APPENDIX 1 STUK's safety performance indicators for NPPs in 2006

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Summary of the results of STUK's safety performance indicators

Background and purpose

The overall assessment of nuclear power plant safety by inspection and safety reviews is complemented by the STUK indicator system. The purpose of the safety performance indicators for nuclear power plants developed by STUK is to describe the safety factors of the NPPs. Correctly focused indicators can be used to obtain an overview of plant safety and on the licensees' operations on an annual level. The system indicators can be used to demonstrate that certain safety factors under scrutiny have remained at earlier levels, or to gain insight into their possible changes and trends in the short and the long run. In the short run the indicators serve as tools for regulatory control. The accumulated data can be used as reference material for inspections. The data used for the indicators is collected and evaluated as part of the inspection activities. Declining trends indicate a possible need to enhance the performance and organisational operation of the plants and STUK's regulatory control in those areas. Even the effectiveness of any corrective actions commenced based on indicator results can be monitored by means of these indicators.

No specific action levels or thresholds have been defined for the indicators. Rather, the aim is to recognise trends in the safety-significant functions of a nuclear power plant or STUK as early as possible. The limit values set in the legislation, in the YVL guides and in the Technical Specifications (Tech Specs), as well as the target values contained in the objectives of the department of Nuclear Reactor Regulation (NRR), will be applied where available.

STUK's indicator system is divided into two principal groups: external indicators for the safety of nuclear facilities and internal indicators for the regulatory effort. External nuclear plant safety indicators are divided into three principal subgroups: safety and quality culture; operational events; and structural integrity. These principal subgroups have a total of 14 indicator areas having 51 specific indicators.

Guide YTV 4.3.3, "Calculation, assessment and utilisation of the NRR indicators", in the NRR Quality Manual defines the responsibilities and procedures for data collection and calculating the NRR's indicators for the safety of nuclear facilities; for interpreting their values and changes; for assessing, reporting and utilising them. Appendix 1 to the guide describes the NRR's indicators for the safety of nuclear facilities; their definitions and data acquisition; the unit and person responsible for the updating of each indicator (person in charge of indicator); and the person who maintains the indicator system (administrator).

As a rule, the data for the indicators for the safety of nuclear facilities is acquired and updated quarterly. Indicator definitions, graphs and results interpretation can be found in STUK's INDI (INdicator DIsplay) application.

The STUK indicators were first included in the revised strategy of early 2003 to describe and measure its success. Of the indicators describing the effectiveness of STUK's activities, the following apply to the NRR: occupational doses, radioactive releases from nuclear facilities and the resultant population exposure in the vicinity of the plants, safety-endangering events at nuclear facilities, condition of components relevant to the accident risk of nuclear facilities, updating of YVL guides, customer satisfaction and number of complaints. The last three indicators describe NRR's own activities and are incorporated in the indicator area for the regulatory effort. Indicators for plant safety, incorporated in the STUK strategy, have quantitative limits contained in the rules and regulations or NRR's own objectives.

All of the nuclear plant safety indicators describe and measure the effectiveness of NRR's activities. Their values are updated quarterly and any deviations and their causes are either immediately tracked down by the responsible persons or considered more widely at departmental or oversight meetings. The development trends of indicators and indicator areas are assessed in the annual summary. The summary is utilised in conjunction with other assessments and inspection observations in the overall assessment of nuclear plant safety conducted by STUK. The annual summary of the indicators is attached to the annual report on regulatory control of nuclear safety submitted to the Ministry of Trade and Industry.

Indicator results for 2006

The data gathered from 2006 for nuclear plant safety indicators did not cause such changes in individual indicators, indicator areas or the three main areas as would have warranted an immediate reaction from STUK. The requirements set for the indicators for the safety of nuclear facilities describing the effectiveness of STUK's activities were fulfilled in all respects.

Safety and quality culture

The indicators in this area illustrate the condition of the plant and the success of the operations of the various organisational units, such as maintenance, operation, and radiation protection, participating in plant operation. Compliance with the Tech Specs is monitored, as well as identified needs for deviating from the Tech Specs. The area also includes an indicator for monitoring the updating of principal documents after plant modifications, as well as an indicator for monitoring the relative fluctuations of investments used for plant maintenance and renovation.

Maintenance operations were evaluated by plant unit concerning the yearly volume of maintenance works, the volume of preventive maintenance and failure repairs of Tech Spec components, and on the basis of the volume of repair works during power operation, the average time spent on failure repairs and the production losses caused by failures. The unavailability of systems required for accomplishing the critical safety functions is also monitored.

In Loviisa the total volume of the yearly maintenance works of Tech Spec components, including both failure repairs and preventive maintenance, has been increasing in the last few years. The distribution of preventive maintenance between plant units is determined by the length of the annual maintenance outages. The volume of preventive maintenance in 2006 is not directly comparable with the previous years since the components included in the indicator have changed. The new LOMAX information system was introduced at the Loviisa power plant in early 2006. As a result, the scope of the indicator concerning the maintenance of Tech Spec components has been extended so that in future the volume of annual maintenance works will also include such failure repairs on Tech Specs components that did not cause an operation restriction. For this reason, the volume of failure repairs and preventive maintenance behind indicator more than tripled in 2006 compared with the previous years. Despite the changes in the work recording procedure, there was no marked change in the ratio of the number of preventive maintenance works to failure repairs in 2006.

The total volume of the yearly maintenance work of Tech Spec components in Olkiluoto has also been increasing in the last few years. Because of the change in the work recording procedure, the volume of maintenance works dropped significantly in 2006 to below one-third of previous levels. Due to a change in the work order system implemented by the utility as of the beginning of 2006 the data is not comparable with previous years' figures. TVO's work order system classification no longer includes maintenance class 3, which includes Tech Spec system components; however, nowhere near all of these systems are subject to restrictions set in the Tech Specs. Despite the work recording procedures, there was no marked change in the ratio of the number of preventive maintenance works to failure repairs in 2006. Judging by this data, maintenance activities at the plants are in balance and carried out according the same principles as before. The volume of preventive maintenance at the plants is affected by preventive maintenance works determined by the length of the annual maintenance outages. In future, changes in the indicator should be mainly attributable to variation due to the scheduling of annual maintenance, which could be regarded as an indication of a functional maintenance strategy.

The total volume of failure repairs of Tech Spec components during power operation at the Loviisa plant in 2006 decreased slightly from the previous year, which meant an end to the slight upward trend of the past few years. The volume of failures during power operation causing an operation restriction at the Olkiluoto plant also showed an upward trend until 2005, at which time it began to decrease. This development was particularly attributable to a declining trend in the volume of failures causing an immediate operation restriction. Failure detection and anticipation have been continuously improved in plant maintenance operations, and components have been replaced. Thanks to these measures, in the indicator or the failure data behind it do not show the potentially negative effect associated with the ageing of the facilities, which indicates functional component ageing management and successful maintenance.

The average repair times of failures causing unavailability of Tech Spec components have remained relatively stable at Loviisa and Olkiluoto for several years, varying from one day (24 hours) to over two days (over 48 hours) at the Loviisa plant units and from five to twelve hours at the Olkiluoto plant units. In 2006 the average repair times decreased at all other plant units except Loviisa 2, where the annual trends of repair times have been changeable. The average repair time at Loviisa 2 is increased by the failure repair of the Tech Spec components for which the Tech Specs allow a long repair time. With regard to the availability of maintenance resources and effectiveness of operations at the Loviisa plant, action should be taken to reduce the repair times for such components. Production losses due to failures at the Loviisa and Olkiluoto plants remained relatively small in 2006, as is also indicated by the plants' high load factors.

Production losses due to failures at the Loviisa and Olkiluoto plants remained relatively small in 2006, as is also indicated by the plants' high load factors. The somewhat higher loss of approximately half a per cent at Loviisa 2 was due to a single failure. This was a leaking check valve in the feed water line; to repair the valve, the plant had to be brought to a start-up state twice during the beginning of the year. At Olkiluoto production losses due to failures at both plant units increased slightly from the markedly low values of 2005, standing at a few tenths of a per cent at both plant units in 2006. At Olkiluoto the single most significant factor was the frequent occurrence of failures in the rubbing-face seals in the feedwater pump of Olkiluoto 1.

The unavailability of safety systems was followed by means of international indices provided by the licensees. The high pressure safety injection system, the auxiliary feed water system and the back-up diesel generators were monitored at the Loviisa power plant; Olkiluoto monitored the containment spray system, the auxiliary feed water system and the back-up diesel generators.

The international indices measuring the unavailability of safety systems indicated that the unavailability of the monitored systems remain at a normal low level. At the Loviisa plant unit the unavailability of the emergency diesel generators was higher than in the previous two years. The failures detected in the diesels were due to normal ageing and not serious. The slight increase in the unavailability index of the auxiliary feed water system was due to maintenance works performed during annual maintenance. At Olkiluoto the unavailability of the containment spray system and the back-up diesels is showing a downward trend. In 2006 the condition of the diesels was at a good level. The unavailability index of the auxiliary feed water system rose from the very low values in 2004, particularly at Olkiluoto 1, which was due to failures in the system's recirculation and safety valves. Corrective actions included adjusting the torque settings of the recirculation line valves actuator motors; preliminary discussions have also been conducted concerning the construction of a separate safety valve testing line. Latent failures were dominant as causes of safety system unavailability.

The operations of the Finnish nuclear power plants were mostly in compliance with the Technical Specifications. There were a total of four plant conditions in non-compliance with the Technical Specifications in 2006, two of which occurred at the Loviisa plant and four at Olkiluoto. Deficiencies were observed at both plants concerning tests defined in Tech Spec, either related to the performance of tests or the process of revising the testing procedures. The safety-significance of individual events was nevertheless very low.

Both the Loviisa and Olkiluoto plants found it necessary to deviate from the Tech Specs in a planned manner four times. The numbers of deviations are showing a downward trend from the previous year and are very small. The exemptions granted did not warrant re-evaluation of the Tech Specs. Two of the exemptions granted to the Loviisa plant were concerned with troubleshooting for a fault in the rotating converter of Loviisa 2 and its repair during power operation; one of the exemptions concerned the change of operational condition during start-up, although one of the position indicators of the ice-condenser's lower door was faulty. In addition, the licensee applied for permission to irradiate one fuel bundle at Loviisa 2 for one additional cycle. It has been estimated that the number of exemptions will increase in the future due to the isolations and modifications due to the upgrading of I&C systems at Loviisa. At Olkiluoto the exemptions were concerned with the replacement of rectifiers during power operation and changing the loading machine radiation measurement limits for the duration of the transfer of fuel bundles and control rods during annual maintenance. Postponing the installations of Olkiluoto 3 also required an exemption.

The indicator describing the currency of plant documentation shows the document revisions, which relate to safety-significant or extensive modifications carried out in the annual maintenances of Loviisa and Olkiluoto, and which must be implemented before the plant is started up after the annual maintenance in question. This means that the modifications implemented during annual maintenance that affect the Tech Specs, emergency operating procedures, procedures for restoring the normal state and operation procedures for power operation, must have been implemented in the relevant documents. Flow diagrams are also to be reviewed. The most extensive modifications at the Loviisa plant were carried out at the Loviisa 2 plant unit. After the plant modifications carried out in the annual maintenance at the Loviisa and Olkiluoto plants the plant documentation had been sufficiently successfully updated with regard to all documents that had to be updated by the start-up. As in previous years, the only deficiency observed at Olkiluoto concerned the updating of diagrams.

The plant units' safety performance indicator for investments in improvements and modifications indicates relative fluctuation in investments. The amounts given in Euro are the utilities' confidential information and are not to be published here. This safety performance indicator was included in the STUK indicator system in 2000 to indicate the potential effect of deregulated electrical markets on investment. The fluctuation in the indicator clearly shows the investments made in 1997–2000 in the plants' power upgrades and modernisation projects. The investments of 2004–2005 were above average levels at both the Loviisa and the Olkiluoto plant. Since 2004 the calculation of the indicator value for Loviisa has changed; major periodic preventive maintenance and QC inspections related to annual maintenance are now regarded as investments. The main investments at the Loviisa plant during the past couple of years have included provisions for severe reactor accidents and the modernisation of the turbine. The most significant current plant modification project at Loviisa concerns the upgrading of the plant units' I&C systems; expenses incurred in relation to this project in 2006 included the construction of new buildings and simulator development. One of the main investments made at the Olkiluoto plant in the past few years was the turbine plant upgrading project, which also included replacement of the steam dryers. A decision was also made to continue the construction of a gas turbine plant, which began in 2005.

STUK works to affect, both directly and indirectly, the radiation doses for nuclear power plant workers and the calculated radiation exposure for the surrounding population arising from releases. This involves low radioactive releases into the environment, which remain clearly below the set limits. The indicators followed in the area of radiation protection are the collective radiation exposure of employees, the average of the ten highest yearly radiation exposures and compliance with the YVL Guide's calculatory threshold. Other indicators followed include radioactive releases into the sea and the atmosphere from the plant, and the calculated dose due to releases to the most exposed individual in the vicinity of the plant.

Most doses are incurred in work done during outages; thus outage duration and the amount of work having significance on radiation protection affect the yearly radiation doses.

The radiation doses for nuclear power plant workers were below the personal dose limits. The Radiation Decree (1512/1991) stipulates that the effective dose for a worker from radiation work may not exceed the 20 mSv/year average over any period of five years or 50 mSv in any one year. Furthermore, the collective dose remained below the calculatory reporting threshold confined to net electric power specified in the Guide YVL 7.9 in 2006. The collective radiation doses at the Olkiluoto plant in 2005–2006 were higher than in the previous years due to the annual maintenance outages, which were exceptionally extensive in terms of the workforce and workload involved.

Releases into the air and water at the Loviisa and Olkiluoto plants remained low in 2006, as did the calculated radiation dose for the most exposed individuals in the population surrounding the Olkiluoto plant. They were well below the set release and dose limits. Releases of iodine and aerosols into the atmosphere indicated a small increase at the Olkiluoto plant due to fuel leakages at both plant units. Releases into the sea from both Loviisa and Olkiluoto were small.

Gaseous fission products, noble gases and iodine isotopes originate in leaking fuel rods, in the minute amounts of uranium left on the outer surfaces on fuel cladding during fuel fabrication, and in reactor surface contamination from earlier fuel leakages. There have been no fuel leakages at the Loviisa plant units for several years. The noble gas releases from the Loviisa plant are dominated by argon-41, an activation product of argon-40, found in the airspace between the reactor pressure vessel and the biological shield.

The Olkiluoto 2 reactor contained leaking fuel almost throughout 2006, and the Olkiluoto 1 reactor for a short time at the very end of the burnup cycle in spring 2006. Fuel leaks show as slightly increased noble gas and iodine releases into the air.

Releases into the sea at the Loviisa and Olkiluoto plants were low since there were no planned releases of low-activity evaporation residues at Loviisa and the Olkiluoto plant has introduced new process water purification and treatment equipment.

The calculated radiation doses for the most exposed individual in the vicinity of both power plants was of the same magnitude as in the previous year. In Loviisa the dose was smaller than in the previous year. The calculated doses of the most exposed individual in the vicinity of both plants are less than 0.1 % of the 100 microSv limit established in the Government Resolution (395/1991).

Operational events

The indicators of this area monitor the volume and risk-significance of operational events reported in accordance with Guide YVL 1.5. Reports are classified according to the nature of events or significance for nuclear safety, as well as immediate causes. The risk indicators in the area monitor the risk-significance of component unavailability and the development of the nuclear facilities' risk levels. The indicators provide insight into the operation of the plant and the effectiveness of the operational experience feedback. A review of the risk indicators jointly with the previous area's indicators, such as non-compliance with the Tech Specs, safety system unavailability, failures of Tech Spec components and production losses due to failures of all components during power operation, provides more information on the significance of related planned and unplanned component unavailabilities.

No events endangering nuclear safety occurred at the Finnish nuclear facilities in 2006. The numbers of operational events at the Loviisa and Olkiluoto power plants were at the average level of the past few years. Five events occurred at the Loviisa power plant for which the plant submitted an operational event report. The number has slightly decreased compared with the previous years. There were also five events warranting a special report at Loviisa. The number has not changed in the long term. Errors in plant operation were dominant as the immediate causes of the operational events at the Loviisa plant. The number of such errors has increased markedly compared with the previous year. Four events warranting a special report occurred at Olkiluoto. The number of events warranting a special report occurring at Olkiluoto has remained relatively stable in the long run. There were also four events warranting an operational transient report at Olkiluoto. The immediate causes of the operational events occurring at Olkiluoto were mainly technical failures rather than human errors. The number of scrams occurring at the Finnish plants has been small; no scrams occurred in 2006.

The effects of unavailabilities caused by significant events such as components failures, preventive maintenance and deviations from operation and maintenance and deviations from operational and maintenance procedures on annual accident risk exceeded the 5% target value set by STUK at both Olkiluoto plant units in 2006. This was party due to the long duration of the preventive maintenance packages of the diesel generators, one-off maintenance works and latent component failures in the safety systems. No special action by STUK was required.

As the indicators, the risk-significance of events caused by component unavailability is followed. For this the events are divided into three groups: 1) unavailabilities due to component failures, 2) planned unavailabilities and 3) initiating events. The events in each group have been further divided by their risk-significance into three categories, and the indicator is the number of events falling into each category. The events analysed for 2006 are considered part of normal nuclear power plant operation and no further measures were required from STUK.

The number of risk-significant events showed a slight decrease from the previous year at Loviisa, while at Olkiluoto the number remained unchanged. The most significant events at the Olkiluoto plant were due to the long-lasting preventive maintenance packages of the diesel generators and latest failures in the auxiliary feed water systems. The most significant events at Loviisa were related to failures in the ventilation systems and the air cooling systems covering the control rooms' I&C facilities. At Loviisa 1 this category includes diesel and auxiliary feedwater system failures. Preventive maintenance of the auxiliary feed water system during annual maintenance also falls into this category.

The numbers of other risk-significant events at Loviisa and Olkiluoto were of the same magnitude as in the previous year. Component failures remained the main cause of unavailabilities at Loviisa. As before, the Olkiluoto events were mostly due to planned unavailabilities, including component isolations executed under exemption from the Tech Specs and preventive maintenance. The events were relatively evenly distributed between the Olkiluoto plant units. At Loviisa there were more events at Loviisa 2.

The number of analysed events falling into the least risk-significant category increased in 2004 as there was a shift in the reporting towards a policy in accordance with the Guide YVL 1.5 (the unavailabilities of all Tech Spec components are presented in monthly or quarterly reports). The number of events falling into this category increased from the previous year at both Loviisa plant units; in 2006 there were a total of 450 events. On the contrary, the number of events falling into this category at Olkiluoto is on the decrease; in 2006 there were 131 events in total. The changes at both plants were due to changes in the recording procedures. At both Loviisa and Olkiluoto the events included both planned unavailabilities and events caused by failures.

Incorporated in the indicators for the effectiveness of STUK's activities is the following objective that considers the condition of components having a bearing on the accident risk of nuclear facilities: The accident risk is reduced or remains unchanged. The risk is evaluated on the basis of a probabilistic risk analysis, which model includes regularly updated data on component reliability. The annual probability of a severe reactor accident calculated for the Loviisa plant units is approximately 10^{-4} and for the Olkiluoto plant units approximately $1.6 \cdot 10^{-5}$. The accident risk of both plants decreased somewhat from 2005 due to certain plant modifications and more detailed analyses.

There was one event classified as an actual fire at the Loviisa plant: the explosion of the voltage transformer at Loviisa 2 and the subsequent fire. One event classified as a fire event also occurred at the Olkiluoto plant: a dustbin caught fire during the annual maintenance of Olkiluoto 1. Alarms triggered by dust, smoke or humidity dominated the automatic fire detector alarms at both the Loviisa and Olkiluoto plants in 2006. A significant number of alarms triggered by sprinkler leakage also occurred at Olkiluoto. The Olkiluoto alarms include alarms occurring in the spent fuel storage, the repository for the low and intermediate-level waste and outdoor areas, which explains the larger number of alarms at Olkiluoto. The automatic fire detectors were upgraded at Loviisa in 2000 and at Olkiluoto in 2001. The numbers of alarms increased at both units after that because of more sensitive equipment and equipment failures. The distinct reduction in alarms at the Loviisa plant since 2003 and at the Olkiluoto plant since 2004 is due to pre-alarms no longer being included in the calculations. There were 16 alarms caused by component failure at Loviisa in 2006, and only six alarms at Olkiluoto.

