LIITE 1 STUK's safety performance indicators for NPPs in 2007

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Summary of the safety performance indicators for the nuclear power plants

Background and objectives of the indicator system

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

The indicator system divides nuclear safety into three sectors: 1) safety and quality culture, 2) operational events, and 3) structural integrity. These three sectors are divided into a total of 15 sub-areas to be interpreted (see the table below). The objective of the indicator system is to recognise changes in plant safety as early as possible. If indicators show declining trends, the factors behind the development are defined, and changes to plant operation and STUK supervision of the area are considered. Indicators can also be used to monitor the efficiency and effect of correcting measures. The information yielded by the indicators is also used when communicating nuclear safety.

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

- No accidents or safety endangering events occur at Finnish nuclear power plants.
- Releases of radioactive substances into the environment are minor and the calculated annual dose due to the releases for the most exposed individual in the vicinity of the plant is less than 1% of the 100 µSv limit defined in the Government Decision 395/1991.
- The individual radiation dose of each nuclear power plant employee is below the limit defined for individuals.

<table>
<tr><th colspan="3">Nuclear safety</th></tr>
<tr><th>A.I Safety and quality culture</th><th>A.II Operational events</th><th>A.III Structural integrity</th></tr>
<tr><td>1. Failures and their repairs</td><td>1. Number of events</td><td>1. Fuel integrity</td></tr>
<tr><td>2. Exemptions and deviations from the Technical Specifications</td><td>2. Direct causes of events</td><td>2. Primary and secondary circuits integrity</td></tr>
<tr><td>3. Unavailability of safety systems</td><td>3. Risk-significance of events</td><td rowspan="5">3. Containment integrity</td></tr>
<tr><td>4. Occupational radiation doses</td><td>4. Accident risk of nuclear facilities</td></tr>
<tr><td>5. Radioactive releases</td><td rowspan="3">5. Number of fire alarms</td></tr>
<tr><td>6. Keeping plant documentation current</td></tr>
<tr><td>7. Investments in facilities</td></tr>
</table>

- The collective occupational dose for all employees of a nuclear power plant remains low in international comparison, staying below the maximum limit defined in Guide YVL 7.9 when figures from both nuclear power plant units are included.
- The accident risk of nuclear power facilities is reduced or remains unchanged.

Since 2006, indicator information has been managed in STUK's INDI (INdicator DIsplay) information system. In 2007 the INDI application was translated into Finnish, minor changes were carried out for the indicators and the potential of statistical trend analysis was surveyed in a licentiate research (Viertävä, J.). Nominated STUK representatives are responsible for the maintenance and analysis of the indicators. Individual indicators, their maintenance procedures and the interpretation of results are presented at the end of this summary.

Indicator results for 2007

Loviisa NPP

Summary

The structural integrity of the barriers containing radioactive releases has remained good. Two special situations and some isolated operational transients were reported relating to plant operation. Based on the descriptions of these events, procedures such as the management of modification work have been further defined. The occupational radiation doses reached an all-time low in 2007. This was brought about by measures to improve radiation protection and the low amount of work having a bearing on radiation protection. The plant's load factors were high, and failures only caused minor production losses. Long-term investments have been made in the improvement of the plant. In 2007, several projects with significance for nuclear safety were in progress, including I&C renewal, waste, storage and decontamination facilities' renewal and the construction of an alternative service water line for the cooling of a shut down reactor. Plant maintenance has been appropriate. However, attention must still be paid to spare parts management and adequate human resources for maintenance operations. Below, the results for the nuclear safety performance indicators are described by indicator area.

Safety and quality culture

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

Plant maintenance was appropriate

The load factors of the Loviisa power plant were high, and component failures caused only minor production losses. In 2007, six failures leading to production losses were recorded in both Loviisa plant units. All five LO1 failures were connected to turbine operation. The most significant of these failures was the hydrogen leak in generator 1 (SP10). For LO2, an oil leak of the reactor coolant pump motor and a trip of the main sea water pump required repair measures.

The plant's maintenance plan aims at keeping the number and effects of the failures at an acceptable level. In 2007, the number of failures causing limitations to component operation decreased slightly, particularly for the LO1 plant unit. The number of failures has remained low and even decreased slightly due to renewed equipment and constant improvements in the prediction and detection of failures.

In 2007, the plant applied for a total of seven exemptions to deviate from the Technical Specifications. Five of these applications concerned overdue repairs of component failures. Attention must be paid to repairing all failures within the time limits set in the Technical Specifications.

Maintenance work includes both repairs and preventive maintenance. Maintenance work on components with an effect on the safe operation of the plant increased in both plant units in 2007 due to preventive maintenance measures, which were more frequent than in the previous years.

The average component repair time was a little over 30 hours. The repair time has remained practically the same as in the previous years. There were differences in the average repair times between plant units: for LO1, the average repair time was less than 24 hours, and for LO2 nearly two days. Component failures requiring fast repair (maximum allowed repair time 3 days) were repaired in 17 hours for LO1 and in 14 hours for LO2. In future, plant operations should be improved to enable faster handling of work with a long maximum allowable time at LO2.

On the basis of the indicators, the plant's lifetime management and maintenance has been appropriate.

Plant safety systems were in good order

The auxiliary feed water system and emergency diesels continued to be in good condition, as in the previous years. The emergency diesel failures which occurred with minor safety significance were caused by the normal ageing of the equipment.

The high pressure safety injection systems for both plant units were out of service for a longer time in 2007 than in the previous years. This was caused by two defects of the motors charging the LO1 6 kV circuit breakers. The defects were discovered in system tests. As the defects had been hidden for three weeks before the test, the indicator showed a significant increase. However, the general condition of the high pressure safety injection systems is good, and the defects discovered were single occurrences.

The employees' radiation doses were at an all-time low

The collective occupational radiation dose for all plant employees was lower in 2007 than ever before (0.7 manSv). The average of ten highest individual radiation doses has also decreased in recent years, being 7.76 mSv in 2007. The main part of the radiation doses is received during annual maintenance work. In 2007, the annual maintenance outages for both Loviisa plant units were short in duration, and there was only a little work with significance for radiation protection. The Loviisa power plant has set clear objectives to decrease radiation doses. The low collective occupational dose is also a result of the increased experience of the Loviisa radiation protection personnel and the increasingly efficient radiation monitoring at the workplace.

As in the previous years, radioactive releases from the plants to the environment were minor, clearly below the set radiation limits. This can partly be explained by the fact that no fuel leaks have occurred for nearly ten years.

Long-term investments in plant improvement

At the Loviisa power plant, special attention has been paid to plant lifetime management. From 1997–2000, significant power upgrade and modernisation projects were carried out at the plant. There have also been higher than average investments in plant improvement in 2004–2006.

Loviisa power plant's accident risk has continued to decrease for the last ten years, and new risk factors discovered as the scope of the risk analysis has been extended have been efficiently removed. The severe accident probability calculated for the Loviisa plant units per annum was very low (approx. $9.2 \cdot 10^{-5}$). The indicator decreased in 2007 due to the new seawater line completed during the period. The new line allows for the alternative intake of seawater from the outlet channel to cool the plant in shutdown operation. The change will decrease risks in situations where algae, frazil ice or an oil spill endanger the availability of seawater through the conventional route.

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

In 2007, the most important investments included the automation renewal, the upgrade of waste, storage and decontamination facilities, the renewal of the loose parts monitoring system, the improvement of the secondary circuit's safety, the renewal of the oxygen and hydrogen analysers for the hydrogen burning plant, and the renewal of the fuel racks. The projects continue in 2008. The high pressure emergency cooling pumps, refuelling machine and primary circuit pressure control will also be renewed in 2008.

Targets for improvement in the document updating procedures

The 2007 annual maintenance of both plant units brought only minor changes to the systems, structures or components of the plant. Thus, only a few documents required updates, and updating was performed well, as in the previous years. The normal procedure at the plant has been to implement the changes to the emergency operating procedures and the procedures for restoring the normal state; however, minor revisions to the operating procedures have been temporarily replaced by a training notification appended to the operating procedure. Since the need for revisions will increase in connection with the automation renewal, the revision process of the operating procedures must be improved.

Operational events

The indicators concerning ***operational events*** *are used to monitor special situations and significant disturbances at the plant. Special situations include events with an effect on the safety of the plant, the personnel or the environment. A special report is required for any special situations. Correspondingly, a disturbance report must be prepared for any significant disturbances occurring at the plant unit. Such disturbances include reactor and turbine trips, and other operational transients leading to a forced reduction of more than 5% in the reactor power or average gross power.*

Risk indicators are used to monitor the safety effect of the equipment's unavailability periods and the development of the plant's risk level. The results provide insight into the operational activities at the plant and the efficiency of the operating experience feedback system.

The number of events was low and their risk significance minor

The number of events warranting a special report has remained low at the Loviisa power plant. In 2007, two situations in non-compliance with the Technical Specifications were observed in relation to electrical systems: 1) a temporary coupling was accidentally left operational in the previous annual maintenance, and 2) during the annual maintenance, an over-current relay of the diesel busbar was falsely tripped.

The safety impact of both events was small, but safety improving measures were launched based on them. On the basis of the first case, coordination and implementation procedures for alteration work were more carefully specified, a more detailed stage designation system was developed for the work orders and the inspection guidelines for electrical work were complemented. In the latter case, the correcting measures concentrated on isolating the technical causes of the event. An investigation of the causes leading to the tripping of the over-current relay is in progress. In addition, the possibilities of creating a back-up system for the power supply of the diesel generators' auxiliary systems are being surveyed.

The number of operational transients has also remained at a reasonable level since 2002. 5–9 transients have been reported annually. No reactor trips occurred in 2005–2007. Reactor trips have been generally rare in Loviisa partly because there are two turbines;. the reactor remains operational even if one turbine trips due to a transient.

Unavailability periods caused by component failures, preventive maintenance and other events had a very low effect on the annual accident risk, approximately 0.9% for LO1 and 2% for LO2. Some single device failures and the preventive maintenance of the auxiliary feed water subsystems had the most effect on the risk.

Positive development for fire safety

Compared to previous years, the fire safety of the Loviisa power plant improved slightly in 2007. No events classified as fires occurred at the plant in 2007, and the number of correct actuations of detector alarms as well as device failures slightly decreased. Several factors affect the number of alarms: the amount of maintenance work, the disconnection of detectors in a large enough area when carrying out work, and the reliable operation of fire detectors. Detector alarms were mainly triggered by dust, smoke or humidity.

Structural integrity

Structural integrity *is assessed on the basis of the leak-tightness of the multiple radioactivity confinement barriers – the fuel, primary and secondary circuits, and the containment. The integrity must meet the set objectives, and the indicators must show no significant deterioration.*

Fuel integrity is monitored on the basis of radioactivity of the primary coolant and the number of leaking fuel bundles.

Water chemistry indicators are used to monitor and control the integrity of the primary and secondary circuits. The monitoring is done by indices depicting water chemistry control and by following selected corrosive impurities and corrosion products.

The integrity of containment is monitored by testing the leak-tightness of isolation valves, penetrations and air locks.

Radioactivity confinement barriers are in good condition

The structural integrity of the barriers containing radioactive releases has remained good. No fuel leaks have occurred at the Loviisa plant units since 1999, and there were no significant changes in the indicators reflecting the integrity of the primary or secondary circuit in 2007. The water chemistry index, which is a combination of secondary circuit parameters, nearly had the optimal value for LO1. The index for LO2 was slightly weaker than for LO1, mainly because of impurities detected in the secondary circuit after the annual maintenance.

Leaks from the containment isolation valves, penetrations and personnel air locks were minor for both plant units. Most of the isolation valves passed the leakage test on the first attempt.

Olkiluoto NPP

Summary
The structural integrity of the barriers containing radioactive releases has remained good. Fuel leaks have occurred at the plant units nearly every year, but the leaks have been very small and leaking bundles have always been removed at the next annual maintenance.

Three reactor trips occurred at the OL2 plant unit in 2007. These were the most significant events as to nuclear safety at the Olkiluoto plant units. However, the technical causes of the trips were not the same.

In addition to reactor trips, the Olkiluoto plant reported three other special situations. The special situations and their immediate causes differed from each other, but deficient management of the plant's status and information particularly in connection with alteration work was identified as a common nominator behind these events.

The employees' radiation doses remained low, as in the previous years. The load factors for the plant units were high, and failures only caused minor production losses, although the production losses caused by failures at OL2 were slightly more significant than in the previous year.

The amount of preventive maintenance work was considerably lower in 2007 than in 2006. The amount of preventive maintenance work varies on a yearly basis according to the work selected for annual outages. Of major investments, the demineralisation plant renewal, laboratory extension, bituminisation equipment renewal and the new landfill were completed in 2007. Below, the results for the nuclear safety indicators are described by indicator area.

Safety and quality culture

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

Safety equipment has been well maintained

The number of failures in components subject to Technical Specifications has decreased compared to 2004. However, compared to the previous year, the number of defects increased slightly in 2007. The indicators concerning failures and maintenance of components subject to Technical Specifications do, however, show that the plant lifetime management and maintenance of the plant are appropriate.

Maintenance work includes repair of failures and preventive maintenance. Compared to 2006, the amount of maintenance work decreased by more than 22%, as the amount of preventive maintenance was reduced. The amount of preventive maintenance varies from year to year based on the work chosen for outages and preventive maintenance packages.

The average repair times became longer in 2007. For OL1, the time was 1.5 times longer than before, and for OL2 more than six times longer. The changes were caused by the long repair times of individual failures. For OL1, the change can be explained by the problems that appeared after the installation of the new 110 kV rectifier, taking more than three days to repair. Correspondingly, it was found at the periodic testing of OL2 that the relief control valve did not close. The defect was located at the motor within the containment, not accessible during normal operation. For this reason, the unavailability period increased to 24 days. The average repair times have remained on a slightly increasing trend since 2003.

Plant safety systems were in good condition

The unavailability times of the containment spray system have been decreasing since 2004. In 2007, the systems were fully operational for both plant units.

The availability of auxiliary feed water improved for both plant units. The higher unavailability for OL1 in 2006 was caused by failures in the recirculation and safety valves in the auxiliary feed water system. To correct the situation, the torque settings of the recirculation line's valve actuator motors were adjusted, and a separate testing line was designed for the safety valves. The first testing line will be built for OL1 during the annual maintenance of 2008.

The availability of the diesel generators has been increasing since 2004. In 2007, the condition of the diesels was considered good, since the number of defects with a significant impact on the availability of diesels has been low in the recent years. This development reflects the success of preventive maintenance schedules and the correct timing of the performed measures.

Employees' radiation doses remained low

The collective radiation dose for the Olkiluoto power plant was 1.2 manSv in 2007. The value was lower than in previous years. The radiation doses of the plant employees remained below the personal dose limits. The average for the ten highest doses was 7.7 mSv, which was less than in the previous years.

Emissions of radioactive substances into the environment from the Olkiluoto power plant were minor and remained clearly under the set emission limits. The process water purification and treatment equipment introduced at the plant has decreased discharges into the sea. The calculated radiation dose for the most exposed individual in the vicinity of the plant also decreased. The doses were less than 0.1% of the 100 microSv limit established in the Government Decision (395/1991).

Long-term investments in the plant lifetime management

Significant investments have been made in the power upgrades and renewals of the units in 1994–2007. The most significant accident risk factors for the Olkiluoto power plant include internal events during power operation (component failures and pipe ruptures leading to an operational transient) and relay failures caused by earthquakes deemed possible in Finland. The annual probability of a severe reactor accident calculated for both Olkiluoto plant units is very low (approximately $1.6 \cdot 10^{-5}$). Small improvements at the plant have brought a slight decrease to this indicator. Defects caused a slight increase in the production losses for OL2 compared to the previous years.

