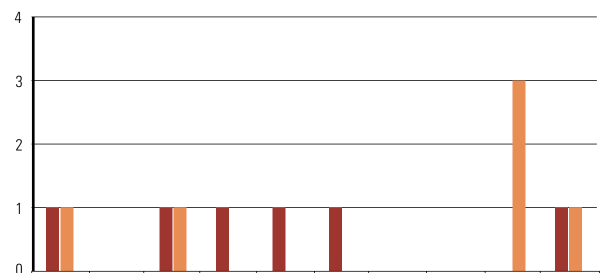
	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
OL1	3	1	3	3	0	3	5	3	1	3
OL2	1	2	0	2	8	3	1	1	2	2

Number of Special Reports, Olkiluoto NPP



	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
OL1	2	2	1	4	7	2	3	4	3	6
OL2	2	1	3	3	1	0	3	0	1	1

Number of reactor scrams, Olkiluoto NPP



	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
OL1	1	0	1	1	1	1	0	0	0	1
OL2	1	0	1	0	0	0	0	0	3	1

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.

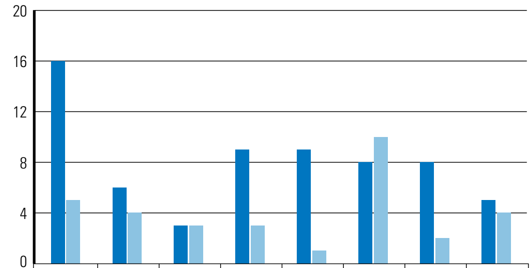
Purpose of indicator
The indicator is used to follow the division of the causes of reported events into technical and non-technical causes. "Non-technical causes" denote failures caused by erroneous operational and maintenance actions. The indicator may be indicative of an organisation's operation.

Responsible unit/person
Organisations and Operations (OKA)
Suvi Ristonmaa and Tomi Koskiniemi

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

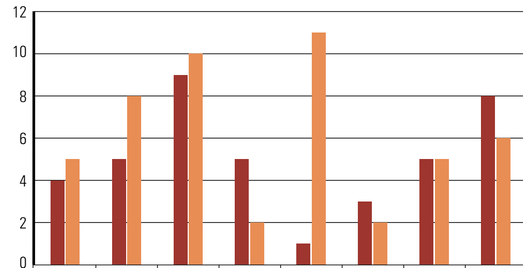
Both technical and non-technical causes can be identified behind many events. In such cases, classification is done based on the most significant cause of the event.

Direct causes of events, Loviisa NPP



	2001	2002	2003	2004	2005	2006	2007	2008
LO, Technical	16	6	3	9	9	8	8	5
LO, Human	5	4	3	3	1	10	2	4

Direct causes of events, Olkiluoto NPP



	2001	2002	2003	2004	2005	2006	2007	2008
OL, Technical	4	5	9	5	1	3	5	8
OL, Human	5	8	10	2	11	2	5	6

A.II.3 Risk-significance of events

Definition

As the indicators, the risk-significance of events caused by component unavailability is followed. As the risk measure, 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 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 indicator

Loviisa

A brief description of the significant events is given below:

Loviisa 1:

1) Component failure: Change in the route of a pneumatic tube of the ventilation UV20 damper control on the outlet side for the distribution rooms of the control room building. The change was necessary as the tube hindered free passage. During the change (4.4 h), UV20 was not available to replace the UV25 system. CCDP = 2.1E-7.
2) Component failure: A diesel generator did not start during a test drive. The alarm remained active. The fault was latent for approximately 13 days. CCDP = 3.7E-7.
3) Component failure: One (B03) of the two cooling machines of the cooling system UV25 of the control room building's instrumentation facility failed (oil pressure and high pressure alarms). CCDP = 1.1E-7.
4) Component failure: The frequency of diesel EY02 was too high in the periodic testing. The diesel was not synchronised with the network until the frequency was lowered. The failure had been latent for approximately 8 days. CCDP = 3.2E-7.
5) 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 be connected to either plant unit. CCDP = 8.6E-7.

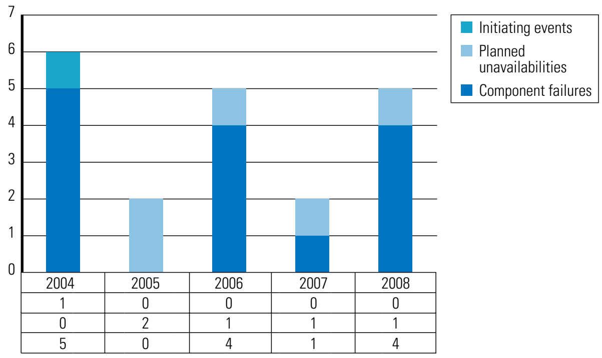
Loviisa 2:

1) Component failure: The water cooling machine of the control room building's instrumentation facility cooling system UV45 made a rattling noise. UV45 was not available during repair. CCDP = 4.9E-7.
2) Component failure: The back-up auxiliary feed water pump RL97 was inoperative due to a low surface level in the diesel engine fuel tank. The failure had been latent for approximately 15 days. CCDP = 1.1E-6.

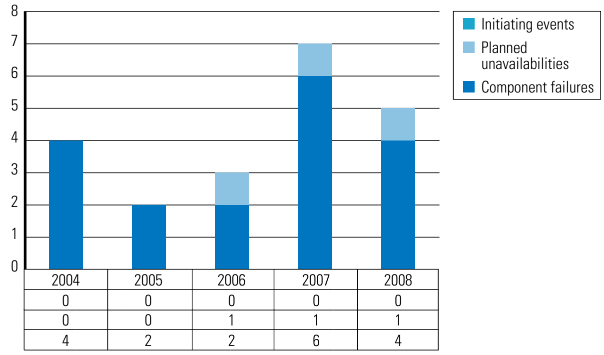
3) Component failure: The temperature measurement of the switchgear and cable space ventilation system did not start up the second pair of inlet and outlet fans (in calculations, the unavailability of the system is replaced with its own square root). CCDP = 2.7E-7.
4) Component failure: The hot safety injection system accumulator of the first redundancy and the cold safety injection system accumulator of the second redundancy were inoperative during the outage for the time of the inspection. The calculation was performed as if the event had occurred during power operation. CCDP = 4.0E-7.
5) 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 = 8.6E-7.

At Loviisa, the risk arising from events consists of a few single device failures and the preventive maintenance of the auxiliary feed water system redundancies. The analysed events are considered to be part of normal nuclear power plant operation, and no further measures were required from STUK.

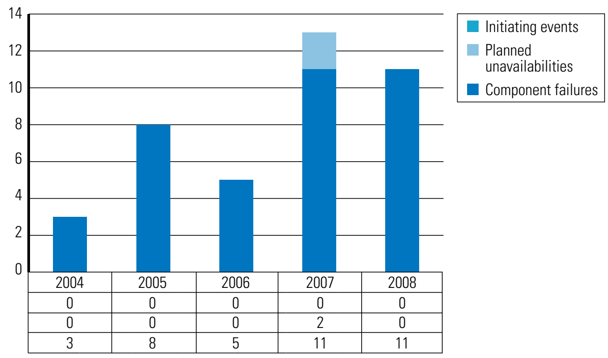
Most risk-significant events CCDP ≥ 1E-7, Loviisa 1 (Total number of events)



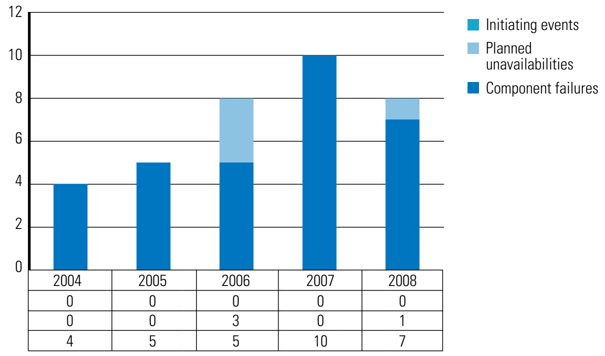
Most risk-significant events CCDP ≥ 1E-7, Loviisa 2 (Total number of events)



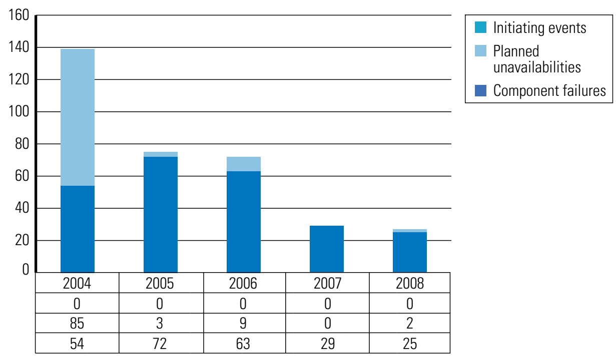
Other significant events 1E-8 ≤ CCDP < 1E-7, Loviisa 1 (Total number of events)



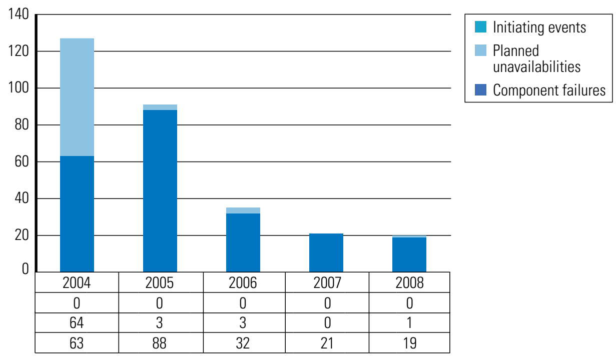
Other significant events 1E-8 ≤ CCDP < 1E-7, Loviisa 2 (Total number of events)



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



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



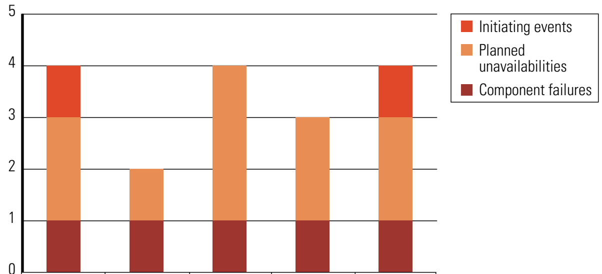
Olkiluoto

A brief description of the significant events is given below:

Olkiluoto1:

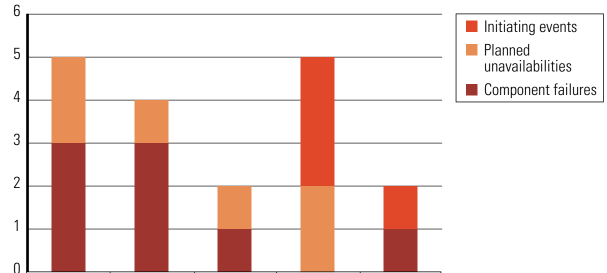
1) Component failure (common cause failure of the diesels): The diesel engine of subsystem C did not start in the reactor protection system test, when all diesel engines were supposed to start. The fault was located in the compressed air motors of the component (two motors per diesel generator). The seals of the check valves of both motors (one valve per motor) were found to be damaged, and air leaked out. All seals for all diesel generators were inspected. For Olkiluoto 1, six of eight seals were damaged. For Olkiluoto 2, one of eight seals was damaged. PSA computation was performed with diesel C as damaged, and diesel D with unavailability set to 0.5. The result was CCDP = 2.7E-6, which is approximately 19% of the annual risk.
2) Initial event: On 30 May 2008 a transient occurred at Olkiluoto 1 plant unit, in which the unit experienced a turbine trip and a reactor trip as a result of a generator overvoltage. In connection with the trips, the reactor coolant pumps stopped. As a result of an overvoltage in the 6.6 kV bus bars, damage occurred in the control systems of the reactor coolant pumps

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



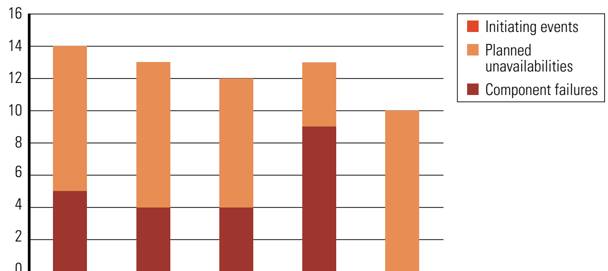
2004	2005	2006	2007	2008
1	0	0	0	1
2	1	3	2	2
1	1	1	1	1

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



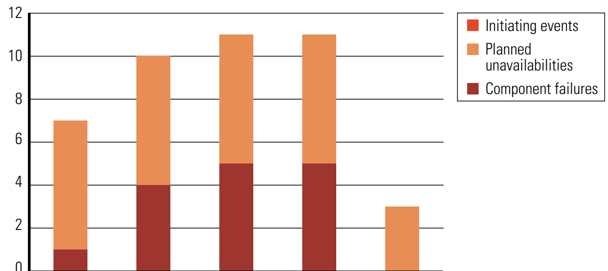
2004	2005	2006	2007	2008
0	0	0	3	1
2	1	1	2	0
3	3	1	0	1

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



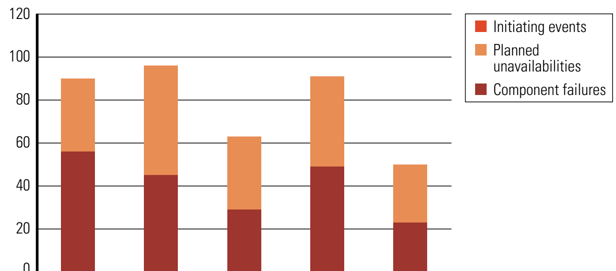
2004	2005	2006	2007	2008
0	0	0	0	0
9	9	8	4	10
5	4	4	9	0

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



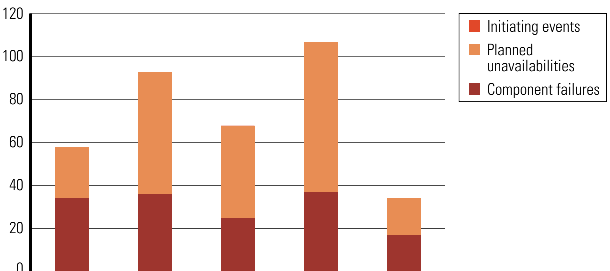
2004	2005	2006	2007	2008
0	0	0	0	0
6	6	6	6	3
1	4	5	5	0

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



2004	2005	2006	2007	2008
0	0	0	0	0
34	51	34	42	27
56	45	29	49	23

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



2004	2005	2006	2007	2008
0	0	0	0	0
24	57	43	70	17
34	36	25	37	17

and the flywheel generators securing their deceleration ramp. At the moment of the event, the plant unit was in the middle of start-up after annual maintenance. Reactor power was approximately 60%, and the plant was synchronised to the national grid. In PSA computation, the initial event 'loss of condenser' was used, and the resulting CCDP was 2.1E-6.