Structural integrity

In the safety performance indicator area the leaktightness of multiple barriers (fuel, primary circuit, secondary circuit, containment) is monitored. The objective is that leaktightness complies with the requirements and deteriorating trends are not allowed, as assessed according to STUK's safety performance indicators.

Based on the 2006 indicators, the structural integrity of barriers preventing the spread of radioactive releases has mostly remained good, and the limits set on the barriers were not exceeded. There have been no fuel leaks at the Loviisa plant units since 1999.

Minor fuel leakages have occurred every year at the Olkiluoto plant units. The development of the leakages has been monitored during power operation and the leaking fuel bundles have been removed from use in the annual maintenance outage following the leak detection. The Olkiluoto 1 reactor contained leaking fuel for a short time in 2006. The leak occurred a few weeks before the plant unit was shut down for the annual maintenance outage. The Olkiluoto 2 reactor contained leaking fuel throughout 2006. The leaking fuel bundle, which was discovered in late July 2005, was removed from the reactor during the 2006 annual maintenance outage. A new fuel leak was detected in July following the annual maintenance. The effects of the leaks showed as larger I-131 activity concentrations during operation. At its highest, the concentration reached approximately 0.2% of the action threshold specified in the Tech Specs.

The water chemistry indicators monitor and control primary and secondary circuit integrity. The monitoring is done by indices depicting water chemistry control and by the concentration levels of selected corrosive impurities and corrosion products. The water chemistry indices combine a number of water chemistry parameters and thus give a good overview of the water chemistry conditions. The chemistry indices indicated that process chemistry control had been successful at both the Loviisa and Olkiluoto plant units in 2006.

There were no significant changes in the indicators describing the integrity of the primary circuit at either Loviisa plant units in 2006. The annual maintenance outages of the plant unit occurred in the third quarter, as a result of which the iron concentration of the rector coolant and the chloride concentration of the steam generator blow-down exceeded normal concentrations during operation. The higher than normal concentrations raise the chemistry index for the entire year. The chemistry index increased due to resin getting into the steam generators during the ion-exchange filter replacement or coating at both plant units.

At Olkiluoto the reactor coolant and feed water chemistry have remained within the target values set by the utility, except for the reactor coolant sulphate concentrations, which show variation due to the runtimes of the plant units' condensate cleaning filter resins. The target sulphate concentrations were exceeded at both Olkiluoto plant units after annual maintenance in the third quarter. At Olkiluoto 2 the average cobalt-60 concentrations in the reactor coolant has shown an upward trend. This is also indicated in the Co-60 activity monitoring in shutdown, which is one of STUK's indicators. Increased Co-60 activity concentrations are attributable to extensive modifications carried out at the unit during the 2005 annual maintenance outage, at which time cobalt-containing materials got into the circuit. The high concentrations are also partially attributable to the spcer grid assembly of a particular fuel type containing nickel, which includes traces of cobalt as an impurity. No significant changes took place in the cobalt-60 and iron contents of the primary coolant or the iron content of the secondary circuit feed water at the Loviisa plant units.

At the Olkiluoto plant leakages from the primary circuit are also monitored by operating cycle. During the operating cycle 2005–2006 the volumes of identified and unidentified leaks in the primary circuit were low at both Olkiluoto plant units. This was the third successive operating cycle during which there were no leaks into the containment atmosphere.

Containment integrity has remained good at both Loviisa and Olkiluoto. The overall as-found leakage of the containment outer isolation valves was below the set limits at both Loviisa plant units, where the volume of leakage was at the same level or smaller than the previous year. As in previous years, the overall as-found leakage of outer isolation valves at Olkiluoto 1 was small. At Olkiluoto 2 the overall as-found leakage increased markedly from the previous year and exceeded the limits set in the Tech Specs. Half of the leakage was from a leak in the isolation valve of the controlled leakage drain system, with a further 16.5% from a leak in one valve in flange cooling system. After repairs the overall as-found leakage was clearly below the limits set in the Tech Specs.

The percentage of isolation valves that passed the leaktightness test at first attempt has remained good and the Olkiluoto plant units show an improvement from the previous year.

The overall as-found leakage of containment penetrations has remained small at both the Loviisa and Olkiluoto plant units. At Loviisa this includes the leaktightness tests of the bellows seals of the personnel airlock, the emergency personnel airlock, the material airlock, the reactor pit, inward relief valves, cable penetrations and the containment maintenance ventilation system, live steam system and feed water system. At Olkiluoto the overall as-found leakage rate includes leakages in the upper and lower personnel airlock the maintenance dome and the containment dome.

Introduction to indicators and their definition

Given next in the report are the definitions, data acquisition, calculation responsibilities and purpose of the indicators for nuclear power plant safety in the STUK indicator system; and indicator values updated on the basis of the 2005 data, their interpretation and assessment of change.

The NRR has assigned persons and units responsible for the acquisition of indicator data as well as for their calculation and analysis. In 2006 resident inspectors of the office of safety management (TUR) were responsible for indicators concerning failures and preventive maintenance of Tech Spec components and safety systems availability. TUR was also responsible for the indicators concerning production losses due to failures and the currency of plant documentation and investments. The data on primary circuit leakages for the Olkiluoto nuclear power plant was provided by the resident inspector. The TUR inspectors gathered and assessed indicators describing the quality of the maintenance function at the Olkiluoto plant. TUR maintained an operational events follow-up table. Resident operation control inspectors appointed to the new office of Organisations and Operations (formed from the earlier office of safety management) at the beginning of 2007 were responsible for the 2006 indicators based on operational events and reports. The office of risk assessment (RIS) assessed the risk-significance of the events. Inspectors from the office of power plant technology (VLT) were responsible for indicators describing the functioning of the fire alarm system as well as the integrity of the fuel and primary circuit. The office of reactor and safety systems (REA) gathered and calculated indicators describing containment leaktightness. The office of radiation protection (SÄT) gathered dose and release data and the corresponding indicators. The safety performance indicator system for nuclear power plants was maintained in the management support unit (YJT) and co-ordinated by the event investigation manager.

There were some personnel changes at NRR concerning those responsible for indicators. The definitions of the safety indicator system or individual indicators were not revised from the previous year. In 2006 an indicator describing the accident risk of nuclear facilities was incorporated in the risk indicator area.

In the latter half of 2005 STUK acquired the INDI (INdicator DIsplay) application for indicator management, analysis and reporting. Since 2006 the indicator system has been managed in the INDI system. Those responsible for indicators enter the indicator data and trend analyses into the system every quarter as a rule.

Safety performance indicators

A.I Safety and quality culture

A.I.1 Failures and their repairs

A.I.1a Failures of components subject to the Technical Specifications

Definition

As the indicator, the number of failures causing unavailability of components defined in the Technical Specifications (Tech Spec components) during power operation is followed. The failures are divided by plant unit into two groups: failures causing an immediate operation restriction and failures causing an operation restriction in connection with repair work.

Source of data

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

Purpose of indicator

The indicator is used to assess the plant ageing management and the development of the condition of components.

Responsible units/persons

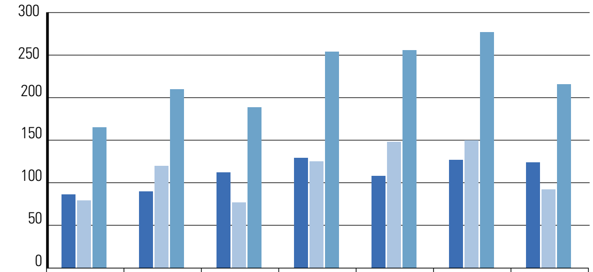
Safety Management (TUR),
resident inspectors
Pauli Kopiloff (Loviisa nuclear power plant)
Jarmo Konsi (Olkiluoto nuclear power plant)

Interpretation of indicator

Loviisa

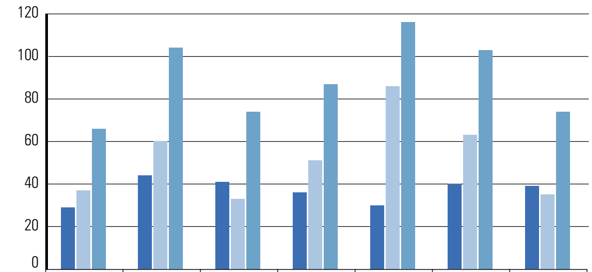
In 2006, the number of failures in Tech Spec components causing an operating restriction was 216, which is significantly lower than in the previous year (277). It is also clearly below the average for the previous four years (244). The change in the total number of failures is mainly attributable to a decrease in the number of failures causing an immediate operating restriction at the LO2 unit since 2004. The annual failure volumes have remained relatively stable; the variation therein is largely due to the random occurrence of normal failures, which are difficult to predict, in a large number

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



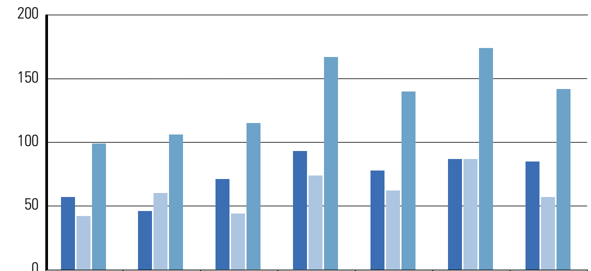
	2000	2001	2002	2003	2004	2005	2006
LO1	86	90	112	129	108	127	124
LO2	79	120	77	125	148	150	92
LO1,2	165	210	189	254	256	277	216

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



	2000	2001	2002	2003	2004	2005	2006
LO1	29	44	41	36	30	40	39
LO2	37	60	33	51	86	63	35
LO1,2	66	104	74	87	116	103	74

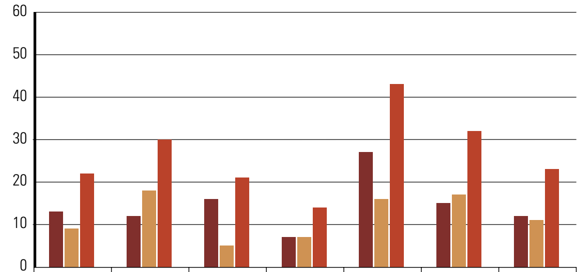
Number of failures of Tech Spec components causing operation restriction from start of a repair work, Loviisa NPP



	2000	2001	2002	2003	2004	2005	2006
LO1	57	46	71	93	78	87	85
LO2	42	60	44	74	62	87	57
LO1,2	99	106	115	167	140	174	142

of components. Failure detection and anticipation have been continuously improved in plant maintenance operations at Loviisa, and components have been replaced. Thanks to these measures, the indicator or the failure data behind it do not show the potentially negative effect associated with the ageing of the facilities, which indicates functional component ageing management and successful maintenance.

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



	2000	2001	2002	2003	2004	2005	2006
OL1	13	12	16	7	27	15	12
OL2	9	18	5	7	16	17	11
OL1,2	22	30	21	14	43	32	23

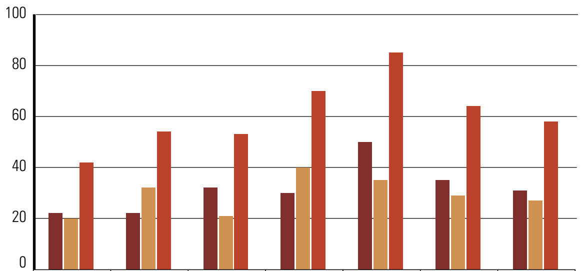
Interpretation of indicator

Olkiluoto

The increase in the number of failures since 2002 cannot be attributed to one straightforward reason. One factor may be the revised work recording procedure. However, the number of failures has shown similar variation in the long term.

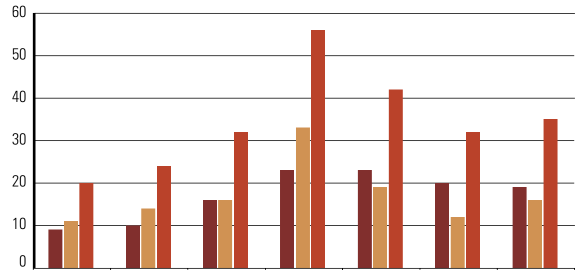
The total number of failures causing an immediate operation restriction has shown a slowly declining trend in the past few years, which seems to indicate the success of the maintenance operations.

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



	2000	2001	2002	2003	2004	2005	2006
OL1	22	22	32	30	50	35	31
OL2	20	32	21	40	35	29	27
OL1,2	42	54	53	70	85	64	58

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



	2000	2001	2002	2003	2004	2005	2006
OL1	9	10	16	23	23	20	19
OL2	11	14	16	33	19	12	16
OL1,2	20	24	32	56	42	32	35

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

Definition

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

Source of data

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

Purpose of indicator

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

Responsible units/persons

Safety Management (TUR),
resident inspectors
Pauli Kopiloff (Loviisa nuclear power plant)
Jarmo Konsi (Olkiluoto nuclear power plant)

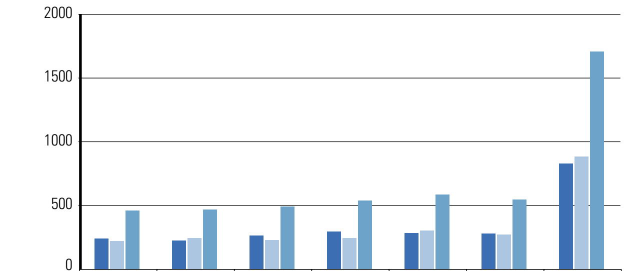
Interpretation of indicator

Loviisa

On 4 February 2006 the Loviisa plant introduced the new LOMAX information system, which is more efficient and versatile than the previous LOTI system. As a result, the scope of the indicator for the maintenance of components subject to the Technical Specifications has been extended so that in future maintenance works will also include such work on Tech Spec components that did not cause an operation restriction.

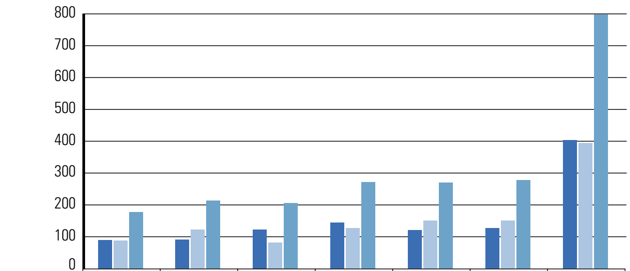
Because of the above-mentioned information system reform, the 2006 indicator is not directly comparable with the previously used indicator; the group of components included has changed and the volumes of fault repairs and preventive maintenance are now approximately 3.2-fold. The number of maintenance works remained stable during the four years preceding 2006. Judging by the data behind the indicator, the year 2006 was not markedly different from the previous years as concerns preventive maintenance. The ratio of the number of preventive maintenance works to failure repairs was 1.13 in 2006, while the average for the four previous years was 1.14. Since the increase in the number of the components covered by the

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



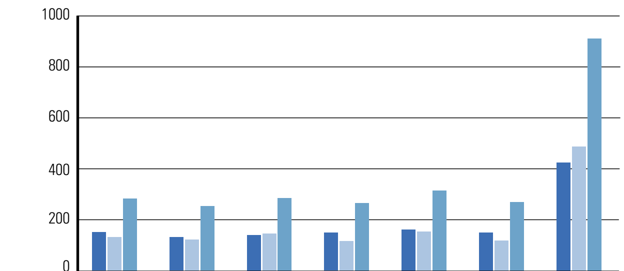
	2000	2001	2002	2003	2004	2005	2006
LO1	241	222	263	293	282	277	827
LO2	219	244	228	243	303	269	881
LO1,2	460	466	491	536	585	546	1708

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



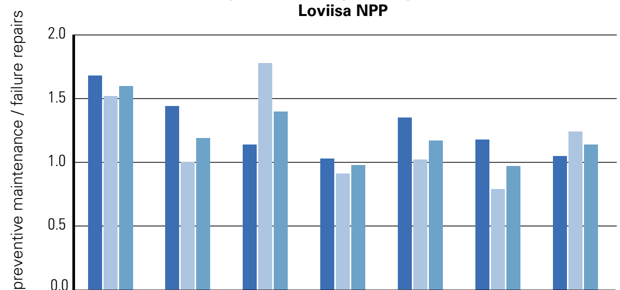
	2000	2001	2002	2003	2004	2005	2006
LO1	90	91	123	144	120	127	403
LO2	87	122	82	127	150	150	394
LO1,2	177	213	205	271	270	277	797

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



	2000	2001	2002	2003	2004	2005	2006
LO1	151	131	140	149	162	150	424
LO2	132	122	146	116	153	119	487
LO1,2	283	253	286	265	315	269	911

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



	2000	2001	2002	2003	2004	2005	2006
LO1	1.68	1.44	1.14	1.03	1.35	1.18	1.05
LO2	1.52	1.00	1.78	0.91	1.02	0.79	1.24
LO1,2	1.60	1.19	1.40	0.98	1.17	0.97	1.14

indicator has not affected the ratio of the number of preventive maintenance works to failure repairs, maintenance activities can be considered to be in balance and consistently implemented on all Tech Spec components at the facility.

When considering the variation in the volume of failure repairs and particularly in the number of preventive maintenance works, the scheduling of various annual maintenance works (fuel replacement outage, 4-year annual maintenance, brief annual maintenance, 8-year annual maintenance) included in the maintenance strategy during a four-year cycle should be considered as this can have a significant impact on the annual figures. The stability of the indicator values, with changes being mainly attributable to variation due to the scheduling of annual maintenance, may be regarded as an indication of a functional maintenance strategy.

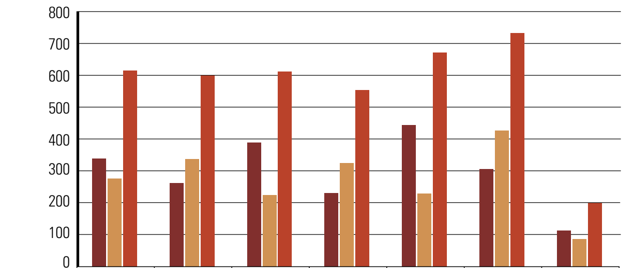
Interpretation of indicator

Olkiluoto

Indicator data is obtained from the plant's work order system. Due to changes in the work order system implemented by the utility as of 1 January 2006, the 2006 data is not comparable with previous years' figures.

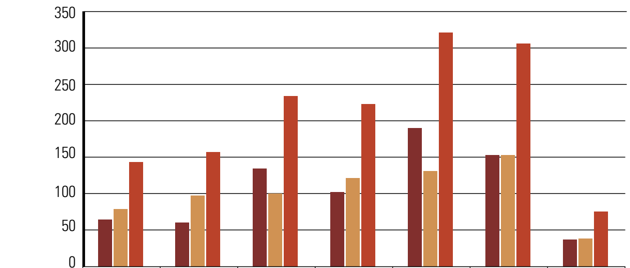
The utility has removed maintenance class 3 (systems subject to the Technical Specifications, Tech Specs) since this class covers all systems specified in the Tech Specs. However, nowhere near all of these systems are subject to restrictions set in the Tech Specs. Thus the indicator is used to monitor the ratio of the number of preventive maintenance works causing unavailability of components to the number of failure repairs.