Of major investments, the demineralisation plant renewal, laboratory extension, bituminisation equipment renewal and the new landfill were completed in 2007. In addition, the construction of the gas turbine continued and the renewal of low pressure turbines and acquisition of new generators began.

Document updates required by plant modifications were quickly implemented

The necessary updates required by significant plant modifications monitored by STUK for the purpose of creating an indicator were quickly implemented in documents, just as in the previous years. The updates related to annual maintenance were implemented before plant start-up. For Olkiluoto power plant, the document update needs and the implementation of updates are monitored within the modification project management system. The 2007 indicator is based on the identification of update needs resulting from modifications implemented during the annual outage and the monitoring of the implementation of these updates. Changes to instructions were smaller in 2007 than in 2005 and 2006, when major modernisation was carried out for the turbines.

Operational events

*The indicators concerning **operational events** are used to monitor special situations and significant disturbances at the plant. Special situations include events with an effect on the safety of the plant, the personnel or the environment. A special report is required for any special situations. Correspondingly, a disturbance report must be prepared for any significant disturbances occurring at the plant unit. Such disturbances include reactor and turbine trips, and other operational transients leading to a forced reduction of more than 5% in the reactor power or average gross power.*

Risk indicators are used to monitor the safety effect of the equipment's unavailability periods and the development of the plant's risk level. The results provide insight into the operational activities at the plant and the efficiency of the operating experience feedback system.

Technical Specifications were observed in plant operation

The limitations set in the Technical Specifications were observed in operational activities. In 2007, two deviations from the Technical Specifications occurred at the Olkiluoto plant, and one error in the reactor monitoring software was observed.

There have been no notable changes in the number of special situations or operational transients in recent years. In 2007, the Olkiluoto plant reported four special situations concerning, firstly, the periodical testing of the relief system valves being carried out in an operating mode other than that specified in the Technical Specifications; secondly, the Olkiluoto 2 reactor scram on 4 September 2007; thirdly, the use of unqualified and unsuitable fuses in safety systems; and fourthly, unlocked containment isolation valves.

Operating routines require continuous improvement

Events warranting a special report and the immediate causes of these events vary, but there were similarities in the factors behind the events. The common factors relate to the management of the plant condition and information, particularly in connection with modifications. TVO has launched several development measures to ensure that components to be installed at the plant conform to the plans and that their condition and instructions meet the requirements.

The OL1 reactor monitoring system was programmed to use erroneous basic data for one fuel bundle type. As a result, the marginal for operational transients affecting the cooling systems was smaller than that indicated by the core monitoring system. The problem was found in TVO's own inspections and the software bug was fixed.

Three reactor scrams at OL2

The three OL2 reactor scrams were the most important events concerning nuclear safety at the Olkiluoto power plant in 2007. In recent years, there has been an average of one reactor scram every two years in the plants, which means that the number of reactor trips in 2007 was higher than usual. However, the reactor scrams had different causes, and they resulted in no threat to nuclear or radiation safety.

In addition, the plant reported three operational transients: 1) the failure of a rubbing-face seal in the OL1 feed water pump; 2) a fire ignited on the OL2 turbine island; and 3) faulty operation of a reactor coolant pump at OL2 and a steam leak in the turbine island. The events had no effect on plant safety, but they did cause production losses.

The events had no significant effect on nuclear safety

The effect of unavailability periods caused by component failures, preventive maintenance and other events on the annual accident risk was approximately 6% at both plant units. The figures were the result of the long duration of the preventive maintenance packages of diesel generators and latent component failures in safety systems. No special measures by STUK were required.

The number of small fires was higher than usual

The fire safety of the Olkiluoto power plant has remained stable for several years. In 2007, there were five events classified as fires at the power plant. The number of detector alarms was smaller than before. The alarms were triggered by dust, smoke or humidity.

Structural integrity

***Structural integrity** is assessed on the basis of the leak-tightness of the multiple radioactivity confinement barriers – the fuel, primary and secondary circuits, and the containment. The integrity must meet the set objectives, and the indicators must show no significant deterioration.*

Fuel integrity is monitored on the basis of radioactivity of the primary coolant and the number of leaking fuel bundles.

Water chemistry indicators are used to monitor and control the integrity of the primary and secondary circuits. The monitoring is done by indices depicting water chemistry control and by following selected corrosive impurities and corrosion products.

The integrity of containment is monitored by testing the leak-tightness of isolation valves, penetrations and air locks.

Radioactivity confinement barriers were in good working order

There were no essential changes in the indicators describing the integrity of the fuel or the primary circuit in 2007. Based on the indicators, the structural integrity of the barriers limiting the dispersion of radioactive substances has remained good.

Fuel leaks have occurred at the plant units nearly every year, but the leaks have remained small and the leaking bundles have been removed during the next annual maintenance. In the early part of 2007, the OL2 reactor contained leaking fuel. The leak had begun in summer 2006, and the leaking fuel bundle was removed in the annual outage of 2007. The water chemistry index, which yields an overview of the water chemistry conditions, was at the best possible level for both plant units.

Containment leaks found at OL1 increased, but the change cannot be attributed to any single factor. At OL2, containment leaks decreased slightly. The volumes of unidentified primary circuit leaks continued low. The containment's largest internal leak volume's ratio to the maximum allowable volume as specified in the Technical Specifications was low for both plant units. This was the fourth consequent operating cycle with very few leaks from the primary circuit to the containment atmosphere.

Leaks from the containment penetrations and personnel air locks were minor for both plant units. Most of the isolation valves passed the leakage test at first attempt. The leaks from the OL1 isolation valve were minor. However, the sum of the leakage test results for the outer OL2 isolation valves exceeded the limit specified in the Technical Specifications. Nearly half of the total leakage came from one valve. After repairs, the total leakage met the requirements of the Technical Specifications.

Safety performance indicators

A.I Safety and quality culture

A.I.1 Failures and their repairs

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

Definition

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

Source of data

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

Purpose of indicator

The indicator is used to assess the plant life-cycle management and the development of the condition of components.

Responsible units/persons

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

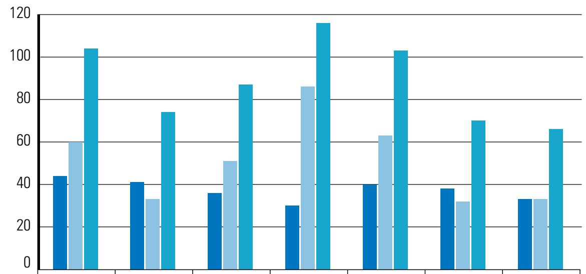
Interpretation of indicator

Loviisa

The total number of failures in equipment subject to Technical Specifications, causing restriction to plant use, decreased from 211 in the previous year to 172 in 2007. The change is mainly due to a decrease in the number of failures causing restrictions to plant use at LO1. The total number of failures in 2007 was clearly lower than the average of the four previous years, 250.

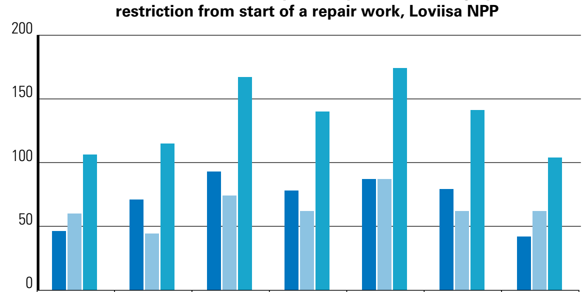
In recent years, the number of annual failures have remained relatively stable. Any variation therein is caused by the random occurrence of normal failures that are difficult to predict but will occur in any large number of components. The

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



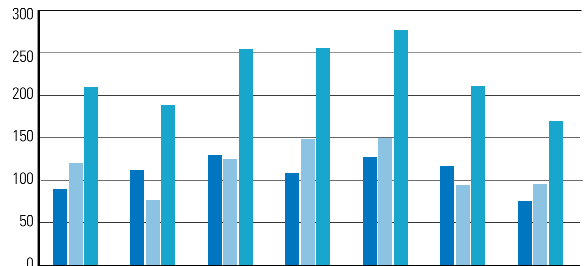
	2001	2002	2003	2004	2005	2006	2007
LO1	44	41	36	30	40	39	33
LO2	60	33	51	86	63	35	33
LO1,2	104	74	87	116	103	74	66

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



	2001	2002	2003	2004	2005	2006	2007
LO1	46	71	93	78	87	79	42
LO2	60	44	74	62	87	62	62
LO1,2	106	115	167	140	174	141	104

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



	2001	2002	2003	2004	2005	2006	2007
LO1	90	112	129	108	127	117	75
LO2	120	77	125	148	150	94	95
LO1,2	210	189	254	256	277	211	170

number of failures causing operation restriction continues to decrease in 2007. This is good for the plant maintenance result, but due to what's stated above, no certain conclusions can be made on the life-cycle management and the condition of the components based on these figures.

Failure detection and anticipation have been continuously improved in plant maintenance operations at Loviisa, and components have been replaced. Due to these measures, the number of component failures with an effect on the safe operation of the plant has remained under control and decreased in recent years. Based on the above it can be stated that 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 life-cycle management and successful maintenance. Interpretation of indicator

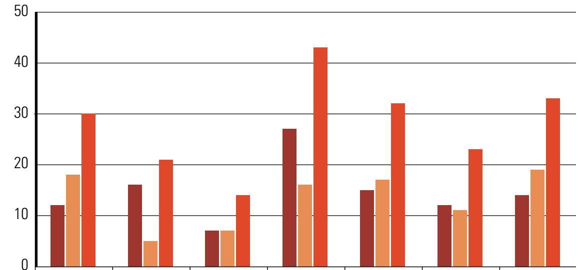
Olkiluoto

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

Immediate operation restrictions resulted for example from a wrong voltage level found in the fuses of the motors of pumps P1–P4 of the shutdown secondary cooling system 721. For OL1, wrong fuses were present in all pumps, and for OL2, for one pump. The observation led to the TechSpec requirement "Shutdown to cold shutdown state". The fuses were quickly replaced, and resolving times remained short. Wrong fuses were observed in other places as well.

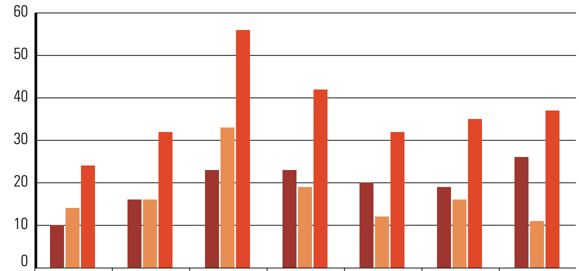
Capacity measurements of the plate heat exchanger of shutdown secondary cooling system 721 are regular. For both plant units, several measurements indicated values below the required capacity. In such cases, the heat exchanger was cleaned. The necessary isolation then causes operation restriction, and the cleaning of one heat exchanger takes nearly 10 h. The matter has been discussed with TVO representatives, and TVO has made a proposal for action to increase the number of heat exchanger plates. TVO will re-evaluate the capacities due to factors such as the increased flow of the shutdown service water system. With these measures, a better "impurity margin" can be achieved for capacity calculations. STUK inspections will monitor the implementation of the proposal.

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



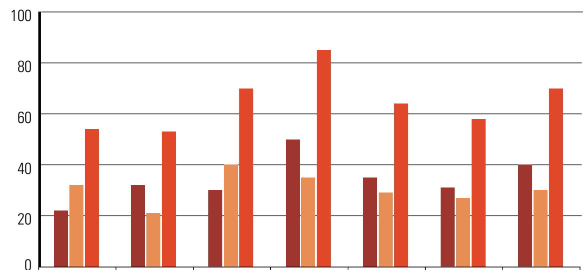
	2001	2002	2003	2004	2005	2006	2007
OL1	12	16	7	27	15	12	14
OL2	18	5	7	16	17	11	19
OL1,2	30	21	14	43	32	23	33

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



	2001	2002	2003	2004	2005	2006	2007
OL1	10	16	23	23	20	19	26
OL2	14	16	33	19	12	16	11
OL1,2	24	32	56	42	32	35	37

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



	2001	2002	2003	2004	2005	2006	2007
OL1	22	32	30	50	35	31	40
OL2	32	21	40	35	29	27	30
OL1,2	54	53	70	85	64	58	70

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

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

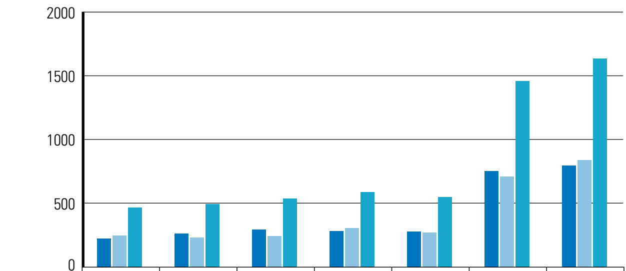
Interpretation of indicator

Loviisa

In 2006, the Loviisa power plant adopted the LOMAX information system to replace 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. Due to the change in the indicator, the figures for 2006 and 2007 are not directly comparable with the earlier figures. The figures for 2006 have been readjusted to correct some interpretation issues caused by the information system change; the issues have now been checked and corrected. Due to the information system change, the 2007 maintenance figures are only comparable with the adjusted values for 2006.

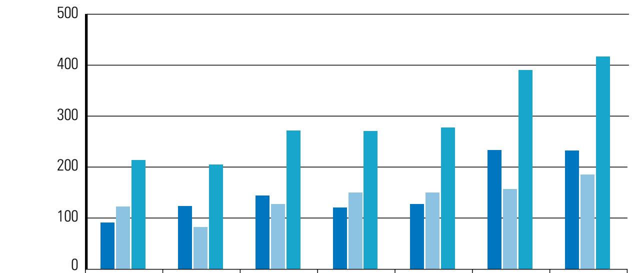
No significant change was observed for the plant units in the number of failure repairs of components subject to Technical Specifications in 2007 compared to the previous year. The preventive maintenance work figures show a distinct increase; for LO1, the number increased by 45 (8%) and for LO2 by 105 (19%) compared to 2006.

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



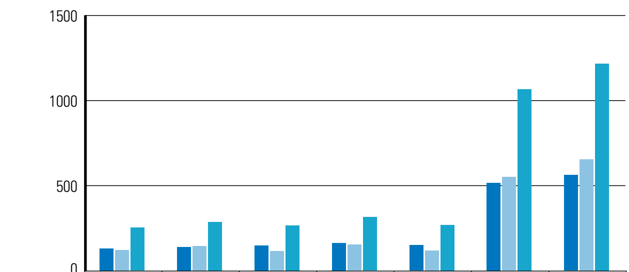
	2001	2002	2003	2004	2005	2006	2007
LO1	222	263	293	282	277	750	794
LO2	244	228	243	303	269	707	840
LO1,2	466	491	536	585	546	1457	1634

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



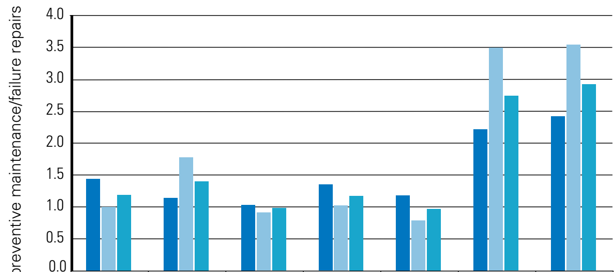
	2001	2002	2003	2004	2005	2006	2007
LO1	91	123	144	120	127	233	232
LO2	122	82	127	150	150	157	185
LO1,2	213	205	271	270	277	390	417

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



	2001	2002	2003	2004	2005	2006	2007
LO1	131	140	149	162	150	517	562
LO2	122	146	116	153	119	550	655
LO1,2	253	286	265	315	269	1067	1217

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



	2001	2002	2003	2004	2005	2006	2007
LO1	1.44	1.14	1.03	1.35	1.18	2.22	2.42
LO2	1.00	1.78	0.91	1.02	0.79	3.50	3.54
LO1,2	1.19	1.40	0.98	1.17	0.97	2.74	2.92

Judging by the data behind the indicator, the year 2007 was not markedly different from the previous years as concerns preventive maintenance. The ratio of the number of preventive maintenance works to the number of fault repairs was 2.92 in 2007, compared to 2.74 in 2006. The increase of the share of preventive maintenance activities reflects the selected maintenance strategy. As a result of the strategy, the number of failures as well as their effects have remained at an acceptable level.