3) Preventive maintenance: The diesel package DIP-A took approximately 17 days. CCDP = 3.8E-7.
4) Preventive maintenance: Pump P3 of shutdown secondary cooling system 721 was unavailable due to inspection of a check valve. CCDP = 1.1E-7.

Olkiluoto2:

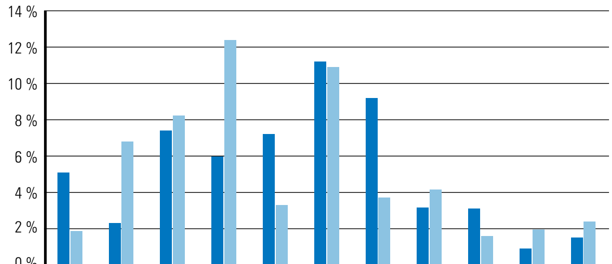
1) Initial event: Rapid decrease of seawater temperature caused the creation of ice chips in band screens. Partial blockage of the band screens (frazil ice) hindered the flow of the water and caused a decline in the water level on the suction side of the circulating water pumps. The turbine trip resulted from high pressure in the condenser. A partial trip followed, and dumping began. This lead to a bypass trip and a reactor trip. In PRA, the case was modelled as a loss of feed water and condenser. The result was CCDP = 3.6E-6.
2) Component failure: In an inspection, the second starter motor of the subsystem B diesel generator was found to be inoperative due to a leaking seal. The fault had been latent for approximately 7 days. CCDP = 1.1E-7.

At Olkiluoto, the risk caused by these events consisted of two initial events leading to a reactor trip (OL2: frazil ice and OL1: generator overvoltage), a common cause failure of diesel generators, a few individual component failures and the long duration of diesel package A at OL1. The initial events and the common cause failure of the diesels have led to additional reports and will lead (or have already led) to changes at the plant or in the maintenance procedures. Other analysed events are considered to be part of normal nuclear power plant operation, and they did not give rise to any further measures by STUK.

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

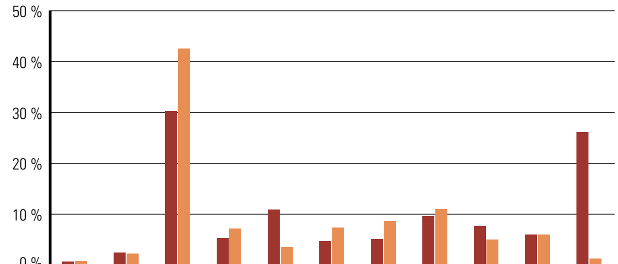
Risks arising from operational activities have remained substantially at the same level as in previous years for all plant units except OL1. The higher value of OL1 was caused by the common cause failure of the diesel generators at the end of May.

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



	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
LO1	5.09	2.30	7.39	5.96	7.20	11.21	9.20	3.15	3.10	0.90	1.50
LO2	1.87	6.80	8.23	12.39	3.30	10.90	3.70	4.14	1.60	1.95	2.40

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



	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
OL1	0.65	2.47	30.30	5.28	10.90	4.68	5.10	9.64	7.60	6.00	26.10
OL2	0.72	2.26	42.50	7.17	3.50	7.39	8.60	10.95	5.00	6.00	1.30

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 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

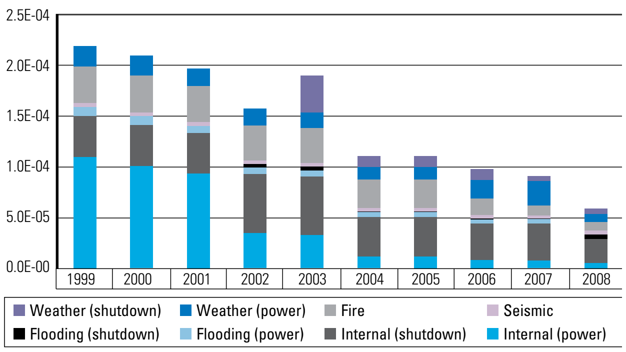
Risk assessment (RIS), Jorma Rantakivi
(PSA computation)
Organisations and Operations (OKA)
(failure data)

Interpretation of indicator

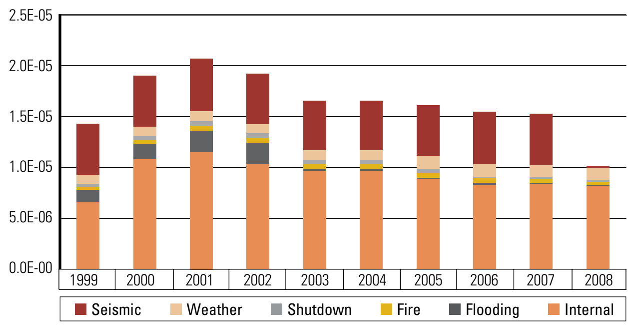
When assessing the indicator, it must be remembered that it is affected by both the development of the power plant and the development of the calculation model. Plant modifications and changes in methods, carried out to remove risk factors, will decrease the indicator value. An increase of the indicator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

Loviisa power plant's accident risk has continued to decrease for 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

Fluctuation of the calculated annual core damage frequency for Loviisa plant units during 1999–2008



Fluctuation of the calculated annual core damage frequency for Olkiluoto plant units during 1999–2008



with the licence renewal. Such changes include: the I&C renewal LARA; the decrease in the probability of a criticality accident using, for example, boron analysers; modernisation of the refuelling machine and the decrease in the probability of an external leak.

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

The indicator for the Olkiluoto plant decreased approximately 30% in 2008 compared to 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. 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 indicator
The indicator is used to follow the effectiveness of fire protection at the nuclear power plants.

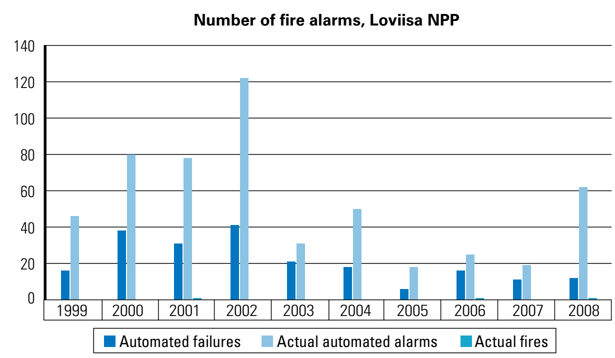
Responsible unit/person
Civil Engineering and Fire Protection (RAK)
Heikki Saarikoski

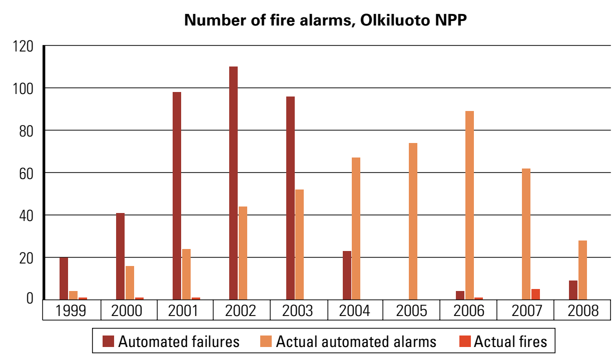
Interpretation of indicator
At the Loviisa power plant, one event classified as a fire occurred in 2008. When starting up a pump of a drains system (RN) belonging to the turbine systems of Loviisa 1 on 19 September 2008, the motor short-circuited, which caused a powerful arc flame and smoke in the pump. The smoke stopped without any measures being taken. The plant's fire brigade inspected the target and the environment. At Loviisa power plant, detection system errors have remained at the level of 2008. Correct alarms from the detectors have, however, increased, partially due to the large amount of work included in the long annual maintenance outages, and the construction of the new I&C buildings.

No events classified as fires occurred in the Olkiluoto plant area (OL1/2) in 2008. Outside the plant area, however, three events classified as fires occurred. All of these were minor and had no effect on plant safety. No detection system failures were observed at Olkiluoto power plant in 2008. The situation was the same as in 2007. The nine device failures 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. Correct alarms from fire detectors have decreased since 2007, partially due to the shorter annual maintenance outages of 2008 and the smaller amount of work included in them.

The fire alarm system was renewed in 2000 at Loviisa power plant and in 2001 at Olkiluoto power plant. After the renewal 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 event of smoke being emitted from an electric motor at the Loviisa power plant. Alarms from the fire alarm system have also been at a relatively low level. Most of the alarms were caused by dust, smoke or humidity. Fire alarm systems are not always disconnected in a wide enough area for maintenance work. The number of alarms from the fire alarm system is also affected by the amount of maintenance and repair work performed at the plants, as well as construction work 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 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

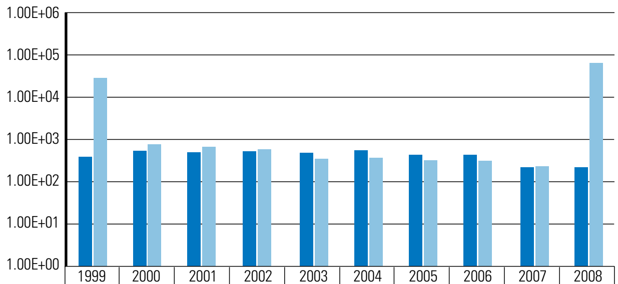
Reactor and Safety Systems (REA),
Kirsti Tossavainen

A.III.1a Primary coolant activity

Interpretation of indicators (Loviisa)

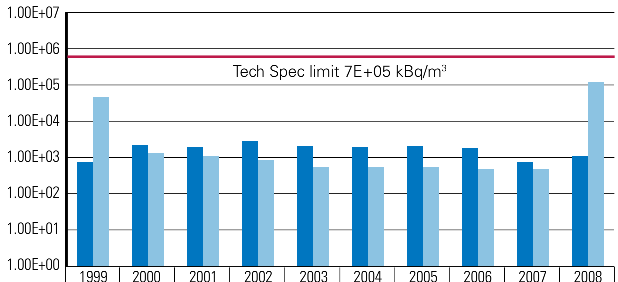
At Loviisa 2, an increase in the activity of gases released from process systems was detected on 28 November 2008. The activity concentration of the iodine isotopes in the primary coolant and the gaseous fission products dissolved into the primary coolant also increased. On 1 December 2008, the observation was confirmed as a fuel leak. After the initial stages of the leak, activity levels did not increase further, and no essential changes had occurred in the activity concentration by the end of the year. By the end of 2008, the maximum I-131 activity concentration was 1.3E+05 kBq/m³. Based on the gases released from the fuel rod and the activity concentrations of the iodine isotopes released into the primary coolant, it was estimated that a minor leak of one fuel rod had occurred. The power company continues to monitor the status and development of the leak using on-line monitoring,

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



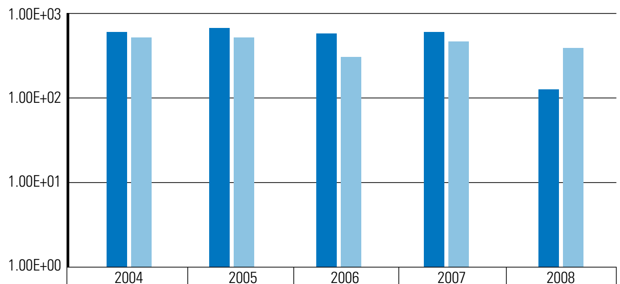
	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
LO1	3.41E+02	4.82E+02	4.45E+02	4.71E+02	4.32E+02	5.01E+02	3.89E+02	3.91E+02	1.90E+02	2.00E+02
LO2	2.55E+04	7.19E+02	6.40E+02	5.74E+02	3.22E+02	3.39E+02	2.91E+02	2.72E+02	2.10E+02	4.90E+04

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



	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
LO1	8.00E+02	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
LO2	5.20E+04	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

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



	2004	2005	2006	2007	2008
LO1	5.71E+02	6.38E+02	5.48E+02	5.70E+02	1.40E+02
LO2	4.97E+02	5.09E+02	2.93E+02	4.40E+02	4.30E+02

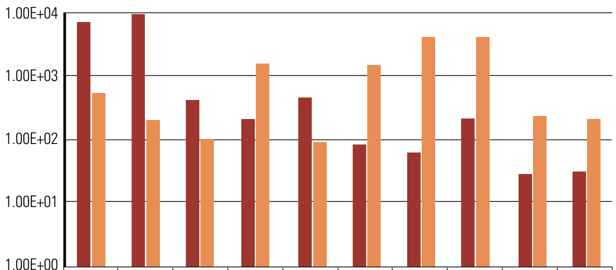
as well as radioactivity measurements carried out at the laboratory. The leaking fuel bundle will be removed from the reactor in the 2009 annual maintenance outage at the latest. The previous fuel leak at Loviisa 2 took place in 1999.

The reactor of Loviisa 1 has had no leaking fuel for several years, so no essential changes have occurred in the I-131 activity concentrations.

At Loviisa plant units, the I-131 activity concentrations have shown no essential changes when the plant units have been brought to shutdown. After the fuel leak at Loviisa 2, no shutdowns had taken place at the plant unit by the end of 2008. The maximum concentrations have been detected in situations in which the plant units were being shut down for annual maintenance.

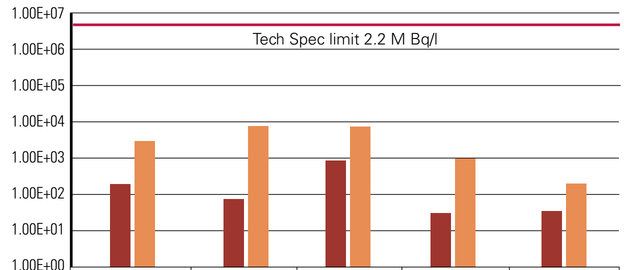
Based on the indicator, fuel integrity has been good at Loviisa 1. At Loviisa 2, fuel integrity was weakened by a minor fuel leak.

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



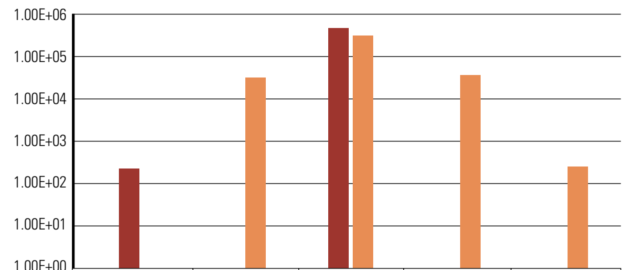
	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
OL1	7.00E+03	9.00E+03	4.00E+02	2.00E+02	4.30E+02	8.20E+01	5.80E+01	2.00E+02	2.70E+01	3.00E+01
OL2	5.12E+02	2.00E+02	1.00E+02	1.50E+03	9.00E+01	1.49E+03	4.00E+03	4.00E+03	2.30E+02	2.10E+02

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



	2004	2005	2006	2007	2008
OL1	1.90E+02	5.90E+01	6.90E+02	3.50E+01	3.70E+01
OL2	3.12E+03	6.52E+03	7.03E+03	9.99E+02	2.30E+02

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



	2004	2005	2006	2007	2008
OL1	2.00E+02	0.00E+00	3.60E+05	0.00E+00	0.00E+00
OL2	0.00E+00	3.44E+04	3.08E+05	3.70E+04	2.52E+02

Interpretation of indicators (Olkiluoto)

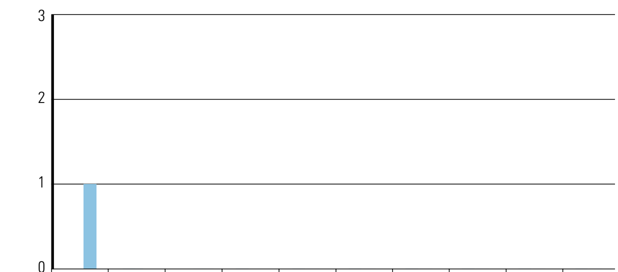
The Olkiluoto plant units had no leaking fuel in 2008, so the I-131 activity concentrations have remained the same or decreased. Similarly, the maximum activities resulting from shutdown have also shown a declining trend. Based on the indicator, fuel integrity has been good at Olkiluoto plant units.