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



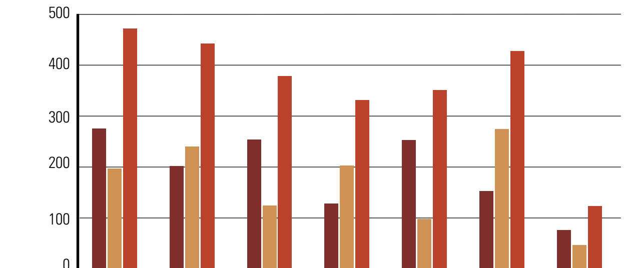
	2000	2001	2002	2003	2004	2005	2006
OL1	339	262	388	230	443	306	113
OL2	276	337	224	324	229	427	85
OL1,2	615	599	612	554	672	733	198

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



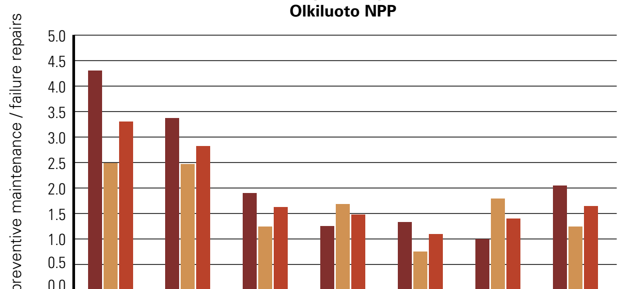
	2000	2001	2002	2003	2004	2005	2006
OL1	64	60	134	102	190	153	37
OL2	79	97	100	121	131	153	38
OL1,2	143	157	234	223	321	306	75

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



	2000	2001	2002	2003	2004	2005	2006
OL1	275	202	254	128	253	153	76
OL2	197	240	124	203	98	274	47
OL1,2	472	442	378	331	351	427	123

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



	2000	2001	2002	2003	2004	2005	2006
OL1	4.30	3.37	1.90	1.25	1.33	1.00	2.05
OL2	2.49	2.47	1.24	1.68	0.75	1.79	1.24
OL1,2	3.30	2.82	1.62	1.48	1.09	1.40	1.64

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

Definition

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

Source of data

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

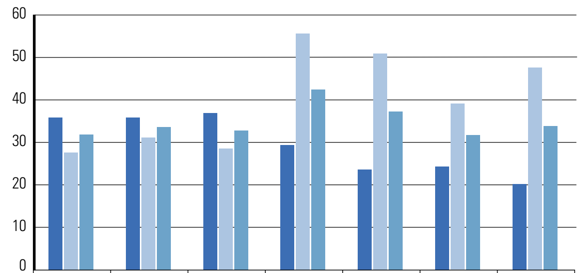
Purpose of indicator

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

Responsible units/persons

Safety Management (TUR),
resident inspectors
Pauli Kopiloff (Loviisa nuclear power plant)
Jarmo Konsi (Olkiluoto nuclear power plant)

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



	2000	2001	2002	2003	2004	2005	2006
LO1	35.9	35.9	36.9	29.4	23.6	24.3	20.2
LO2	27.6	31.2	28.6	55.6	50.9	39.1	47.6
LO1,2	31.8	33.6	32.8	42.5	37.3	31.7	33.9

Interpretation of indicator

Loviisa

The repair times allowed in the Tech Specs for component failures are based on the safety significance of the components; the repair times vary from 4 hours to 21 days depending on the case. As a rule, failures in Tech Spec components are to be repaired within the allotted time without undue delay. Individual works causing an operation restriction may have a significant impact on the indicator value, even when completed within the repair time allowed. This aspect of the indicator is taken into account in the interpretation of the indicator by evaluating the significance of individual long-term failure repairs in terms of maintenance strategy, resources and efficiency of operations.

The average repair times of failures causing unavailability of components have remained relative stable at the Loviisa plant for several years. At LO1, repair times have shown a descending trend since 2002, and the average repair time achieved in 2006 (20.2 hours) is significantly lower than the average for the preceding four years (28.6). At LO2, the annual development of the repair time has been somewhat unstable; the decreasing trend that began in 2003 ended last year. The average repair time for 2006, 47.6 hours, is slightly higher than the average for the four preceding years (43.6 hours). The average repair time for the plant units in 2006 is 33.9 hours, which is close to the average of the four preceding years (36.1). In 2006, the average repair time of Tech Spec component failures that had an allowed repair time of at most 72 hours was 12.0 hours at LO1 and 13.5 hours at LO2.

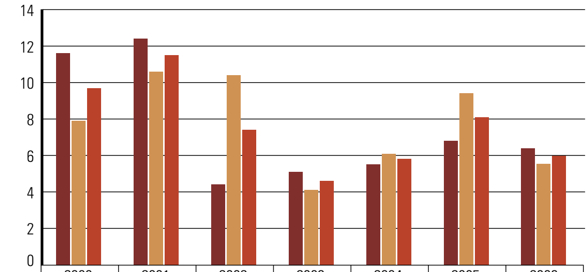
Based on the 2006 indicators and the data behind them, the maintenance strategy applied at the plant can be deemed to be appropriate. With respect to the availability of resources and effectiveness of operations, action should be taken to reduce the repair times of Tech Spec components at LO2, including repair works for which the Tech Specs allow a long repair time.

Interpretation of indicator

Olkiluoto

From 2000 to 2006 the average repair times for Tech Spec components have varied between five and twelve hours. The upward trend seems to have stopped, and in 2006 the average repair times decreased compared with the repair times in 2005. The figures indicate that sufficient resources are available for the repair of Tech Spec component failures and that repairs are carried out without delay.

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



	2000	2001	2002	2003	2004	2005	2006
OL1	11.6	12.4	4.4	5.1	5.5	6.8	6.4
OL2	7.9	10.6	10.4	4.1	6.1	9.4	5.5
OL1,2	9.7	11.5	7.4	4.6	5.8	8.1	6.0

A.I.1d Common cause failures

Definition

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

Source of data

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

Purpose of indicator

The indicator is used to follow the quality of maintenance.

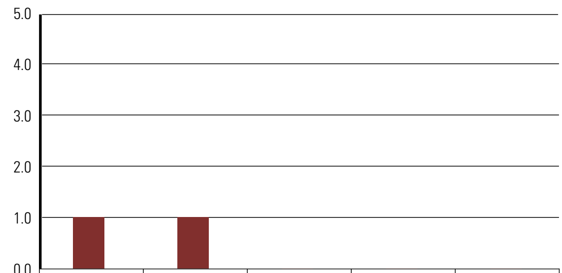
Responsible unit/person

Safety Management (TUR)
Jukka Kupila

Interpretation of indicator

In 2006, no realised common cause failures were detected at either the Loviisa or the Olkiluoto plant in systems defined in the Tech Specs. The situation is normal.

Number of common cause failures (CCF) of Tech Spec components or systems, Olkiluoto NPP



	2002	2003	2004	2005	2006
Olkiluoto	1	1	0	0	0

A.I.1g Production loss due to failures

Definition

As the indicator, the loss of power production caused by failures in relation to rated power (gross) is followed.

Source of data

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

Purpose of indicator

The indicator is used to follow the significance of failures from the point of view of production.

Responsible unit/person

Safety Management (TUR)
Tomi Koskiniemi

Interpretation of indicator

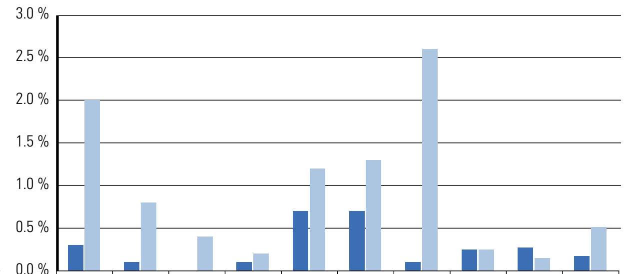
Production losses due to failures have been small at both Loviisa and Olkiluoto, as is also indicated by the plants' high load factors.

The two major peaks in the graphs both concern the Loviisa plant. The Loviisa 2 indicator value for 1997, which is an anomaly, was caused by an approx. 7-day-long shutdown to repair a leakage of the primary circuit, and the 2003 anomaly was caused by work to replace the stator of a plant unit generator, which took 41 days, causing a 2.6% production loss.

The year 2006 was a good year for both plants, with production loss due to failures remaining small. The value for the Loviisa 2 plant unit is higher than the rest, which is due to a single fault. This was a leaking check valve RL31S006 in the feed water line; to repair the valve, the plant had to be brought to a start-up state twice during the beginning of the year.

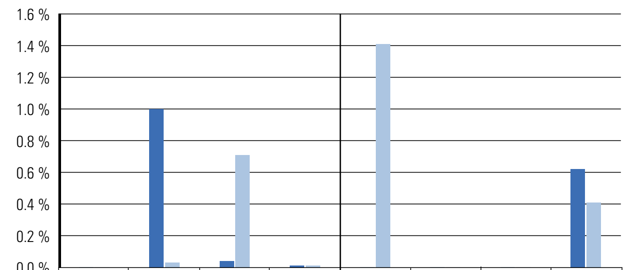
At Olkiluoto the single most significant factor was the frequent occurrence of failures in the rubbing-face seals in the feedwater pump of OL1. At the OL1 unit are all four pumps required for full power. Problem does not limit the power at OL2 since the pumps have been replaced and only three pumps are required when operating the unit at full power (the pumps have a higher capacity) and thus one pump is available as backup.

Loss of power production due to failures, Loviisa NPP



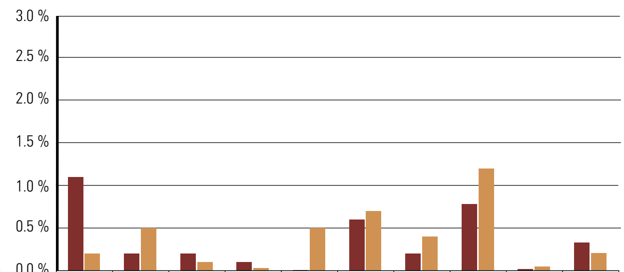
	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
LO1	0.30	0.10	0.00	0.10	0.70	0.70	0.10	0.25	0.27	0.17
LO2	2.00	0.80	0.40	0.20	1.20	1.30	2.60	0.25	0.15	0.51

Loss of power production due to failures in 2005–2006, Loviisa NPP



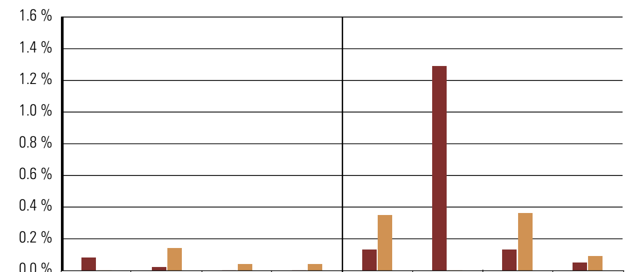
	I/05	II/05	III/05	IV/05	I/06	II/06	III/06	IV/06
LO1	0.00	1.00	0.04	0.01	0.00	0.00	0.00	0.62
LO2	0.00	0.03	0.71	0.01	1.41	0.00	0.00	0.41

Loss of power production due to failures, Olkiluoto NPP



	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
OL1	1.10	0.20	0.20	0.10	0.01	0.60	0.20	0.78	0.02	0.33
OL2	0.20	0.50	0.10	0.03	0.50	0.70	0.40	1.20	0.05	0.21

Loss of power production due to failures in 2005–2006, Olkiluoto NPP



	I/05	II/05	III/05	IV/05	I/06	II/06	III/06	IV/06
OL1	0.08	0.02	0.00	0.00	0.13	1.29	0.13	0.05
OL2	0.00	0.14	0.04	0.04	0.35	0.00	0.36	0.09

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

Definition

As the indicators, the number of non-compliances with the Tech Specs as well as the number of exemptions granted by STUK are followed.

Source of data

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

Purpose of indicator

The indicators are used to follow the utilities' activities in accordance with the Tech Specs: compliance with the Tech Specs and identified situations during which it is necessary to deviate from them; of which conclusions can be made as regards the appropriateness of the Tech Specs.

Responsible unit/person

Safety Management (TUR)
Tomi Koskiniemi

Interpretation of indicator

Exemptions

In general, more exemptions are required at Loviisa than at Olkiluoto as the plant systems have been largely designed as two redundant (cf. four redundancy of Olkiluoto), for which reason repairs or modifications during operation almost always require an exemption. For example, the large number of exemptions granted in 2003 is explained by replacement of the fixed radiation measurement system (the MONU project); work related to this project required an exemption in any operating state.

At Olkiluoto the upward trend in the number of exemptions granted in the past few years (2004 and 2005) has been due to the modernisation of the Olkiluoto 1 and 2 plant units as well as work and installations related to the construction of Olkiluoto 3.

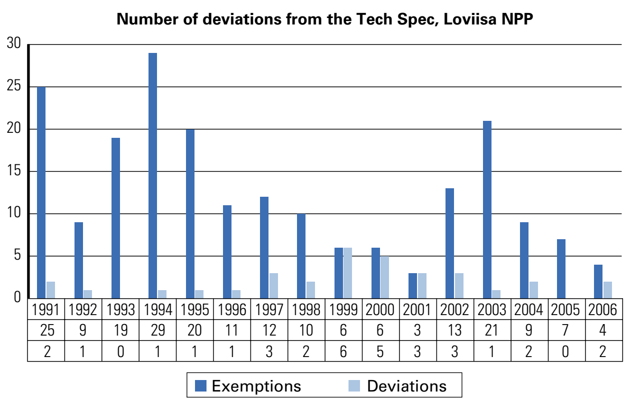
The number of exemptions granted in 2006 was very small compared with previous years, particularly at Loviisa. However, the number of exemptions will increase in the future due to the isolations and modifications required by the upgrading of I&C systems at Loviisa. Two of the exemptions at Loviisa were concerned with troubleshooting for a fault in the rotating converter of Loviisa 2 and its repair during power operation. Two further exemptions were related to the annual maintenance of Loviisa 2 – permission to irradiate one fuel bundle for an additional fifth cycle and permission to change the operating state because one of the SAM position indicators of the ice-condenser's lower door was faulty.

At Olkiluoto the exemptions were concerned with the replacement of rectifiers during power operation (the TASURI project), the high-tension line work related to OL3 and the necessary 110 kV line arrangements being postponed to a later date, as well as adjustment of the transfer machine radiation measurement limits implemented during the transfer of fuel bundles and control rods during annual maintenance.

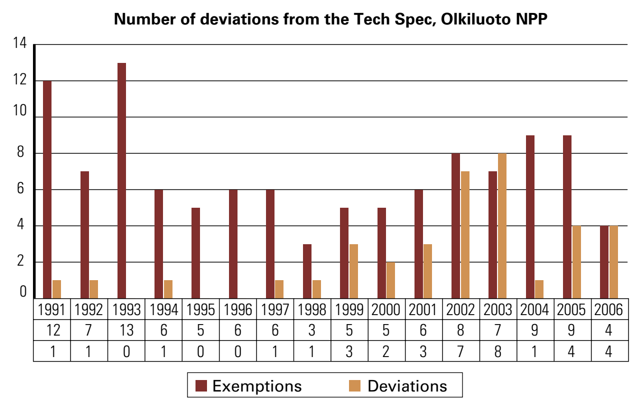
Non-compliances with the Tech Specs

The number of non-compliances with the Tech Specs have varied somewhat at both plants, remaining at previous years' levels. The licensee always prepares a special report on the non-compliance and any corrective action, which is submitted to STUK for decision.

In 2006 deficiencies occurred at both plants with respect to Tech Spec testing, either concerning



	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Exemptions	25	9	19	29	20	11	12	10	6	6	3	13	21	9	7	4
Deviations	2	1	0	1	1	1	3	2	6	5	3	3	1	2	0	2



	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Exemptions	12	7	13	6	5	6	6	3	5	5	6	8	7	9	9	4
Deviations	1	1	0	1	0	0	1	1	3	2	3	7	8	1	4	4

the performance of tests or the process of revising the testing procedures. The safety-significance of individual events was nevertheless very low.

There were two non-compliances with the Tech Specs at Loviisa. The first occurred momentarily as two redundancy functions were isolated when the Steam generators blow-down (RY) activity measurement system was calibrated while the condenser radiation measurement system was out of order. The second non-compliance concerned the exclusion of the high-capacity Pressurizing system (YP12) blow-down lines and valves from Tech Spec testing during annual maintenance as the need to update the Tech Specs was overlooked at the time of changing the testing interval.

There were four non-compliances with the Tech Specs at Olkiluoto. The first non-compliance concerned one instance in which the maximum number of working hours specified in the Tech Specs was exceeded, which had not been considered when updating the Tech Specs in connection with the adoption of the new 12-hour work shift system. The second non-compliance was concerned with the testing interval of battery packs in the spent fuel storage, which was exceeded by two days. The third non-compliance concerned the failure to carry out a periodic test on measuring system in the vent stack measuring channel at Olkiluoto 1. This was due to the integration of two tests to be carried out under the same work order in 2004 and 2006. The fourth non-compliance concerned the dryout coefficient, which describes the sufficiency of fuel cooling, falling below the lowest allowed limit at Olkiluoto.

A.I.3 Unavailability of safety systems

Definition

As the indicators, the unavailability of safety systems is followed by plant unit. The systems followed at Olkiluoto nuclear power plant are the containment spray system (322), the auxiliary feed water system (327) and the emergency diesel generators (651–656). Those followed at Loviisa nuclear power plant are the high pressure safety injection system (TJ), auxiliary feed water system (RL92/93, RL94/97) and emergency diesel generator (EY).

Essentially, the ratio of a system's unavailability hours and its required availability hours are calculated as the indicator. Unavailability hours are the combined unavailability of redundant subsystems divided by the number of subsystems. It does not indicate the simultaneous unavailability of several subsystems. Subsystem unavailability hours include the time required for planned maintenance of components and unavailability due to failures. The latter includes, in addition to the time spent on repairs, the estimated unavailability time prior to failure detection. If a failure is assessed to have occurred in a previous successful test, and is assessed to have escaped detection, the time between periodic tests is added to the unavailability time. If a failure has occurred between tests such that its date of occurrence is unknown, half of the time period between tests is added to the unavailability time. Whenever the occurrence of the failure can be identified as an operational, maintenance, testing or other event, the time between the event and the fault detection is added to the unavailability time.

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

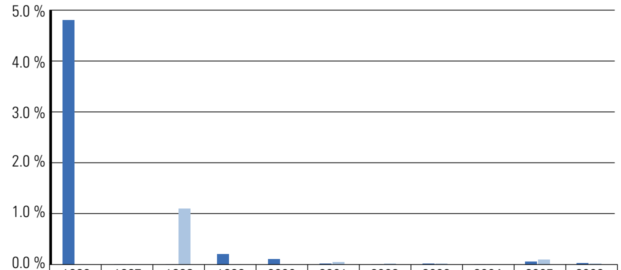
Source of data

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

Purpose of indicator

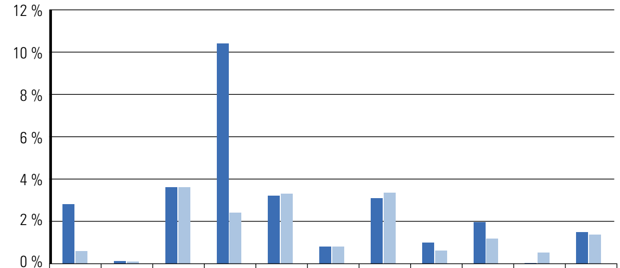
The indicator indicates the unavailability of safety systems; the condition and status of safety systems and their development can be monitored by means of the indicator.

