Regulatory control of nuclear safety in Finland

Annual report 2008

Erja Kainulainen (ed.)
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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 gastight 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.
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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

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

**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.

**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**

**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.
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 startup. 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 require-
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ments 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 metrological 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 opera-
tion 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

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

<table>
<thead>
<tr>
<th>Plant unit</th>
<th>Start-up</th>
<th>National grid</th>
<th>Nominal electric power, (gross/net, MW)</th>
<th>Type, supplier</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loviisa 1</td>
<td>8 Feb 1977</td>
<td>9 May 1977</td>
<td>510/488</td>
<td>PWR, Atomenergoexport</td>
</tr>
</tbody>
</table>

Olkiluoto NPP

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

<table>
<thead>
<tr>
<th>Plant unit</th>
<th>Start-up</th>
<th>National grid</th>
<th>Nominal electric power, (gross/net, MW)</th>
<th>Tyyppi, toimittaja</th>
</tr>
</thead>
<tbody>
<tr>
<td>Olkiluoto 1</td>
<td>2 Sep 1978</td>
<td>10 Oct 979</td>
<td>890/860</td>
<td>BWR, Asea Atom</td>
</tr>
<tr>
<td>Olkiluoto 2</td>
<td>18 Feb 1980</td>
<td>1 Jul 1982</td>
<td>890/860</td>
<td>BWR, Asea Atom</td>
</tr>
<tr>
<td>Olkiluoto 3</td>
<td>Construction</td>
<td></td>
<td>about 1,600 (net)</td>
<td>PWR, Areva NP</td>
</tr>
<tr>
<td></td>
<td>license granted</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>17 Feb 2005</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Onkalo

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

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.

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.


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.](image-url)
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.
<table>
<thead>
<tr>
<th>A</th>
<th>General safety guides</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.1</td>
<td>Regulatory control of the safe use of nuclear energy</td>
</tr>
<tr>
<td>A.2</td>
<td>Structure and definitions applied in STUK-YVL guides</td>
</tr>
<tr>
<td>B</td>
<td>Safety management of nuclear facilities</td>
</tr>
<tr>
<td>B.1</td>
<td>Siting of nuclear facilities</td>
</tr>
<tr>
<td>B.2</td>
<td>Management systems of nuclear facilities</td>
</tr>
<tr>
<td>B.3</td>
<td>Personnel of nuclear facilities</td>
</tr>
<tr>
<td>B.4</td>
<td>Construction of NPPs</td>
</tr>
<tr>
<td>B.5</td>
<td>Operation of NPPs</td>
</tr>
<tr>
<td>B.6</td>
<td>Risk management at NPPs</td>
</tr>
<tr>
<td>B.7</td>
<td>Modification management at nuclear facilities</td>
</tr>
<tr>
<td>B.8</td>
<td>Condition monitoring, maintenance and ageing management of nuclear facilities</td>
</tr>
<tr>
<td>B.9</td>
<td>Security arrangements at nuclear facilities</td>
</tr>
<tr>
<td>B.10</td>
<td>Emergency preparedness arrangements at nuclear facilities</td>
</tr>
<tr>
<td>B.11</td>
<td>Reporting by nuclear facilities</td>
</tr>
<tr>
<td>B.12</td>
<td>Operating experience feedback at nuclear facilities</td>
</tr>
<tr>
<td>C</td>
<td>Plant and system design</td>
</tr>
<tr>
<td>C.1</td>
<td>Classification of systems, structures and equipment at nuclear facilities</td>
</tr>
<tr>
<td>C.2</td>
<td>Safety-classified systems</td>
</tr>
<tr>
<td>C.3</td>
<td>Nuclear fuel and reactor</td>
</tr>
<tr>
<td>C.4</td>
<td>Reactor coolant circuits of NPPs</td>
</tr>
<tr>
<td>C.5</td>
<td>Containments of NPPs</td>
</tr>
<tr>
<td>C.6</td>
<td>Internal and external threats to nuclear facilities</td>
</tr>
<tr>
<td>C.7</td>
<td>Fire protection at nuclear facilities</td>
</tr>
<tr>
<td>C.8</td>
<td>Safety assessment</td>
</tr>
<tr>
<td>D</td>
<td>Radiation safety at nuclear facilities</td>
</tr>
<tr>
<td>D.1</td>
<td>Radiation protection of personnel at nuclear facilities</td>
</tr>
<tr>
<td>D.2</td>
<td>Control of environmental releases from nuclear facilities</td>
</tr>
<tr>
<td>D.3</td>
<td>Measurement of environmental releases from nuclear facilities</td>
</tr>
<tr>
<td>D.4</td>
<td>Structural radiation safety of nuclear facilities</td>
</tr>
<tr>
<td>E</td>
<td>Nuclear materials and waste</td>
</tr>
<tr>
<td>E.1</td>
<td>Regulatory control of nuclear non-proliferation</td>
</tr>
<tr>
<td>E.2</td>
<td>Transport of nuclear materials and waste</td>
</tr>
<tr>
<td>E.3</td>
<td>Handling, storage and encapsulation of spent nuclear fuel</td>
</tr>
<tr>
<td>E.4</td>
<td>Handling and storage of low- and intermediate-level waste at, and decommissioning of, nuclear facilities</td>
</tr>
<tr>
<td>E.5</td>
<td>Final disposal of nuclear waste</td>
</tr>
<tr>
<td>F</td>
<td>Structures and equipment of nuclear facilities</td>
</tr>
<tr>
<td>F.1</td>
<td>Manufacture and use of nuclear fuel</td>
</tr>
<tr>
<td>F.2</td>
<td>Mechanical components and structures of nuclear facilities, construction plan</td>
</tr>
<tr>
<td>F.3</td>
<td>Mechanical components and structures of nuclear facilities, regulatory control</td>
</tr>
<tr>
<td>F.4</td>
<td>Verification of strength of pressure equipment at nuclear facilities</td>
</tr>
<tr>
<td>F.5</td>
<td>Non-destructive testing at nuclear facilities</td>
</tr>
<tr>
<td>F.6</td>
<td>Buildings and structures of nuclear facilities</td>
</tr>
<tr>
<td>F.7</td>
<td>Electrical and I&amp;C equipment of nuclear facilities</td>
</tr>
</tbody>
</table>