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 will be removed from the reactor in the 2009 annual maintenance outage at the latest. The previous fuel leak occurred at Loviisa in 1999.

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

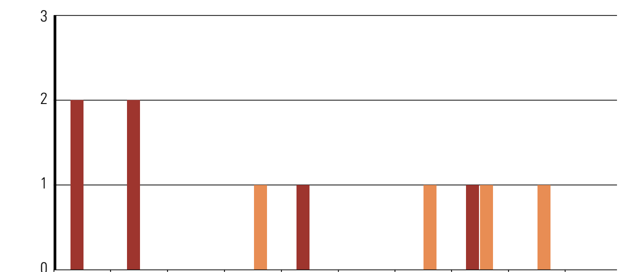


	1999	2000	2001	1002	2003	2004	2005	2006	2007	2008
LO1	0	0	0	0	0	0	0	0	0	0
LO2	1	0	0	0	0	0	0	0	0	0

Interpretation of indicators (Olkiluoto)

In recent years, fuel leaks have occurred at Olkiluoto plant units nearly every year. Leaks have been small and the leaking bundles have been removed in annual maintenance outages following leak detection. In 2008, 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, Olkiluoto NPP



	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
OL1	2	2	0	0	1	0	0	1	0	0
OL2	0	0	0	1	0	0	1	1	1	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 steam generator blow-down and the feedwater. For steam generator blow-down, 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 blow-down (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 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 and 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)

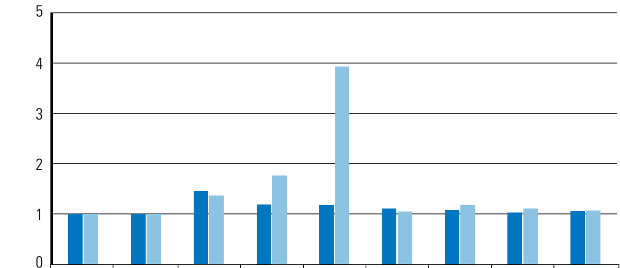
In the Technical Specifications for the secondary circuit, the normal state value for the steam generator blowdown water chloride content was changed. The new normal state limit is < 100 µg/l, while the earlier value was < 500 µg/l. The new limit was already included in the new chemistry guidelines applied since 2006. The cation conductivity of the steam generator blowdown water during power operation was also added to the Technical Specifications of secondary circuit chemistry.

At Loviisa 2, the chloride content in the blowdown water of all steam generators exceeded the Tech Specs limit when the plant unit was brought back to power operation after the annual maintenance outage. The content was brought to within the limit in less than 24 hours. At Loviisa 1, the cation conductivity of the steam generator blowdown water exceeded the Tech Specs limit when power operation began. The high conductivity was due to organic impurities. The conductivity values were brought to within Tech Specs limits in approximately 24 hours. The limits were only exceeded for a short period of time and therefore had no substantial effect on the plant units' chemistry indices.

The iron contents of the primary coolant and the secondary circuit feed water have complied with the power company's guidelines. The Co-60 activity concentrations measured while bringing the plant units to shutdown showed no deviation from the values of previous years.

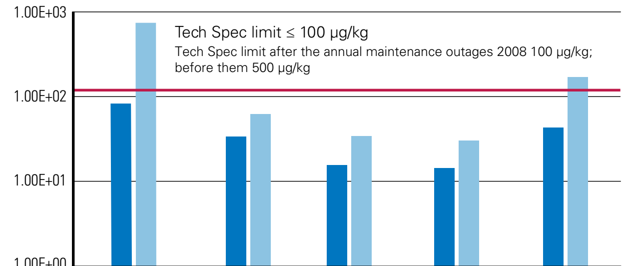
Based on the water chemistry indicators, the primary circuit integrity of Loviisa plant units has remained good.

Integrity of the secondary circuit: Chemistry index, Loviisa NPP



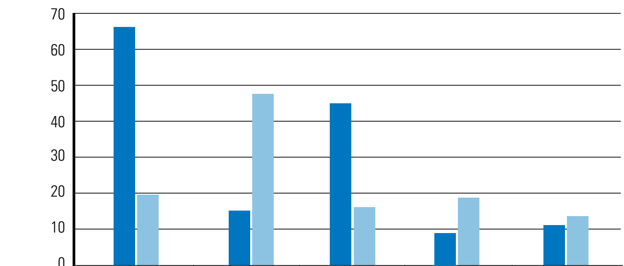
	2000	2001	2002	2003	2004	2005	2006	2007	2008
LO1	1.00	1.00	1.45	1.19	1.18	1.11	1.08	1.03	1.06
LO2	1.00	1.00	1.36	1.76	3.93	1.05	1.18	1.11	1.07

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



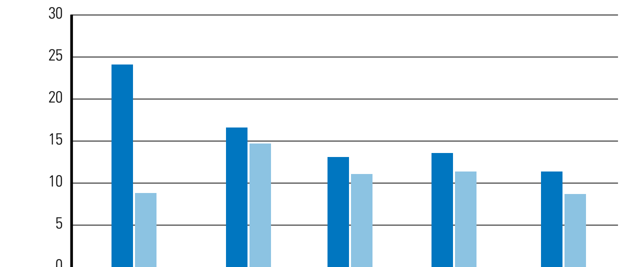
	2004	2005	2006	2007	2008
LO1	7.95E+01	3.33E+01	1.84E+01	1.43E+01	3.64E+01
LO2	6.06E+02	5.28E+01	3.73E+01	3.19E+01	2.10E+02

Integrity of primary circuit: Corrosion products; Maximum iron concentration of the solids in primary coolant (Fe_{tot} µg/l) during power operation, Loviisa NPP



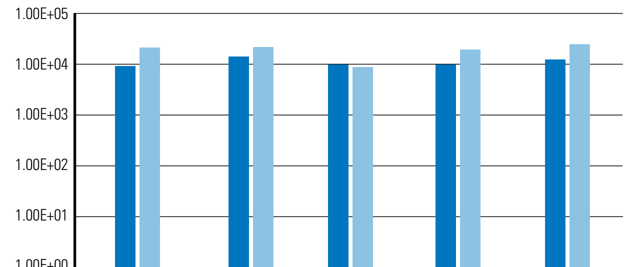
	2004	2005	2006	2007	2008
LO1	66.1	15.1	44.9	8.9	11.0
LO2	19.5	47.5	16.0	18.7	13.6

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



	2004	2005	2006	2007	2008
LO1	24.1	16.6	13.1	13.6	11.4
LO2	8.8	9.4	11.1	11.4	8.7

"Integrity of primary circuit: Maximum cobalt-60 activity concentration (kBq/m³) in primary coolant during shutdown or after reactor scram, Loviisa NPP



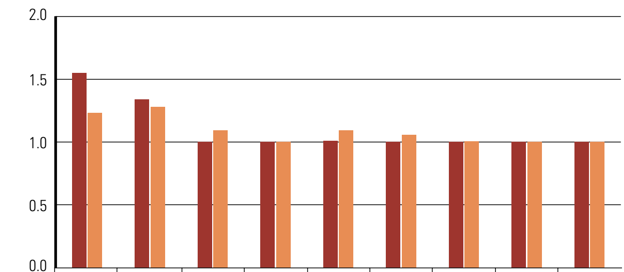
	2004	2005	2006	2007	2008
LO1	9.70E+03	1.50E+04	9.60E+03	1.09E+04	1.29E+04
LO2	2.30E+04	2.30E+04	9.00E+03	2.30E+04	2.40E+04

Interpretation of indicators (Olkiluoto)

In previous years, Olkiluoto plant units have experienced problems with the reactor coolant sulphate content exceeding the guideline set by the power company. The sulphate in the reactor coolant originates in the sulphate released from the ion-exchange resins of the condensate cleaning filters. Temperature is one of the factors in the release of sulphate from the filter resins. Changes have been made at the plant units to reduce the temperature of the water entering the condensate cleaning filters by changing the location of the condensate system pre-heater. The relocation was carried out at OL2 in 2003 and at OL1 in 2004. In addition to temperature, the replacement interval of filter resins also has an effect on the sulphate concentration. The guideline for the reactor coolant sulphate content was not exceeded in 2008. With the exception of individual deviations, the reactor coolant sulphate content has, in recent years, remained in compliance with the guideline (< 5 µg/l) set by the power company. Thus, STUK approved the power company's suggestion to the effect that annual reports concerning the cleaning of condensate will no longer be required by STUK.

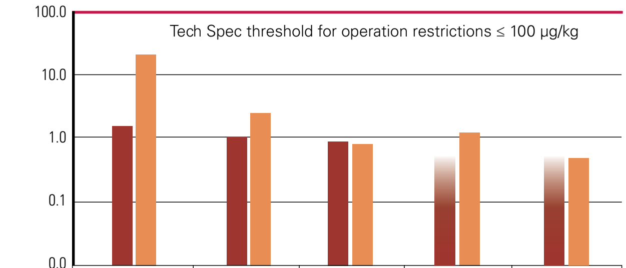
In one analysis, the iron content of the reactor coolant (1.1 µg/l) exceeded the target value (< 1 µg/l) set by the power company.

Integrity of primary circuit: Chemistry index, Olkiluoto NPP



	2000	2001	2002	2003	2004	2005	2006	2007	2008
OL1	1.55	1.34	1.00	1.00	1.01	1.00	1.00	1.00	1.00
OL2	1.23	1.28	1.09	1.00	1.09	1.06	1.00	1.00	1.00

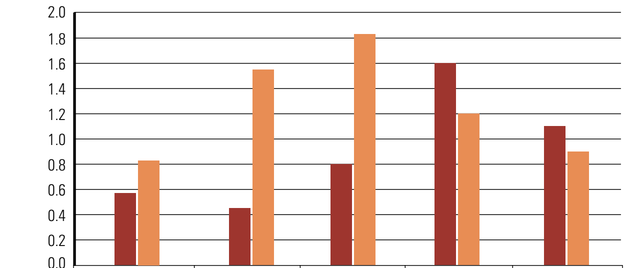
Integrity of primary circuit: Corrosive impurities; Maximum chloride concentration in primary coolant (µg/kg) in power operation, Olkiluoto NPP



	2004	2005	2006	2007	2008
OL1	1.5	1.0	0.9	0.5	0.5
OL2	21.3	2.5	0.8	1.2	0.6

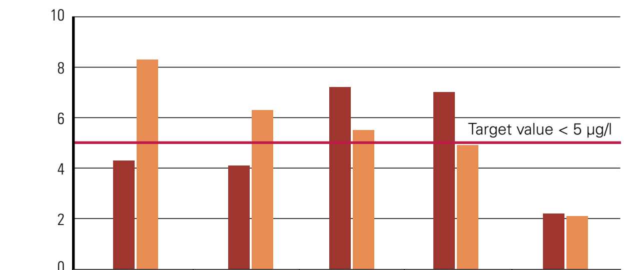
below detection limit

Integrity of primary circuit: Corrosion products; Maximum iron concentration in reactor feed water (µg/l), Olkiluoto NPP



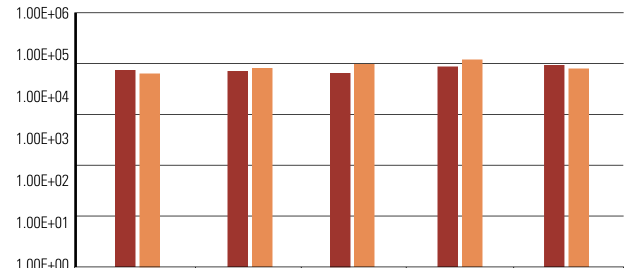
	2004	2005	2006	2007	2008
OL1	0.57	0.45	0.80	1.60	1.10
OL2	0.83	1.55	1.83	1.20	0.90

Integrity of primary circuit: Corrosion products; Maximum sulphate concentration in primary coolant (µg/l) in power operation, Olkiluoto NPP



	2004	2005	2006	2007	2008
OL1	4.3	4.1	7.2	7.0	2.2
OL2	8.3	6.3	5.5	4.9	2.1

Integrity of primary circuit: Corrosion products; Maximum cobalt-60 activity concentration (kBq/m³) in primary coolant during shutdown or after reactor scram, Olkiluoto NPP



	2004	2005	2006	2007	2008
OL1	6.80E+04	6.24E+04	5.70E+04	7.08E+04	8.34E+04
OL2	5.70E+04	7.63E+04	9.67E+04	1.46E+05	7.01E+04

The chemistry index has remained steady at the best possible value (1).

The maximum concentrations of Co-60 activity during shutdown represent concentrations that were measured when plant units were brought to shutdown for annual maintenance. Olkiluoto 1 also had a short hot shutdown and a reactor trip immediately after the annual maintenance outage, but the Co-60 activity concentrations were, in these situations, lower than when the plant unit was brought to shutdown for annual maintenance. The average Co-60 activity concentration of Olkiluoto 2 reactor coolant during power operation has seen an increase in recent years. In 2007, the concentration began to decrease, which also shows as a decrease in the maximum concentrations during shutdown in 2008. The Co-60 activity concentration of Olkiluoto 1 reactor coolant was slightly above normal before the 2008 annual maintenance outage, which could explain the concentration being a little higher than in the previous year. Year-on-year variation in the concentration has been, however, small. Variation can be created even by small differences in the conditions that prevail when a plant unit is brought to shutdown.

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

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, and
- 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 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 indicator

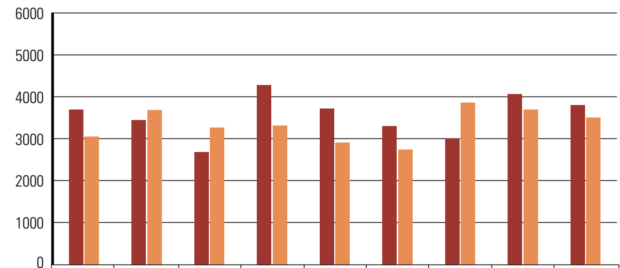
One of the purposes of controlled leakage drain system 352 is to collect seal box leakages from valves, pumps and other such components. The drains from the seal boxes of the valves within the containment are equipped with temperature sensors to locate any leaks. Temperature sensors installed on the 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. In the operating cycle of 2007–2008, the number of identified leaks within the containment decreased to some extent compared to the previous operating cycle.