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



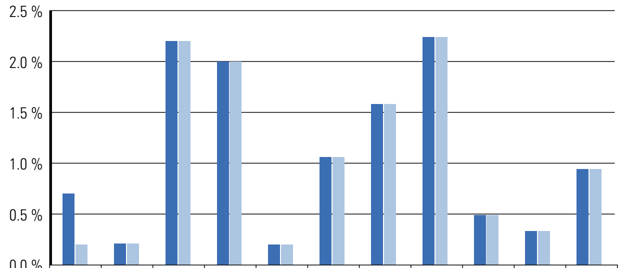
	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
LO1	4.80	0.00	0.00	0.20	0.10	0.01	0.00	0.01	0.00	0.05	0.02
LO2	0.00	0.00	1.10	0.00	0.00	0.04	0.01	0.01	0.00	0.09	0.01

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



	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
LO1	2.80	0.12	3.60	10.40	3.20	0.81	3.09	0.98	1.96	0.03	1.49
LO2	0.60	0.10	3.60	2.40	3.30	0.80	3.34	0.61	1.17	0.53	1.36

Unavailability of emergency diesel generators (EY), Loviisa NPP



	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
LO1	0.70	0.21	2.20	2.00	0.20	1.06	1.58	2.24	0.49	0.33	0.94
LO2	0.20	0.21	2.20	2.00	0.20	1.06	1.58	2.24	0.49	0.33	0.94

Responsible units/persons

Safety Management (TUR),
resident inspectors
Pauli Kopiloff (Loviisa nuclear power plant)
Jarmo Konsi (Olkiluoto nuclear power plant)

Interpretation of indicator

Loviisa

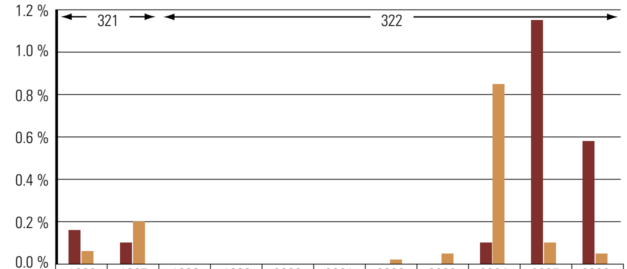
The unavailabilities of the plant units' high pressure safety injection systems (TJ) remained low in 2006. The total unavailability of 10 hours of the units' TJ systems was due to normal maintenance. Based on the above, the TJ systems can be considered to be in good condition, and there is nothing to indicate a significant change to the situation.

The unavailability of the auxiliary feed water systems was low in 2006, i.e. their condition and availability were good. In 2006 the plant units' total unavailability of the auxiliary feed water systems was 1,001 hours, of which RL94/97 works carried out during annual maintenance accounted for 938 hours. Detected failures were not significant and the impact of repairs carried out outside the annual maintenance works on total unavailability was 63 hours.

Emergency diesel unavailability was higher than in the two previous years, nevertheless remaining below the average for the five preceding years (1.14). In 2006, the total unavailability for all of the eight diesel generators was 659 hours, of which 158 hours were spent on failure repairs; the remaining 501 hours was the estimated unavailability time prior to failure detection, calculated according to the indicator's calculation rule.

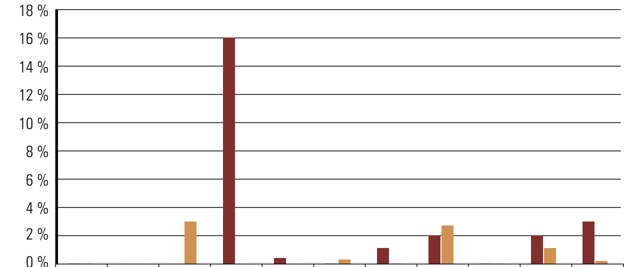
Diesel failures in 2006 were due to normal component ageing. The failures were not significant and did not cause any significant unavailabilities. Based on the indicators and the failures behind them, the condition of the EY diesels can be regarded as good.

Unavailability of shut-down cooling system (321) or containment spray system (322), Olkiluoto NPP



	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
OL1	0.16	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.10	1.15	0.58
OL2	0.06	0.20	0.00	0.00	0.00	0.00	0.02	0.05	0.85	0.10	0.05

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



	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
OL1	0.01	0.00	0.00	16.00	0.40	0.03	1.10	2.00	0.01	2.00	2.98
OL2	0.02	0.00	3.00	0.00	0.00	0.30	0.01	2.71	0.01	1.10	0.18

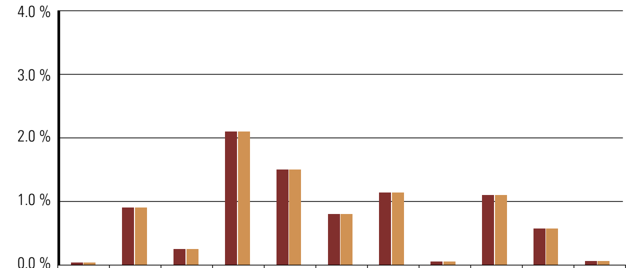
Interpretation of indicator

Olkiluoto

The unavailability of the containment spray system has decreased slightly from the previous year; however, the unavailability of Olkiluoto 1 remains higher than that of Olkiluoto 2.

The unavailability of the auxiliary feed water system has increased significantly compared with the practically non-existent level of 2004. The increased unavailability of Olkiluoto 1 in 2006 was due to faults in the recirculation and safety valves in the system 327. Corrective actions included adjusting the torque settings of the recirculation line valves actuator motors; preliminary discussions have also been conducted concerning the construction of a separate safety valve testing line.

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



	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
OL1	0.04	0.90	0.25	2.10	1.50	0.80	1.14	0.05	1.10	0.57	0.06
OL2	0.04	0.90	0.25	2.10	1.50	0.80	1.14	0.05	1.10	0.57	0.06

Diesel unavailability seems to continue its downward trend. The diesels were in good condition in 2006 and their unavailability was very small.

A.I.4 Occupational radiation doses

Definition

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

Source of data

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

Purpose of indicator

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

Responsible unit/person

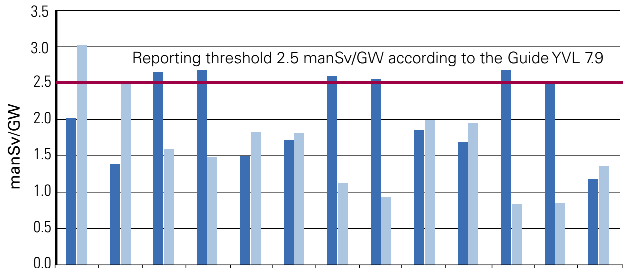
Radiation protection (SÄT)
Janne Liuko

Interpretation of indicator

Loviisa

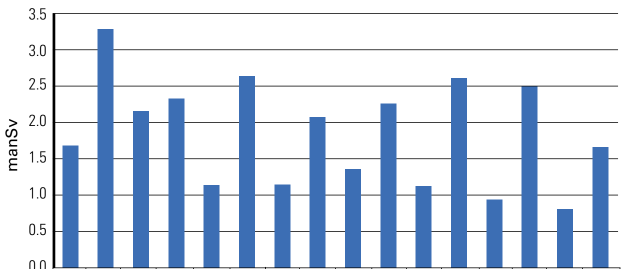
Most doses are incurred through work done during outages; thus outage duration and the amount of work having significance in radiation protection affect the yearly radiation doses.

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



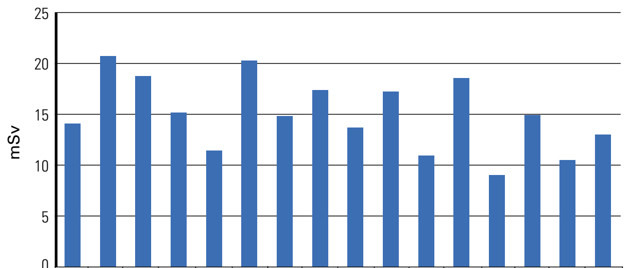
	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
LO1	2.02	1.39	2.65	2.68	1.49	1.71	2.59	2.55	1.85	1.69	2.68	2.53	1.18
LO2	3.02	2.51	1.59	1.48	1.82	1.81	1.12	0.93	1.99	1.95	0.84	0.85	1.36

Collective occupational radiation dose (manSv), Loviisa NPP



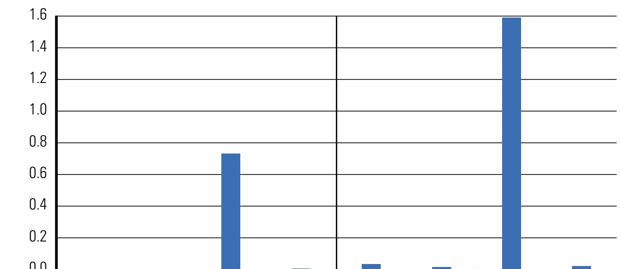
	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
LO1	1.68	3.29	2.16	2.33	1.14	2.64	1.14	2.07	1.36	2.26	1.13	2.61	0.94	2.49	0.81	1.66

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



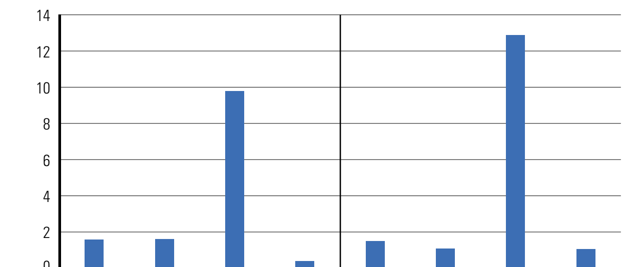
	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
LO	14.1	20.7	18.8	15.1	11.4	20.3	14.8	17.4	13.7	17.3	10.9	18.5	9.0	14.9	10.5	13.0

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



	I/05	II/05	III/05	IV/05	I/06	II/06	III/06	IV/06
LO	0.0027	0.0022	0.7300	0.0060	0.0346	0.0155	1.5900	0.0203

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



	I/05	II/05	III/05	IV/05	I/06	II/06	III/06	IV/06
LO	1.59	1.60	9.80	0.40	1.50	1.08	12.88	1.06

The radiation doses for nuclear power plant workers are below the personal dose limits. The Radiation Decree (1512/1991) stipulates that the effective dose for a worker from radiation work may not exceed the 20 mSv/year average over any period of five years or 50 mSv in any one year.

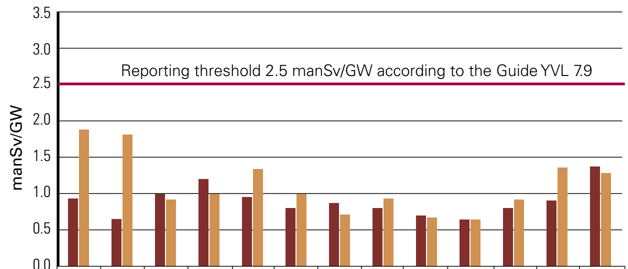
Furthermore, the threshold set for the collective occupational dose was not exceeded in 2006. If at one plant unit the collective occupational radiation dose average over two successive years exceeds 2.5 manSv per one GW of net electrical power, the utility is to report the causes of this to STUK, and any measures possibly required to improve radiation safety (Guide YVL 7.9).

Interpretation of indicator

Olkiluoto

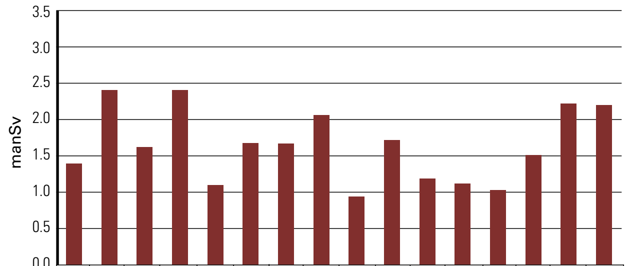
The collective radiation doses at the Olkiluoto plant in 2005–2006 were higher than in the previous years due to the annual maintenance outages, which were exceptionally extensive in terms of the workforce and workload involved. The limits set for personal and collective radiation doses were not exceeded.

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



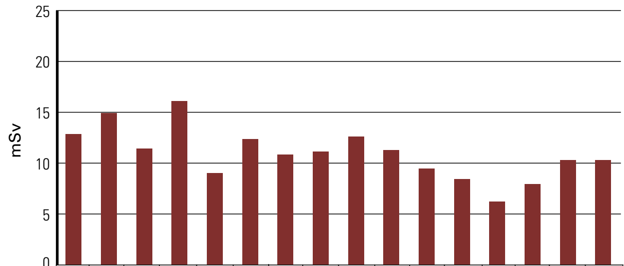
	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
OL1	0.93	0.65	0.99	1.20	0.95	0.80	0.87	0.80	0.70	0.64	0.80	0.90	1.37
OL2	1.88	1.81	0.92	0.99	1.34	0.99	0.71	0.93	0.67	0.64	0.92	1.36	1.28

Collective occupational radiation dose (manSv), Olkiluoto NPP



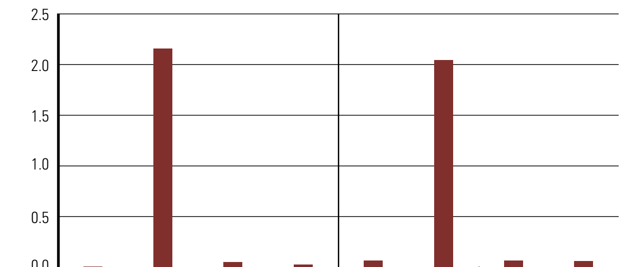
	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
OL	1.40	2.40	1.62	2.40	1.10	1.68	1.67	2.06	0.94	1.72	1.18	1.12	1.03	1.51	2.22	2.20

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



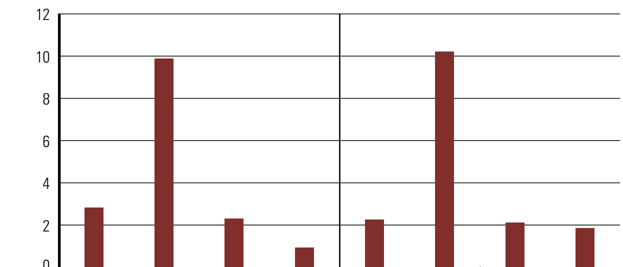
	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
OL	12.9	14.9	11.4	16.1	9.0	12.3	10.9	11.1	12.6	11.3	9.5	8.4	6.2	8.0	10.3	10.3

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



	I/05	II/05	III/05	IV/05	I/06	II/06	III/06	IV/06
OL	0.007	2.159	0.052	0.027	0.067	2.045	0.065	0.064

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



	I/05	II/05	III/05	IV/05	I/06	II/06	III/06	IV/06
OL	2.83	9.89	2.31	0.93	2.25	10.21	2.12	1.87

A.I.5 Radioactive releases

Definition

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

Source of data

Data for the indicators is collected from the utilities' quarterly and annual reports. STUK's Research and Environmental Surveillance Department (TKO) calculates the dose for the most exposed individual in the vicinity of the plant and submits it to the person in charge of this indicator.

Purpose of indicator

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

Responsible unit/person

Radiation protection (SÄT), Janne Liuko (release data)
Research and Environmental Surveillance (TKO), Environment of nuclear power plants (YVL)
Seppo Klemola (dose calculation)

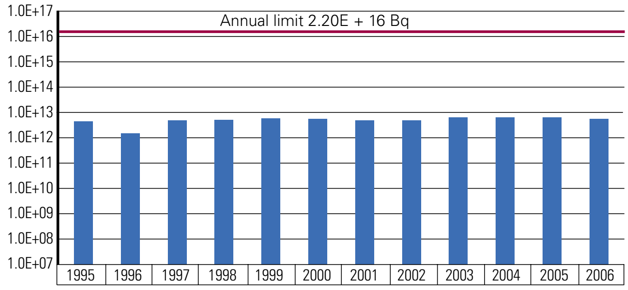
Interpretation of indicator

Releases into the atmosphere

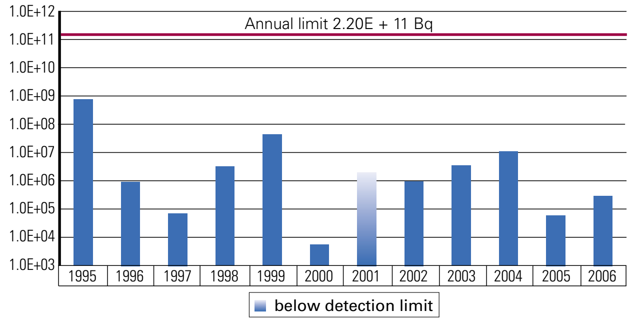
Releases into the atmosphere were of the same magnitude as in the preceding years. Radioactive releases into the environment from the Loviisa and Olkiluoto nuclear power plants were small. They are well below the set limits.

Gaseous fission products, noble gases and iodine radioisotopes originate in leaking fuel rods, in the minute amounts of uranium left on the outer surfaces on fuel cladding during fuel fabrication, and in reactor surface contamination from earlier fuel leaks. At both Loviisa and Olkiluoto the numbers of fuel leaks have been very small. The indicator A.III.1 describes fuel integrity. The noble gas releases from the Loviisa plant are dominated by argon-41, an activation product of argon-40, found in the airspace between the reactor pressure vessel and the biological shield. Aerosol nuclides (including activated corrosion products) are released during maintenance work.

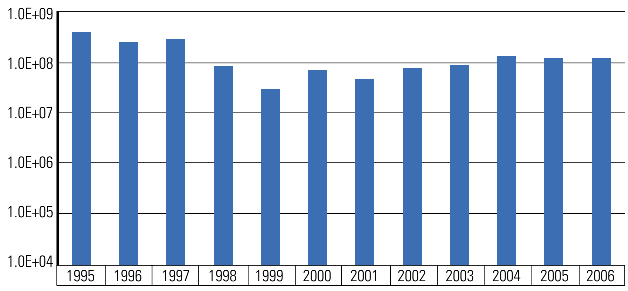
Noble gas releases (Bq $^{87}Kr_{ekv}$), Loviisa NPP



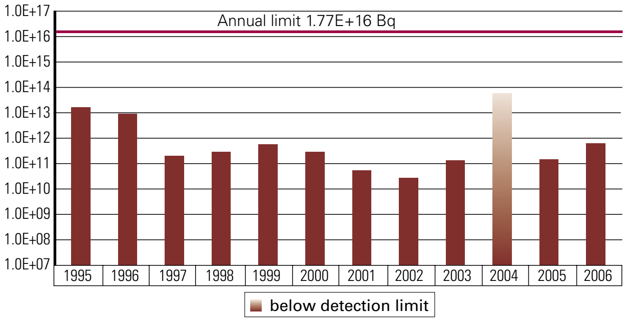
Iodine isotope releases to atmosphere (Bq $^{131}I_{ekv}$), Loviisa NPP



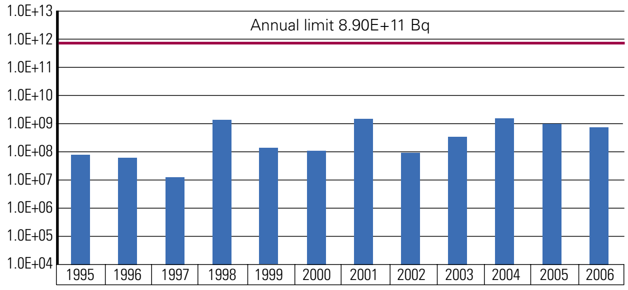
Aerosol releases to atmosphere (Bq), Loviisa NPP



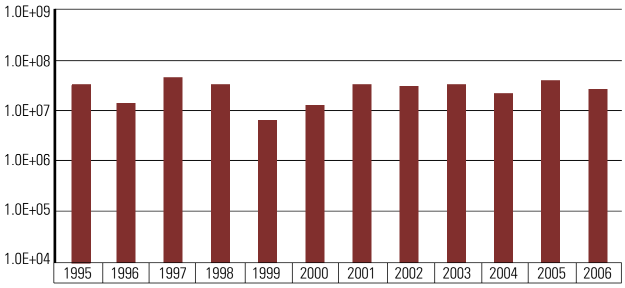
Noble gas releases (Bq $^{87}Kr_{ekv}$), Olkiluoto NPP



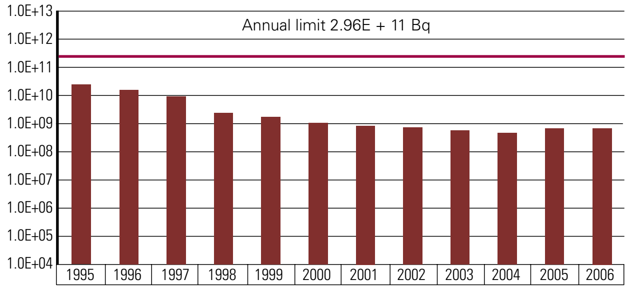
Gamma activity of liquid effluents (Bq), Loviisa NPP



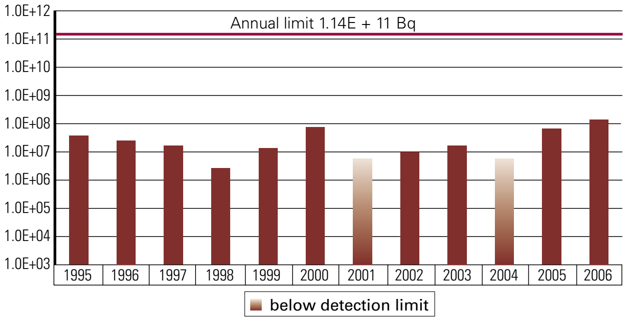
Aerosol releases to atmosphere (Bq), Olkiluoto NPP



Gamma activity of liquid effluents (Bq), Olkiluoto NPP



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



Releases into the sea

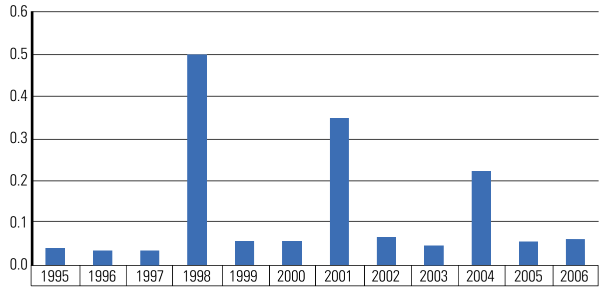
Releases into the sea from the Loviisa power plant were slightly smaller than in the previous year. The plant discharged low-activity evaporation residues into the sea as planned in 2004. Releases into the sea from the Olkiluoto plant have reduced since the plant commissioned new process water purification and treatment equipment.