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

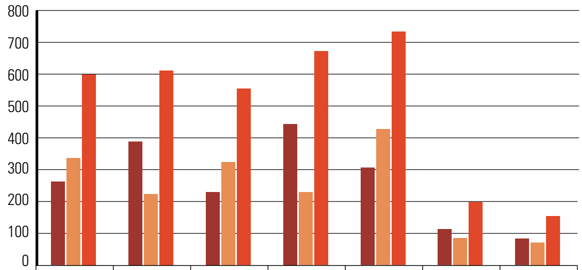
Olkiluoto

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 data is not comparable with the figures for earlier years. Class 3 data (systems subject to the Technical Specifications, Tech Specs) has been removed from the work order classification, since 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.

The number of maintenance work included in this indicator has decreased a little over 22% from 2006 to 2007. The decrease is mainly due to the smaller number of preventive maintenance works. The number of preventive maintenance works largely depends on the work included in outages and the so called preventive maintenance packages.

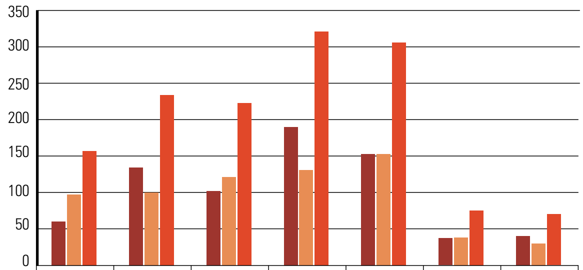
The development of the preventive maintenance and failure repair ratio can only be used to estimate the plant condition when figures from several years become available.

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



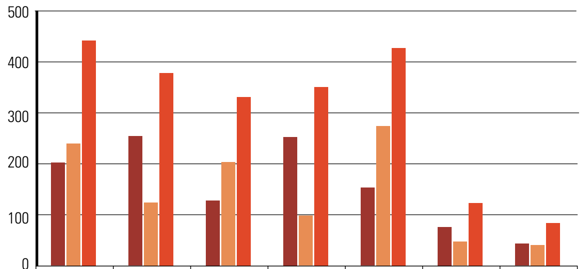
	2001	2002	2003	2004	2005	2006	2007
OL1	262	388	230	443	306	113	83
OL2	337	224	324	229	427	85	71
OL1,2	599	612	554	672	733	198	154

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



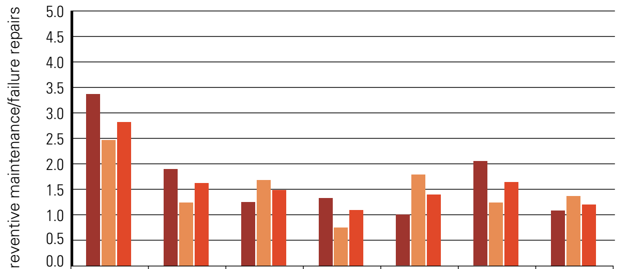
	2001	2002	2003	2004	2005	2006	2007
OL1	60	134	102	190	153	37	40
OL2	97	100	121	131	153	38	30
OL1,2	157	234	223	321	306	75	70

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



	2001	2002	2003	2004	2005	2006	2007
OL1	202	254	128	253	153	76	43
OL2	240	124	203	98	274	47	41
OL1,2	442	378	331	351	427	123	84

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



	2001	2002	2003	2004	2005	2006	2007
OL1	3.37	1.90	1.25	1.33	1.00	2.05	1.08
OL2	2.47	1.24	1.68	0.75	1.79	1.24	1.37
OL1,2	2.82	1.62	1.48	1.09	1.40	1.64	1.20

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

Definition

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

Source of data

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

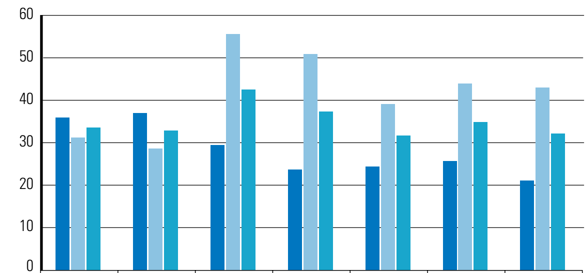
Purpose of indicator

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

Responsible units/persons

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

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



	2001	2002	2003	2004	2005	2006	2007
LO1	35.9	36.9	29.4	23.6	24.3	25.6	21.1
LO2	31.2	28.6	55.6	50.9	39.1	43.9	43.0
LO1,2	33.6	32.8	42.5	37.3	31.7	34.8	32.1

Interpretation of indicator

Loviisa

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

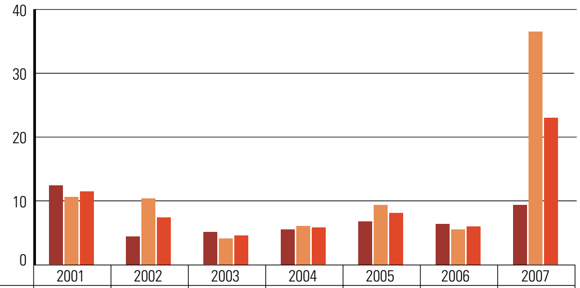
Due to the small number of work requiring operation restrictions and the varying allowable repair times, an individual operation may have a significant effect on the indicator value even when it is performed within the allotted time. This aspect of the indicator is taken into account in the interpretation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

The average repair times of failures causing unavailability of components have remained relatively stable at the Loviisa plant for several years. In 2007, the average repair time for the plant units was 32.0 h, while the average of the four previous years was 36.4. In recent years, the average repair times have been considerably lower for LO1 than for LO2, due to faster implementation of work with long allowed repair time. In 2007, the average repair time of Tech Spec component failures that had an allowed repair time of 72 hours or less was 17.0 hours at LO1 and 14.3 hours at LO2.

On the basis of 2007 indicators and the data behind them, the plant's maintenance strategy meets the requirements. However, the plant should take measures to improve performance concerning the adequacy of resources and the management of maintenance activities to avoid undue delays also when the allowed repair time is long.

Interpretation of indicator

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



	2001	2002	2003	2004	2005	2006	2007
OL1	12.4	4.4	5.1	5.5	6.8	6.4	9.4
OL2	10.6	10.4	4.1	6.1	9.4	5.5	36.5
OL1,2	11.5	7.4	4.6	5.8	8.1	6.0	23.0

Olkiluoto

The indicator is used to monitor the repair times of components subject to the Technical Specifications. The repair time for each component is compared to the allowed repair time as defined in the Technical Specifications. The usual allowed repair time is 30 days for a single subsystem and 3 days when two subsystems fail simultaneously. Depending on the system and the component, other allowed repair times may be defined in the Technical Specifications.

The average repair time has increased slightly since 2003. No single cause can be defined for the increase. In 2007, repair times increased strongly for both plant units, to 1.5 times the previous figure at OL1 and to over six times the previous figure at OL2.

A new 110 V rectifier was installed at OL1 on 18 January 2007. The following day, the rectifier was isolated because it emitted abnormal noise. A mobile rectifier was connected to supply the busbar. The rectifier was returned to operation on 22 January 2007 and the operation restriction of 30 days was removed. The repair took nearly 74 hours. Thus an individual device increased the average annual repair time for OL1.

At OL2, the motor operated regulating valve V22 of the 314 relief system did not close at periodic testing on 21 April 2007 due to a burned fuse. The 30-day Tech Spec restriction began on 21 April at 00:55 (Tech Specs: If the pressure regulation operation of valve 314 V21 or 314 V22 fails, unrestricted use of the reactor is allowed for 30 days.) The failure was located in the motor of the 314V22 within the container, not accessible during normal operation. ON 15 May 2007 a busbar breaker tripped and caused a turbine and reactor trip at the plant unit. In this connection, the 314V22 motor could be changed within the containment, and the 30-day tech Spec restriction was removed. The unavailability period was rather long, over 24 days. This unavailability of a single device has a considerable effect on the average repair time. The long unavailability period was due to the utility's plans to repair the failure in the annual outage beginning on 20 May 2007, thus formally remaining within the 30-day Tech Spec restriction.

A.I.1d Common cause failures

Definition

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

Source of data

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

Purpose of indicator

The indicator is used to follow the quality of maintenance.

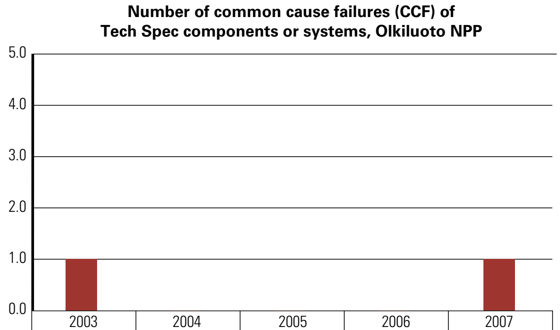
Responsible unit/person

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

Interpretation of indicator

In 2007, no safety-significant common cause failures were identified at the Loviisa power plant. The situation is good.

One common cause failure was identified at Olkiluoto. In two of the six frequency converters for the flywheel motor at Olkiluoto 1, an I&C-related failure was detected in connection with a 400 kV grid fault. The problem will be repaired by changing the signal filtering in 2007 and 2008.



	2003	2004	2005	2006	2007
Olkiluoto	1	0	0	0	1

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

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

Interpretation of indicator

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

Loviisa

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

In 2007, both Loviisa plant units had 6 failures leading to production losses. Despite the relatively high number of failures, the production loss caused by them was small as in the previous years, and continued stable.

Five of the failures at Loviisa 1 were related to turbine operation. The most significant of these was the repair of a hydrogen leak for the SP10 generator.

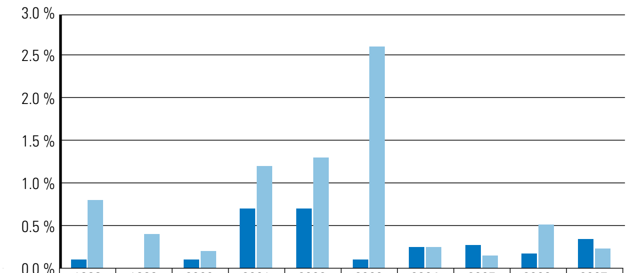
At Loviisa 2, the most significant failures were the oil leak of the reactor coolant pump YD11D001's motor, leading to limitation of the plant's power output on two occasions, and the tripping and repair of the main sea water pump VC52D201.

Olkiluoto

Olkiluoto 2 experienced higher production losses from component failures in 2007 than in the previous years. Three reactor trips occurred at the plant unit due to disturbances and component failures. The plant was separated from the national grid during the inspection and repairs. In addition, the start-up after the annual outage had to be interrupted when oil remaining in the high pressure turbine insulation after an oil leak ignited. In June, the low pressure turbine was balanced. The second highest production losses occurred in 2004. The loss was mainly caused by the repair of a short-circuit caused by deterioration of a recirculation pump's insulation resistance, and the repair of the generator cooling system and a sea water leak in the condenser.

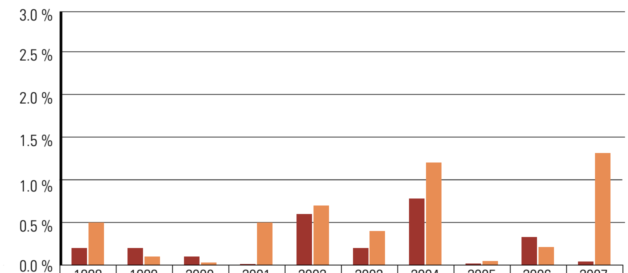
At Olkiluoto 1, the wear of the feedwater pumps' rubbing-face seals has been the most significant fault with an effect on production. The feedwater pump in question must be stopped for replacement of the seal, and production decreases from 100% to 87%. The replacement of the seals for the Olkiluoto 2 feedwater pumps does not cause a corresponding production loss due to the higher capacity of the OL2 feedwater pumps, allowing 100% production with only three feedwater pumps. The fourth pump is a stand-by.

Loss of power production due to failures, Loviisa NPP



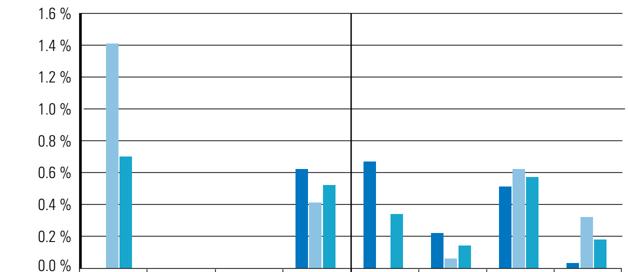
	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
LO1	0.10	0.00	0.10	0.70	0.70	0.10	0.25	0.27	0.17	0.34
LO2	0.80	0.40	0.20	1.20	1.30	2.60	0.25	0.15	0.51	0.23

Loss of power production due to failures, Olkiluoto NPP



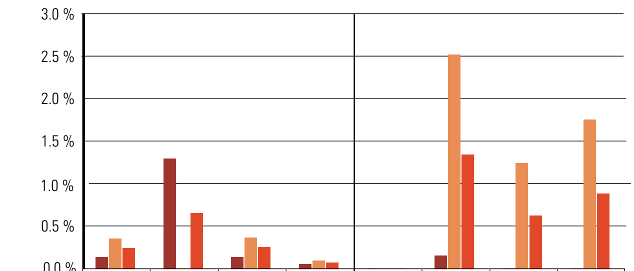
	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
OL1	0.20	0.20	0.10	0.01	0.60	0.20	0.78	0.02	0.33	0.04
OL2	0.50	0.10	0.03	0.50	0.70	0.40	1.20	0.05	0.21	1.31

Loss of power production due to failures, Loviisa NPP



	I/06	II/06	III/06	IV/06	I/07	II/07	III/07	IV/07
LO1	0.00	0.00	0.00	0.62	0.67	0.22	0.51	0.03
LO2	1.41	0.00	0.00	0.41	0.00	0.06	0.62	0.32
LO1,2	0.70	0.00	0.00	0.52	0.34	0.14	0.57	0.18

Loss of power production due to failures, Olkiluoto NPP



	I/06	II/06	III/06	IV/06	I/07	II/07	III/07	IV/07
OL1	0.13	1.29	0.13	0.05	0.00	0.15	0.00	0.00
OL2	0.35	0.00	0.36	0.09	0.00	2.52	1.24	1.75
OL1.2	0.24	0.65	0.25	0.07	0.00	1.34	0.62	0.88

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

Responsible unit/person

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

Interpretation of indicator

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

Non-compliance with the Tech Specs refers to a situation where the plant or a system or component of the plant is not in a safe state as required by the Technical Specifications. The objective is that no events with non-compliance to the Technical Specifications occur at the plants. The licensee always prepares a special report on the non-compliance and any corrective action, and submits the report to STUK for decision.