At the lowest point of the containment dry-well, there is drain water pit T33, which collects the drain water from the containment dry-well floor drains and any leakage from the control rod actuator seals. The number of unidentified leaks from the primary circuit has been small for three consecutive operating cycles.

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 2007–2008, the containment's largest internal daily leak volume's ratio to the maximum allowable volume, as specified in the Technical Specifications, was low for both plant units. This was the fifth consecutive operating cycle with hardly any leaks from the primary circuit into the containment atmosphere.

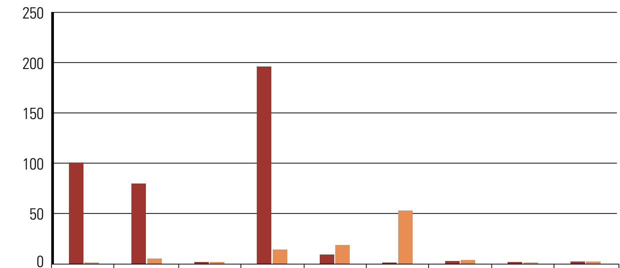
The primary circuit was leak-proof in the operating cycle of 2007–2008.

Identified leakages of primary circuit (352T1, m³), Olkiluoto NPP



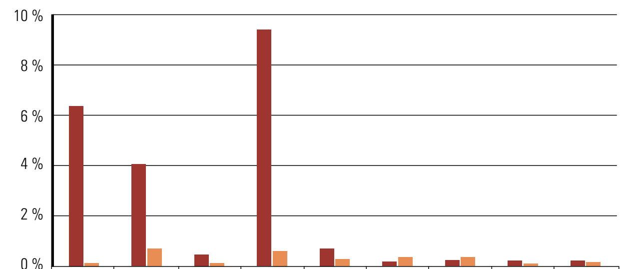
	2000	2001	2002	2003	2004	2005	2006	2007	2008
OL1	3694	3443	2678	2481	3716	3300	3004	4058	3805
OL2	3047	3677	3262	3307	2908	2741	3862	3696	3502

Unidentified leakages of primary circuit (345T33, m³), Olkiluoto NPP



	2000	2001	2002	2003	2004	2005	2006	2007	2008
OL1	100.8	79.6	1.8	196.0	9.2	1.1	2.5	1.6	2.2
OL2	1.4	5.4	1.8	14.0	18.6	53.0	3.8	1.3	2.0

The maximum unidentified leakage in ratio to the Tech Spec limit, Olkiluoto NPP



	2000	2001	2002	2003	2004	2005	2006	2007	2008
OL1	6.37	4.05	0.46	9.40	0.70	0.18	0.23	0.21	0.21
OL2	0.12	0.69	0.12	0.60	0.27	0.35	0.35	0.09	0.16

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 at the first attempt (i.e. as-found leakage smaller than acceptance criteria of valve and no consecutive exceeding of the so-called attention criteria of a valve without repair); 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 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

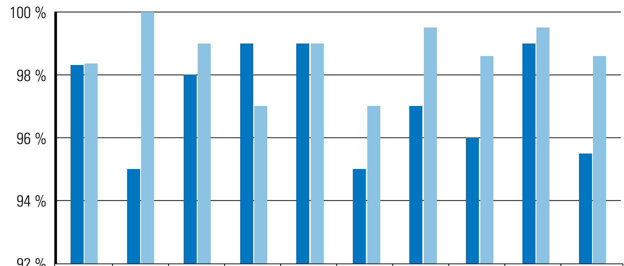
Interpretation of indicator

Loviisa

The overall as-found leakages of the outer isolation valves have increased for both plant units, but both remained below the overall leakage limit defined in the Technical Specifications. For Loviisa 1, the largest leaks came via the ice condenser cooling system valve (approximately 25%) and the special active canalisation system valve (approximately 16%). At Loviisa 2, the largest leaks came via the four valves of the emergency core cooling system (approximately 40%). These four valves will be tested together, and the result will be calculated four-fold in the overall as-found leakage.

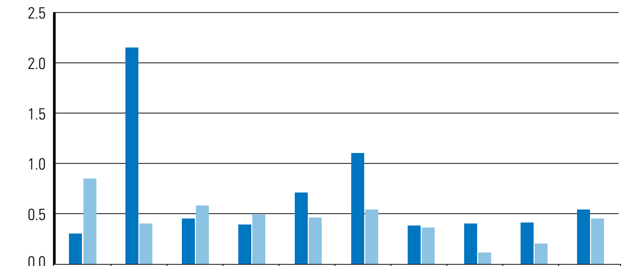
The percentage of isolation valves which passed the leakage test at the first attempt has remained high.

Isolation valves passing the leakage test at the first attempt, Loviisa NPP



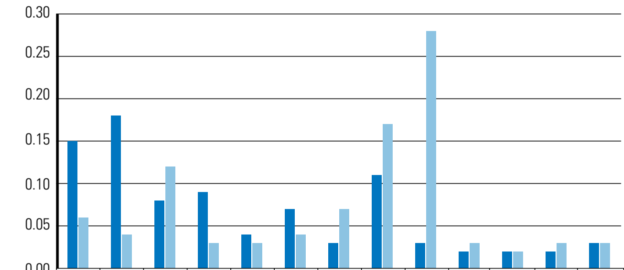
	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
LO1	98.31	95.00	98.00	99.00	99.00	95.00	97.00	96.00	99.00	95.50
LO2	98.35	100.00	99.00	97.00	99.00	97.00	99.50	98.60	99.50	98.60

The overall as-found leakage of outer isolation valves compared with the highest allowed overall leakage of outer isolation valves, Loviisa NPP



	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
LO1	0.30	2.15	0.45	0.39	0.71	1.10	0.38	0.40	0.41	0.54
LO2	0.85	0.40	0.58	0.49	0.46	0.54	0.36	0.11	0.20	0.45

Combined leak rate of containment penetrations and air locks compared to the leak limit, Loviisa NPP



	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
LO1	0.15	0.18	0.08	0.09	0.04	0.07	0.03	0.11	0.03	0.02	0.02	0.02	0.03
LO2	0.06	0.04	0.12	0.03	0.03	0.04	0.07	0.17	0.28	0.03	0.02	0.03	0.03

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 bellows seals (RA, RL, TL23), is small at both plant units.

Olkiluoto

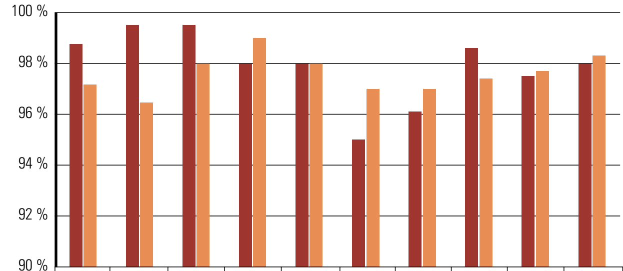
The overall as-found leakage found in the first integrity tests of the OL1 outer isolation valves exceeded the overall as-found leakage limit set in the Tech Specs. The largest leak (approximately 61.4% of the overall as-found leakage) came via one valve in the controlled leakage drain system. The leak was caused by a maintenance error. After repairs, the total leakage met the requirements of the Technical Specifications.

At OL2, the sum of the first integrity test results for outer isolation valves was within the limit set in the Technical Specifications. The largest leaks came via the flange cooling system valve (approximately 20%), the scram system valve (approximately 17%) and the main steam valve (approximately 14%).

The percentage of isolation valves that passed the leak tightness test at first attempt has remained high for both plant units.

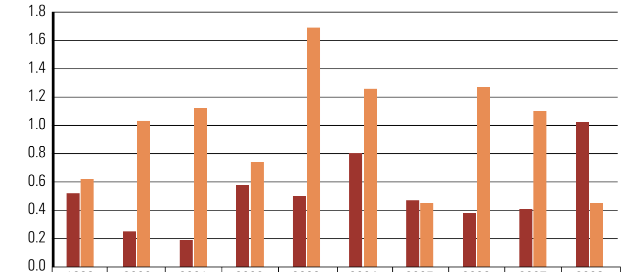
The total as-found leakage rate of containment penetrations, in which TVO includes leakages in the upper and lower personnel airlocks, the maintenance dome and the containment dome, has remained small for both plant units.

Isolation valves passing the leakage test at the first attempt, Olkiluoto NPP



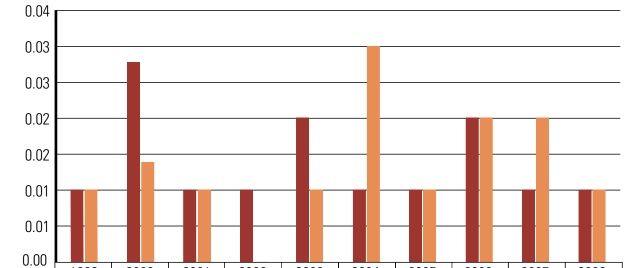
	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
OL1	98.77	99.51	99.51	98.00	98.00	95.00	96.10	98.60	97.50	98.00
OL2	97.16	96.45	98.00	99.00	98.00	97.00	97.00	97.40	97.70	98.30

The overall as-found leakage of outer isolation valves compared with the highest allowed overall leakage of outer isolation valves, Olkiluoto NPP



	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
OL1	0.52	0.25	0.19	0.58	0.50	0.80	0.47	0.38	0.41	1.02
OL2	0.62	1.03	1.12	0.74	1.69	1.26	0.45	1.27	1.10	0.45

Combined leak rate of containment penetrations and air locks compared to the leak limit, Olkiluoto NPP



	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
OL1	0.01	0.03	0.01	0.01	0.02	0.01	0.01	0.02	0.01	0.01
OL2	0.01	0.01	0.01	0	0.01	0.03	0.01	0.02	0.02	0.01

APPENDIX 2 Occupational radiation dose distribution at Loviisa and Olkiluoto nuclear power plants in 2008

According to the Radiation Decree, the annual effective dose from radiation work for a worker must not exceed 50 mSv, and 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 2004–2008 was 62.3 mSv. The dose was accumulated at the Loviisa and Olkiluoto nuclear power plants.

dose range (mSv)	Number of persons by dose		
	Loviisa	Olkiluoto	total*
< 0,1	729	1119	1781
0.1–0.49	189	484	665
0.5–0.99	104	219	307
1.00–1.99	131	172	272
2.00–2.99	73	70	134
3.00–3.99	56	30	90
4.00–4.99	37	6	47
5.00–5.99	30	6	40
6.00–6.99	18	2	27
7.00–7.99	11	6	22
8.00–8.99	17	2	28
9.00–9.99	8	0	9
10.00–10.99	1	–	6
11.00–11.99	4	–	6
12.00–12.99	3	–	4
13.00–13.99	2	–	4
14.00–14.99	0	–	1
15.00–15.99	–	–	1
16.00–16.99	–	–	0
17.00–17.99	–	–	–
18.00–18.99	–	–	–
19.00–19.99	–	–	–
20.00–20.99	–	–	–
21.00–24.99	–	–	–
25.00–	–	–	–

* 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

Partially stuck control rod at Loviisa 1

In the control rod tests carried out in connection with plant start-up, one of the control rods could not be lifted all the way to the top end position. The control rod drive mechanisms are located above the reactor vessel head. The head has openings for the bars that move the control rods. The reactor can be tripped by dropping the control rods into the core.

When the fault in the operation of the control rod had been detected, the plant start-up was interrupted. Possible causes for the failure were examined by inspecting and operating the control rods. First, the control rod drive mechanism was replaced, and the plant was brought to a cold shutdown to perform the work. After the repairs, the plant was heated up again, but the control rod still stuck. An indentation was observed in the bottom section of the opening's thermal barrier sleeve on the video tapes recorded during the replacement work. The movement of the control rod stopped at a shoulder on the bar, limiting the upward movement of the control rod. The dent did not prevent the control rod from returning into the reactor.

It was found that the dent was caused by a lifting lug that was left in an upright position on the radiation shield dome. During the outage, two corrosion protection sleeves at the reactor vessel head openings were repaired. Because the inside of the vessel head was active, the work was performed via an opening in the radiation shield dome below the head. One of the lifting lugs of the dome had not been turned down, and when rotating the dome, the lug hit a thermal barrier sleeve at the bushing.

The indentation was corrected by pushing a bar through the sleeve. Before the repair work, the method was tested with a thermal barrier sleeve removed in connection with the repair of a bushing corrosion protection sleeve.

No catching was detected for other control rods. The insides of the vessel head will be inspected during the next outage.

Unclear testing instructions for the containment ice condenser door control system valves

In July 2008 it was observed at Loviisa plant that the valves of the containment ice condenser door opening systems had been tested less frequently than required in the Technical Specifications of the plant.

The valves are a part of a system used by the operator to open the containment ice condenser doors from the control room. The function is needed in severe accident conditions to create circulation between the upper and lower containment compartments. Circulation of containment atmosphere ensures that hydrogen possibly created during a severe accident is efficiently diluted. The system consists of two parallel redundancies, either one of which is capable to open a sufficient circulation route through the ice condensers.

The plant's Technical Specifications require that the valves for both redundancies are tested once a year. However, the plant testing instructions and procedures specified a testing interval of two years, requiring that the valves of one redundancy are tested each year.

When the conflict in the instructions was detected, the valve testing interval was changed to comply with the value specified in the Technical Specifications, one year. In addition, the plant has inspected the compliance of all procedural testing intervals with the Technical Specifications. No other similar conflicts were found in the inspection.

On the International Nuclear Event Scale (INES) with seven levels, the event was rated at level 0.

Absence of an uninterrupted power supply in a substation at Loviisa 1

It was noted at Loviisa 1, in conjunction with an inspection on 30 October 2008, that the power supply of one DC switchboard did not have the necessary battery backup. It was most likely that the backup had been unavailable since the annual maintenance outage. The event had minor nuclear safety significance.

The 24 V DC switchboard left without a backup was part of the power supply system of the severe accident management system at Loviisa 1. The switchboard manages the power supply of the local control centre of the steel shell isolation valves, as well as the I&C cabinets related to severe accident management, among other things. Normally, the switchboard is supplied by the diesel-backed 400 V AC switchboard through rectifiers, and is backed up by a battery bank.

In the inspections carried out for the batteries every three months it was observed that there were fuses missing from the supply lines from the batteries. It is probable that the fuses were removed during preliminary maintenance work during the plant's annual maintenance in September, and had not been put back.

At the time of the event, the switchboard was live but had no uninterrupted power supply (battery backup) available. Normally, severe accident management systems are supplied from an external power network, backed up by the plant's own emergency diesel generators and batteries. In addition, the power supply and distribution is carried out as two parallel subsystems and is designed to be tolerant of single failures.