Population exposure

The calculated radiation dose for the most exposed individual in the vicinity of each power plant was of the same magnitude as in the previous year. In Loviisa the dose was smaller than in the previous year. The Loviisa graph shows how the dose for the most exposed individual is affected by the controlled discharge of low-activity evaporation residues into the sea. The previous controlled discharge was made in 2004.

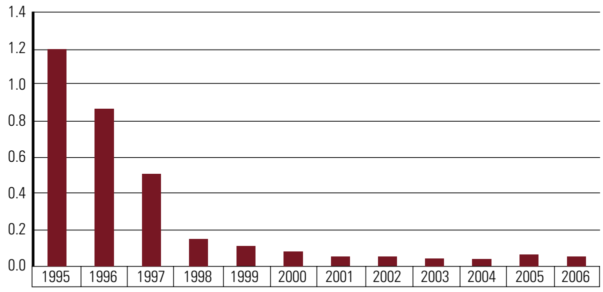
The calculated doses of the most exposed individual in the vicinity of both plants are less than 0.1 % of the 100 microSv limit established in the Government Resolution (395/1991).

The calculated dose (µSv) of the most exposed individual in the environment of Loviisa NPP



Annual dose limit 100 µSv

The calculated dose (µSv) of the most exposed individual in the environment of Olkiluoto NPP



Annual dose limit 100 µSv

A.I.6 Keeping plant documentation current

Definition

This indicator follows the need to update documents due to plant modifications and their realisation by the start-up following the next annual maintenance. The documents to be followed-up are the Technical Specifications, the Final Safety Analysis Report (FSAR), safety classification documents and diagrams, PSA documentation, operation and maintenance procedures, and process flow-charts. As the indicator, the ratio of the number of implemented document revisions to the number of identified document revisions is followed.

Source of data

The data for the indicator calculation is obtained from STUK's plant modifications register.

Purpose of indicator

The indicator is used to follow plant quality management and the ability to maintain plant documentation.

Responsible unit/person

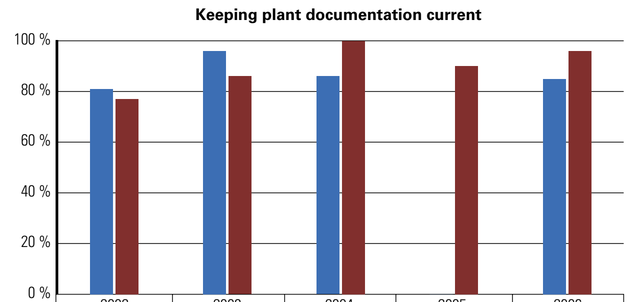
Safety Management (TUR)
Tomi Koskiniemi

Interpretation of indicator

The currency of plant modification as concerns safety-significant documents is one of the specifications and an item to be inspected when STUK grants a start-up permit for the plant after annual maintenance. This means that the modifications implemented during annual maintenance that affect the Tech Specs, emergency operating procedures, procedures for restoring the normal state and operation procedures for power operation must have been implemented in the documents. Flow diagrams are also to be reviewed. STUK reviews the realisation of document amendments and revisions in the main control rooms of both plants.

Loviisa

Identification of document amendments and revisions pertaining to modifications at the Loviisa plant is mostly by pre-inspection documents and training notices. In addition, a list of necessary changes to the operating manual maintained at the Loviisa plant is used in the identification of amendments and revisions. The basic principle applied at Loviisa is that any revisions or amendments to



	2002	2003	2004	2005	2006
LO	81	96	86	0	85
OL	77	86	100	90	96

the emergency operating procedures will be implemented, but in connection with minor revisions in the operation procedures, document updates may be temporarily replaced by a training notification, which is appended to the operating procedure.

The 2005 figure for Loviisa is not present since no major modifications were carried out during the year.

The 2006 indicator for Loviisa is based on the identified needs for document updating related to modifications implemented during annual maintenance at Loviisa 1 and 2 in 2006 and their realisation (need for updating/implemented). The most extensive modifications were carried out at the Loviisa 2 plant unit.

On the basis of a random inspection carried out at the Loviisa 1 and 2 main control rooms, the document revisions necessitated by modifications had been implemented in the most relevant documents in connection with the annual maintenance in 2006. Furthermore, the necessary training notification had been appended to other instructions. However, the training notification cannot be regarded as a document update, which also affects in the indicator value. The calculated indicator indicates that as in previous years, document updates were reasonably successful.

Olkiluoto

The indicator for the Olkiluoto plant is based on the modification project control system, which includes control forms describing the need to update modification documents and its realisation. Document revisions necessitated by individual modifications are now documented on a project-specific basis, and thus the presented lists of changes to procedures link an individual revision to a given modification.

The indicator for Loviisa is based on the identified needs for document updating related to modifications implemented during annual maintenance at the Olkiluoto 1 plant unit in 2006 and their realisation (need for updating / implemented). The modifications were quite similar to those carried out at Olkiluoto 2 during the annual maintenance in 2005 and due to the same extensive modernisation.

On the basis of a random inspection, it was noted that the document revisions necessitated by modifications in the main control room during the annual maintenance of 2006 had been implemented in the most relevant documents. The operations manual was also extensively updated by the end of the annual maintenance. The only minor deficiency concerned the "red pen" versions of the PI diagrams. The calculated indicator indicates that as in previous years, document updates were successful.

A.I.7 Investments in facilities

Definition

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

Source of data

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

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

Purpose of indicator

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

Responsible unit/person

Safety Management (TUR)
Tomi Koskiniemi

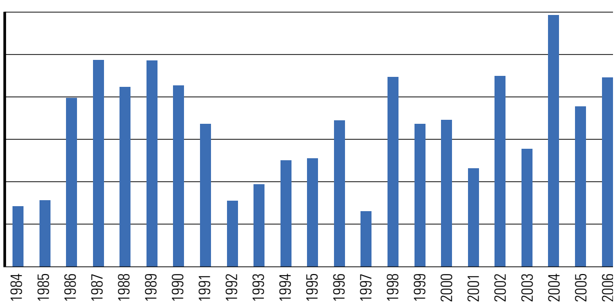
Interpretation of indicator

The fluctuation in the indicator clearly shows the investments made in 1997–2000 in the plants' power upgrades and modernisation projects. The investments of 2004–2005 are above average levels at both the Loviisa and the Olkiluoto plant. Since 2004, the calculation of the indicator value for Loviisa has changed; major periodic preventive maintenance and QC inspections related to annual maintenance are now regarded as investments. This change is due to the introduction of IFRS reporting.

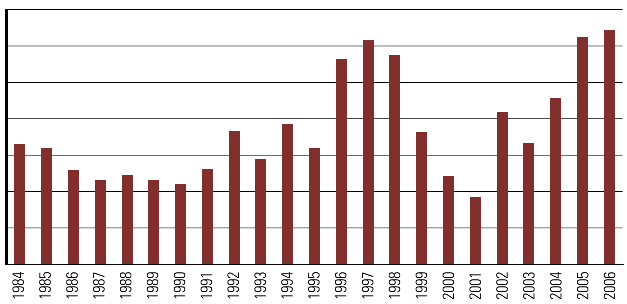
The Loviisa plant replaced its maintenance and materials management control and information systems in 2005–2006; the most important system in terms of maintenance, LOMAX, was introduced in early 2006. The new rescue station also reached completion by year-end. The modifications carried out during the annual maintenance of Loviisa 2 concerned two new emergency pumps, the replacement of screws in the core barrel and the modernisation of the stator; these were very large investments for the year under review. Two emergency pumps will also be replaced at Loviisa 1 during the annual maintenance of 2008. In addition, expenses were incurred in 2006 concerning the I&C system upgrade due to the construction of new buildings and simulator development.

The investments made at Olkiluoto in 2006 are similar to those in 2005, at which time an extensive modernisation project was carried out at Olkiluoto 2. In 2006, a similar modernisation project was carried out on Olkiluoto 1, including the replacement of the reheater and high pressure turbine, steam dryer, turbine automation (TARMO) and the 6.6 kV switchgears (REMES). Construction of the gas turbine plant, which had begun in 2005, was also continued, and modifications were carried out at the water plant (capacity increase and automation) and the demineralization plant (OL3 extensions). Other investments included bituminization equipment and laboratory extension.

Maintenance investments and renovations, Loviisa NPP



Maintenance investments and renovations, Olkiluoto NPP



A.II Operational events

A.II.1 Number of events

Definition

As the indicators, the numbers of events reported in accordance with Guide YVL 1.5 (events warranting a special report, reactor scrams and operational transients) are followed.

Source of data

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

Purpose of indicator

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

Responsible unit/person

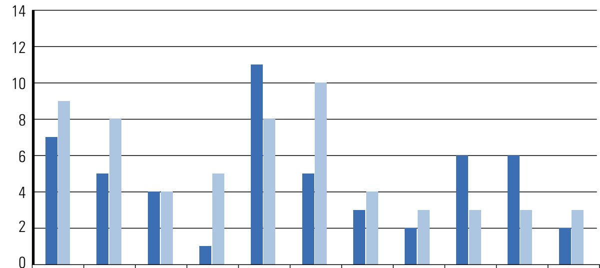
Organisations and Operations (OKA)
Suvi Ristonmaa and Tomi Koskiniemi

Interpretation of indicator

Loviisa

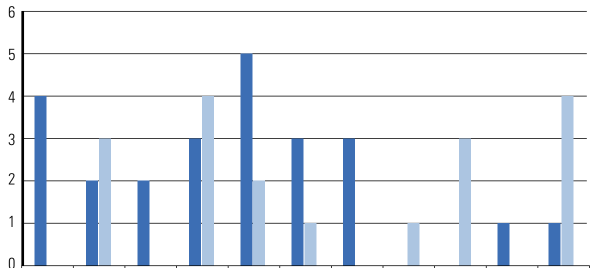
The number of events warranting a special report has not changed markedly in the long term.

Number of operational event reports, Loviisa NPP



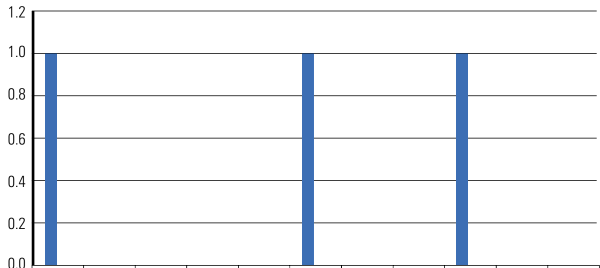
	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
LO1	7	5	4	1	11	5	3	2	6	6	2
LO2	9	8	4	5	8	10	4	3	3	3	3

Number of Special Reports, Loviisa NPP



	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
LO1	4	2	2	3	5	3	3	0	0	1	1
LO2	0	3	0	4	2	1	0	1	3	0	4

Number of reactor scrams, Loviisa NPP
3-year average

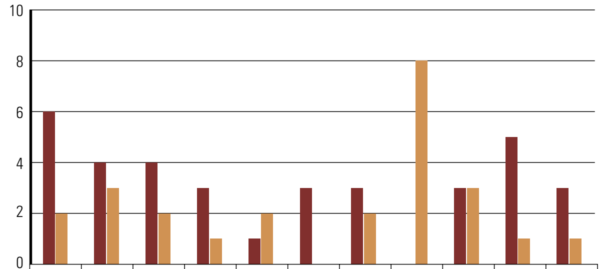


	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
LO1	1	0	0	0	0	1	0	0	1	0	0
LO2	0	0	0	0	0	0	0	0	0	0	0

Olkiluoto

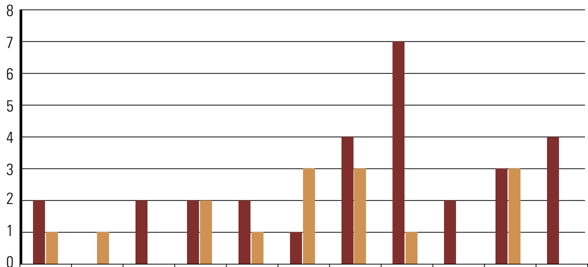
The numbers of special reports and operational event reports have not changed markedly. The number of scrams is small; no scrams occurred in 2006.

Number of operational event reports, Olkiluoto NPP



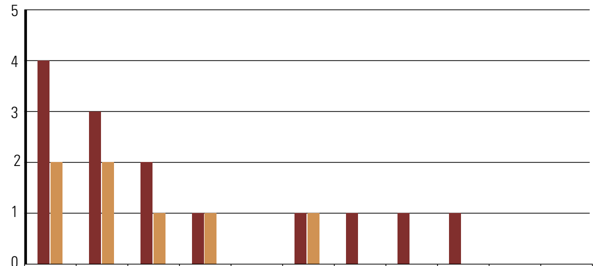
	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
OL1	6	4	4	3	1	3	3	0	3	5	3
OL2	2	3	2	1	2	0	2	8	3	1	1

Number of Special Reports, Olkiluoto NPP



	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
OL1	2	0	2	2	2	1	4	7	2	3	4
OL2	1	1	0	2	1	3	3	1	0	3	0

Number of reactor scrams, Olkiluoto NPP



	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
OL1	4	3	2	1	0	1	1	1	1	0	0
OL2	2	2	1	1	0	1	0	0	0	0	0

A.II.2 Direct causes of events

Definition

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

Source of data

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

Purpose of indicator

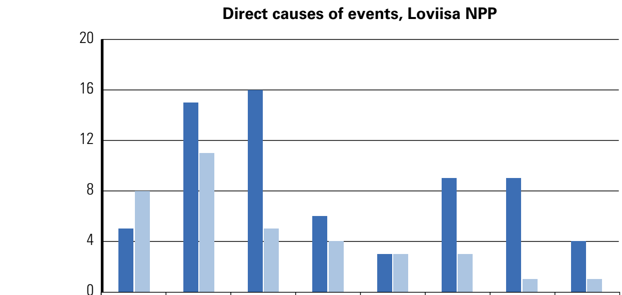
The indicator is used to follow the division of the causes of reported events into technical and non-technical. "Non-technical causes" denote failures caused by erroneous operational and maintenance actions. The indicator may be descriptive of an organisation's operation.

Responsible unit/person

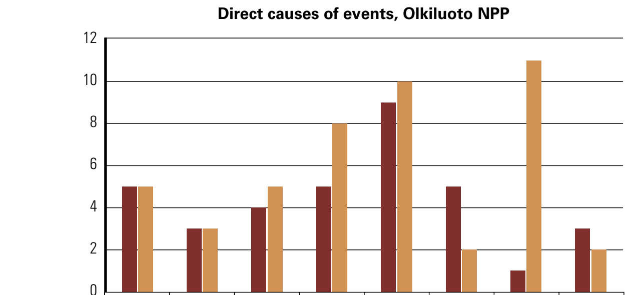
Organisations and Operations (OKA)
Suvi Ristonmaa and Tomi Koskiniemi

Interpretation of indicator

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



	1999	2000	2001	2002	2003	2004	2005	2006
Technical	5	15	16	6	3	9	9	4
Human	8	11	5	4	3	3	1	1



	1999	2000	2001	2002	2003	2004	2005	2006
Technical	5	3	4	5	9	5	1	3
Human	5	3	5	8	10	2	11	2

A.II.3 Risk-significance of events

Definition

The risk-significances of events caused by component unavailabilities are used as indicators. An increase in the Conditional Core Damage Probability (CCDP) associated with each event is employed as the risk measure. CCDP takes the duration of each event into consideration. Events are divided into three categories: 1) unavailabilities due to component failures, 2) planned unavailabilities and 3) initiating events. In addition, events are grouped into three categories according to their risk-significance (CCDP): the most risk-significant events (CCDP≥1E-7), other significant events (1E–8≤CCDP<1E–7) and other events (CCDP<1E–8). The number of events in each category is used as the indicator value.

Unavailabilities caused by work for which STUK has granted exemption are in category 2. Possible non-compliances with the Tech Specs are in category 1, if they can be utilised for this indicator. Non-compliances with the Tech Specs are also dealt with under indicator A.I.2.

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

Source of data

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

Purpose of indicator

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

Responsible unit/person

Risk assessment (RIS), Jorma Rantakivi and Ulla Vuorio (PSA computation)
Safety Management (TUR) (failure data)

Interpretation of indicator

Loviisa

A brief description of the significant events is given below:

Loviisa 1:

1) An electronic card failure affected the back-up emergency feed water system. The unavailability lasted approximately 7 days.
2) Diesel (EY02) failed to start during testing. The cause of the failure was not identified, but a contact failure in the acknowledgement button was suspected. The failure was latent for approximately 9 days.
3) The check dampers S011 and S021-S026 of the ventilation system UV20 failed to open and S005 failed to close during testing. The system failure had lasted for approximately 2.5 days.

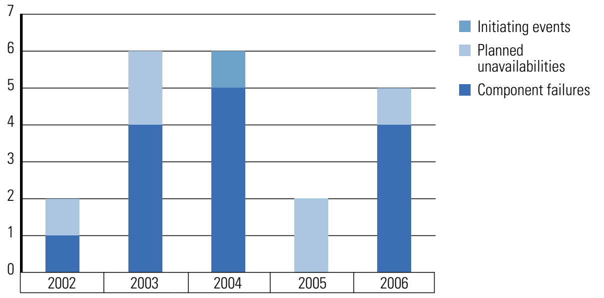
4) Preventive maintenance: Backup emergy of the auxiliary feed water system RL94 during revision (duration approximately 18 days).
5) During periodic testing, the water cooling equipment 11UV25B002 in the control room instrumentation facilities in LO1 failed to start. The failure was detected on 21 November 2006. When troubleshooting for a fault, no fault was found and the component functioned normally on 24 November 2006. According to the daily report, the fault occurred between the previous test and the moment of detection. Furthermore, according to the report the fault was estimated to have been latent for 116 days.