Loviisa

Exemptions

Exemptions have been more frequent for Loviisa than for Olkiluoto due to the double redundancy of many Loviisa systems. Due to double redundancy, alterations carried out during operation nearly always require an exemption. For example, the large number of exemptions granted in 2003 can be explained by replacement of the fixed measurement system (the MONU project); work related to this project required an exemption in any operating state.

In 2007, the Loviisa power plant applied for a total of 7 examptions from the Tech Specs. One of the applications was related to an extensive servicing of an auxiliary power transformer and another to the Loviisa I&C renewal (LARA project). In future, the number of LARA-related exemptions will increase. Five applications were related to failures and their repair; this is a fairly high figure. In the previous years, the number has been three. Attention will be paid to this in the future when making applications. The basic objective is that the conditions for operating state changes and the repair times set for components in the Tech Specs are met during all faults.

Non-compliances with the Tech Specs

The number of non-compliances with the Tech Specs has remained low in Loviisa in the recent years, and the safety significance of any events has been low. In the last year, two non-compliances with the Tech Specs were observed, both related to power supply.

In March, a temporary coupling left operational after the 2006 annual outage was found at Loviisa 2, non-compliant to the Tech Specs. The coupling was immediately restored. In addition to a special report, a root cause analysis was prepared on the issue and delivered to STUK.

During the 2007 annual outage, the diesel busbar's 6 kV BC/BW busbar's over-current relay tripped at Loviisa 1, causing the residual heat removing pumps of the operating subsystem (the other subsystem was under maintenance) to stop. There were not two pumps available as required by the Technical Specifications (one operational, one as a stand-by), but only one, started up by automation. The plant operated as planned in an individual failure. Other stand-by systems were available to take care of any dangerous situation.

Olkiluoto

Exemptions

In 2007, the Olkiluoto power plant applied five times for STUK's approval for non-compliance with Technical Specifications. STUK approved all applications. Four of the applications concerned deviations from Technical Specifications caused by alterations or refurbishments to the plant, and one was related to a test being carried out in the operating waste cave. In 2004 and 2005, the number of exemptions was increased by work and installations related to the modernisation of OL1 and OL2 and the construction of OL3.

Non-compliances with the Tech Specs

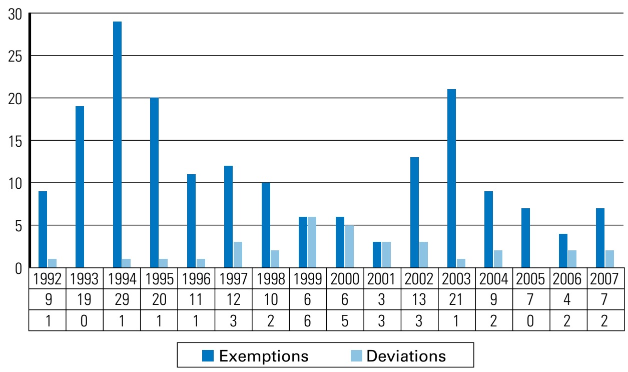
There were only few non-compliances with the Tech Specs at Olkiluoto in 2007. The lowering trend indicates good development.

In 2007, there were two situations at the Olkiluoto plant in which the Technical Specifications were violated.

In TVO's own inspections it was found that the Olkiluoto 1 reactor monitoring system's so called dry-out correlation was programmed to use erroneous basic data for one fuel bundle type. As a result, the margin for operational transients affecting the cooling systems was in fact smaller than that indicated by the core monitoring system. The smaller margin would not have jeopardised fuel integrity even if a simultaneous pressure regulator failure limiting the cooling capacity had occurred.

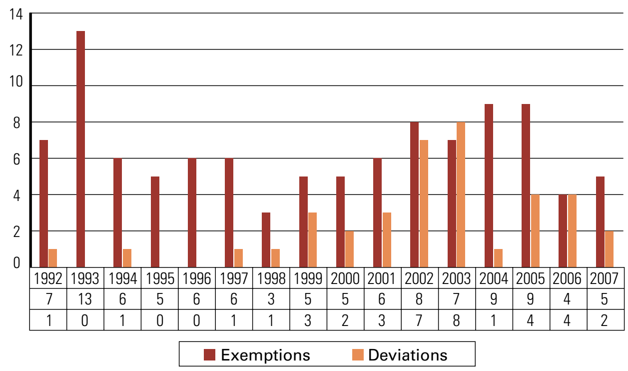
Since 2001, TVO has performed the testing of two main steam relief rapid opening valves in the wrong operational condition. According to the Technical Specifications, one rapid opening valve should be tested after annual outage before the plant unit begins power operation, and the other during power operation. TVO has tested both valves before power operation. The safety significance of the event is minor. The operability of both valves has been stated in regular tests.

Number of deviations from the Tech Spec, Loviisa NPP



	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Exemptions	9	19	29	20	11	12	10	6	6	3	13	21	9	7	4	7
Deviations	1	0	1	1	1	3	2	6	5	3	3	1	2	0	2	2

Number of deviations from the Tech Spec, Olkiluoto NPP



	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Exemptions	7	13	6	5	6	6	3	5	5	6	8	7	9	9	4	5
Deviations	1	0	1	0	0	1	1	3	2	3	7	8	1	4	4	2

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 the emergency diesel generators (EY).

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

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

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

Source of data

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

Purpose of indicator

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

Responsible units/persons

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

Interpretation of indicator

Loviisa

TJ system

The unavailability of the plant units' high pressure safety injection systems increased significantly in 2007.

For LO1, the increase was caused by two failures in the motors charging the 6 kV circuit breakers. The repair of these failures took the total of 19.3 hours after the detection of the failures. However, the unavailability time prior to failure detection, used to calculate the unavailability, was 531.9 hours. This alone was enough to increase the indicator value. In addition to the failures of the two 6 kV circuit breakers, the LO1 TJ system had one repair requiring the adjustment of the limit switch for one valve actuator, which took 1.2 hours.

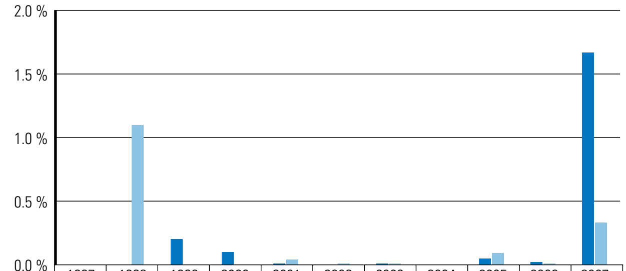
The unavailability of LO2 was caused by the inspection and repair work related to the shaft seal tightness problems occurring in the TJ11 and 52D01 pumps renewed in 2006. The unavailability time resulting from this work was 88.1 hours. In addition, a leak in the oil box of a pump bearing had to be inspected and repaired for TJ52D01, which took 22.5 hours.

The problems of the 6 kV oil-filled circuit breakers causing unavailability of the TJ system have been thoroughly addressed at the plant. To remove the problem, the modernisation of the plant's switchgears continues in accordance with the lifecycle surveys. In the 2008 annual outage, parts of the intermediate circuit breakers will also be renewed according to separate plans, and an inspection of the 6 kV circuit breaker charging status at four weeks' interval will be included in the switchgear inspection procedure.

The occasional leak of shaft sealing water inside the pump observed in the new LO2 TJ pumps, particularly the TJ52D01, has been inspected in cooperation between the plant and the equipment supplier. In January 2008, the seals of the TJ52D01 pump were replaced. In the new seals, the closing force directed at the sealing surfaces has been increased with a structural redesign. In the TJ52D01 test run performed after the change, the new seals have functioned reliably. No leaks have been observed in the seals of the TJ11D01 pump since March 2007, but they will be still replaced in 2008 annual outage to comply with the new, improved structure. If any leaks appear, the seals will be replaced earlier as repair work.

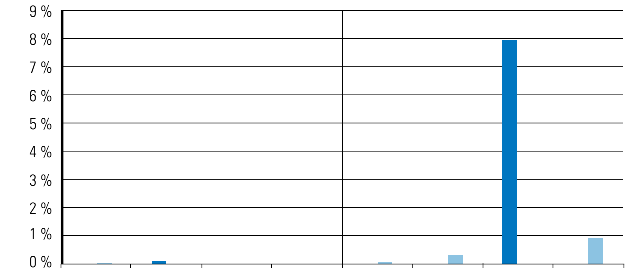
When assessing the condition of the TJ systems, the frequency, significance, identification and repair time of failures, as well the improvements done to prevent the failures from recurring must be observed, among other factors. Based on what is stated above, the plant's TJ systems are still in good condition, and the rare single failures and problems observed have not decreased the reliability of systems to any significant extent.

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



	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
LO1	0.00	0.00	0.20	0.10	0.01	0.00	0.01	0.00	0.05	0.02	1.67
LO2	0.00	1.10	0.00	0.00	0.04	0.01	0.01	0.00	0.09	0.01	0.33

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



	I/06	II/06	III/06	IV/06	I/07	II/07	III/07	IV/07
LO1	0.00	0.08	0.00	0.00	0.00	0.00	7.93	0.00
LO2	0.03	0.00	0.00	0.00	0.04	0.30	0.00	0.92

RL system

In 2007, the unavailability of the auxiliary feed water systems remained in the previous years' level.

For LO1, the total unavailability time was 444 hours, 252 hours of which were RL94 maintenance performed at the annual outage. The total unavailability during power operation, caused by four failure repairs, was 192 hours. 172 hours of this were due to the repair of the RL92D01 pump's free end shaft seal (box), performed as work number 635626; the repair time was 25 hours and the estimated unavailability before the failure was detected was 147 hours.

For LO2, the total unavailability time was 221 hours, 167 hours of which were RL97 maintenance performed at the annual outage. The total unavailability during power operation was 54 hours, due to the replacement of the RL93D01 pump's box seal.

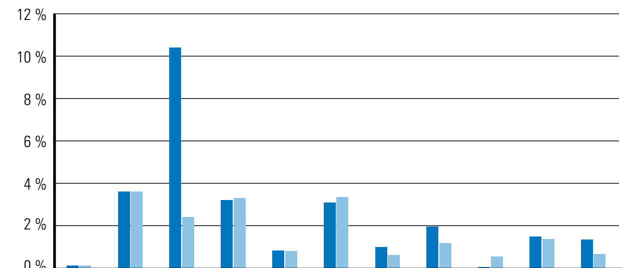
The unavailability of the auxiliary feed water systems was low in 2007, i.e. their condition and availability were good.

EY system

The unavailability of the emergency diesel generators was very low in 2007, i.e. their availability was very good. In 2007 the total unavailability time for all eight diesel generators was 71 hours, consisting of the repair time of five failures. The failures were due to normal component ageing. The failures were not serious.

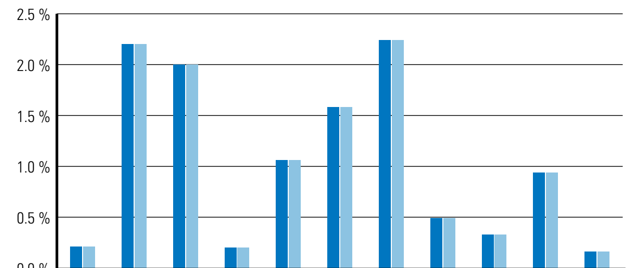
Based on the indicators and the failures behind them, the condition of the EY diesels can be regarded as good.

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



	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
LO1	0.12	3.60	10.40	3.20	0.81	3.09	0.98	1.96	0.03	1.49	1.34
LO2	0.10	3.60	2.40	3.30	0.80	3.34	0.61	1.17	0.53	1.36	0.66

Unavailability of emergency diesel generators (EY), Loviisa NPP



	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
LO1	0.21	2.20	2.00	0.20	1.06	1.58	2.24	0.49	0.33	0.94	0.16
LO2	0.21	2.20	2.00	0.20	1.06	1.58	2.24	0.49	0.33	0.94	0.16

Interpretation of indicator

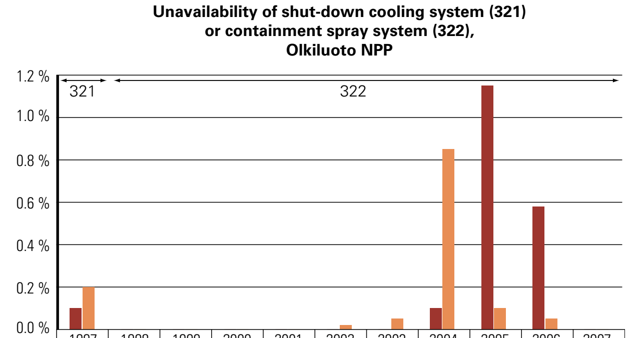
Olkiluoto

The unavailability times of the containment spray system have been decreasing since 2004. In 2007, the unavailability was 0 for both plant units.

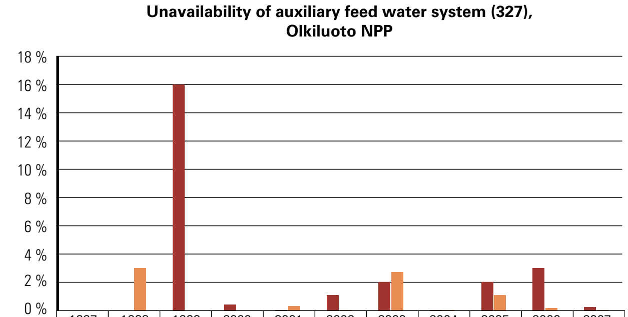
The unavailability of the auxiliary feed water system increased significantly since 2004, when the unavailability was practically at zero. The increased unavailability of Olkiluoto 1 in 2006 was due to faults in the recirculation and safety valves in system 327. As corrective measures, the torque settings of the recirculation line's valve actuator motors were adjusted, and a separate testing line were planned for the safety valves. The first testing line is to be implemented for OL1 in the 2008 annual outage.

There were no significant failures in 2007, and the unavailability of the auxiliary feed water system decreased considerably for both plant units.

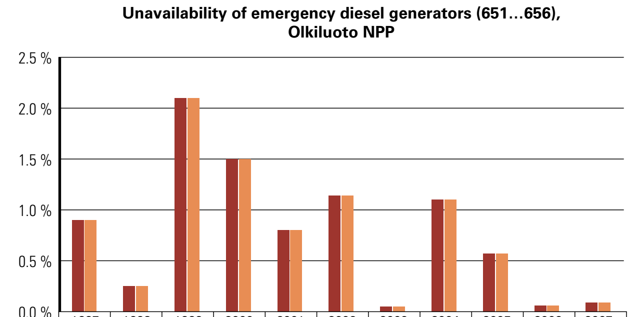
The unavailability of the diesel generators has decreased since 2004, and was very low in 2006. In 2007, the condition of the diesels continued nearly as good as in 2006.