Fortum has examined the event and the reasons behind it, but there is no certainty as to how the event took place. It is likely that a human error occurred in connection with the electrical isolation and reconnection measures. No separate inspections are carried out at the Loviisa power plant after annual maintenance work to ensure that appropriate fuses are in place. The backup batteries have no monitoring system to indicate the absence of fuses.

The uninterrupted power supply for the switchboard was made available immediately when the deficiency was detected. Fortum has also decided to improve the labelling procedures for the substations and batteries related to severe accident management. In addition, the couplings of the common electrical systems used by both plant units will be inspected after each annual maintenance.

On the International Nuclear Event Scale (INES) with seven levels, the event was rated at level 0.

Deficiency in the reactor protection system of Loviisa 2

It was observed at Loviisa 2 on Friday 12 December 2008 that a simulation had been left in the reactor protection system indicating that three reactor coolant pumps were in operation. As a result, the reactor protection system would not have been informed if these pumps had stopped and the reactor trip signal, triggered if four or more reactor coolant pumps had stopped, would not have been activated. The condition was in non-compliance with the Technical Specifications. The simulations were immediately removed when the incorrect setup was detected.

The event caused no danger to the environment or the personnel, but it weakened the operability of the reactor protection system.

The error had not been detected in connection with the monthly reactor protection system tests. No physical inspections of the couplings in the I&C cabinets in question are carried out during normal operation of the plant. The error was revealed as an instrumentation technician performed measures related to a different test at the cabinets in question. Apparently, the simulations had remained active after the testing completed in the annual maintenance outage that ended in October.

The event indicates a significant deficiency in practices at the Loviisa plant: the protection system had been made unavailable without adequate documentation. For this reason, simulations were left undetected and remained in place when the plant was started up. The unavailability was also not possible to detect in the periodic tests carried out monthly at the plant.

The reactor trip command would not have worked if the reactor coolant pumps had stopped due to, for example, a power failure. In such a case, the reactor trip would have occurred a little later, resulting from increased reactor pressure or coolant temperature. This would have led to a momentary deterioration of reactor cooling, and an increase in pressure. However, based on safety analyses carried out for the plant unit, there would have been no risk of fuel damage. The stopping of reactor coolant pumps with no resulting reactor trip is included in the safety analyses that the plant unit's operating licence is based on.

The power company investigates the event and performs additional analyses to gain a more detailed understanding of the reactor behaviour in these conditions. In addition, the power company will prepare a special report to propose how to prevent similar events in the future.

On the seven-level International Nuclear Event Scale (INES), the event was rated at level 1.

Olkiluoto NPP

Reactor trip at Olkiluoto 2 as a result of the freezing of coolant

Seawater cooled rapidly in front of the Olkiluoto nuclear power plant on the morning of Saturday 5 January 2008. The frazil ice formed as a result of this cooling blocked the circulating water screening filters of Olkiluoto 2 and weakened the flow of the seawater used as coolant in the plant. As a result, a turbine trip occurred at the plant unit, leading to a reactor trip. In connection with the event, a steam leak into the containment via a failed valve was detected. The plant unit was disconnected from the national grid for approximately 19 hours to assess the situation and repair faults.

Seawater is led to the plant via an inlet channel. Impurities are removed from the water as it flows through coarse screens, fine screening units and band screens. On the morning of 5 January 2008, the temperature of the seawater decreased rapidly, causing a risk of freezing of the screens. There was a partial failure in ice prevention, because one of the necessary pumps did not start due to a power failure caused by the humidity. The purpose of the pumps is to pump warm water from an Olkiluoto 2 pond to the mouth of the circulating water inlet channel. Rapid cooling of the water has also not been observed to an adequate degree in operational procedures. Frazil ice formed in the band screens, weakening the water flow. The water level in the pump chambers of circulating water pumps went down, and the pumps stopped. This resulted in increased pressure in the condenser, a turbine trip and a partial reactor trip. Immediately after this, a reactor trip occurred.

The steam generated in the reactor was led into the containment condensation pool via the steam relief pipes. Approximately three hours after the reactor trip, a steam leak was detected in the containment. The leak ended when the active steam pipe, or the steam relief control line, was closed and another corresponding line was activated. In the following inspection it was observed that the so-called vacuum breaker valve of the control line was damaged, and steam had leaked from the valve. The locking bolt of the valve stem was installed incorrectly in the annual maintenance of 2007, and the internals of the valve had become misaligned. The internals were replaced.

In the same vacuum breaker valve and in another corresponding valve, loosening of the screws of the ring that keeps the valve disc in place was detected. The power company gave instructions for the drive method of the valves to avoid such situations in the future. The fixing of the screws was improved at both plant units in the spring 2008 annual maintenance.

Olkiluoto 2 was synchronised to the national grid early on 6 January 2008. In less than an hour, however, the increase of reactor power was interrupted, because the drain control valve of the reheater's drain tank was stuck in the bottom position. The valve internals were replaced.

Reactor cooling was adequate during the event. Cooling was carried out using the outlet water, which is warmer than the circulating water in the inlet side. In addition, the steam leak mentioned above was detected and stopped quickly. The power company gave new instructions on the operation of the ice prevention pumps for the purpose of enabling a faster reaction to rapid cooling of seawater. In practice, this means that the pumps will be started up sooner.

On the seven-level International Nuclear Event Scale (INES), the event was rated at level 0 (IRS report #7921).

Control rod operation in non-compliance with Technical Specifications at Olkiluoto 1

During the annual maintenance of Olkiluoto 1 on 29 May 2008, one of the control rods was withdrawn from the reactor without written instructions, in non-compliance with the Technical Specifications.

The reactor core contains sensor probes to measure the neutron flux. The probe tubes are placed between the fuel bundles inside protective tubes. When reactor is operated at low load or is shut down, measurements use the Source and Intermediate Range Measurement (SIRM) system which includes eight probes. In the previous annual maintenance, extension sleeves had been installed for five probe tubes of the SIRM system to secure the support of the top end. Four of the protective tubes were replaced in the annual maintenance of 2008, and one was disabled. Extension sleeves were removed at the same time. To be able to remove the sleeve, the fuel bundles around the probe had to be removed. In addition, the control rod next to the probe tube had to be withdrawn by 15–20%. According to the Technical Specifications, control rods can only be withdrawn according to a specified sequence, operation order or written instructions drawn up by a reactor engineer. The control operation related to the removal of the first protective tube was, however, carried out in non-compliance with the Technical Specifications, with no written instructions. There were no fuel bundles next to the control rod, so the event did not compromise the reactor's criticality safety.

TVO has prepared a special report according to YVL Guide 1.5 on the event. In addition, TVO will prepare a root cause analysis. On the INES scale, the event is rated at level 1.

Omission of weekly noble gas sampling at Olkiluoto 1

One round of noble gas sampling was omitted at Olkiluoto 1 during the period 19 to 25 May 2008. This is a gas sample that is collected at the vent stack and analysed in the laboratory. The sample yields information on the composition of any emissions (which nuclides and how much of them are present). The reports on atmospheric emissions of noble gases by the power plant are based on these measurements. The Technical Specifications require weekly samples to be taken in all operational states of the power plant.

Any release into the atmosphere would have been detected regardless of the event. The noble gas content of the air released from the vent stack is monitored using continuously operating measurement channels. If a release had been detected in these measurements, more frequent sampling would have begun.

The event was caused by human error. On the International Nuclear Event Scale (INES), the event is rated at level 0.

Failures in the seals of diesel generators' pneumatic starter motors

Both plant units have four diesel generators that start up when necessary to supply power to plant systems. Such situations include disturbances resulting in a loss of the connection to the national grid. According to the Technical Specifications, unrestricted use of the reactor is allowed for three days when two of the four diesel generators are unavailable, but the fault is not systematic.

One of the diesel generators at Olkiluoto 1 did not start in connection with the reactor protection system testing carried out during the start-up after annual maintenance on 28 May 2008. Damage in the seals of both pneumatic starter motors was found to be the cause of the failure. Replacement of seals is not included in the maintenance programme of the pneumatic starter motors, leading to the embrittlement of the seals due to ageing and the lubrication oil mixed with the air.

After these observations, TVO inspected the seals for all diesel generators for both plant units. For Olkiluoto 1, five of eight seals were damaged. For Olkiluoto 2, one of eight seals was damaged. The seals were replaced, and the start-up of the diesel generators was tested on 29 May 2008. The diesel generator will start up if one of the two pneumatic starter motors is operational. It is therefore likely that all four diesel generators at Olkiluoto 2 would have started when necessary. At Olkiluoto 1, there was a risk that two diesel generators would not have started. All diesel generators had started in the periodic test preceding the event.

TVO prepared a special report on the event. On the INES scale, the event is rated at level 1 (IRS report #7935).

Reactor trip at Olkiluoto 1 as a result of a generator voltage regulator failure on 30 May 2008

When Olkiluoto 1 was being started up after annual maintenance on 30 May 2008, the generator voltage began to increase as a result of a malfunction of the new voltage regulator installed during the annual maintenance. Reactor power was 60%. The protective devices of the electrical network disconnected the generator and power plant's main connection to the national 400 kV grid. The backup connection from the 110 kV grid connected automatically after two seconds to supply power to the plant systems. The overvoltage peak caused by the opening of a plant breaker shut down all six reactor coolant pumps circulating cooling water within the reactor pressure vessel. The flywheel generators that are designed to slow down the pump deceleration stopped, and part of the control electronics of the reactor coolant pumps and flywheels was damaged. As a result of the transient, a turbine trip and partial reactor trip occurred at Olkiluoto 1, with an immediate reactor trip following as the actuator oil pumps of turbine valves stopped and the direct dumping of steam into the turbine condenser was prevented.

The four pumps of the auxiliary feed water system started up as planned, and two of them pumped water into the reactor for more than ten minutes in total. The water pumped into the reactor was colder than the water already in the reactor, and the colder water went to the bottom of the reactor pressure vessel. The reactor coolant pumps were not running, so the water did not mix and a temperature difference was created between the top and bottom parts of the reactor pressure vessel. Contrary to the operating procedures, the control room started up the reactor coolant pumps too early, and the colder water flowed through the reactor core. The temperature difference was, however, so small that, based on the estimates, the premature starting up of the pumps did not endanger the integrity of the fuel or reactor internals or the mobility of the control rods.

STUK required that TVO deliver a report of the event for approval before the starting up of Olkiluoto 1. If the event had happened while the reactor was in full-power operation, a considerably higher proportion of the fuel than what is allowed (0.1%) would have experienced a heat transfer crisis. This could have resulted in damage to the fuel. STUK required that the operation of Olkiluoto 1 and Olkiluoto 2 is designed and carried out so that, in connection with operational transients, the operational limits applied to the fuel do not observe the effect of flywheel generators on pump deceleration until the corrective measures related to overvoltage protection have been completed and approved by STUK. In practice, this means that Olkiluoto 1 was not started up, and that Olkiluoto 2 began decreasing power to approximately 80%. Olkiluoto 1 was started up to part load on 2 June 2008.

On 7 June 2008, TVO delivered to STUK a proposal for the improvement of the overvoltage protection of reactor coolant pumps' frequency converters. TVO suggested that the uncontrolled stoppages of reactor coolant pumps caused by overvoltage can be temporarily prevented by modifying the protective relay function in the auxiliary power supply network. In addition, the power company will amend the plant operating instructions. STUK approved the suggestion and stated that they will inspect the actual changes on site. In addition, it was required that TVO prepare by 1 September 2008 a plan for long term changes to improve the overvoltage tolerance of the reactor coolant pumps' electrical drives.

Changes to the voltage protection were completed on 10 June 2008 for both plant units. After inspections, a power increase to 100% began. Olkiluoto 2 reached 100% power in the same evening and Olkiluoto 1 the following evening.

TVO prepared a special report on the event. On the INES scale, the event is rated at level 1 (IRS report #7932).

Leak in the outer isolation valve of the reactor pressure vessel head cooling spray system

The reactor pressure vessel is surrounded by a containment that prevents the access of radioactive substances into the environment in various operational conditions and potential emergency conditions. The pipeline that penetrates the containment and is a part of the primary circuit has two isolation valves. One of the valves is outside and the other inside the containment. The valves close when necessary. If, for example, a pipe carrying steam from the reactor to the turbines breaks outside the containment, the isolation valves will close and the leak will stop.

The isolation valves are tested for leak tightness during annual maintenance. The purpose of the tests is to ensure that the valves and the containment meet the leak tightness requirements set for them. The leak and attention limits are defined in the plant's Technical Specifications.

The annual maintenance at Olkiluoto 2 took place between 4 and 12 May 2008. The leak-tightness test results for the outer isolation valve of the reactor pressure vessel head cooling spray system exceeded the set limit. The valve was repaired by grinding the sealing surface of the casing and by replacing parts. The leak-tightness test was repeated after repair, and the result exceeded the attention criteria. According to the Technical Specifications, the valve should have been repaired so that the attention criteria are not exceeded. A fault report should have been issued to launch new corrective measures. This was, however, not done, and the plant unit was started up after annual maintenance even though the isolation valve was inoperable. The error was discovered on 11 August 2008 when reviewing the leak tightness test results of isolation valves. The opening of the inner isolation valve was prevented in accordance with the Technical Specifications, and the faulty valve will be replaced in the next annual maintenance in 2009. The pipeline in question will be needed when the plant unit is shut down, in the annual maintenance of 2009 at the latest. TVO applied for permission to open the inner isolation valve if necessary. STUK approved the application.

The isolation valve leak exceeding the attention limit has no significance for the overall leak tightness of the containment, as the overall as-found leakage is clearly below the set limit.

Deficient leaktightness of pipe penetrations

A STUK inspector observed deficiencies in the leak tightness of the emergency cooling system pump facilities, the so-called H rooms, at the Olkiluoto nuclear power plant. The pipe penetrations through the walls had not been properly sealed. As the H rooms are also separate fire compartments, the problem also concerned the integrity of fire compartmentation. STUK required that TVO clarify the situation and launch corrective measures. TVO began repairs on the penetrations on 15 October 2008, and the work was completed on 23 October 2008. At Olkiluoto 1 and 2, 33 and 11 poorly sealed penetrations were repaired, respectively.

Both plant units have four so-called H rooms in their reactor buildings. These facilities include the necessary pumps for the reactor emergency cooling and the containment pressure relief. The H rooms have a connection to the containment condensation pool via pump suction lines. If a pump suction line breaks and the leak cannot be isolated, the condensation pool water leaking from the pipe will flow into the H room. The flow will end when the water levels in the H room and the containment condensation pool are equal. Plant design provides provision for such situations. If the H room is not leakproof, condensation water will also flow outside the H room, and the surface level of the condensation pool could become too low. Part of the reactor emergency cooling systems and containment pressure control functions would then be lost.

The probability of an unisolated pipe break as described above is very low. Pump suction lines have isolation valves that close automatically in case of a leak. No significant stress that would threaten the integrity of the pipes is targeted at the suction lines.