Loviisa 2:

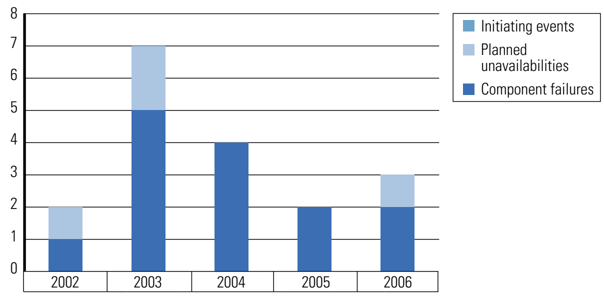
1) Preventive maintenance: Maintenance of the backup emergy feed water system RL97 during revision (duration approximately 20 days).
2) The fan D0132 in the ventilation system UV40 failed to switch on in connection with the periodic maintenance. The component failure had lasted for approximately 3 days.
3) A failure in the compressor water coolant equipment UV46B002, included in the cooling system UV46 of the LO2 control room building's instrumentation facilities, was detected immediately as it triggered an alarm in the control room on 2 October 2006. Start-up protection card, did not function. Failure repair (electrical failure): the compressor's heating resistor was replaced with another type on 20 October 2006. The unavailability of the cooling equipment was estimated as 18 days in the report.

The analysed events are considered part of normal nuclear power plant operation and no further measures were required from STUK.

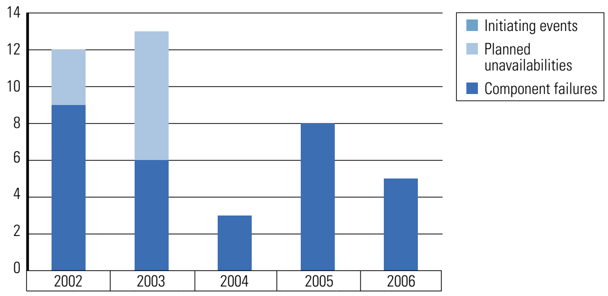
Most risk-significant events CCDP ≥ 1E-7
Loviisa 1 (Total number of events)



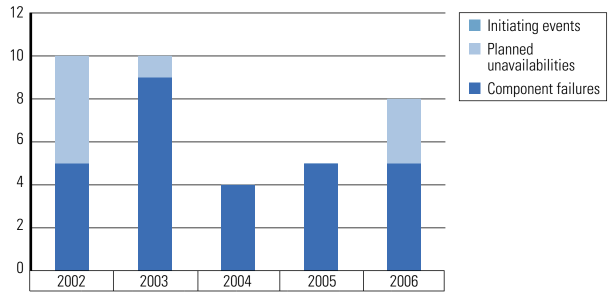
Most risk-significant events CCDP ≥ 1E-7
Loviisa 2 (Total number of events)



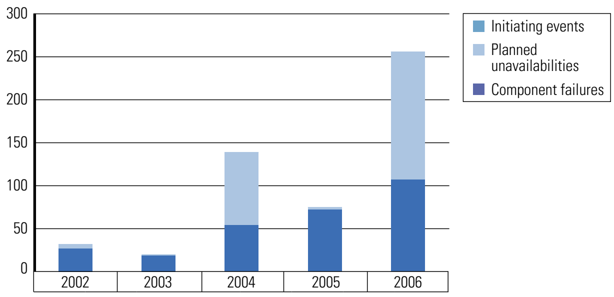
Other significant events 1E-8 ≤ CCDP < 1E-7
Loviisa 1 (Total number of events)



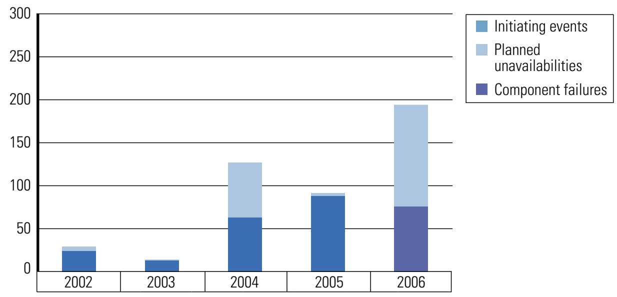
Other significant events 1E-8 ≤ CCDP < 1E-7
Loviisa 2 (Total number of events)



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



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



Olkiluoto

A brief description of the significant events is given below:

Olkiluoto1:

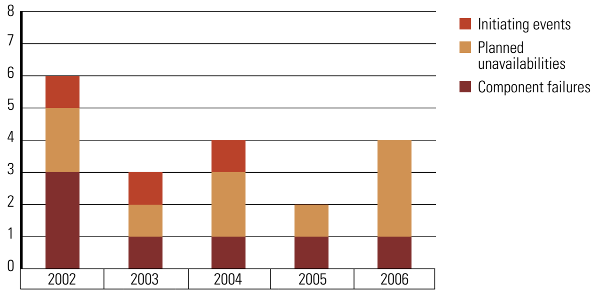
1) The over-current relay of the auxiliary feed water system pump P3 triggered in connection with the startup during periodic testing. No fault was detected, and re-start was successful. The failure had been latent for approximately 15 days.
2) Preventive maintenance: The D-dip diesel package EH-DIP-D/06 lasted a relatively long time (156 h).
3) Preventive maintenance: The A-dip diesel package EH-DIP-A/06 lasted a relatively long time (112 h).
4) Preventive maintenance: The C-dip diesel package EH-DIP-C/06 and repair of the 712 P3 suction channels lasted a relatively long time (442 h).

Olkiluoto2:

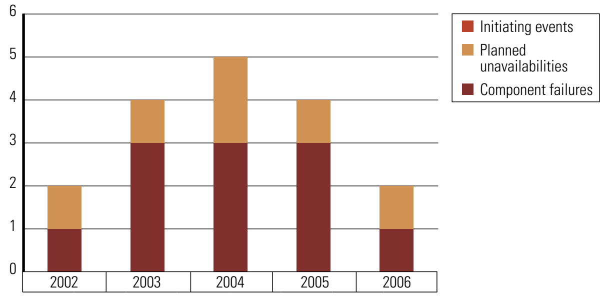
1) A fault occurred in the position indicator of a valve (V202) in the auxiliary feed water system (327); the fault had been latent for approximately 14 days.
2) Preventive maintenance: The C-dip diesel package EH-DIP-C/06 lasted a relatively long time (419 h).

The analysed events are considered part of normal nuclear power plant operation and no further mesures were required from STUK.

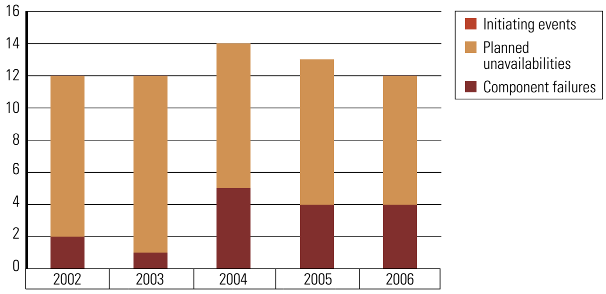
Most risk-significant events CCDP ≥ 1E-7
Olkiluoto 1 (Total number of events)



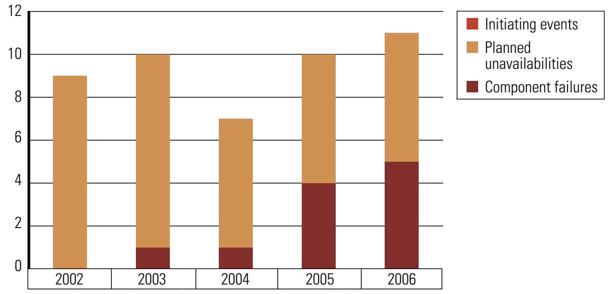
Most risk-significant events CCDP ≥ 1E-7
Olkiluoto 2 (Total number of events)



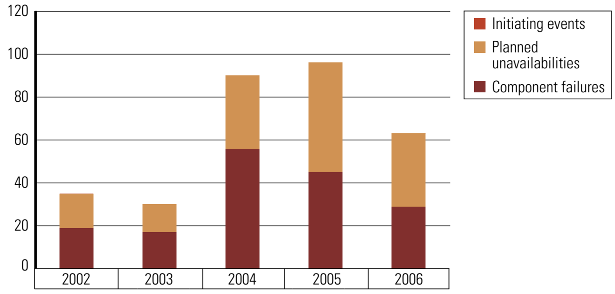
Other significant events 1E-8 ≤ CCDP < 1E-7
Olikiluoto 1 (Total number of events)



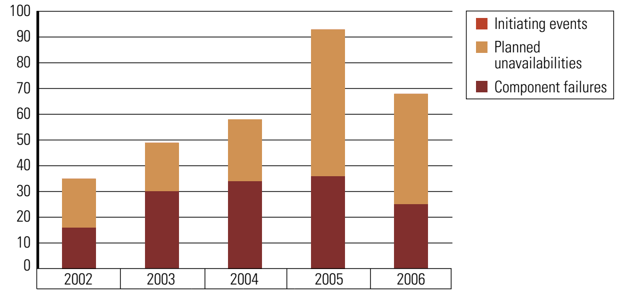
Other significant events 1E-8 < CCDP < 1E-7,
Olkiluoto 2 (Total number of events)



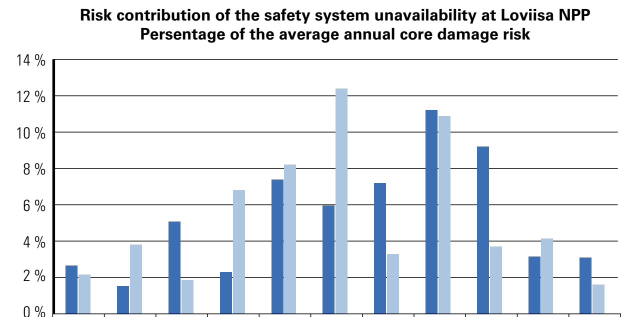
Other events CCDP < 1E-8
Olkiluoto 1 (Total number of events)



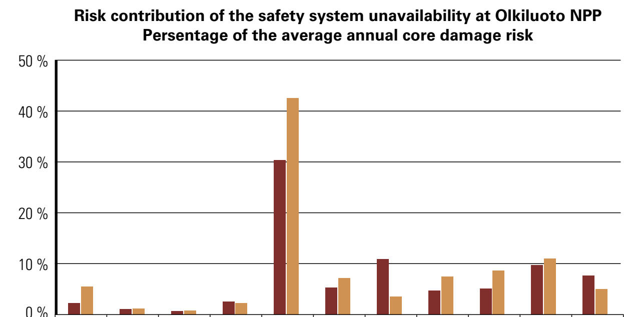
Other events CCDP < 1E-8
Olkiluoto 2 (Total number of events)



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



	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
LO1	2.66	1.54	5.09	2.30	7.39	5.96	7.20	11.21	9.20	3.15	3.10
LO2	2.17	3.80	1.87	6.80	8.23	12.39	3.30	10.90	3.70	4.14	1.60



	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
OL1	2.17	1.05	0.65	2.47	30.30	5.28	10.90	4.68	5.10	9.64	7.60
OL2	5.46	1.14	0.72	2.26	42.50	7.17	3.50	7.39	8.60	10.95	5.00

A.II.4 Accident risk of nuclear facilities

Incorporated in STUK's standing objectives is the following objective: ”The accident risk of nuclear facilities is reduced or remains unchanged”.

Definition

A nuclear facility is to be maintained and operated in such a manner that its accident risk is reduced or remains unchanged, and any needs for plant modifications are identified based on analyses. The risk of a nuclear facility is evaluated on the basis of a probabilistic risk analysis (PSA, PRA). The baseline data for the analysis (including component reliability data) are updated regularly.

Source of data

The nuclear facility's PSA results.

Purpose of indicator

The indicator is used to follow the development of the nuclear power plant's risk level.

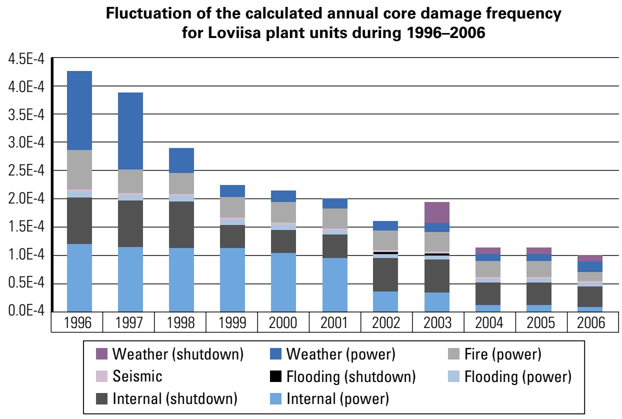
Responsible unit/person

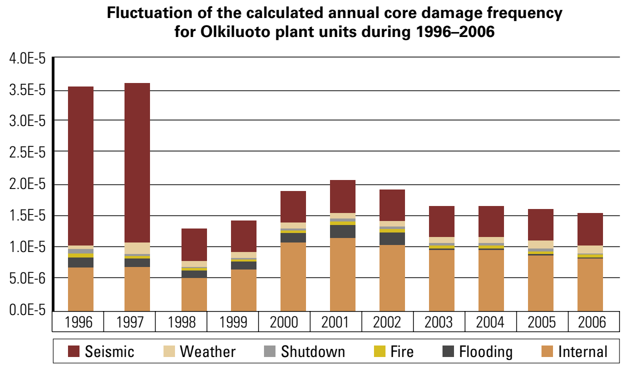
Risk assessment (RIS), Jorma Rantakivi (PSA computation)
Organisations and Operations (OKA) (failure data)

Interpretation of indicator

The annual probability of a severe reactor accident calculated for the Loviisa plant units is approximately 10^{-4}. The slight decrease from 2005 is due to certain plant modifications and more detailed analysis.

The annual probability of a severe reactor accident calculated for both Olkiluoto plant units is approximately $1.6 \cdot 10^{-5}$. As a result of certain plant modifications and more detailed analyses, this figure is lower than in 2005.





A.II.5 Number of fire alarms

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

Source of data
Data for the indicators is collected from the utilities. The licensees submit the data needed for the indicator to the person responsible for the indicator at STUK.

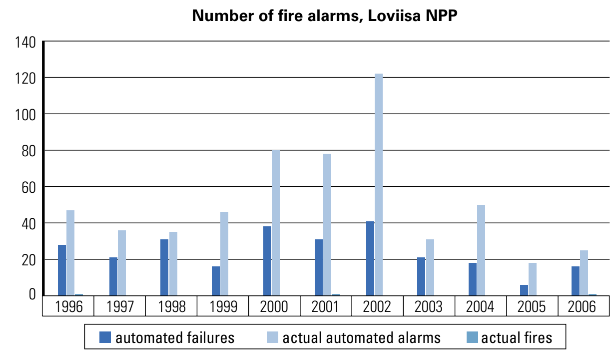
Purpose of indicator
The indicator is used to follow the effectiveness of fire protection at the nuclear power plants.

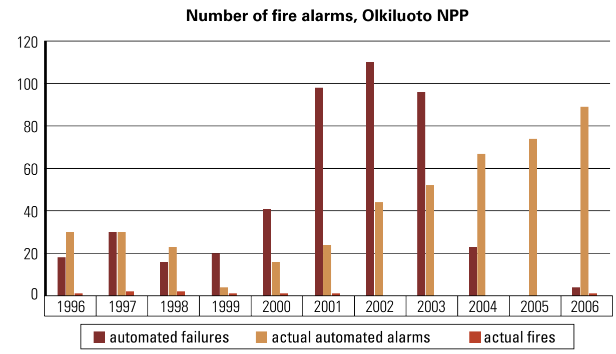
Responsible unit/person
Power Plant Technology (VLT)
Heikki Saarikoski

Interpretation of indicator
There was one event classified as an actual fire at the Loviisa plant: the explosion/fire of the voltage transformer at Loviisa 2. At Olkiluoto, one event was classified as a fire: a dustbin caught fire during the annual maintenance of Olkiluoto 1.

Alarms triggered by dust, smoke or humidity dominated the automatic fire detector alarms at both the Loviisa and Olkiluoto plants in 2006. A significant number of alarms triggered by sprinkler leakage also occurred at Olkiluoto. The Olkiluoto alarms also include alarms occurring in the spent fuel storage (KPA), the repository for the low and intermediate-level waste (VLJ) and outdoor areas, which explains the larger number of alarms at Olkiluoto. The automatic fire detectors were upgraded at Loviisa in 2000 and at Olkiluoto in 2001. The number of alarms after the upgrade due to more sensitive equipment and equipment failures.

The distinct reduction in alarms at the Loviisa plant since 2003 and at the Olkiluoto plant since 2004 is due to pre-alarms no longer being included in the calculations.





A.III Structural integrity

A.III.1 Fuel integrity

Definition

As the indicators, the following parameters are followed by plant unit: the maximum activity concentration of the primary coolant (Loviisa: as I-131 equivalent; Olkiluoto: I-131 only) and the peak value of maximum activity concentration in even, steady-state operation (Loviisa: the sum of the iodine isotope activity concentrations in hot standby, start-up state or power operation; Olkiluoto: I-131 activity in power operation). The maximum activity concentration of I-131 during depressurisation while entering shutdown or after reactor scram and the number of leaking fuel bundles removed from the rector are also followed as indicators.

Source of data

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

Purpose of indicator

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

Responsible unit/person

Power Plant Technology (VLT)
Kirsti Tossavainen

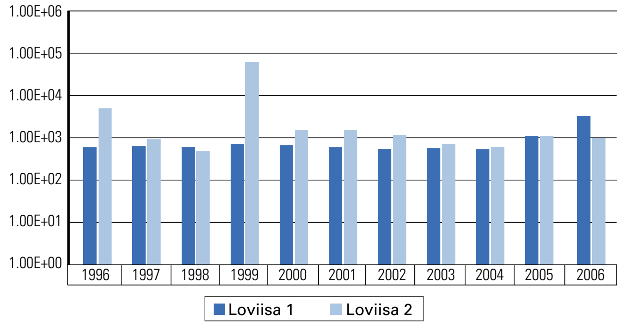
Interpretation of indicators

Primary coolant activity, Loviisa

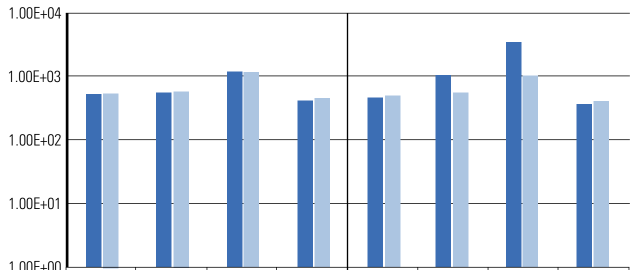
There were no fuel leaks at the Loviisa plant units in 2006, thus significant changes in the activity concentration of the primary coolant did not occur. In addition to the activity concentration calculated as I-131 equivalents, the sum of the activity concentrations of different iodine isotopes of the primary coolant is followed at the Loviisa plant. According to the Tech Specs, the sum activity may not exceed the value 1.0E+8 kBq/m³. At both plant units the sum activities have been around 0.1% of the Tech Specs limit.

The I-131 activity concentration of the primary coolant when plant units are being shut down and during reactor scrams has also been followed as a STUK indicator since 2002. No significant changes have occurred in the iodine activity concentrations when plant units are being shut down at the Loviisa plant because there have been no fuel leaks at the plant units during the monitoring period.