	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
OL1	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.10	1.15	0.58	0.00
OL2	0.20	0.00	0.00	0.00	0.00	0.02	0.05	0.85	0.10	0.05	0.00



	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
OL1	0.00	0.00	16.00	0.40	0.03	1.10	2.00	0.01	2.00	2.98	0.25
OL2	0.00	3.00	0.00	0.00	0.30	0.01	2.71	0.01	1.10	0.18	0.02



	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
OL1	0.90	0.25	2.10	1.50	0.80	1.14	0.05	1.10	0.57	0.06	0.09
OL2	0.90	0.25	2.10	1.50	0.80	1.14	0.05	1.10	0.57	0.06	0.09

A.I.4 Occupational radiation doses

Definition

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

Source of data

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

Purpose of indicator

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

Responsible unit/person

Radiation protection (SÄT)
Antti Tynkkynen

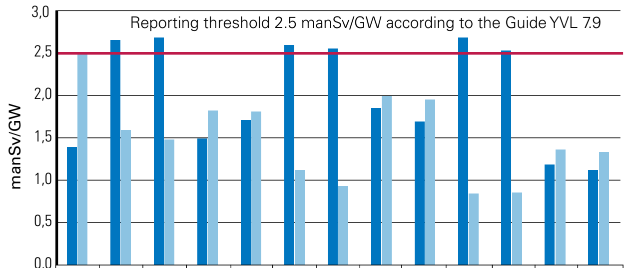
Interpretation of indicator

Loviisa

Most doses are incurred through work done during outages; thus outage duration and the amount of work having significance in radiation protection affect the yearly radiation doses. Both Loviisa plant units have major annual outages every four and eight years (the 4-year annual maintenance and the 8-year annual maintenance) so that both plant units never have a major annual maintenance outage in the same year. In the previous years, major outages have been held in even years and normal outages in odd years. The effect of annual outages on the collective dose is clearly visible in the diagram. In 2007 the annual maintenance outages for the Loviisa plant units were short of duration, and there were only a few works having a bearing on for radiation protection. For this reason, the collective dose of the Loviisa power plant was at an all time low. The low dosage is also partly a result of the increased experience of the Loviisa radiation protection personnel and the increasingly efficient radiation monitoring at the workplace. In addition, the Loviisa power plant has set clear objectives for reducing radiation doses.

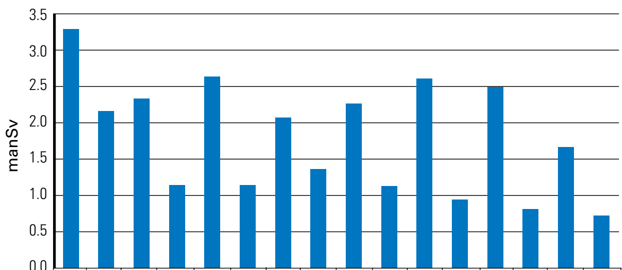
The radiation doses for nuclear power plant

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



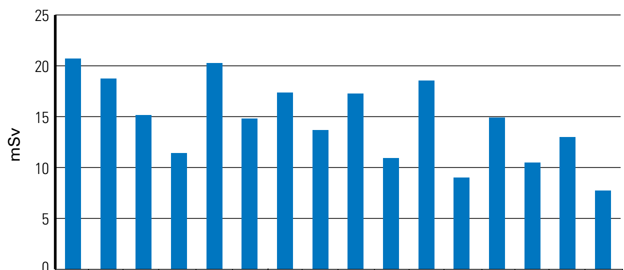
	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
LO1	1.39	2.65	2.68	1.49	1.71	2.59	2.55	1.85	1.69	2.68	2.53	1.18	1.12
LO2	2.51	1.59	1.48	1.82	1.81	1.12	0.93	1.99	1.95	0.84	0.85	1.36	1.33

Collective occupational radiation dose (manSv), Loviisa NPP



	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
LO1	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	0.72

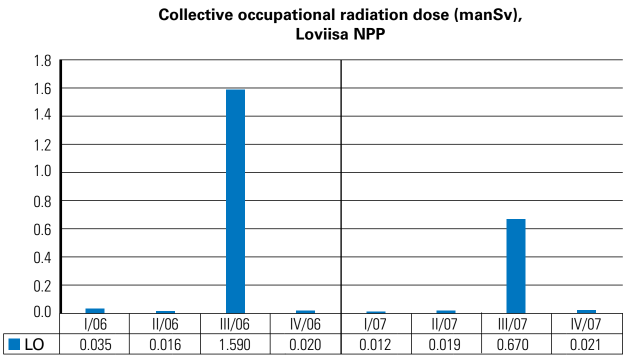
Average of the ten highest doses (mSv), Loviisa NPP

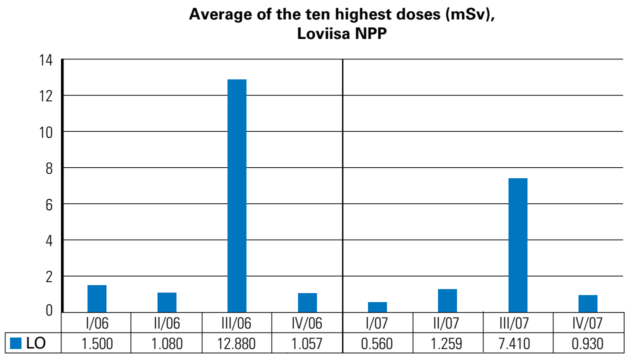


	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
LO	20.7	18.7	15.1	11.4	20.2	14.8	17.3	13.7	17.2	10.9	18.5	9.0	14.9	10.4	13.0	7.8

workers remain below the personal dose limits. The average for ten highest doses has been decreasing for some years, and in 2007 the average was lower than ever. The Radiation Decree (1512/1991) stipulates that the effective dose for a worker from radiation work must not exceed the 20 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 2007. 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).





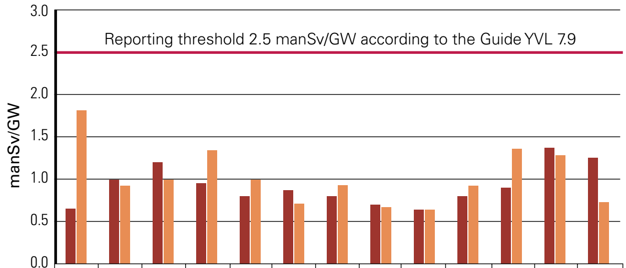
Interpretation of indicator

Olkiluoto

Most doses are incurred through work done during outages; thus outage duration and the amount of work having a bearing on radiation protection affect the yearly radiation doses. The annual outages for the Olkiluoto power plant units are divided into two groups: the refuelling outages and the maintenance outages. The refuelling outage is shorter of duration (approx. 7 days). The length of the maintenance outage depends on the amount of work (2–3 weeks). Annual outages are scheduled so that in the same year, one plant unit has maintenance outage and the other a refuelling outage. In 2005 and 2006 the collective doses for the workers were high due to turbine work with considerable significance to radiation protection.

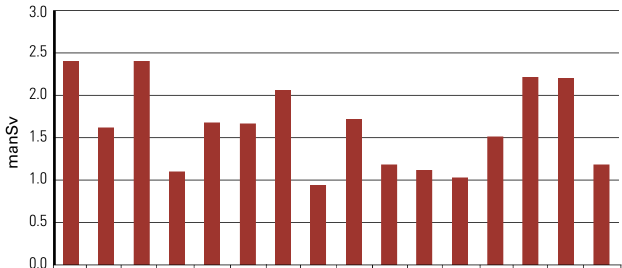
In 2007, the collective dose at Olkiluoto was lower than average. In addition, the average for ten highest doses was lower than in the previous years, and the set dose limits (YVL 7.9, the Radiation Decree 1512/1991) were not exceeded.

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



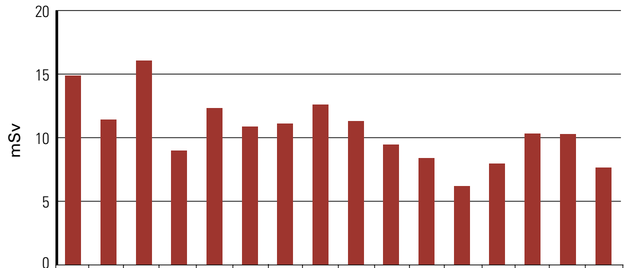
	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
OL1	0.65	0.99	1.20	0.95	0.80	0.87	0.80	0.70	0.64	0.80	0.90	1.37	1.25
OL2	1.81	0.92	0.99	1.34	0.99	0.71	0.93	0.67	0.64	0.92	1.36	1.28	0.73

Collective occupational radiation dose (manSv), Olkiluoto NPP



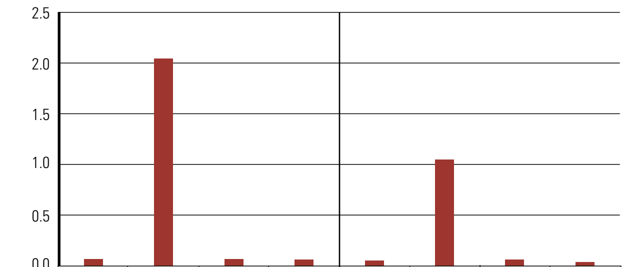
	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
OL	2.40	1.62	2.40	1.10	1.68	1.67	2.06	0.94	1.72	1.18	1.12	1.03	1.51	2.22	2.20	1.18

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



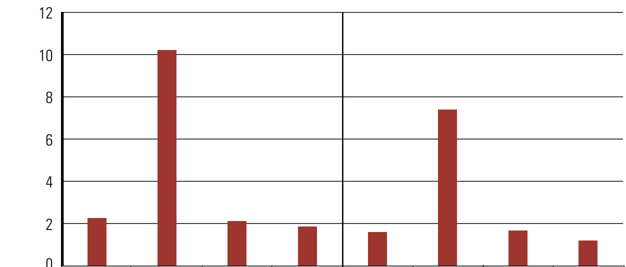
	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
OL	14.9	11.4	16.1	9.0	12.3	10.9	11.1	12.6	11.3	9.5	8.4	6.2	8.0	10.3	10.3	7.6

Collective occupational radiation dose (manSv), Olkiluoto NPP



	I/06	II/06	III/06	IV/06	I/07	II/07	III/07	IV/07
OL	0.067	2.045	0.065	0.064	0.052	1.048	0.060	0.039

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



	I/06	II/06	III/06	IV/06	I/07	II/07	III/07	IV/07
OL	2.250	10.210	2.120	1.865	1.590	7.395	1.670	1.205

A.I.5 Radioactive releases

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

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

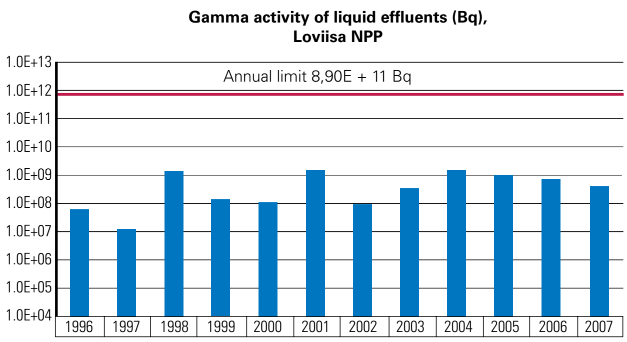
Purpose of indicator
The indicator is used to follow the amount and trend of radioactive releases and to assess factors having a bearing on any changes in them.

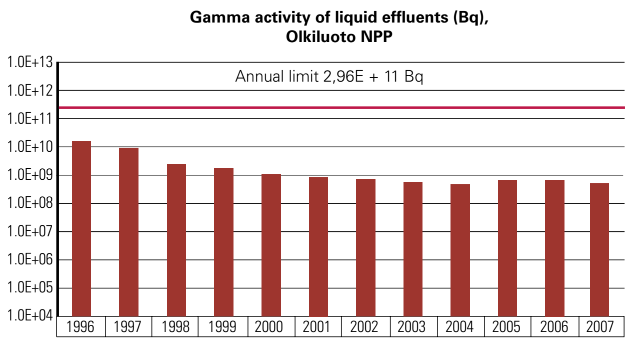
Responsible unit/person
Radiation protection (SÄT), Antti Tynkkynen

Interpretation of indicator (releases into the sea)
Releases into the sea from the Loviisa power plant were slightly smaller than in the previous year. The plant made a last controlled discharge of low-activity clarified evaporation residues into the sea in 2004. Releases into the sea from the Olkiluoto plant have reduced after the commissioning of new process water purification and treatment equipment.

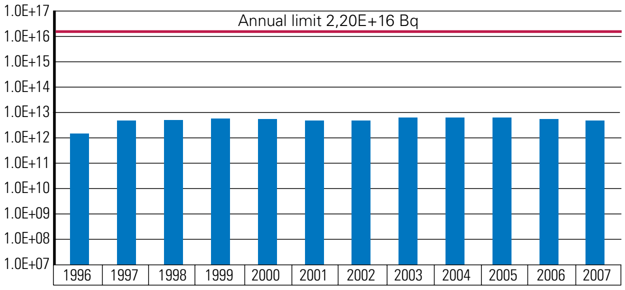
Interpretation of indicator (releases into the atmosphere)
Releases into the atmosphere were of the same magnitude as in the preceding years. Radioactive releases into the environment from the Loviisa and Olkiluoto nuclear power plants were small. They are well below the set limits.

Gaseous fission products, noble gases and iodine 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 leaks. At both Loviisa and Olkiluoto, fuel leaks have been very small. The indicator A.III.1 describes fuel integrity. The noble gas releases from the Loviisa plant are dominated by argon-41, an activation product of argon-40, found in the airspace between the reactor pressure vessel and the biological shield. Aerosol nuclides (ia activated corrosion products) are released for example during maintenance work.