STUK required that TVO estimate the plant maintenance procedures due to the event and will make the necessary changes to the procedures. TVO is currently executing a project to survey all pipe penetrations at the plant and to assess their maintenance procedures.

TVO delivered a report on the situation to STUK on 16 October 2008, and reported the issue in more detail in a special report in November, as required by YVL Guide 1.5. In February, the special report was complemented with test results.

In January 2009, TVO carried out tests on the pressure response of the penetration structure. Based on the test results, it was observed that it is unlikely that all H room penetrations meet the pressure response requirements, even after the repairs. Problematic penetrations have a fabric bellows on one side of the penetration and rubber bellows on the other side. Such a structure would not withstand water pressure from the fabric bellows side. TVO repaired the penetrations by installing rubber bellows on both sides of the penetration. The work was completed on 18 January 2009.

On the seven-level International Nuclear Event Scale (INES), the event was rated at level 1 (IRS report #7997).

Omission of periodic testing of the radiation measurement systems at Olkiluoto 1

Periodic tests of the radiation measurement system of the exhaust gas system, the radiation measurement system of the vent stack, and the waste water activity meters were omitted at Olkiluoto 1 in September 2008. The Technical Specifications require that the measurements are taken at three-month intervals. The omission was observed on 26 November 2008.

Tests include the inspection of alarm limit settings and calibrations. Tests reveal possible failures causing measuring errors. TVO carried out the tests on 27 and 28 November 2008, and the results were acceptable, meaning that there was no measuring error. The tests were previously carried out at the end of June 2008.

The event was caused by human error. The components of the Olkiluoto 1 exhaust gas system radiation measurement system were replaced during the annual maintenance of 2008. At the same time, changes were made to the periodic testing schedule. This conjunction led to the measurements taken in September at 11 measurement points being incorrectly recorded in the preventive maintenance system as year 2009 measurements instead of 2008.

On the International Nuclear Event Scale (INES) with seven levels, the event was rated at level 1. The event was classified one step higher due to its recurring nature. In recent years, TVO has omitted or delayed other periodic tests required by the Technical Specifications.

APPENDIX 4 Licences and approvals in accordance with the Nuclear Energy Act in 2008

Teollisuuden Voima Oy

- C214/297, 28 March 2008
  OL1 system 216/531 – import of SIRM protective sleeves from Germany. Four pipes weighing approximately 18 kg each. Valid until 13 May 2008.
- C214/298, 11 April 2008
  OL1/OL2, 222, Import of control rods from Sweden. Ten rods weighing approximately 130 kg each. Valid until 31 December 2008.
- C214/304, 13 August 2008
  Import of nuclear fuel with uranium content of Australian origin from Spain. 116 assemblies, a total of 20 600 kg (maximum) of low-enriched uranium. Valid until 31 December 2009.
- C214/305, 22 August 2008
  Import of nuclear fuel from Sweden. 60 assemblies, a total of 10 500 kg (maximum) of low-enriched uranium. Valid until 31 December 2009.
- C214/306, 22 August 2008
  Import of nuclear fuel with uranium content of Australian origin from Sweden. 56 assemblies, a total of 9 750 kg (maximum) of low-enriched uranium. Valid until 31 December 2009.
- C214/308, 1 September 2008
  Import of nuclear fuel with uranium content of Australian origin from Germany. Eight assemblies, a total of 1 460 kg (maximum) of low-enriched uranium. Valid until 31 December 2009.
- C214/309, 28 October 2008
  Import from Germany of fuel channels manufactured in Japan. Eight channels manufactured of zirconium alloy with the hafnium weight ratio to zirconium less than 1:500. Valid until 31 November 2010.
- G214/4, 11 December 2008
  OL3 – Import of a boron concentration measuring system from Germany and import of neutron source elements from France. Three online boron concentration measuring systems based on neutron absorption, including a total of five measuring devices and three primary and secondary source elements. Valid until 31 December 2011.
- C821/94, 7 May 2008
  Handover of waste oil (approximately 5000 l) cleared from control to Ekokem Oy to be used as raw material for chainsaw chain oil. Valid until 28 February 2009.

Fortum Power and Heat Oy

- A214/108, 13 June 2008
  Loviisa 1 and 2; Import of in core neutron flux sensors from Canada. Total of 80 sensors. Valid until 31 December 2014.
- A214/107, 30 June 2008
  Import and transportation of uranium of Russian origin and the import of nuclear fuel model assembly containing zirconium rods to the Loviisa power plant. Maximum total of 185 tonnes of low-enriched uranium as nuclear fuel and one model assembly with a maximum of 60 kg of zirconium. Valid with regard to the import of the model bundle until 30 June 2009, and with regard to the import and transportation of nuclear fuel until 31 December 2015.
- A214/110, 17 July 2008
  Loviisa 1 and 2; Import of neutron flux sensors from Russia. A total of 10 ionisation chambers. Valid until 31 December 2008.

Others

- Y214/170, 9 January 2008 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 2008 VTT
  Export of uranium samples (2 uranium pellets and 2 crushed uranium samples) to Germany for research purposes, and the extension of licence Y214/164 granted for Sweden until 31 May 2008.

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 2008	
		Loviisa 1 and 2	Olkiluoto 1 and 2
Management, management system and personnel			
A1	Management and safety culture	25 March 2008	
A2	Personnel resources and competence	25 May 2008	26 August 2008
A3	Functionality of the management system	7 November 2008	27 October 2008
Plant safety and its improvement			
B1	Assessment and improvement of safety		18 December 2008
B2	Plant safety functions	27 November 2008	1 December 2008
B3	PSA and safety management	13 November 2008	29 September 2008
B4	International operating experience feedback	26 May 2008	6 October 2008
Operational safety			
C1	Operation	22 April 2008 1 December 2008	12 February 2008 1 September 2008 19 November 2008
C2	Plant maintenance		26 November 2008
C3	Electrical and I&C systems		12 November 2008
C4	Mechanical engineering		27 February 2008
C5	Structures and buildings		
C6	Information management and security		
C7	Chemistry	24 April 2008	14 October 2008
Personal and plant protection			
D1	Radiation protection	30 October 2008	18 March 2008
D2	Fire protection	4 March 2008	11 June 2008
D3	Emergency response	15 October 2008	9 June 2008
D4	Security	16 December 2008	17 December 2008
Nuclear waste and its storage			
E1	Reactor waste	9 June 2008	8 October 2008
E2	Final disposal facilities		17 November 2008
Special items			
F1	LARA	23 June 2008	
Additional inspections			
	Qualification of maintenance personnel	20 November 2008	

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 monitors 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.

	Inspections in 2008
Main functions	
Project management and the management of safety	29 to 30 May 2008
Project quality management	22 to 23 September 2008
Work processes	
Inspection procedures – the assessment and inspection of installation plans at TVO	27 to 28 February 2008
Quality assurance • maintenance	28 March 2008
Training of the operating personnel	2 to 3 October 2008
Radiation safety	17 October 2008
Utilisation of PRA	27 November 2008
Inspections outside the programme	
Site safety culture	26 to 28 August 2008

APPENDIX 7 Inspection programme during the construction phase of Onkalo

The objective of the construction inspection programme is to verify that high-quality implementation of approved plans is ensured in the construction of the underground research facility, in compliance with regulations and without jeopardizing safe disposal. The inspection programme includes assessment and monitoring of Posiva's operations in constructing 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.

		Inspections in 2008
Management system		
ONP-A	Management system	8 December 2008
Planning and management		
ONP-B1	Project management and control	10 to 11 April 2008
ONP-B2	Safety management	
ONP-B3	Project quality management	27 to 28 October 2008
ONP-B4	Planning and management of the research and monitoring programme	27 to 28 March 2008
ONP-B5	Design of Onkalo	
Implementation		
ONP-C1	Site inspection and monitoring procedures	
ONP-C2	Drilling and modelling	
ONP-C3	Foreign substances	26 November 2008
ONP-C4	Excavation and EDZ	5 June 2008
ONP-C5	ONKALO in-flows	16 December 2008
ONP-C6	Monitoring and research methods	4 November 2008

APPENDIX 8 Commissions funded by STUK, completed in 2008

Reports supporting official decisions

Olkiluoto 3

VTT-R-04015-08; Saarenheimo Arja, Calonius Kim: Analysis of APC Scenarios, Structural Integrity Studies on OL3 Fuel Building.

Janne Nyman NEMKO Oy: Memorandum NEX 99317 EMC, assessment of junction boxes and intermediate terminal boxes [NLEO-G/2007/en/1008, Rev. A].

VTT-R-00598-08; Simo Hostikka, Joonas Sorvari & Johan Mangs: Fire Safety Analysis of a Cable Room in the OL3 Nuclear Power Plant.

VTT-R-01923-08 Arja Saarenheimo, Lauri Eerikäinen, Markku Hänninen, Pasi Junninen, Jarto Niemi, Timo Pättikangas, Antti Timperi and Ari Vepsä: OL3 – loop analyses, pipe break at RPV-hot leg nozzle.

VTT-R-01563-08; Risto Huhtanen, Tuomo Sevón, Jarto Niemi: MELCOR and FLUENT analysis of the SBLOCA and LOOP accident scenarios.

VTT-R-11372-07; Ismo Karppinen, Esko Pekkarinen: OL3 – Steam generator tube rupture analysis with APROS.

VTT-R-03752-08; Arja Saarenheimo, Kim Calonius: OL3 NPP APC Studies for PSAR and Other Loads.

VTT-R-08776; Risto Huhtanen, Jarto Niemi: Olkiluoto 3 0 – Oil fire simulation or reactor coolant pump.

Finnish Meteorological Institute; A statement on the reports presented by Teollisuuden Voima Oyj on the Olkiluoto construction site.

JL Summers; Document Review, Olkiluoto 3 NPP Overall Plant Commissioning Programme Document number: NECC DC 3 Rev C.

VTT-S-11296-08; Antti Pakonen, Jussi Lahtinen, Janne Valkonen, Hannu Harju: Assessment of the I&C systems of nuclear power plants 5/08–12/08.

Insinööritoimisto Pontek Oy; Several inspection reports on the safety buildings and other design materials concerning the Olkiluoto 3 nuclear power plant unit.

VTT; Inspections of the stress and resilience of Safety Class 1 and 2 piping at Olkiluoto 3.

Fortum Power and Heat Oy Service; Several inspection reports on the Olkiluoto 3 containment design materials.

Olkiluoto NPP

VTT-R-03625-08; Markku Reunanen, Janne Sarsama: A systematic further analysis of human-error-induced events and common cause failures at the Olkiluoto power plant; OL1 & 2.

VTT-R-08498; Eveliina Takasuo, Tuomo Sevón, Kari Ikonen, Jaakko Miettinen: Debris Coolability in Olkiluoto 1&2 Lower Drywell in a Severe Accident.

Loviisa NPP

VTT-R-03619-08; Janne Sarsama, Markku Reunanen: A further analysis of human-error-induced failures at the Loviisa power plant, LO1 and 2, of years 2003 and 2005.

Posiva

Modelling coupled T-H-M processes in heterogeneous fractures media; Stevan Chu.

Expected evolution of a spent nuclear fuel repository at Olkiluoto (POSIVA report 2006-05); Review Group: Chin-Fu Tsang, Martin Mazurek, Matti Saarnisto, Timo Saarto.

Olkiluoto biosphere description report (POSIVA 2007-02); Kirsti-Liisa Sjöblom.

A Concept for Radionuclide Transport Modelling (Posiva Working Report 2007-24): Chin-Fu Tsang, Auli Niemi.

Assessment of the operational system of Posiva; Jussi Moisio

Groundwater in the design and construction of Onkalo; Kai Auvinen.

SR Can Review – Methodological observations; VTT-R-04733; Kari Rasilainen.

Process Report – FEPs and Scenarios for a Spent Fuel Repository at Olkiluoto (POSIVA report 2007-12); Review Group: Ole Stephansson, Mick Apted, Martin Mazurek, Auli Niemi, Steven Chu, Chin-Fu Tsang, Kari Rasilainen, Hannu Hänninen, R. Arthur, Bath.

Reports on the transportation of spent nuclear fuel; Riitta Hänninen.

Regulatory control of nuclear materials

Analysis of wipe samples (analysis of total sample and particles); VTT.

STUK's own development projects

Internal draft guideline: Finland's actions to meet the obligations of the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management; Kirsti-Liisa Sjöblom.

APPENDIX 9 International co-operation

IAEA

IAEA working groups

- 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 countries, Director General Jukka Laaksonen.
- 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 countries, Director Tero Varjoranta.
- Expert groups preparing IAEA safety standards:
  - Safety Requirements GSR-1, Governmental, Legal and Regulatory Framework for Safety, Director General Jukka Laaksonen, Chairman of the group
  - Safety Guide DS 424, Establishing a Safety Infrastructure for a National Nuclear Power Programme, Director General Jukka Laaksonen, Chairman of the group
  - Safety Guide DS 367, Safety Classification of Structures, Systems and Components in Nuclear Power Plants, Assistant Director Keijo Valtonen, member
  - Safety Guide NS-G-2.12, Ageing Management for Nuclear Power Plants, Deputy Director Pentti Koutaniemi, member.
- CSS, Commission of Safety Standards – Commission that directs the preparation of IAEA safety standards and endorses the completed standards before approval by the IAEA Board of Governors, Director General Jukka Laaksonen, member and lawyer Mari Andersin, assistant.
- NUSSC, Nuclear Safety Standards Committee – A group directing the preparation of IAEA nuclear safety standards; the group approves draft standards to be sent to the CSS, Deputy Director Marja-Leena Järvinen, member.
- WASSC, Waste Safety Standards Committee – A group directing the preparation of IAEA nuclear waste management safety standards; the group approves draft standards to be sent to the CSS, Development Manager Kaisa-Leena Hutri, member.
- TRANSSC, Transport Safety Standards Committee – A group directing the preparation of IAEA safety standards for the safe transportation of radioactive material; the group approves draft standards to be sent to the CSS, Inspector Anna Lahkola, member.
- RASSC, Radiation Safety Standards Committee – A committee to monitor the preparation of IAEA radiation protection standards; the committee presents radiation protection standards to the CSS for approval, Section Head Mika Markkanen, member.
- Training for regulatory bodies in countries with nuclear power plants, bureau, Development Manager Kaisa Koskinen, member.
- ASTOR, Application of Safeguards to Geological Repositories, Section Head Elina Martikka and Senior Inspector Olli Okko.
- GEOSAF, International Project on Demonstrating the Safety of Geological Disposal, Senior Inspector Ari Luukkonen.
- Scientific Committee of the IAEA/WHO Network of Secondary Standards Dosimetry Laboratories, Head of Laboratory Antti Kosunen, member.
- IAEA/WHO Network of Secondary Standards Dosimetry Laboratories, person responsible for STUK SSDL laboratory, member, Head of Laboratory Antti Kosunen.
- National Focal Point (NFP) for Denials of Shipment of Radioactive Material, Senior Inspector Eero Oksanen (the scope of the Radiation Act).
- IAEA, import and export of radiation sources / controlling authority, Senior Inspector Eero Oksanen, contact person.