Fuel integrity: Iodine maximum activity concentration level of primary coolant ($^{131}I_{eq}$ kBq/m³), Loviisa NPP

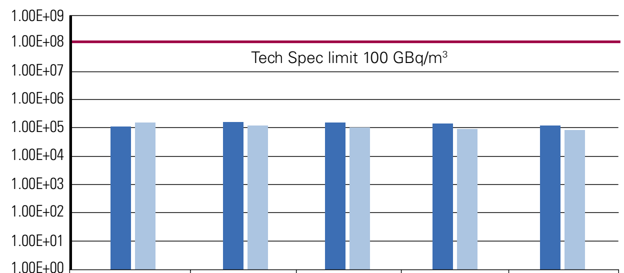


Fuel integrity: Iodine maximum activity concentration level of primary coolant ($^{131}I_{eq}$ kBq/m³), Loviisa NPP



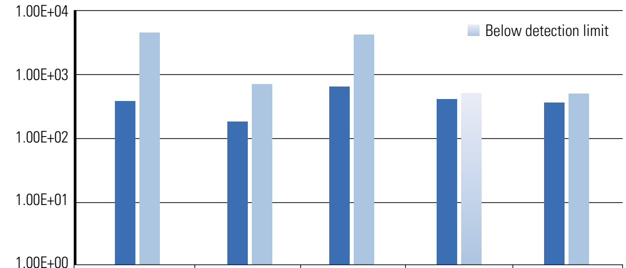
	I/05	II/05	III/05	IV/05	I/06	II/06	III/06	IV/06
LO1	4.92E+02	5.20E+02	1.10E+03	3.80E+02	4.30E+02	9.50E+02	3.20E+03	3.50E+02
LO2	5.17E+02	5.60E+02	1.10E+03	4.30E+02	4.80E+02	5.30E+02	9.80E+02	3.80E+02

Fuel integrity: Iodine maximum activity concentration of primary coolant in power operation, Loviisa NPP (sum of the iodine isotope activity concentrations, kBq/m³)



	2002	2003	2004	2005	2006
LO1	1.10E+05	1.40E+05	1.40E+05	1.30E+05	1.06E+05
LO2	1.40E+05	1.00E+05	9.50E+04	8.19E+04	7.58E+04

Fuel integrity: Iodine maximum activity concentration of primary coolant ($^{131}I_{eq}$ kBq/m³) during shutdown, Loviisa NPP



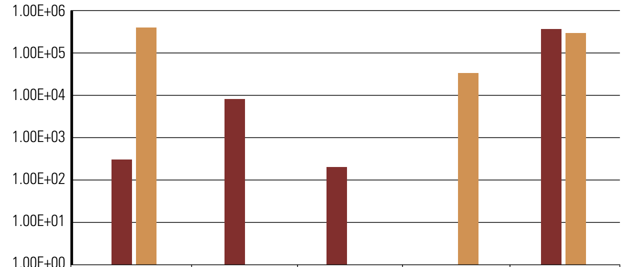
	2002	2003	2004	2005	2006
LO1	3.70E+02	1.80E+02	6.30E+02	4.00E+02	3.50E+02
LO2	4.50E+03	6.90E+02	5.90E+02	< 5.00E+02	4.80E+02

Primary coolant activity, Olkiluoto

The Olkiluoto 1 reactor contained leaking fuel for a short time in 2006. The leak was detected a few hours after midnight on 17 April 2006; based on leakage detection, the leak was estimated to have begun on 16 April 2006. The effect of the leak showed as larger I-131 activity concentrations of the reactor coolant both during operation and when the unit was shut down for annual maintenance outage. During operation, the I-131 activity concentration reached its peak immediately after the leak was detected, reaching to less than 0.1% of the action threshold specified in the Tech Specs. No uranium was dissolved from the fuel into the reactor coolant from the leakage site. The leaking fuel bundle was removed from the reactor during the annual maintenance outage, which began on 7 May 2006.

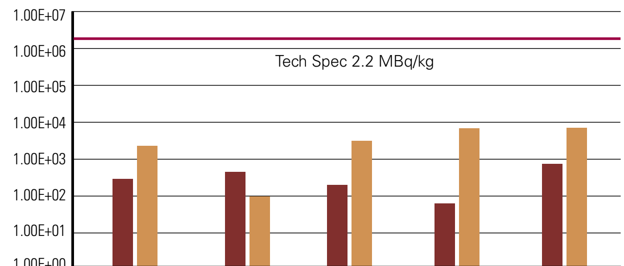
The Olkiluoto 2 reactor continued leaking fuel almost throughout 2006, as a result of which the I-131 concentration of the reactor coolant remained above normal levels. There were two leaking fuel bundles, one of which had begun leaking on 23 July 2005. The leaking fuel bundle was removed from the reactor during the annual maintenance outage, which began on 4 June 2006. The second fuel leak was detected after the annual maintenance outage on 18 July 2006. The effects of the leaks showed as larger I-131 activity concentrations during operation and, as concerns the 2005 leak, also in the shutdown to annual maintenance outage. As a result of the 2005 leak, the I-131 activity concentration peaked during plant operation at approximately 0.2% of the action threshold specified in the Tech Specs. This maximum concentration occurred in connection with the turbine trip in February. The leak did not increase the reactor core uranium contamination, which was present at the core following the fuel leak in the previous operating cycle. The site of the fuel leak that occurred in July 2006 has remained small, and no uranium has entered the coolant flow. The maximum I-131 concentration of the reactor coolant occurred in connection with the power reduction due to periodic testing in August. The maximum activity was approximately 0.3% of the action threshold. The leaking fuel will be removed from the reactor in the 2007 annual maintenance outage at the latest.

Fuel integrity: Iodine maximum activity concentration of primary coolant (^{131}I kBq/m^3) during shutdown, Olkiluoto NPP



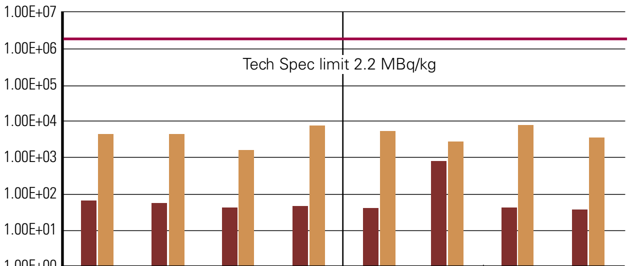
	2002	2003	2004	2005	2006
OL1	3.00E+02	8.20E+03	2.00E+02	0.00E+00	3.69E+05
OL2	3.88E+05	0.00E+00	0.00E+00	3.44E+04	3.08E+05

Fuel integrity: Iodine maximum activity concentration of primary coolant (^{131}I kBq/m^3) in power operation, Olkiluoto NPP



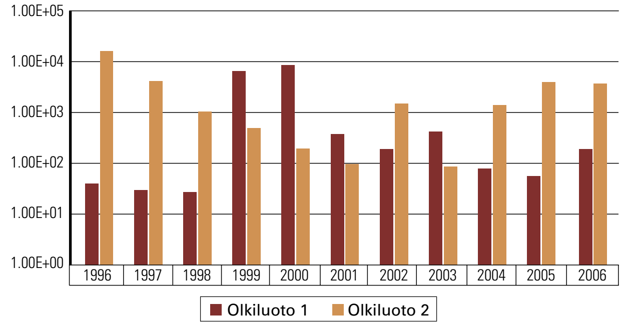
	2002	2003	2004	2005	2006
OL1	2.90E+02	4.30E+02	1.90E+02	5.90E+01	6.90E+02
OL2	2.37E+03	9.10E+01	3.12E+03	6.52E+03	7.03E+03

Fuel integrity: Iodine maximum activity concentration of primary coolant (^{131}I kBq/m^3), Olkiluoto NPP

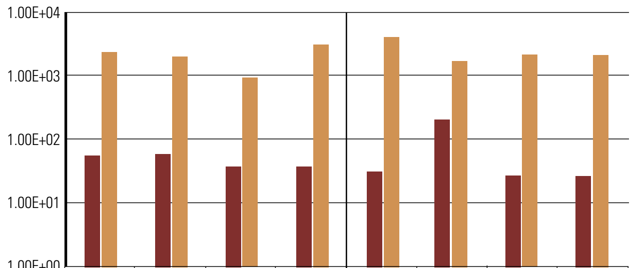


	I/05	II/05	III/05	IV/05	I/06	II/06	III/06	IV/06
OL1	5.90E+01	5.20E+01	3.76E+01	3.99E+01	3.60E+01	6.90E+02	3.80E+01	3.35E+01
OL2	4.20E+03	4.14E+03	1.47E+02	6.52E+03	4.60E+03	2.51E+03	7.03E+03	3.17E+03

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



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



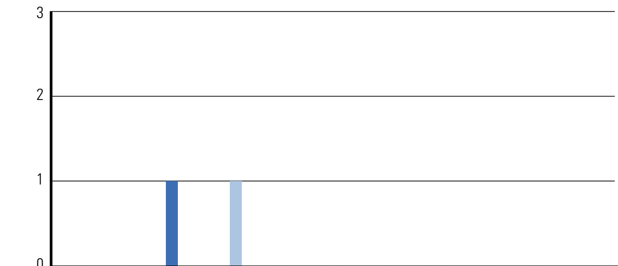
	I/05	II/05	III/05	IV/05	I/06	II/06	III/06	IV/06
OL1	5.50E+01	5.80E+01	3.60E+01	3.70E+01	3.00E+01	2.00E+02	2.60E+01	2.60E+01
OL2	2.40E+03	2.02E+03	9.50E+02	3.00E+03	4.00E+03	1.70E+03	2.15E+03	2.14E+03

Number of leaking fuel bundles

There have been no fuel leaks at the Loviisa plant units in the past few years.

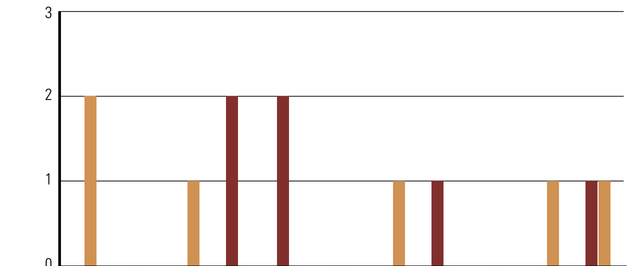
Fuel leakages have occurred almost every year at the Olkiluoto plant units. They have been small and the leaking fuel bundles have been removed in annual maintenance outages following leak detection.

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



	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
LO1	0	0	1	0	0	0	0	0	0	0	0
LO2	0	0	0	1	0	0	0	0	0	0	0

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



	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
OL1	0	0	0	2	2	0	0	1	0	0	1
OL2	2	0	1	0	0	0	1	0	0	1	1

A.III.2 Primary circuit integrity

Definition

The water chemistry indicators are

- chemistry performance indices used by the licensees, depicting the effectiveness of water chemistry control in the secondary circuits of PWRs and in the reactor circuits of BWRs. The indicator for Olkiluoto is the international index used by the licensee. The indicator for Loviisa is a new index developed and introduced at the plant in 2003 parallel to the international index. The new index describes the water chemistry conditions in the secondary circuit at Loviisa plant units with a higher degree of sensitivity than the corresponding international index for VVER plants. This index observes corrosive factors and concentrations of corrosion products in steam generator blow-down and feed water. For steam generator blow-down, the calculation includes the chloride, sulphate and sodium concentrations and acid conductivity; for feed water, it includes the iron, copper and oxygen concentrations. The chemistry index of the Olkiluoto plant is affected by the chloride and sulphate concentrations of the reactor water and the iron concentration in the feed water. The indices for both plants only cover the aforementioned values during power operation.
- the maximum chloride concentration of the steam generator blow-down (Loviisa) and the reactor water (Olkiluoto) during operation compared with the Tech Spec limit in the monitoring period. At the Olkiluoto plant the maximum sulphate content of reactor water on even, steady-state operation is followed as well.
- Corrosion products released from the surfaces of the reactor circuit and the secondary circuit into the coolant. For the Loviisa plant, the iron concentration of the primary coolant solid material and the secondary circuit feed water (maximum values for the monitoring period) are followed. For the Olkiluoto plant, the iron concentration of feed water (maximum value for the monitoring period) is followed. In addition, the maximum Co-60 activity concentration of the reactor coolant while bringing the plant to a cold shutdown or after a reactor scram is followed for both plants.

The indices below are used to follow identified and unidentified primary circuit leakages at the Olkiluoto plant units:

- total volume (m^3) of identified (from containment to collection tank 352 T1 of the controlled leakage drain system) and unidentified (total volume of leakages into the sump of the controlled floor drainage system, 345 T33) containment internal leakages during the operating cycle, and
- highest containment internal leakage volume during the year in relation to the allowed leakage volume in the Tech Specs (outflow water volume of water condensing in the air coolers of the containment cooling system 725/Tech Specs limit).

Source of data

The licensees submit indicators describing water chemistry control to the respective responsible person at STUK. The concentration levels of corrosive substances and corrosion products are obtained from quarterly reports submitted by the licensees. The licensee submits data on primary circuit leakages at the Olkiluoto power plant to the responsible person at STUK.

Purpose of indicator

Water chemistry indicators

The water chemistry indicators are used to monitor and control primary and secondary circuit integrity. The monitoring is done by indices depicting water chemistry control and by chosen corrosive impurities and corrosion products. The water chemistry indices combine a number of water chemistry parameters and thus give a good overview of the water chemistry conditions. STUK indicators are also used to monitor the fluctuation of certain parameters in more detail. In addition to the parameters described here, the licensees use several other parameters to monitor the plant units' water chemistry conditions.

The corrosive substances monitored by the STUK indicator system include chloride and sulphate, which are significant corrosives. The maximum chloride concentrations of steam generator blow-down (the highest value of the chloride concentrations of all six steam generators) is followed for the Loviisa plant units. According to the

Tech Specs, the chloride concentration of steam generator blow-down may not exceed the value 0.5 mg/kg. If the excess is minor (0.5–1.0 mg/kg), the plant has one week to bring the concentration into agreement with the Tech Specs. If the deviation is greater (1.0–5.0 mg/kg), the plant has one day to restore the concentration. If the deviation is even greater than that, the plant unit must be shut down. At the Olkiluoto plant units, the STUK indicator system includes the maximum chloride concentration of the reactor water. The Tech Specs limit for the chloride concentration of reactor water is 0.1 ppm (100 µg/l), which sets restrictions on plant operation. A chloride concentration higher than the limit is only allowed for 330 hours a year. If the requirement cannot be complied with, the plant must be brought to a cold shutdown. The plant must immediately be brought to a cold shutdown if the chloride concentration of reactor water exceeds 2 ppm (2000 µg/l).

The Olkiluoto plant units have earlier had the problem of a sulphate concentration higher than the reactor water target value. Under certain circumstances, sulphate is a significant factor in stress corrosion. The sulphate in the reactor water originates in the sulphate released from the ion-exchange resins of the condensate cleaning filters. Temperature is one of the factors in the release of sulphate from the filter resins. Changes have been made at the plant units to reduce the temperature of the water entering the condensate cleaning filters by changing the place of the condensate system pre-heater. The relocation was carried out at Olkiluoto 2 in 2003 and at Olkiluoto 1 in 2004. Teollisuuden Voima Oy has set a target limit of 5 µg/l for the sulphate concentration in reactor water. This target value must not be exceeded. In addition to temperature, the replacement interval of filter resins also has an effect on the sulphate concentration. The purpose of the indicator is to monitor the success of the licensee's actions related to the use of purification systems in keeping the sulphate concentration below the target value.

The corrosive products followed in the indicator system are iron and radioactive Co-60. The goal is to minimise the iron concentration iron that is dissolved from the components of the secondary circuit feed water and primary coolant at the Loviisa plant units and the reactor feed water at the Olkiluoto units. This is to prevent the formation of excess crust on the surface of the fuel or steam generator tubes. Radioactive cobalt-60 isotope is generated as an activation product of materials containing cobalt in components within the reactor circuit. Co-60 isotope is a significant source of radiation exposure from nuclear power plants. In the STUK indicator system the activity concentration of Co-60 isotope while bringing the plant to cold shutdown is used to describe the access of cobalt-containing structural materials into the reactor circuit and the success of the water chemistry control and the shutdown procedures.

Primary circuit leakages

The indicators describing primary circuit leakages are used to follow and monitor the integrity of the primary circuit.

Responsible units/persons

Power Plant Technology (VLT), Kirsti Tossavainen (water chemistry indices)
Safety Management (TUR), Jarmo Konsi (primary circuit leaks)

Interpretation of indicators

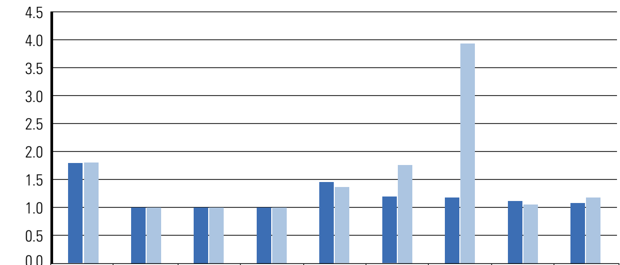
Water chemistry conditions, Loviisa

There were no significant changes in the indicators describing the integrity of the primary circuit at either Loviisa plant units in 2006. The annual maintenance outages of the plant unit occurred in the third quarter, as a result of which the iron concentration of the primary circuit and the chloride concentration of the steam generator blow-down exceeded normal concentrations during operation. The limit set on the chloride concentration of the steam generator blow-down was not exceeded. Because of the annual maintenance outages, the chemistry index values were also above average level during the third quarter, which increases the overall value of the index for the entire year. Resin getting into the steam generators during the ion-exchange filter replacement or coating also increased the chemistry index at both plant units.

Water chemistry conditions, Olkiluoto

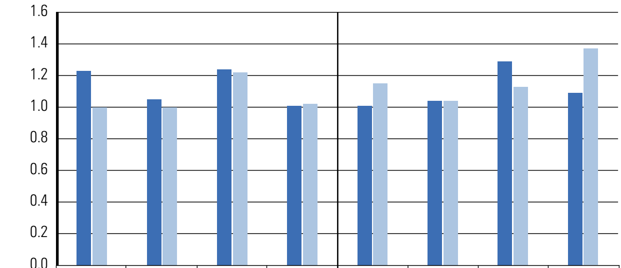
At the Olkiluoto plant units, the reactor and feed water chemistry have remained within the target values set by the licensee, except for the reactor water sulphate concentrations, which exceeded the target value in the third quarter. This was caused

Integrity of the secondary circuit: Chemistry index, Loviisa NPP



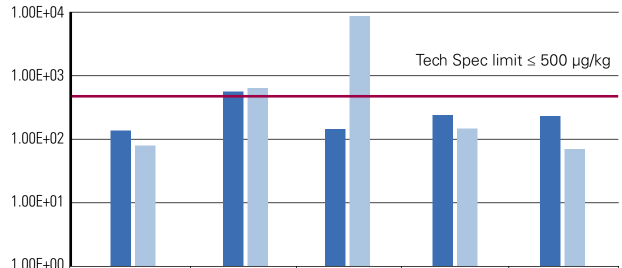
	1998	1999	2000	2001	2002	2003	2004	2005	2006
LO1	1.79	1.00	1.00	1.00	1.45	1.19	1.18	1.11	1.08
LO2	1.80	1.00	1.00	1.00	1.36	1.76	3.93	1.05	1.18

Integrity of the secondary circuit: Chemistry index, Loviisa NPP



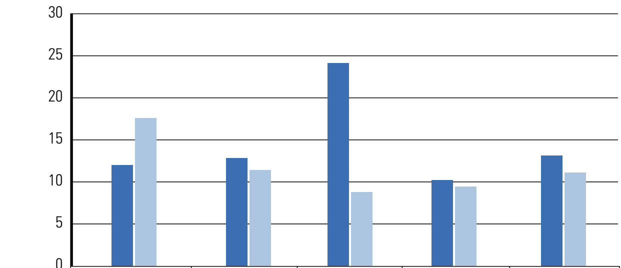
	I/05	II/05	III/05	IV/05	I/06	II/06	III/06	IV/06
LO1	1.23	1.05	1.24	1.01	1.01	1.04	1.29	1.09
LO2	1.00	1.00	1.22	1.02	1.15	1.04	1.13	1.37

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



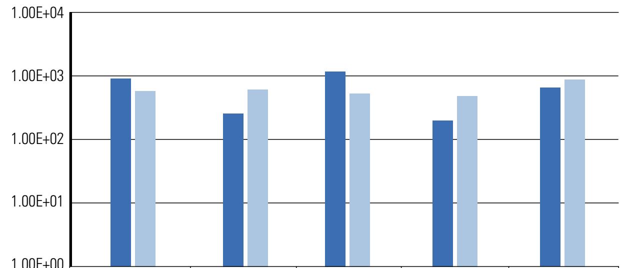
	2002	2003	2004	2005	2006
LO1	1.27E+02	5.12E+02	1.34E+02	2.24E+02	2.18E+02
LO2	7.40E+01	6.09E+02	8.20E+03	1.34E+02	6.63E+01

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



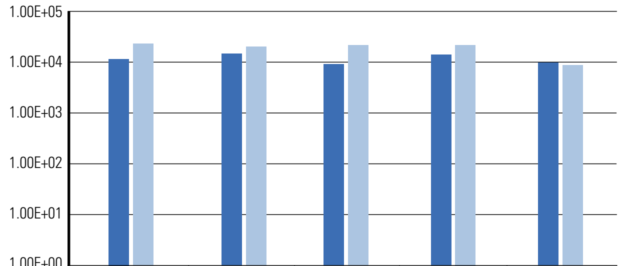
	2002	2003	2004	2005	2006
LO1	12.0	12.8	24.1	10.2	13.1
LO2	17.6	11.4	8.8	9.4	11.1

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



	2002	2003	2004	2005	2006
LO1	8.65E+02	2.36E+02	1.10E+03	1.95E+02	6.18E+02
LO2	5.53E+02	5.83E+02	5.22E+02	4.63E+02	8.49E+02

Integrity of primary circuit: Maximum cobalt-60 activity concentration (kBq/m³) in primary coolant during shutdown (outages and reactor scrams), Loviisa NPP

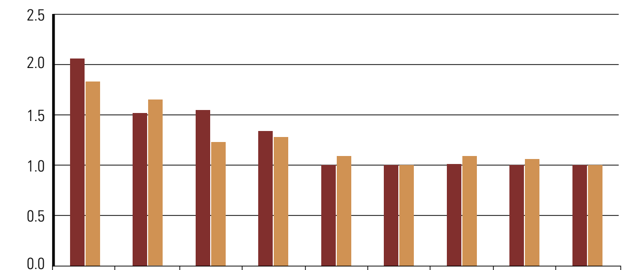


	2002	2003	2004	2005	2006
LO1	1.20E+04	1.50E+04	9.70E+03	1.50E+04	9.60E+03
LO2	2.50E+04	2.10E+04	2.30E+04	2.30E+04	9.00E+03

by variation in the runtimes of the condensate cleaning filter resins and the higher than usual temperature of the condensate during the summer. At Olkiluoto 2, the average iron concentration remained at the previous year's level in 2006. The 2006 value represents a single maximum concentration. The chemistry index, which is also affected by the sulphate and iron concentration, has been almost optimal i.e.1.00.