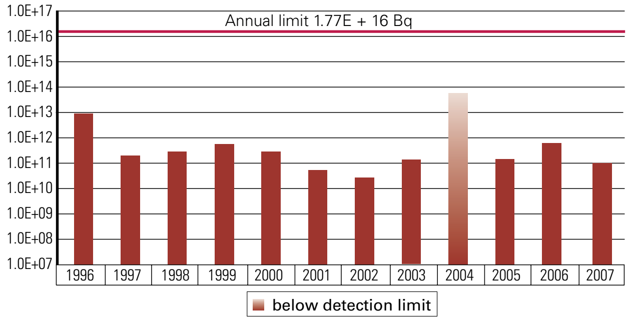




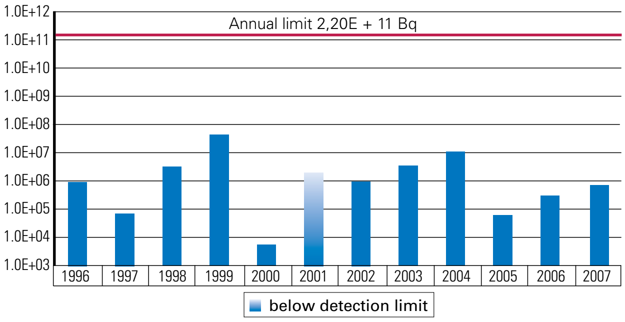
Noble gas releases (Bq $^{87}Kr_{eq}$), Loviisa NPP



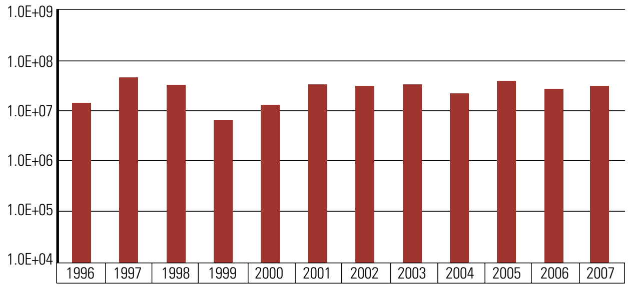
Noble gas releases (Bq $^{87}Kr_{eq}$), Olkiluoto NPP



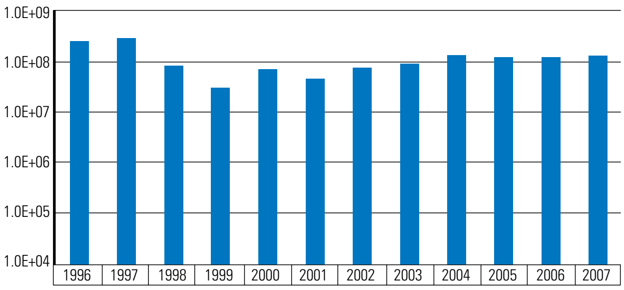
Iodine isotope releases to atmosphere (Bq $^{131}I_{eq}$), Loviisa NPP



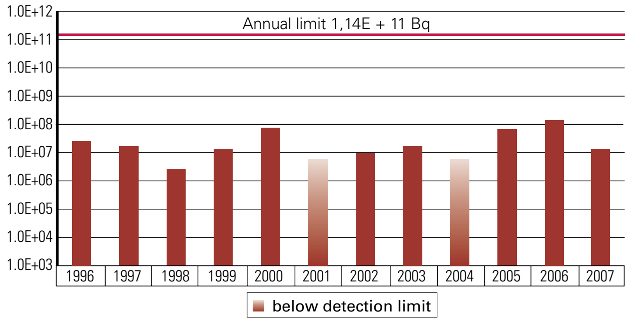
Aerosol releases to atmosphere (Bq), Olkiluoto NPP



Aerosol releases to atmosphere (Bq), Loviisa NPP



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

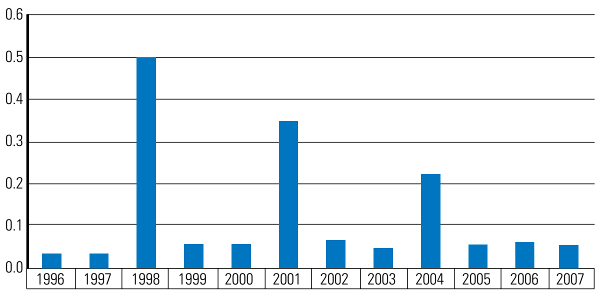


Interpretation of indicator (population exposure)

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 both Loviisa and Olkiluoto, 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.

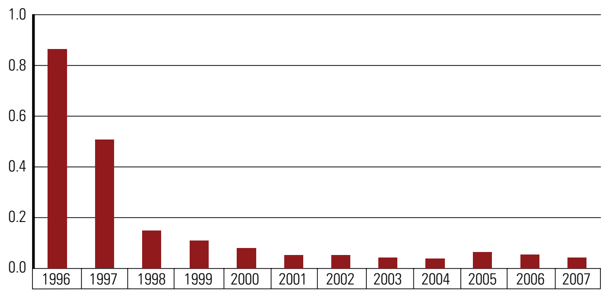
The calculated doses of the most exposed individual in the vicinity of both plants are less than 0.1% of the 100 microSv limit established in the Government Decision (395/1991).

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



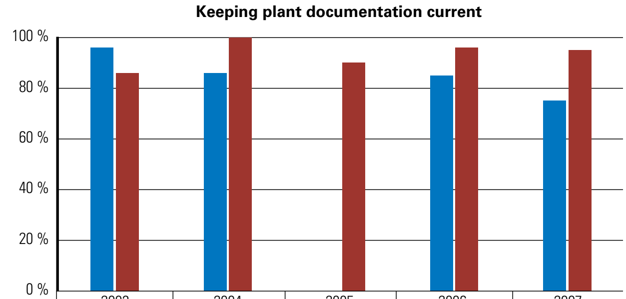
Annual dose limit 100 μSv

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



	2003	2004	2005	2006	2007
LO	96	86	0	85	75
OL	86	100	90	96	95

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 needed for the calculation of the indicator value are requested directly from the utility.

Purpose of indicator

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

Responsible unit/person

Organisations and Operations (OKA)
Tomi Koskiniemi

Interpretation of indicator

The currency of plant documentation 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. The extent of the Loviisa operating manual is roughly double to the Olkiluoto manual.

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 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 2007 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 2007 and their realisation (need for updating/implemented). Both plant units had a short annual outage, and the number of modifications remained very low. This also showed in the number of document updates.

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 2007. Updated documentation included emergency operating procedures, Technical Specifications and PI diagrams. Operating manuals had not been updated, but a necessary training notification had been attached to the procedure instead. Training notifications cannot be considered an update.

The calculated indicator indicates that as in previous years, document updates were reasonably successful. However, there is room for improvement especially for the operating procedures. The number of updates will multiply in connection with the Loviisa automation system renewal, requiring attention to the issue in the future.

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 Olkiluoto is based on the identified needs for document updates related to modifications implemented during annual maintenance at the Olkiluoto 2 plant unit in 2007 and their realisation (need for updating / implemented). Changes to instructions were considerably smaller in 2007 than in the previous years (2005 and 2006), when major modernisation was carried out for the turbines.

On the basis of a random inspection, it was noted that the document revisions necessitated by modifications in the Olkiluoto 2 main control room during the annual maintenance of 2007 had been implemented in the most relevant documents. The instruction documents required no comments in general. All inspected procedures were up to date.

The only deficiency concerned the hand written ("red pen") versions of the PI diagrams, which were slightly clearer than in recent years. TVO's established practice is to update old pictures during revisions with so called red pen versions or additional notes, and to update the actual flow charts later in the autumn.

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

Organisations and Operations (OKA)
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.

Investments at the Loviisa plant units for 2004–2006 were above average. 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.

Correspondingly, the figures for Olkiluoto show the extensive modernisation carried out for both plant units in 2005–2006, with renewal of the reheater, high pressure turbine, moisture separator, turbine automation and the 6.6 kV switchgears.

Both plants have paid very much attention to life-cycle management, which also shows as continuous long term investment plans. The renewal of the operation permit of the Loviisa plant in 2007 and the upcoming intermediate assessment at Olkiluoto have also had an effect on the investment plans. At the moment, the situation is good at both plants.

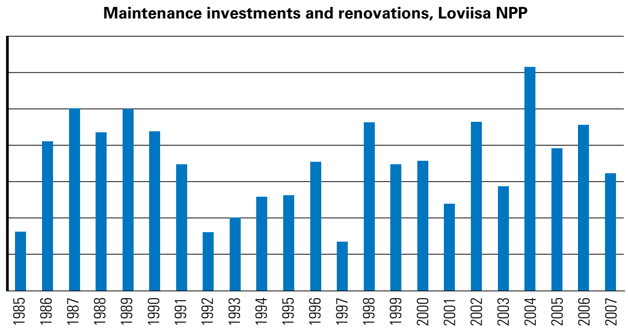
Loviisa

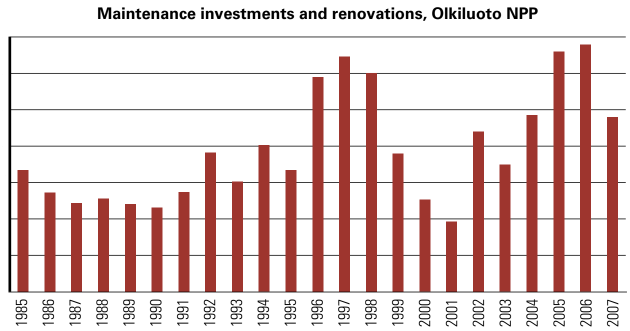
The most important investments at Loviisa power plant in 2007 were local works related to the Loviisa automation renewal (LARA), the upgrade of the waste, storage and decontamination facilities (VAJAKO), the renewal of the loose parts monitoring system, the improvement of the secondary circuit's safety (LARA/SETU), the renewal of the oxygen and hydrogen analysers for radioactive gases (TS system renewal), and the new fuel racks.

Olkiluoto

At Olkiluoto, the most important investments in 2007 included the start of the low pressure turbine renewal, the generator acquisition projects that were begun at OL1 and continued at OL2, and the continuing construction of the gas turbine, begun in 2007. All these projects relate to power production and life-cycle management of the plant.

Of major investments, the demineralisation plant renewal (additions required by OL3), laboratory extension, bituminisation equipment renewal and the new landfill were completed in 2007.





A.II Operational events

A.II.1 Number of events

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

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

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

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

Interpretation of indicator

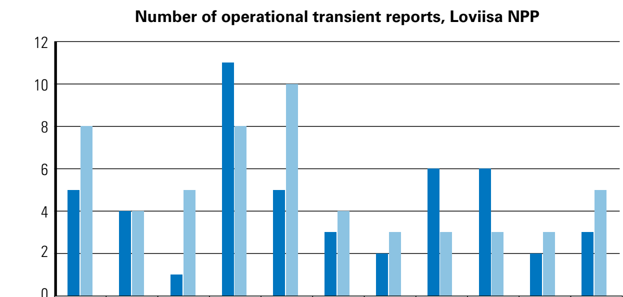
Loviisa
The numbers of events warranting a special report went down from the previous year, but there have been no major changes in the long term. The numbers have remained reasonably low.

In the last year, two events warranting a special report (both non-compliances with the Tech Specs, see section A.I.2) were observed, both related to power supply. At Loviisa 2, a temporary coupling had been left operational in the 2006 annual outage; in the 2007 annual outage of Loviisa 1, an over-current relay tripped in the 6 kV busbar of the diesel busbar, causing the residual heat removing pumps of the operating subsystem to stop (the other subsystem was under maintenance).

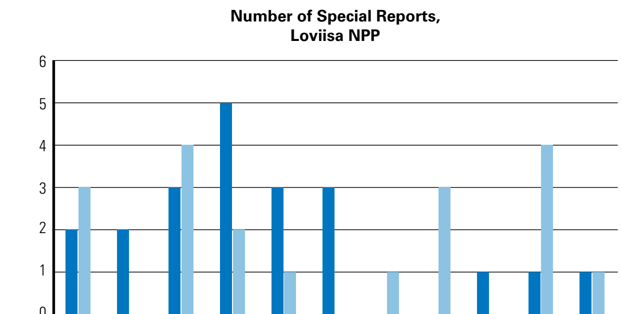
The safety effect of both events is minor: the erroneous coupling at Loviisa 2 was immediately restored, and the plant operated as planned when the diesel busbar's overcurrent relay tripped at Loviisa 1, with other back-up systems available in addition to the one pump, ensuring the management of any dangerous situation.

Corrective measures were targeted at modification coordination for the first of these events, and at implementation management, the scheduling of work in the work order system, and more specific inspection instructions for electrical work for the latter. In the latter case, the cause of the malfunction of the over-current relay was left undetected, and is being inspected. At the same time, possibilities for backing up the power supply of the diesel generator's auxiliary systems are surveyed.

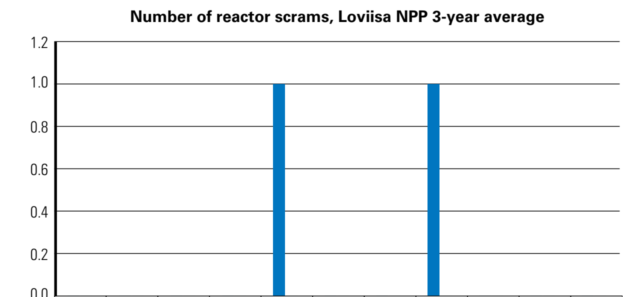
The number of reported operational transients has remained reasonably good since 2002, between 5 and 9 transients per year. Transients occurred in turbine control at Loviisa 1 (2 events) and a disturbance in the 110 kV network. At Loviisa 2, transients included a feed water pump failure,



	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
LO1	5	4	1	11	5	3	2	6	6	2	3
LO2	8	4	5	8	10	4	3	3	3	3	5



	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
LO1	2	2	3	5	3	3	0	0	1	1	1
LO2	3	0	4	2	1	0	1	3	0	4	1



	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
LO1	0	0	0	0	1	0	0	1	0	0	0
LO2	0	0	0	0	0	0	0	0	0	0	0

reactor coolant pump trip due to a fault, protective trip of the main seawater pump, drop of one control rod due to damages, and an erroneous opening of a transformer breaker (national grid connection). The plant operated as planned during the transients.

The number of reactor trips has been low at Loviisa, partly due to the two turbines. These guarantee that if one turbine trips due to a malfunction or other cause, the reactor remains operational. No reactor scrams occurred in 2005–2007.

Olkiluoto

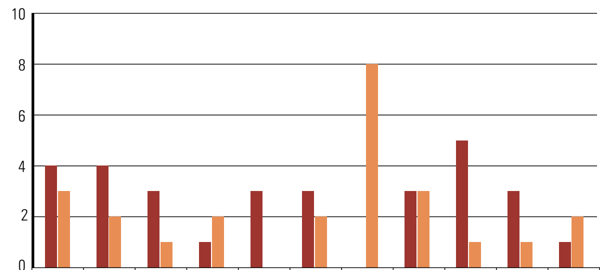
Three reactor scrams occurred at Olkiluoto 2 in 2007: 15 May, 4 September and 29 December. There have been fewer reactor scrams in the 2000s than in the 1990s; the previous reactor trip occurred at Olkiluoto 1 in 2004.

There were no significant changes in the number of events warranting a special report or an operational transient report. The number of events warranting a special report at Olkiluoto 2 does not give a correct conception of the division of events by plant unit, since for system technical reasons, the reports for both plant units have been entered for Olkiluoto 1. For example, all three Olkiluoto 1 events in 2007 also applied to Olkiluoto 2.

Events warranting a special report in 2007 included the periodical testing of the relief system valves in an operational mode other than the one specified in the Technical Specifications, the Olkiluoto 2 reactor scram on 4 September 2007, the use of unqualified and unsuitable fuses and the unlocked containment isolation valves.

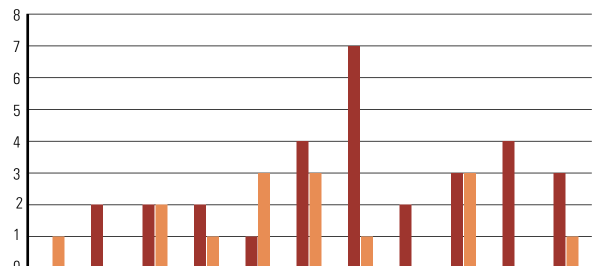
Operational transient reports were prepared on the failure of a rubbing-face seal in an Olkiluoto 1 feed water pump, a fire ignited at Olkiluoto 2 turbine island and the operational transients at Olkiluoto 2 in 27–29 December 2007 (wrong running direction of a reactor coolant pump, steam leaks in the turbine island).