IAEA field experts

- IRRS, International Regulatory Review Service, IAEA expert group to assess national nuclear safety regulation
  - Assessment of the Spanish authority Consejo de Seguridad Nuclear (CSN) on 28 January to 8 February 2008, Deputy Director Marja-Leena Järvinen, assessment team member
  - Assessment of the Ukrainian authority State Nuclear Regulatory Committee of Ukraine (SNRCU) on 9 to 19 June 2008, Section Head Heikki Reponen, assessment team member
  - Assessment of the German authority on 7 to 18 September 2008, Deputy Director Marja-Leena Järvinen, assessment team member.
- IAEA external expert to assist the Cuban authority in the regulation of medical radiation utilisation (RLA/9/053-12), 10 to 14 March 2008, Santiago, Cuba, Section Head Ritva Bly.
- IAEA training for the national authority of Nigeria (NNRA). National Training Course for Regulators, 17 to 28 March 2008, Abuja, Nigeria, Senior Inspector Petri Sipilä, trainer.
- IAEA international radiation protection course for doctors who use X-ray methods but are not radiology or cardiology experts, 16 to 17 May 2008, Sofia, Section Head Ritva Bly.
- RER/9/084 Workshop on Regulatory Approaches to Aging Management and Life Time Extension of NPPs, Mamaia, Romania, 23 to 27 June 2008, Senior Inspector Yrjö Hytönen
  - Ageing Management at Loviisa NPP
  - Finnish experience of performing preliminary safety review at Loviisa NPP
  - Overview of technical condition of Loviisa 1 Reactor Pressure Vessel
  - Examples of Originally Insufficient Equipment Qualifications at Loviisa NPP
  - Some cracking cases in VVER-440 environment assisted by environmental conditions.
- IAEA training for the national authorities of Eastern European countries. Regional workshop on regulatory control of public exposure, 30 June to 4 July 2008, Prague, Section Head Mika Markkanen, trainer.
- Engineering Safety Review Mission, assessment of the safety assessment process of the Pickering B nuclear power plant, 25 to 29 August 2008, Senior Inspector Kirsi Alm-Lytz, assessment team member.
- IAEA training for the national authority of Vietnam (VARANSC). National Workshop on Radiation Protection Management, 9 to 31 October 2008, Hanoi, Section Head Mika Markkanen, trainer.
- IAEA external expert to assist the authority of Kazakhstan in the Eastern European regional project for the radiation protection of medical patients, RER9093. 17 to 21 November 2008, Almaty, Kazakhstan, Section Head Ritva Bly.

CTBTO

- Meetings of Working Group B and radionuclide expert group, Senior Inspector Mikael Moring, representative of Finland and Chairman of the expert group.
- Evaluation-NDC Workshop, 5 to 9 May 2008, Baden, Austria, Inspector Paula Karhu, Chairman of the meeting group.
- Laboratory Workshop, Senior Inspector Mikael Moring, Vice-Chairman of the meeting group.

OECD/NEA

- CSNI, Committee on the Safety of Nuclear Installations, Assistant Director Keijo Valtonen, member
  - WGAMA, Working Group on Analysis and Management of Accidents, Senior Inspector Nina Lahtinen, member
    - OECD/NEA/CSNI, SETH-2 project Programme Review Group, Senior Inspector Eero Virtanen, Chairman
    - OECD/NEA/CSNI, PKL-2 project Management Board, Senior Inspector Eero Virtanen, Chairman
    - OECD/NEA/CSNI, ROSA project Management Board, Senior Inspector Eero Virtanen, member
  - WGRISK, Working Group on Risk Assessment, Section Head Reino Virolainen, member
    - WGRISK, Working Group on Risk Assessment, Task Group on Probabilistic Safety Analysis (PSA) of Other Off-site External Events than Earthquake, Section Head Reino Virolainen, member, Senior Inspector Jorma Sandberg, Chairman
  - WGHOF, Working Group on Human and Organisational Factors, Senior Inspector Nina Koivula, member

  - WGFS, Working Group on Fuel Safety, Section Head Risto Sairanen, member
  - SCAP, Stress Corrosion and Cable Ageing, Section Head Martti Vilpas, member of the Steering Committee, and Section Head Kim Wahlström, member
  - DIDELSYS, Defence in Depth of Electrical Systems and Grid Interaction with nuclear power plants, Section Head Kim Wahlström, member
  - IAGE, Working Group on Integrity and Ageing of Components and Structures, Sub-Group on the Integrity of Metal Components and Structures, Senior Inspector Rauli Keskinen, member
  - ICDE, International Common-Cause Failure Data Exchange, Section Head Reino Virolainen, member
  - FIRE, Fire Data Exchange, Senior Inspector Jouko Marttila, national coordinator and member of the working group, Senior Inspector Matti Lehto, member
  - COMPSIS, Exchange of Operating Experience Concerning Computer-based Systems Important to Safety, Steering Group, Senior Inspector Heimo Takala, member
  - OPDE, Piping Failure Data Exchange, Senior Inspector Rauli Keskinen, national coordinator.
- CNRA, Committee on Nuclear Regulatory Activities, Bureau, Director Lasse Reiman, member
  - WGIP, Working Group on Inspection Practices – Working group to develop inspection operations of authorities, Section Head Timo Eurasto, member
  - WGOE, Working Group on Operating Experience, Investigation Manager Seija Suksi, member
  - WGRNR, Working Group on Regulating New Reactors – Authority cooperation group to share experience of the construction of new plants, Assistant Director Petteri Tiippana, member
  - WGPC, Working Group on Public Communication of Nuclear Regulatory Organisations, Information Officer Risto Isaksson, member.
- CRPPH, Committee on Radiation protection and Public Health, Section Head Olli Vilkamo, member
  - WPNEM, Working Party on Nuclear Emergency Matters, Head of Emergency Preparedness Hannele Aaltonen, member
  - EGOE, Expert Group on Occupational Exposure, Section Head Olli Vilkamo
  - EGBAT, Expert Group on Best Available Technologies, Senior Inspector Lauri Pöllänen, member
  - ISOE, Information System on Occupational Exposure, Senior Inspector Veli Riihiluoma, official representative of the bureau, Vice-Chairman.
- RWMC, Radioactive Waste Management Committee, nuclear waste committee, Principal Adviser Esko Ruokola, member
  - RWMW-RF, Regulators Forum, Principal Adviser Esko Ruokola, member
  - IGSC, Integration Group for the Safety Case – NEA RWMC technical support group to work on methods and strategies for the characterisation and assessment of final disposal locations, as well as viewpoints for the assessment of the safety of final disposal, Inspector Petri Jussila, member.
- Expert Group on Stakeholder Involvement and Organisational Structures (EGSIOS), Inspector Markku Koskelainen, Chairman.

EU

- ENSREG, European Nuclear Safety Regulator's Group – Group to develop EU operations in the fields of nuclear safety and nuclear waste management, Director General Jukka Laaksonen, member
  - ENSREG WG 1, Working group to develop EU operations in the field of nuclear safety, Deputy Director General Hannu Koponen, member
  - ENSREG WG 2, Working group to develop EU operations in the field of nuclear waste management, Director Tero Varjoranta, member.
- European Clearinghouse on Operational Experience Feedback – Director General Jukka Laaksonen, Chairman of the steering group, and Investigation Manager Seija Suksi, assistant.
- Advisory Committee on Council Directive 2006/117/EURATOM on the supervision and control of shipments of radioactive waste and

spent fuel, Deputy Director Arja Tanninen, member.

- Atomic Questions Group, Safeguards Experts, Section Head Elina Martikka, Member State representative.
- CBRN Task Force, Radiological/nuclear subgroup, Section Head Mika Markkanen, member and Section head Elina Martikka, member.
- Joint Research Centre Decommissioning and Waste Management Expert Group (JRC D&WM Expert Group), advisory expert group for the decommissioning of old nuclear facilities and the management of radioactive waste, Section Head Risto Paltemaa, member.
- Group of Experts Referred to in Article 37 of the Euratom Treaty, Senior Inspector Lauri Pöllänen, member
  - Article 37 Working Party on the Revision of the Commission Recommendation 99/829/Euratom, Senior Inspector Lauri Pöllänen, member.
- Group of Experts Referred to in Article 31 of the Euratom Treaty, Director Eero Kettunen, member and Section Head Olli Vilkamo, member
  - Medical Exposures working group under the Group of Experts Referred to in Article 31 of the Euratom Treaty, Director Eero Kettunen, Chairman
  - Graded Approach to Regulatory Control working group under the Group of Experts Referred to in Article 31 of the Euratom Treaty, Director Eero Kettunen, member.
- EUTERP (European Training and Education in Radiation Protection Platform), Deputy Director Ritva Havukainen, member and contact person.
- EURADOS, European Dosimetry Group, Principal Advisor Hannu Järvinen, STUK representative
  - EURADOS/CONRAD, Working Group 9 Radiation protection in medicine, Principal Advisor Hannu Järvinen, Chairman
  - EURADOS, Working Group 2 Harmonisation of Individual Monitoring, Inspector Timo Ansaranta, member.
- EAN (European ALARA Network) Steering Group, Inspector Maaret Lehtinen, member.
- EURAMET, European Collaboration in Measurement Standards, Head of Laboratory Antti Kosunen, Finnish contact person for ionising radiation and a member of the working group.
- TAIEX Expert mission on Radiation Protection and Safety Law, 1 to 5 December 2008, Skopje, Macedonia, Section Head Mika Markkanen, expert sent by the Commission.
- ASAMPSA2, Advanced Safety Assessment Methodologies: Level 2 PSA – European best practises development to PRA level 2, Principal Advisor Ilkka Niemelä, member; Senior Inspector Jorma Rantakivi, member; Section Head Risto Sairanen, member.
- ENSRA, European Nuclear Security Regulators Association, Senior Inspector Ronnie Olander, member.
- Meetings of the European Regulators for Radiation Protection, Director Eero Kettunen, STUK representative
  - WG 1 Working group on Outside Workers & Dose Passports, Deputy Director Ritva Havukainen, member
  - WG 3 Working Group New Medical Techniques & Patient Release, Section Head Ritva Bly, member
  - WG 5 Working Group Stakeholder Involvement & Medical Practices, Director Eero Kettunen, member.

Nordic cooperation

- Nordic Chefsmöte – Working group for the Directors of Nordic nuclear and radiation safety authorities, Director General Jukka Laaksonen, member.
- NKS, Nordisk kärnsäkerhetsforskning, styrelse, Deputy Director Marja-Leena Järvinen, member.
- NORDFYS, Fysiskt skydd i Nordisk kärnteknisk verksamhet, Senior Inspector Ronnie Olander, member.
- Advisory groups for the OECD Halden project's I&C and control room research, Senior Inspector Harri Heimbürger, member.
- Nordic Society on Non-Proliferation Issues, 7 to 8 October 2009. Presentations: Senior Inspectors Jaakko Tikkinen and Mikael Moring, Assistant Inspector Antero Kuusi and Principal Advisor Juha Rautjärvi.
- Nordic-Baltic group of X-ray diagnostics, Ålesund, Head of Section Ritva Bly, Chairman, Principal Advisor Hannu Järvinen, secretary.

- Nordic Working Group of X-ray Diagnostics, Head of Section Ritva Bly, Chairman, Principal Advisor Hannu Järvinen, secretary.
- Arbetsgrupp inom dosimetri, Head of Laboratory Antti Kosunen, member.
- NORGUSS – Working Group for Nordic authorities responsible for the regulation of sealed sources, Senior Inspector Eero Oksanen, Chairman and Inspector Markku Koskelainen, secretary.
- Nordic Working Group for Dosimetry, Head of Laboratory Antti Kosunen, member.

Other multinational working groups

- **WENRA,** Western European Nuclear Regulator's Association, Director General Jukka Laaksonen, member and Deputy Director Pentti Koutaniemi, assistant
  - WGWD, Working Group for Waste and Decommissioning, Principal Advisor Esko Ruokola, member.
- **MDEP**, Multinational Design Evaluation Programme – Initiative of 10 countries to globally harmonise the construction of new nuclear power plants, Director General Jukka Laaksonen, member of the Steering Committee, Director Lasse Reiman, member of the Steering Technical Committee
  - MDEP/VICWG, Vendor Inspection Co-operation Working Group, Assistant Director Matti Ojanen, member, and Section head Martti Vilpas, member
  - MDEP/CSWG, Codes and Standards Working Group, Assistant Director Matti Ojanen, member, and Senior Inspector Yrjö Hytönen, member
  - MDEP, Multinational Design Evaluation Project – EPR Working Group – Intiative of 5 countries to assess the design of EPR plants and to exchange experiences of construction, Director Lasse Reiman, Assistant Director Petteri Tiippana (Chairman of the EPR WG), Assistant Director Keijo Valtonen, Section Head Risto Sairanen, Section Head Kim Walhlström, Senior Inspector Ari Julin, Senior Inspector Matti Lehto
  - MDEP/EPRWG PRA Group (Senior Inspector Ari Julin, Chairman)
  - MDEP/EPRWG I&C working group, Section Head Kim Wahlström, member.
- **VVER-Forum**, working group for the authorities of countries operating VVER plants, Director General Jukka Laaksonen, member, and Section Head Timo Eurasto, assistant.
  - VVER-Forum's three-year subgroup VVER WG on organisational issues, a working group to compare requirements and regulation practices connected to the management systems and organisations in various VVER countries and to identify best practices, Section Head Timo Eurasto, Chairman of the group.
  - VVER Forum, PSA WG, comparison of probabilistic risk analyses of seven countries, Principal Advisor Ilkka Niemelä, performing the comparison, Section Head Reino Virolainen, Chairman of the group.
- NERS, Network of Regulators of Countries with Small Nuclear Programmes, Deputy Director Marja-Leena Järvinen, member.
- Board of Directors of the International Association for Probabilistic Safety Assessment and Management (IAPSAM), Section Head Reino Virolainen, member.
- ICG-EAC (International Collaborative Group on Environmental Assisted Cracking) working group, Section Head Martti Vilpas, member and Senior Inspector Yrjö Hytönen, member.
- CEN TC 54 WG D, manufacture of pressure vessels, Senior Inspector Jorma Hietalahti, member.
- CEN TC 54, Subgroup Low Temperature, Senior Inspector Jorma Hietalahti, member.
- ESARDA, European Safeguards Research and Development Association, Section Head Elina Martikka, Chairman
  - ESARDA, Integrated Safeguards Working Group, Section Head Elina Martikka, member
  - ESARDA, Verification Technologies and Methodologies Working Group, Senior Inspector Olli Okko, member.
- ITWG, International Technical Working Group to Counter Illicit Nuclear Trafficking – reports to the Nuclear Safety and Security Group of G-8 countries (G-8 NSSG), 13th annual meeting, meetings of working groups, 17 to 19 June 2009, Sofia, Bulgaria, Inspector Paula Karhu, Assistant Inspector Antero Kuusi.