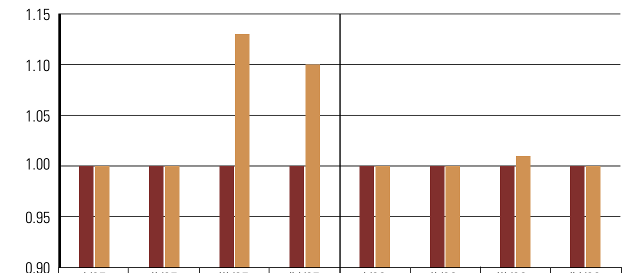
At Olkiluoto 2, the average Co-60 concentrations in the reactor water have shown an upward trend. This is also indicated by higher concentrations in shutdown. The increase is attributable to extensive plant modifications carried out during the annual maintenance in 2005, at which time cobalt-containing materials entered the circuit during the introduction of component replacements. Increased activity concentrations are also partially caused by the nickel-containing material which has been used in the spacer grid for a particular fuel type and which has dissolved in the reactor water. The activation products of nickel include Co-58 and Co-60. The surfaces of the spacer grids of new fuel bundles have been treated with a method that has been proven to improve the corrosion resistance of the material in tests.

Integrity of primary circuit: Chemistry index, Olkiluoto NPP



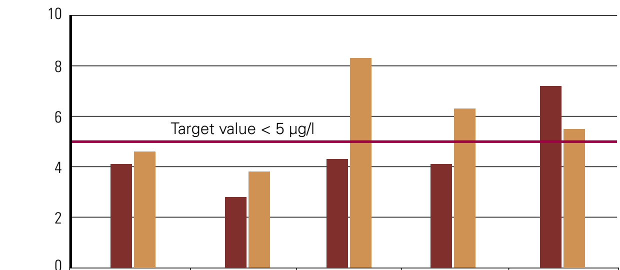
	1998	1999	2000	2001	2002	2003	2004	2005	2006
OL1	2.06	1.52	1.55	1.34	1.00	1.00	1.01	1.00	1.00
OL2	1.83	1.65	1.23	1.28	1.09	1.00	1.09	1.06	1.00

Integrity of primary circuit: Chemistry index, Olkiluoto NPP



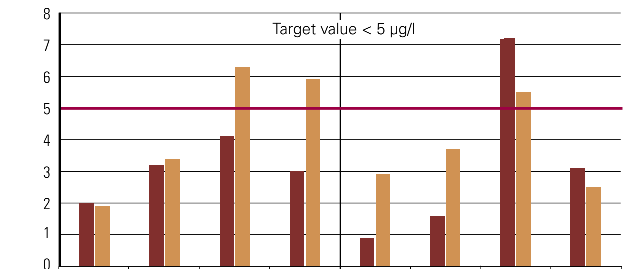
	I/05	II/05	III/05	IV/05	I/06	II/06	III/06	IV/06
OL1	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
OL2	1.00	1.00	1.13	1.10	1.00	1.00	1.01	1.00

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



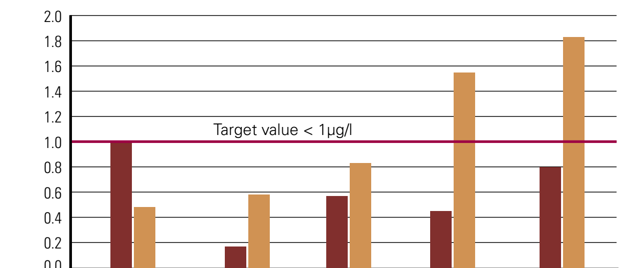
	2002	2003	2004	2005	2006
OL1	4.1	2.8	4.3	4.1	7.2
OL2	4.6	3.8	8.3	6.3	5.5

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



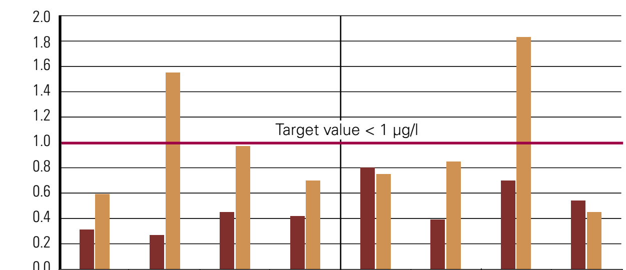
	I/05	II/05	III/05	IV/05	I/06	II/06	III/06	IV/06
OL1	2.00	3.20	4.10	3.00	0.90	1.60	7.20	3.10
OL2	1.90	3.40	6.30	5.90	2.90	3.70	5.50	2.50

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



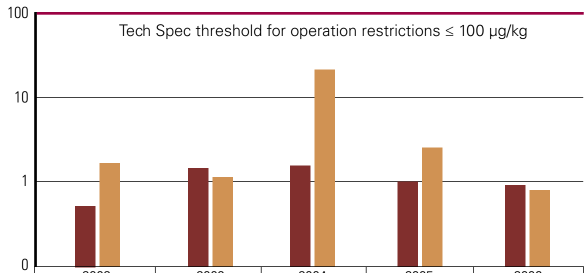
	2002	2003	2004	2005	2006
OL1	1.00	0.17	0.57	0.45	0.80
OL2	0.48	0.58	0.83	1.55	1.83

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



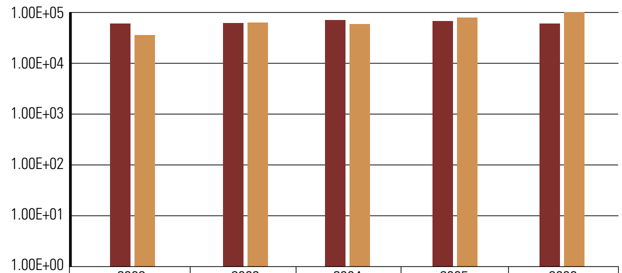
	I/05	II/05	III/05	IV/05	I/06	II/06	III/06	IV/06
OL1	0.31	0.27	0.45	0.42	0.80	0.39	0.70	0.54
OL2	0.59	1.55	0.97	0.70	0.75	0.85	1.83	0.45

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



	2002	2003	2004	2005	2006
OL1	0.5	1.4	1.5	1.0	0.9
OL2	1.6	1.1	21.3	2.5	0.8

Integrity of primary circuit: Maximum cobalt-60 activity concentration (kBq/m³) in primary coolant during shutdown (outages and reactor scrams), Olkiluoto NPP



	2002	2003	2004	2005	2006
OL1	5.60E+04	5.70E+04	6.80E+03	6.24E+04	5.70E+04
OL2	3.60E+04	5.90E+04	5.70E+04	7.63E+04	9.67E+04

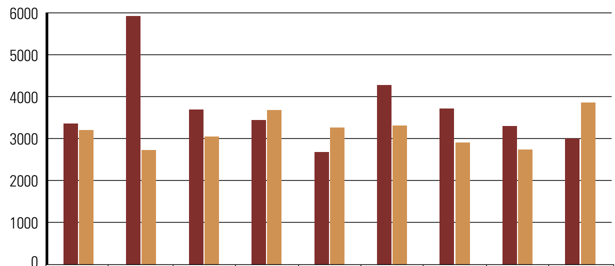
Primary circuit leakages, Olkiluoto

Leaks identified in the operating cycle 2005–2006 were 3,004 m³ (OL1) and 3,862 m³ (OL2). At OL1, the downward trend continued, while at OL2 the declining trend stopped and the leakage volume exceeded that of 2005.

In the operating cycle 2005–2006 the volume of unidentified leaks remained very small at 2.52 m³ (OL1) and 3.84 m³ (OL2).

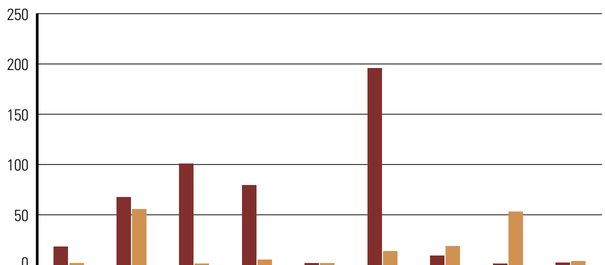
In the operating cycle 2005-2006 the ratio of the greatest containment internal leakage volume to the allowed leakage volume in the Tech Specs was low for both plant units; 0.23% at OL1 and 0.35% at OL2. This was the third successive operating cycle during which there were no leaks into the containment atmosphere.

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



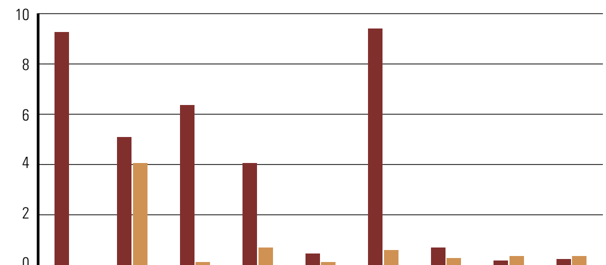
	1998	1999	2000	2001	2002	2003	2004	2005	2006
OL1	3355	5924	3694	3443	2678	2481	3716	3300	3004
OL2	3209	2731	3047	3677	3262	3307	2908	2741	3862

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



	1998	1999	2000	2001	2002	2003	2004	2005	2006
OL1	18.4	67.7	100.8	79.6	1.8	196.0	9.2	1.1	2.5
OL2	1.8	55.4	1.4	5.4	1.8	14.0	18.6	53.0	3.8

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



	1998	1999	2000	2001	2002	2003	2004	2005	2006
OL1	9.26	5.09	6.37	4.05	0.46	9.40	0.70	0.18	0.23
OL2	0.00	4.05	0.12	0.69	0.12	0.60	0.27	0.35	0.35

A.III.3 Containment integrity

Definition

As the indicators, the parameters below are followed: overall as-found leakage of outer isolation valves compared with the highest allowed overall leakage of the outer isolation valves, percentage of isolation valves tested during the year in question at each plant unit that passed the leakage test at first attempt (i.e. as-found leakage smaller than acceptance criteria of valve and no consecutive exceeding of the so-called attention criteria of a valve without repair), combined leakage rate of containment penetrations and airlocks in relation to their highest allowed overall leakage at each plant unit. The combined leakage rate at Olkiluoto includes leakages in personnel airlocks, the maintenance dome and the containment dome. At Loviisa the combined leakage rate is comprised of the leakage test results from personnel airlocks, the material airlock, the cable penetrations of inspection equipment, the containment maintenance ventilation systems (TL23), the main steam piping (RA) and the feed water system (RL) penetrations; the seals of blind-flanged penetrations of ice-filling pipes are also included.

Source of data

Data is extracted from the utilities' leaktightness test reports submitted by the licensee to STUK for information within three months of the completion of annual maintenance. STUK calculates the overall as-found leakages, since the reports give total leakages as they are at the end of an annual maintenance outage (i.e. after completion of repairs and re-testing).

Purpose of indicator

The indicator is used to follow the integrity of the containment isolation valves, penetrations and air locks.

Responsible unit/person

Reactor and Safety Systems (REA),
Päivi Salo

Interpretation of indicator

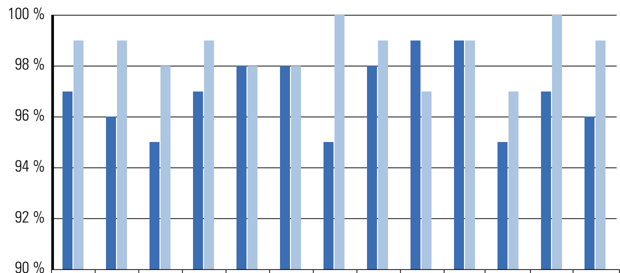
Loviisa

The overall as-found leakage of the Loviisa 1 outer isolation valves has remained small and the leaks were spread among several valves. The overall as-found leakage of the Loviisa 2 outer isolation valves has decreased further. A leak in the isolation valve in the fuel pool cooling system (TG40) accounted for 47.5% of the leakage, with a further 22% being due to a leak in one of the valves in the ice-condenser cooling system (XM30).

The percentage of isolation valves that passed the leaktightness test at first attempt has remained high.

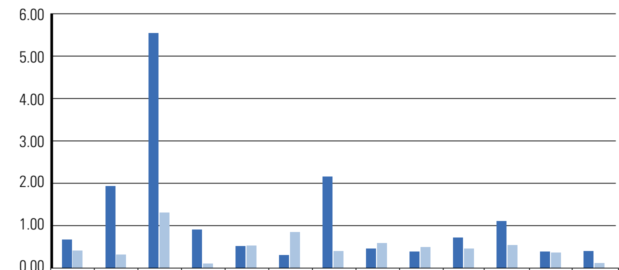
The overall as-found leakage of containment penetrations, which at Loviisa includes leaktightness tests of the personnel airlock, the emergency

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



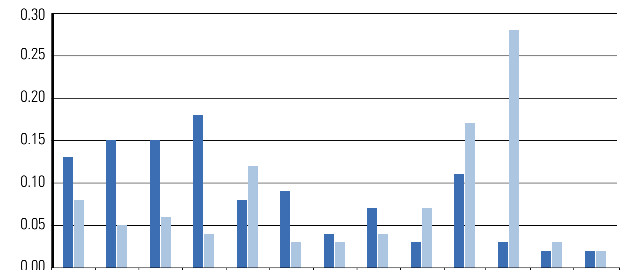
	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
LO1	97	96	95	97	98	98	95	98	99	99	95	97	96
LO2	99	99	98	99	98	98	100	99	97	99	97	100	99

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



	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
LO1	0.67	1.93	5.54	0.90	0.52	0.30	2.15	0.45	0.39	0.71	1.10	0.38	0.40
LO2	0.41	0.31	1.31	0.10	0.53	0.85	0.40	0.58	0.49	0.46	0.54	0.36	0.11

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



	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
LO1	0.13	0.15	0.15	0.18	0.08	0.09	0.04	0.07	0.03	0.11	0.03	0.02	0.02
LO2	0.08	0.05	0.06	0.04	0.12	0.03	0.03	0.04	0.07	0.17	0.28	0.03	0.02

personnel airlock, the material airlock, the reactor pit, inward relief valves, cable penetrations and bellows seals, is small at both plant units.

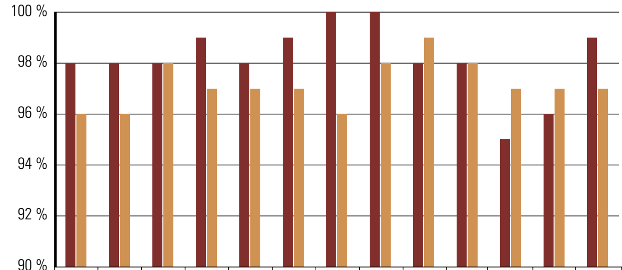
Olkiluoto

At OL1, the as-found leakage of the outer isolation valves has remained small. Approximately 12% came from a leak in the isolation valve in the shutdown reactor cooling system 321 and approximately 11% from the leak in one valve in the reactor vessel. In leaktightness testing, the largest leakage occurred from the inner main steam valve 311V2. At OL2, the as-found leakage of the outer isolation valves exceeded the limit set in the Tech Specs and showed a marked increase from the previous year. A total of 49.6% of the leakage was from a leak in the isolation valve of the controlled leakage drain system 352, with a further 16.5% from a leak in one valve in the flange cooling system 326. The largest individual leaks detected during leaktightness tests occurred from the inner isolation valves of system 326 and the boron system 351 and the outer isolation valve in system 352. After repairs and re-testing, the overall as-found leakage rate was clearly below the limits set in the Tech Specs.

The percentage of isolation valves that passed the leaktightness test at first attempt has remained high.

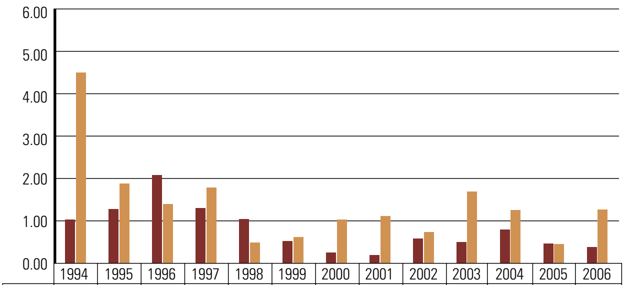
The overall as-found leakage rate of containment penetrations, in which TVO includes leakages in the upper and lower personnel airlock, the maintenance dome and the containment dome, has remained small.

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



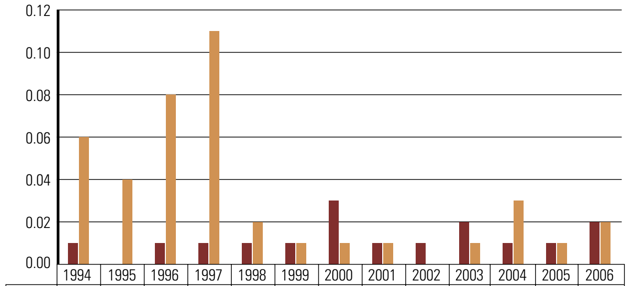
	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
OL1	98	98	98	99	98	99	100	100	98	98	95	96	99
OL2	96	96	98	97	97	97	96	98	99	98	97	97	97

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



	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
OL1	1.03	1.28	2.08	1.30	1.04	0.52	0.25	0.19	0.58	0.50	0.80	0.47	0.38
OL2	4.50	1.88	1.40	1.79	0.49	0.62	1.03	1.12	0.74	1.69	1.26	0.45	1.27

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



	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
OL1	0.01	0.00	0.01	0.01	0.01	0.01	0.03	0.01	0.01	0.02	0.01	0.01	0.02
OL2	0.06	0.04	0.08	0.11	0.02	0.01	0.01	0.01	0.00	0.01	0.03	0.01	0.02