Number of operational transient reports, Olkiluoto NPP



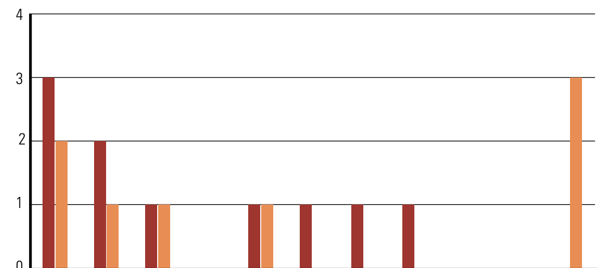
	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
OL1	4	4	3	1	3	3	0	3	5	3	1
OL2	3	2	1	2	0	2	8	3	1	1	2

Number of Special Reports, Olkiluoto NPP



	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
OL1	0	2	2	2	1	4	7	2	3	4	3
OL2	1	0	2	1	3	3	1	0	3	0	1

Number of reactor scrams, Olkiluoto NPP



	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
OL1	3	2	1	0	1	1	1	1	0	0	0
OL2	2	1	1	0	1	0	0	0	0	0	3

A.II.2 Direct causes of events

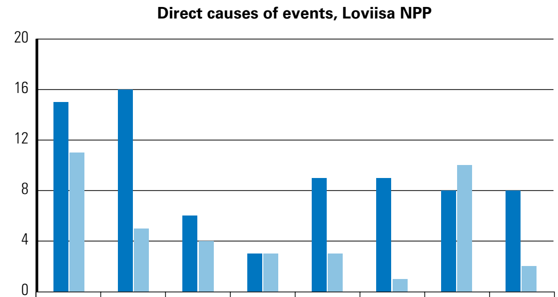
Definition
As the indicators, the direct causes of events reported in accordance with Guide YVL 1.5 are followed. The causes of the events are divided into technical failures and erroneous operational and maintenance actions (non-technical, human errors).

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

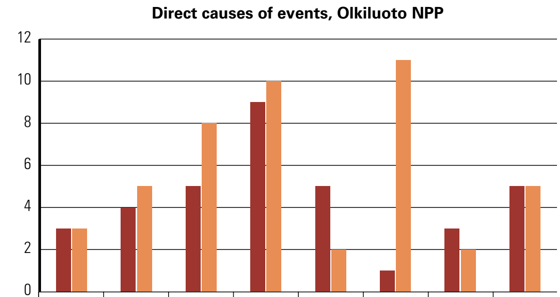
Purpose of indicator
The indicator is used to follow the division of the causes of reported events into technical and non-technical causes. "Non-technical causes" denote failures caused by erroneous operational and maintenance actions. The indicator may be descriptive of an organisation's operation.

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.



	2000	2001	2002	2003	2004	2005	2006	2007
Technical	15	16	6	3	9	9	8	8
Human	11	5	4	3	3	1	10	2



	2000	2001	2002	2003	2004	2005	2006	2007
Technical	3	4	5	9	5	1	3	5
Human	3	5	8	10	2	11	2	5

A.II.3 Risk-significance of events

Definition

As the indicators, the risk-significance of events caused by component unavailability is followed. As the risk measure, an increase in the Conditional Core Damage Probability (CCDP) associated with each event is employed. CCDP takes the duration of each event into consideration. Events are divided into three categories: 1) 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 indicator is the number of events in each category.

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

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

Source of data

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

Purpose of indicator

The indicator is used to follow the risk-significance of component 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. Another objective of the event analysis is to systematically identify signs of deteriorating organisational and safety culture.

Responsible unit/person

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

Interpretation of indicator

Loviisa

A brief description of the significant events is given below:

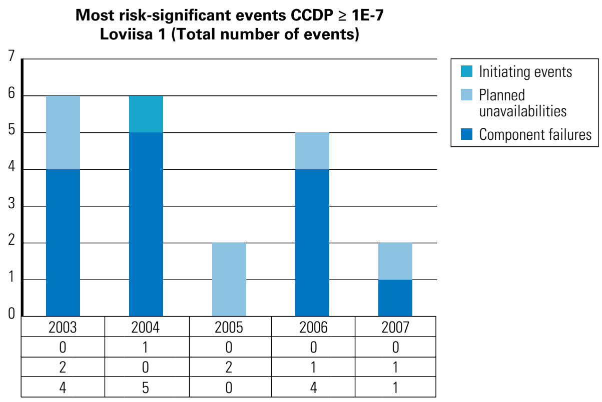
Loviisa 1:

1) High pressure safety injection system pump TJ11D01 unavailable due to a failure of a 6 kV circuit breaker. The failure was undetected for 14 days.
2) Preventive maintenance: Maintenance of the auxiliary feed water system RL97 during revision (duration approximately 11 days).

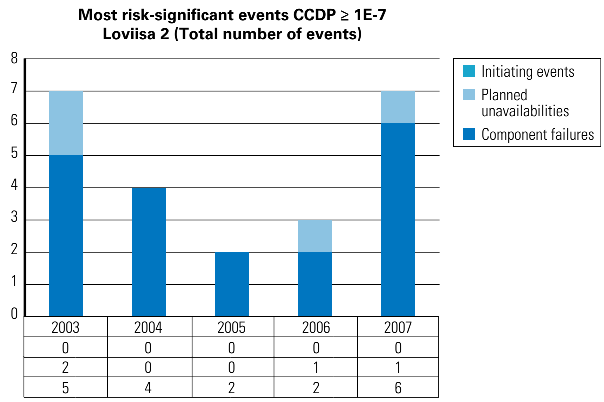
Loviisa 2:

1) Valve S02 of the intermediate cooling circuit TF33 didn't operate reliably, which endangered the operation of the line in question. The failure had been latent for approximately 15 days.
2) The diesel EY02 failed to start during testing, oil level alarm.
3) Preventive maintenance: Maintenance of the auxiliary feed water system RL94 during revision (duration approximately 11 days).
4) A pump of the containment spray system started to leak during testing. The failure had been latent for approximately 6 days.
5) A disturbance in the cooling appratus B02 of the air conditioning system UV46 of the I&C facilities.
6) A leak in the sea water condenser of the air conditioning system UV45 of the I&C facilities.

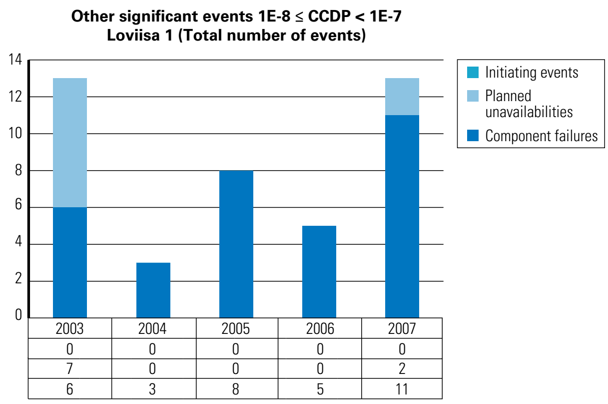
At Loviisa, the risk arising from events consists of a few single device failures and the preventive maintenance of the auxiliary feed water system redundancies. The analysed events are considered part of normal nuclear power plant operation, and no further measures were required from STUK.



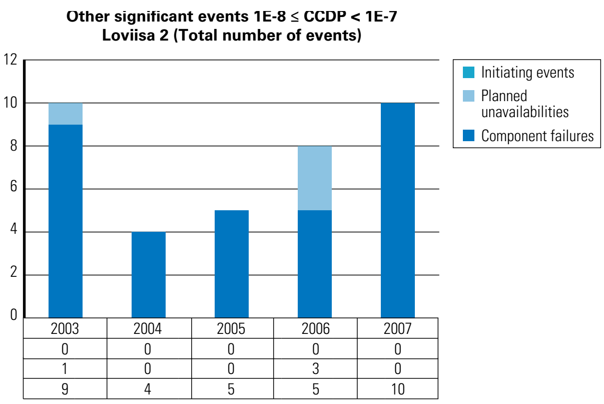
	2003	2004	2005	2006	2007
Initiating events	0	1	0	0	0
Planned unavailabilities	2	0	2	1	1
Component failures	4	5	0	4	1



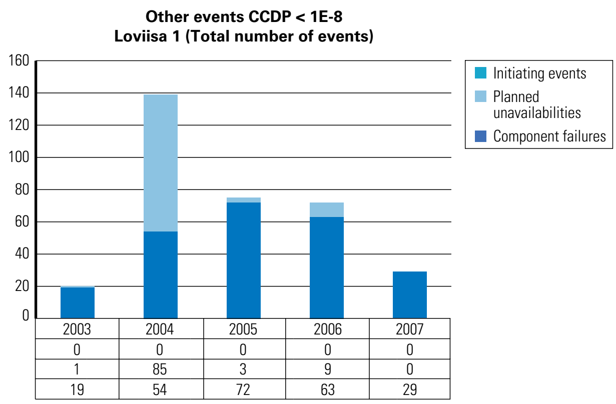
	2003	2004	2005	2006	2007
Initiating events	0	0	0	0	0
Planned unavailabilities	2	0	0	1	1
Component failures	5	4	2	2	6



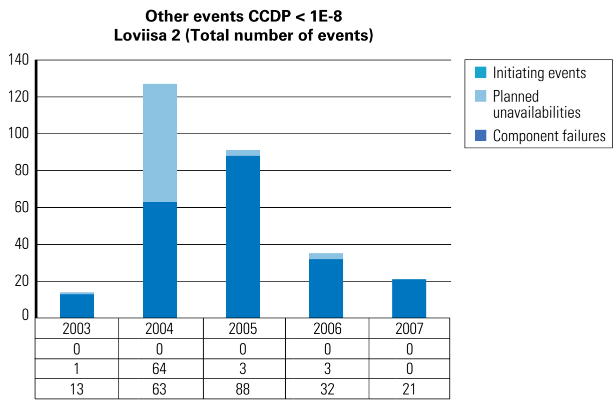
	2003	2004	2005	2006	2007
Initiating events	0	0	0	0	0
Planned unavailabilities	7	0	0	0	2
Component failures	6	3	8	5	11



	2003	2004	2005	2006	2007
Initiating events	0	0	0	0	0
Planned unavailabilities	1	0	0	3	0
Component failures	9	4	5	5	10



	2003	2004	2005	2006	2007
Initiating events	0	0	0	0	0
Planned unavailabilities	1	85	3	9	0
Component failures	19	54	72	63	29



	2003	2004	2005	2006	2007
Initiating events	0	0	0	0	0
Planned unavailabilities	1	64	3	3	0
Component failures	13	63	88	32	21

Olkiluoto

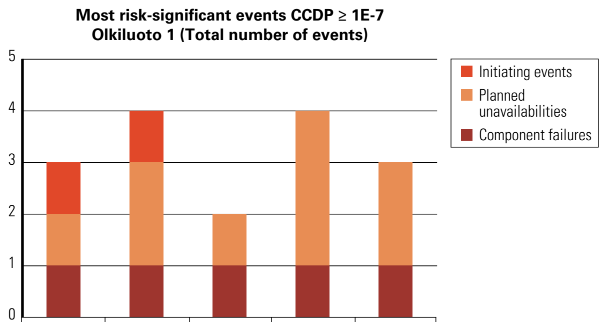
A brief description of the significant events is given below:

Olkiluoto1:

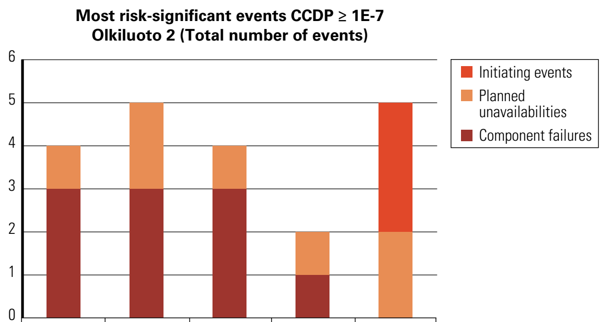
1) The flow measurement K321 of line 3 of the service water system 712 was defective and prevented the normal operation of the line. The failure had been latent for approximately 3 days.
2) Preventive maintenance: The diesel package DIP-B took approximately 17 days.
3) Preventive maintenance: The diesel package DIP-D took approximately 4 days.

Olkiluoto2:

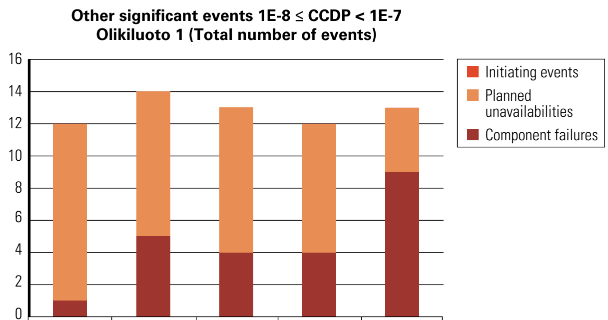
1) Initial event: A trip and a loss of condenser and feed water caused by faulty operation of the steam bypass valves.
2) Initial event: Trip, the plant operated as expected.
3) Initial event: Trip, the plant operated as expected.
4) Preventive maintenance: The diesel package DIP-D took approximately 4 days.
5) Preventive maintenance: The diesel package DIP-B took approximately 18 days.



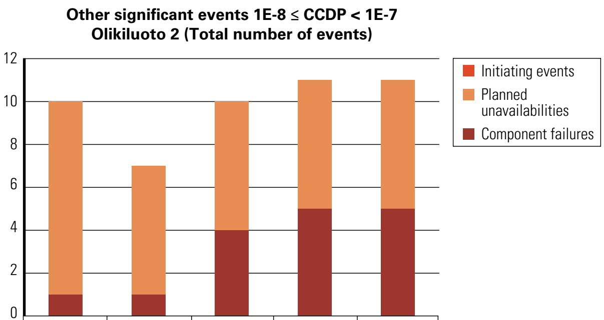
2003	2004	2005	2006	2007
1	1	0	0	0
1	2	1	3	2
1	1	1	1	1



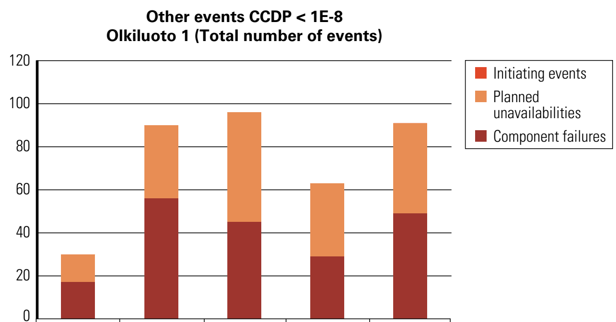
2003	2004	2005	2006	2007
0	0	0	0	3
1	2	1	1	2
3	3	3	1	0



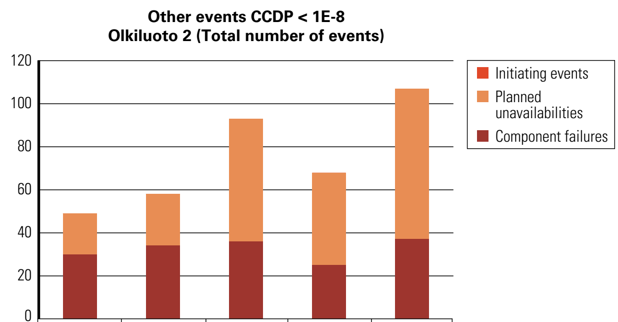
2003	2004	2005	2006	2007
0	0	0	0	0
11	9	9	8	4
1	5	4	4	9



2003	2004	2005	2006	2007
0	0	0	0	0
9	6	6	6	6
1	1	4	5	5



2003	2004	2005	2006	2007
0	0	0	0	0
13	34	51	34	42
17	56	45	29	49



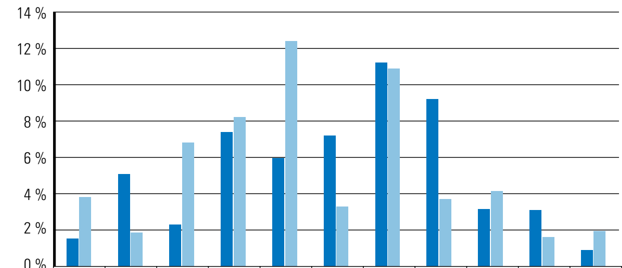
2003	2004	2005	2006	2007
0	0	0	0	0
19	24	57	43	70
30	34	36	25	37

At Olkiluoto, the risk arising from events consisted of three trips and a few single device failures, as well as the long duration of diesel packages. The analysed events are considered part of normal nuclear power plant operation, and no further measures were required from STUK.