- European Pilot Group on Regulatory Review of the Safety Case for Geological Disposal of Radioactive Waste (EPS), Senior Inspector Jussi Heinonen (subgroup 1), Section Head Risto Paltemaa.
- ICRU, Report Committee on Mammography: Assessment of Image Quality, Special Researcher Markku Tapiovaara, member.
- AAPM American Association of Physics in Medicine, Head of Laboratory Antti Kosunen, member.
- WHO Global Initiative on Radiation Safety in Healthcare Settings, Director Eero Kettunen, member.

Standardisation working groups

- CEN TC 54 WG D, manufacture of pressure vessels, Senior Inspector Jorma Hietalahti, member.
- CEN TC 54, Subgroup Low Temperature, Senior Inspector Jorma Hietalahti, member.
- IEC/TC45/SC45A/Working Group A3, preparation of nuclear power plant I&C standards, Senior Inspector Harri Heimbürger, member (SESKO).
- IEC/TC45/SC45A/Working Group A8, preparation of nuclear power plant control room standards, Senior Inspector Harri Heimbürger, member (SESKO).
- Sub-committee SC 62C (Equipment for Radiotherapy, Nuclear Medicine and Radiation Dosimetry) of IEC Technical Committee TC 62 (Electrical Equipment in Medical Practice), Senior Inspector Petri Sipilä, contact person and member of the monitoring group.
- Working Group 1 (Beam Teletherapy and Particle Accelerators) of Sub-committee SC 62C (Equipment for Radiotherapy, Nuclear Medicine and Radiation Dosimetry) of IEC Technical Committee TC 62 (Electrical Equipment in Medical Practice), Senior Inspector Petri Sipilä, member.
- Working Group 3 (Performance of Dosemeters) of Sub-committee SC 62C (Equipment for Radiotherapy, Nuclear Medicine and Radiation Dosimetry) of IEC Technical Committee TC 62 (Electrical Equipment in Medical Practice), Head of Laboratory Antti Kosunen, member.
- IEC Technical Committee TC 62 (Electrical Equipment in Medical Practice), Senior Scientist Markku Tapiovaara, member of the monitoring group.
- Sub-committee SC 62B (Diagnostic Imaging Equipment) of IEC Technical Committee TC 62 (Electrical Equipment in Medical Practice), Senior Scientist Markku Tapiovaara, contact person and member of the monitoring group.
- Sub-committee SC 45B (Radiation Protection Instrumentation) of IEC Technical Committee IEC TC 45 (Nuclear Instrumentation), Inspector Markku Koskelainen, contact person.
- Sub-committee SC 2 (Radiation Protection) of ISO Technical Committee TC 85 (Nuclear Energy), Inspector Ilkka Jokelainen, contact person and member of the monitoring group.
- CENELEC Technical Committee TC 62 (Electrical Equipment in Medical Practice), Senior Scientist Markku Tapiovaara, member of the monitoring group.

Bilateral cooperation

- Advisory committee on nuclear safety to support the Swedish nuclear authority (SSM, Strålsäkerhetsmyndigheten), Director Lasse Reiman, member.
- Statens Kärnkraftinspektions (SKI) Kärnbränslecykelnämd, advisory committee of the Swedish nuclear safety authority on the nuclear fuel cycle, Director Tero Varjoranta, member.
- 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, Director Tero Varjoranta, member.
- Advisory committee on nuclear safety in Lithuania, Director Tero Varjoranta, member.
- Advisory committee on nuclear safety in France (Groupe permanent d'experts pour les réacteurs nucléaires), Senior Inspector Nina Lahtinen, member.
- SSM cooperation on operations control, with the purpose of exchanging experience on the operation, failures, events and regulative procedures at the Forsmark and Olkiluoto plants, Site Inspector Suvi Ristonmaa, contact person.

- STUK–ASN (France) cooperation on the construction of Olkiluoto 3 and Flamanville 3, Assistant Director Petteri Tiippana, Section Head Pekka Välikangas, Senior Inspector Jukka Myllymäki.
- STUK–NRC (USA) cooperation on the design, construction and commission of new plants, Assistant Director Petteri Tiippana, Local Inspector Lasse Kuosa.
- STUK–Vatesi (Liettua) cooperation on the construction of new plants (local inspector's visit to STUK and Olkiluoto), Assistant Director Petteri Tiippana, Local Inspector Lasse Kuosa.
- STUK and UK Committee on Radioactive Waste Management (advisory committee of the British Government on nuclear waste management) meeting, 26 March 2008, Director Tero Varjoranta, Chairman.
- TÜV SÜD ET – STUK Cooperation Meeting on PSA, Helsinki, 21 to 22 August 2008, Principal Advisor Ilkka Niemelä, Senior Inspector Jorma Sandberg, Section Head Reino Virolainen.
- SSM–STUK meeting, Stockholm, 18 November 2008, Development Manager Kaisa-Leena Hutri: Regulatory co-operation between STUK and SSM in nuclear waste management research and reviews.

Events organised by STUK

- ISOE European Symposium on Occupational Exposure Management at Nuclear Facilities, Turku, 25.–27.6.2008, joint project by TVO, Fortum and STUK, Senior Inspector Veli Riihiluoma.
- ISOE Regulatory Body meeting, Turku, 24 June 2008, Senior Inspector Veli Riihiluoma, Chairman.
- Workshop on Licensing and Regulatory Oversight of New Nuclear Build, Helsinki, 1 to 4 September 2008, STUK presentations by Jukka Laaksonen, Lasse Reiman, Petteri Tiippana, Martti Vilpas, Matti Ojanen, Pekka Välikangas, Jorma Sandberg, Keijo Valtonen, Janne Nevalainen, Kaisa Koskinen, Nina Lahtinen, Risto Sairanen, Ari Julin, Jouko Mononen, Kim Wahlström, Mari Andersin.
- International Workshop on Practical Implementation of Clinical Audit for Medical Exposure, Tampere Hall, 8 to 10 September 2008, Principal Advisor Hannu Järvinen, responsible organiser, secretary of the local organisation committee.
- ASN–SSM–STUK cooperation meeting, annual meeting of the French (L'Autorité de sûreté nucléaire), Swedish (Strålskyddsmyndigheten) and Finnish nuclear waste management regulatory authorities at STUK, 4 to 5 November 2008, presentations by Jussi Heinonen and Risto Paltemaa.
- MDEP EPRWG meeting at STUK, 19 to 21 November 2008, presentations by Petteri Tiippana, Ari Julin, Matti Lehto, Ilkka Niemelä, Kim Wahlström, Keijo Valtonen, Risto Sairanen.

Presentations at international events

- ENSRA workshop on security of radioactive sources, Paris, 6 to 8 February 2008, Senior Inspector Petri Sipilä: Finnish situation on security of radioactive sources.
- US NRC Regulatory Information Conference, Washington D.C., 12 March 2008, Director General Jukka Laaksonen: Experiences from regulating EPR construction.
- NEA/CSNI Workshop on Recent Findings in Probabilistic Seismic Hazard Analysis Methodologies and Applications, Lyon, France, 7 to 9 April 2008, Senior Inspector Jorma Sandberg: The Finnish Approach to Seismic Hazard Analysis – Case Loviisa.
- Second EUTERP Platform Workshop 'Definitions, Qualifications and Requirements for Radiation Protection Experts, Radiation Protection Officers and Radiation Workers', Vilnius, 23 to 25 April 2008, Deputy Director Ritva Havukainen: Proposals for definitions and competence requirements for RPEs and RPOs, as well as their roles, duties and responsibilities. Finnish views on the impacts for the implementation of the proposals.
- Nuclear Power Plants in North-West Russia: Common Nordic Approach for Cooperation, Stockholm, 13 to 14 May 2008
  - Head of Unit Heikki Reponen: Previous co-operation and common achievements
  - Head of Unit Heikki Reponen: Safety level reached through different efforts
  - Head of Unit Heikki Reponen: What needs to be done
  - Anneli Puura-Märkälä and Head of Unit Heikki Reponen: Funding prospects and possibilities for common Nordic plan.

- PSAM9, International Conference on PSA Methodology, Hong Kong, 19 to 23 May 2008
  - Section Head Reino Virolainen and Senior Inspector Ari Julin: Role of PRA and Applications in Licensing of Olkiluoto 3 Nuclear Power Plant in Finland
  - Principal Advisor Ilkka Niemelä: FinPSA: New Features in PRA Software
  - Senior Inspector Matti Lehto: Living PSA Development for RBMK Units 1 and 2 of Leningrad NPP.
- Nordic Radiation Protection Society – NSFS, conference Ålesund, Norway, 27 to 30 May 2008, Section Head Olli Vilkamo: Construction of OL3 reactor, site assessment and environmental assessment of Finnish new NPP projects.
- IAEA Regional workshop on licensing process through the whole life cycle of nuclear installations, Bulgaria, 2 to 6 June 2008, Director Tero Varjoranta: Chairman and presentations: Extending operating license, periodic safety review, life time management and Case Loviisa NPP, and Dealing with vendors.
- Slottsmöte – annual meeting of Nordic PRA operators, Porvoo, 10 June 2008, Principal Advisor Ilkka Niemelä: PRA Activities at STUK.
- MIT Nuclear Safety Course, 23 June 2008, Director General Jukka Laaksonen: Licensing and Construction of EPR in Finland.
- IAEA workshop on the roles and responsibilities of vendor countries and countries embarking on nuclear power programmes to ensure long-term safety, Vienna, 1 July 2008, Director General Jukka Laaksonen: Preparing the national infrastructure for regulation and safety analysis of the first NPP in Finland.
- Symposium on Conditions for Restarting the Nuclear Energy in Italy, Milan, 16 July 2008, Director General Jukka Laaksonen: The Finnish model and experience.
- IBC's 19th Annual Residential Summer School on Radiological Protection, Christ's College, Cambridge, 14 to 18 July 2008, Section Head Mika Markkanen: Practical Aspects of Natural Radiation and NORM.
- The 33rd IGC Geoscience World Congress 2008, Geology and disposal of nuclear waste: Nordic approach – special aspects of the disposal in crystalline bedrock, Oslo, 12 August 2008, Development Manager Kaisa-Leena Hutri: How to licence a SNF disposal site? – A Finnish approach.
- 11th Technical Meeting on Experiences with Risk-based precursor analysis, Brussels, 5 to 7 November 2008, Senior Inspector Jorma Rantakivi: Risk follow-up in Finland.
- PSA 2008, International Topical Meeting on Probabilistic Safety Assessment & Analysis, 7 to 11 September 2008, Hilton Knoxville, TN, USA, Invited presentation, "Experience of Using PRA in Licensing of EPR – Olkiluoto 3 NPP in Finland", A. Julin, L. Reiman, R. Virolainen.
- International Youth Nuclear Congress 20.–26.9.2008, Interlaken, Switzerland, Senior Inspector Kirsi Alm-Lytz: Challenges for new nuclear power plant projects in Europe; Finnish experiences from the regulator's point of view.
- IAEA Scientific Forum "The future of the IAEA", IAEA Safeguards and Verification, Chairman and key note speech, Director Tero Varjoranta, 30 September to 1 October 2008, Vienna.
- IAEA/INMM workshop "Meeting safeguards and challenges in an expanding nuclear world", Tokyo, 6 to 9 October 2008, Director Tero Varjoranta: Developing safeguards and expanding nuclear above and below the ground level.
- EURAMET working group meeting, Rome, 8 to 10 October 2008. Presentation on STUK's measurement standard operations of 2008, Head of Laboratory Antti Kosunen.
- 50th ILK (The International Committee on Nuclear Technology) Meeting, 21 October 2008, InterCity Hotel at Frankfurt Airport, Germany, Invited presentation on the use of PRA in licensing of NPP, Section Head Reino Virolainen.
- Nordic Working Group for Dosimetry. GammaRate project on radiation measurements in emergency preparedness. Workshop for personnel at the Nordic secondary standard dosimetry laboratories (SSDLs) and emergency preparedness organisations, Oslo 28 to 29 October 2008, Senior Scientist Teemu Siiskonen: The Dose Rate Monitoring Network in Finland.
- Nordic Working Group for Dosimetry. Gamma-Rate project on the radiation measurements in emergency preparedness. Workshop for personnel at the Nordic secondary standard dosimetry laboratories (SSDLs) and emergency prepared-

ness organisations, Oslo, 28 to 29 October 2008, Head of Laboratory Antti Kosunen: Radiation meter standards.

- Management in Radiology (MIR) conference, Athens, 29 to 30 October 2008, Principal Advisor Hannu Järvinen, invited presentation: How to organize a clinical audit at national level.
- Consultant Meeting on IRRS Lessons Learned, 29 to 31 October 2008, Director Tero Varjoranta, Chairman.
- NKS NordThreat seminar, 30 to 31 October 2008, Oslo, Heikki Reponen: Russian Nuclear Reactors 2010–2020.
- Nationellt möte om strålbehandling, Tema Verktyg för Strålsäkerhetsmyndighetens tillsyn, Stockholm (SSM Strålsäkerhetsmyndighten), 11 November 2008, Head of Section Ritva Bly and Senior Inspector Petri Sipilä: Tillsyn och Klinisk revision i Finland.
- OECD/NEA Working Party on Decommissioning and Dismantling (WPDD); Topical session on applying decommissioning experience to the design and operation of new plants, Senec, Slovakia, 12 to 13 November 2008, Senior Inspector Arto Isolankila: Decommissioning issues in the licensing of new facility.
- IAEA International Conference on Topical Issues in Nuclear Installation Safety, Mumbai, 17 November 2008
  - Director General Jukka Laaksonen: Ensuring Nuclear Safety for Sustainable Development
  - Director General Jukka Laaksonen: Regulation and operation experience feedback
  - Seija Suksi, Event Investigation: Sharing and implementing the lessons learned from operational experience – View of a country with a small nuclear programme, Chairman of the session.
- Kärnteknik 2008, symposium organised by Inspecta, Stockholm, 26 to 27 November 2008, Section Head Pekka Välikangas: Reactor building against large passenger plane crash.
- FAK PSA Meeting – Cooperation meeting of German nuclear safety organisations, Cologne, 30 November 2008, Principal Advisor Ilkka Niemelä: PRA Software FinPSA.
- Global Initiative on Radiation Safety in Healthcare Settings, WHO technical meeting, Geneva, 15 to 17 December 2008, Principal Advisor Hannu Järvinen, STUK representative and invited presentation: Guidance on clinical audit: The EC project.
- IAEA; Self-assessment of national regulatory infrastructure for nuclear and radiation safety, 16 to 19 December 2008, Director Tero Varjoranta, Chairman.

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
The Regulatory Guides on nuclear safety (YVL) will be updated by the end of 2011 and published as STUK-YVL Guides.

TechSpec
Technical Specifications

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. YVL Guides will no longer be prepared after 2008; in future, STUK-YVL Guides will replace YVL Guides.