**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 its 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.

<table>
<thead>
<tr>
<th>Event</th>
<th>Non-compliances with the Technical Specifications</th>
<th>Special report</th>
<th>INES rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unclear testing instructions for the containment ice condenser door control system valves at Loviisa 1 and Loviisa 2</td>
<td>•</td>
<td>•</td>
<td>0</td>
</tr>
<tr>
<td>Absence of an uninterrupted power supply in a substation at the Loviisa plant</td>
<td>•</td>
<td>•</td>
<td>0</td>
</tr>
<tr>
<td>Incorrect simulations in the reactor protection system of Loviisa 2</td>
<td>•</td>
<td>•</td>
<td>1</td>
</tr>
</tbody>
</table>

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 inspection.
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.

#### Operation and operational events

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

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**Figure 7.** Load factors of the Loviisa plant units.

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

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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
4.1 LOVIISA NPP

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
4.1 LOVIISA NPP

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 under-voltage 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
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 in-service 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 modernisation 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 backup 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.

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 adopted 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.
4.1 Loiisa NPP

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.](image)

![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.](image)
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.

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.

<table>
<thead>
<tr>
<th>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.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample</td>
</tr>
<tr>
<td>Air</td>
</tr>
<tr>
<td>Aquatic plants</td>
</tr>
<tr>
<td>Sediment</td>
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<tr>
<td>Seawater</td>
</tr>
</tbody>
</table>
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 its 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.

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

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 driven withdraw 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.
Events non-compliant with the Tech Specs

During annual maintenance, one control rod at Olkiluoto 1 was withdrawn from the reactor in non-compliance 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.](image1)

![Figure 13. Daily average gross power of the Olkiluoto plant in 2008.](image2)
4.2 Olkiluoto NPP units 1 & 2

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, 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.

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.

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.

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.

In a 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 disturbance 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 operational experience feedback reports.
rooms and bringing the instructions up to date.

STUK carried out radiation protection inspections during the annual maintenance 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.

**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

<table>
<thead>
<tr>
<th>Sample</th>
<th>Detected nuclides (number of samples)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aquatic plants</td>
<td>Co-60 (10), Mn-54 (1)</td>
</tr>
<tr>
<td>Sedimenting materials</td>
<td>Co-60 (7)</td>
</tr>
<tr>
<td>Fish</td>
<td>Co-60 (1)</td>
</tr>
<tr>
<td>Shelled fish</td>
<td>Co-60 (1)</td>
</tr>
<tr>
<td>Seawater</td>
<td>H-3 (4)</td>
</tr>
<tr>
<td>Rain water</td>
<td>H-3 (2)</td>
</tr>
</tbody>
</table>

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.
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 regarding on the project's process indicators of the project and 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 documenta-
tion 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 versitseparation 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 housekeeping 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. 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
4.3 Olkiluoto 3

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 transferred 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, codes 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 of 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 control 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 regula-
tory 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:

- 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 performance 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’s 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 documentation, 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.](image1)

![Figure 17. Amount of plutonium in Finland.](image2)
nvironmental 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.

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

<table>
<thead>
<tr>
<th>Location</th>
<th>Natural uranium (kg)</th>
<th>Enriched uranium (kg)</th>
<th>Depleted uranium (kg)</th>
<th>Plutonium kg</th>
<th>Torium kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loviisa plant</td>
<td>–</td>
<td>510 970</td>
<td>–</td>
<td>4 550</td>
<td>–</td>
</tr>
<tr>
<td>Olkiluoto plant</td>
<td>–</td>
<td>1 377 955</td>
<td>–</td>
<td>9 933</td>
<td>–</td>
</tr>
<tr>
<td>VTT / FIR 1 research reactor</td>
<td>1 511</td>
<td>60</td>
<td>0.002</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Other facilities</td>
<td>– 2344</td>
<td>– 1.7</td>
<td>– 1694</td>
<td>– 0</td>
<td>– 5</td>
</tr>
</tbody>
</table>
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, hydro-acoustic 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](http://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 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.ydjytutkimus.fi/tiedoteetmain.html](http://www.ydjytutkimus.fi/tiedoteetmain.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.](image1)

![Figure 26. Distribution of working hours (person-years) of the regulatory personnel by subject of control in 2001–2008.](image2)
Table 7. Distribution of working hours (person-years) of the regulatory personnel in each duty area.

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

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.
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 groundbreaking 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 procedures 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 granting 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.

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

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**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 Affecto Oy and Avain Technologies Oy was selected as the system supplier. The project is in progress and will continue until 2010.**
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.