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

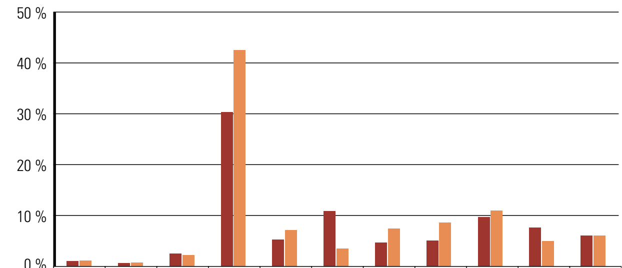
Risk arising from operational activities has remained substantially at the same level as in the previous years.

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



	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
LO1	1.54	5.09	2.30	7.39	5.96	7.20	11.21	9.20	3.15	3.10	0.90
LO2	3.80	1.87	6.80	8.23	12.39	3.30	10.90	3.70	4.14	1.60	1.95

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



	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
LO1	1.05	0.65	2.47	30.30	5.28	10.90	4.68	5.10	9.64	7.60	6
LO2	1.14	0.72	2.26	42.50	7.17	3.50	7.39	8.60	10.95	5.00	6

A.II.4 Accident risk of nuclear facilities

Definition

As the indicator, the annual probability of an accident leading to severe damages to nuclear fuel (core damage frequency) is followed. The accident risk is presented per one nuclear power plant unit.

Source of data

The data is obtained as the result of probabilistic risk analyses (PRA/PSA) of the nuclear power plants. The risk analysis is based on detailed calculation models, continuously developed and complemented. A total of 200 man-years have been used at Finnish nuclear power plants to develop the models. As the basic data of the risk analyses, globally collected reliability information of components and operator activities as well as the operating experience from Finnish power plants are used.

Purpose of indicator

The indicator is used to follow the development of the nuclear power plant's accident risk. The objective is to operate and maintain the nuclear power plant so that the accident risk decreases or remains stable. Risk analyses can help detect needs for making modifications to the plant or changing operating methods.

Responsible unit/person

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

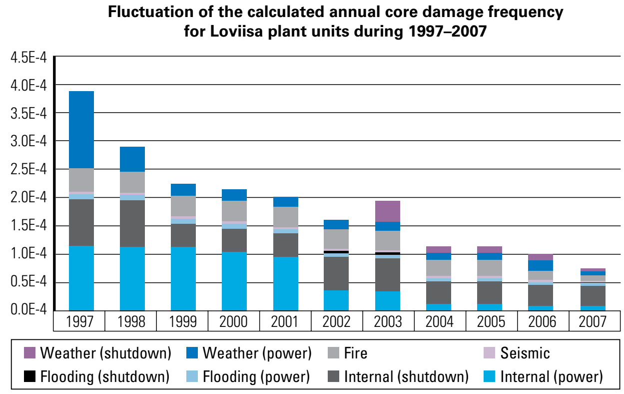
Interpretation of indicator

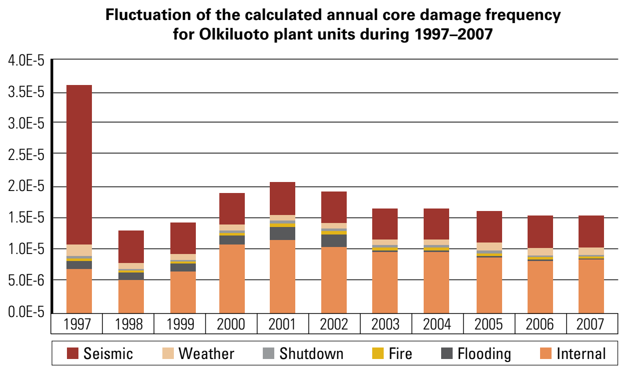
When assessing the indicator, it must be remembered that it is affected by both the development of the power plant and the development of the calculation model. Plant modifications and changes in methods, carried out to remove risk factors, will decrease the indicator value. Increase of the indicator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

Loviisa power plant's accident risk has continued to decrease for the last ten years, and new risk factors discovered as the scope of the risk analysis has been extended have been efficiently removed. The indicator decreased in 2007 due to the new seawater line completed during the period. The new line allows for the alternative intake of seawater from the outlet channel to cool the plant in shutdown operation. The change will decrease risks in situations where algae, frazil ice or an oil release endanger the availability of seawater through the conventional route.

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

In the recent years, the indicator for the Olkiluoto power plant has remained relatively stable or decreased slightly due to minor improvements at the plant. The most important accident risk factors for the Olkiluoto power plant include internal events during power operation (equipment defects and pipe ruptures leading to an operational transient)





and relay failures caused by earthquakes deemed possible in Finland.

A.II.5 Number of fire alarms

Definition
As the indicators, the numbers 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
Civil Engineering and Fire Protection (RAK)
Heikki Saarikoski

Interpretation of indicator
There were no events classified as fires at the Loviisa power plant in 2007.

At the Olkiluoto power plant, there were five classified events. Below is a list of the fire events:

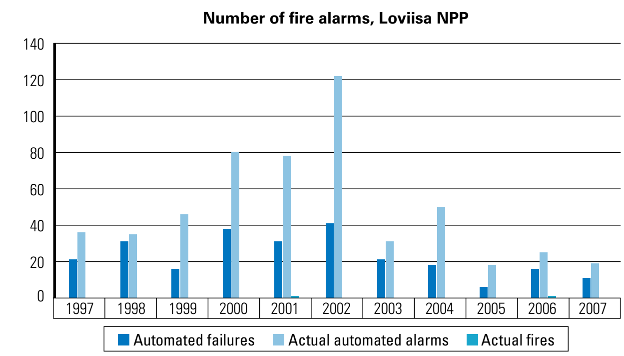
- 5.4.2007: Water station: A short-circuit and some kind of explosion occurred in the UPS equipment.
- 7.6.2007: A small oil fire occurred in the OL2 turbine building. An operational transient report has been drawn up on the event.
- 26.6.2007: OL1, security centre building: A filter in an air conditioning device produced smoke.
- 5.7.2007: OL1, hydrogen centre: Hydrogen fire in a pressure gauge station. An event report has been drawn up on the fire.
- 16.12.2007: OL1, the diesel room for the subsystem A: Starting compressor had broken and there was smoke in the room. The alarm was initially a pre-warning and then became a real fire alarm.

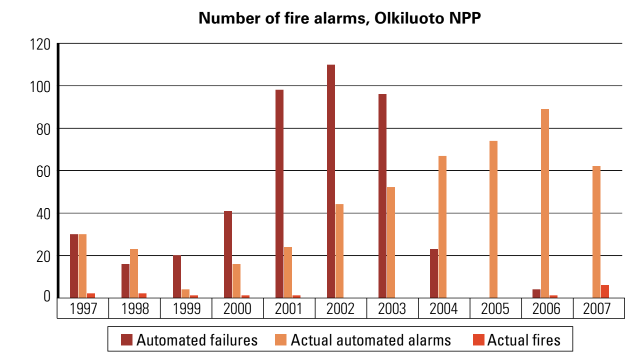
At the Loviisa power plant, the fire alarms and detector failures decreased to some extent compared to the previous year. At the Olkiluoto power plant, the fire alarms also decreased to some extent compared to the previous year. Several factors affect the number of alarms: the number of completed maintenance work, area of disconnecting detectors when carrying out so called hot works during maintenance period, and the reliability of operation of fire detectors.

Fire alarms caused by dust, smoke or humidity dominated the number of fire alarms at both the Loviisa and Olkiluoto plants. The number of Olkiluoto alarms also includes alarms 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 fire detection system was replaced at Loviisa in 2000 and at Olkiluoto in 2001. The number of alarms increased at both units after that due to more sensitive fire detectors and occurred equipment failures. The distinct reduction in fire 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 number of fire alarms.

For both the Loviisa and Olkiluoto plants, fire safety has remained stable at the same average level. At the Loviisa plant, fire safety can be considered slightly improved since the number of fire alarms has decreased and there have been no classified fire events. At the Olkiluoto plant, fire safety can be estimated to have remained at the same level as in the previous year, since the number of fire alarms has decreased and the number of classified fire events has only increased by a few minor events.





A.III Structural integrity

A.III.1 Fuel integrity

Definition

As the indicators, plant unit-specific maximum level and the highest maximum activity concentration of the iodine-131 in the primary coolant in steady-state operation (start-up operation or power operation for Loviisa and power operation for Olkiluoto) are followed. As the indicator for the Loviisa plant, the activity level of the primary coolant calculated as I-131 equivalent concentrations, as well as the maximum activity as the sum of iodine isotopes, were followed until the end of 2006. Late in 2006, the Technical Specifications limit concerning the iodine activities in primary coolant was defined as an I-131 activity concentration instead of the sum of iodine isotopes used until then. At the same time, I-131 activity concentrations were adopted for the monitoring of the maximum activity level. Loviisa power plant delivered the values for I-131 activity concentrations retrospectively from 1997–2006.

The maximum activity concentration of I-131 during depressurisation while entering shutdown or after reactor scram, as well as the number of leaking fuel bundles removed from the reactor, are also followed as indicators.

Source of data

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

Purpose of indicator

The indicators describe fuel integrity and the size of a fuel cladding failure during the operating cycle. The indicators for shutdown situations also describe the success of the shutdown concerning radiation protection.

Responsible unit/person

Reactor and Safety Systems (REA),
Kirsti Tossavainen

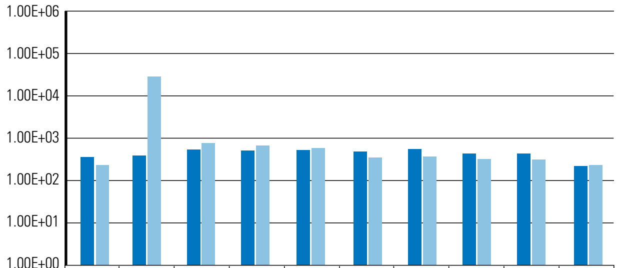
Primary coolant activity

Interpretation of indicators (Loviisa)

There were no fuel leaks at the Loviisa plant units in 2007, thus there were no essential changes in the activity concentration of the primary coolant. The maximum activity concentrations were approximately one hundredth of a per mille of the limit specified in the Technical Specifications.

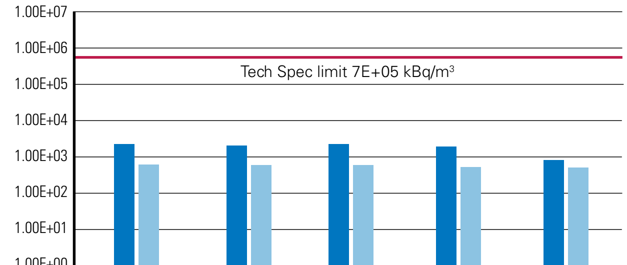
The I-131 activity concentration of the primary coolant when plant units are being shut down, as well as during reactor scrams, is also followed as a STUK indicator. No significant changes have occurred in the I-131 activity concentrations when plant units are being shut down at the Loviisa plant because there have been no fuel leaks at the plant units since 1999.

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



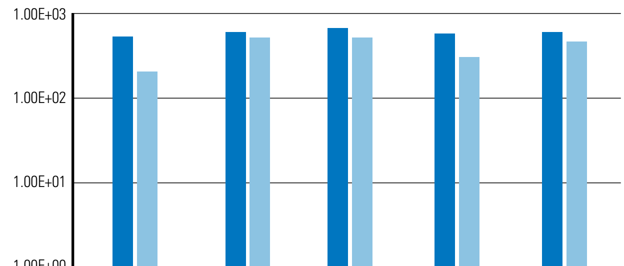
	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
LO1	3.15E+02	3.41E+02	4.82E+02	4.45E+02	4.71E+02	4.32E+02	5.01E+02	3.89E+02	3.91E+02	1.90E+02
LO2	2.15E+02	2.55E+02	7.19E+02	6.40E+02	5.74E+02	3.22E+02	3.39E+02	2.91E+02	2.72E+02	2.10E+02

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



	2003	2004	2005	2006	2007
LO1	2.30E+03	2.10E+03	2.20E+03	1.90E+03	8.10E+02
LO2	6.00E+02	5.80E+02	5.90E+02	5.20E+02	5.00E+02

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



	2003	2004	2005	2006	2007
LO1	5.19E+02	5.71E+02	6.38E+02	5.48E+02	5.70E+02
LO2	2.02E+02	4.97E+02	5.09E+02	2.93E+02	4.40E+02

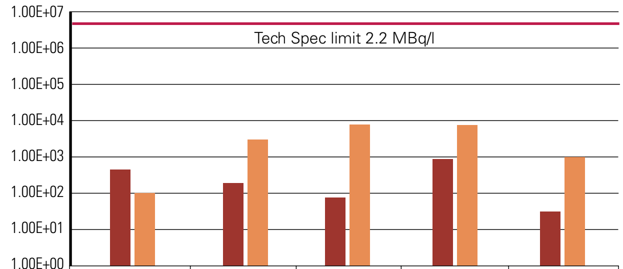
Primary coolant activity

Interpretation of indicators (Olkiluoto)

In 2007, the OL2 reactor had leaking fuel. The leak had begun on 18 July 2006, and the leaking bundle was removed from the reactor in the annual outage begun on 20 May 2007. The leak remained small the whole time. In steady power operation, the I-131 activity concentration of the reactor coolant was at most less than a per mille of the action threshold. The fuel leakage dissolved no uranium into the reactor coolant. The activity concentration of shutdown situations was at its highest point (37,000 kBq/m³) during the start-up after the reactor scram occurred on 15 May 2007. Two reactor scrams also occurred at OL2 after the annual outage, when leaking fuel was no longer present in the reactor. In the start-ups after these, the I-131 activity concentration of the reactor coolant showed no essential deviation from the activity concentration during power operation.

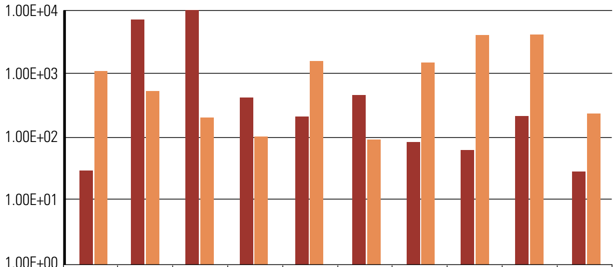
At OL1, no leaking fuel has been present since the 2006 annual outage, and no essential changes have thus occurred in the I-131 activity concentrations of the reactor coolant.

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



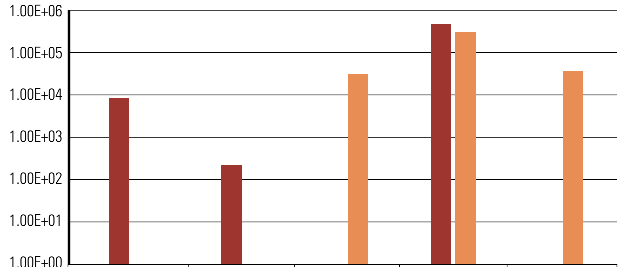
	2003	2004	2005	2006	2007
OL1	4.30E+02	1.90E+02	5.90E+01	6.90E+02	3.50E+01
OL2	9.10E+01	3.12E+03	6.52E+03	7.03E+03	9.99E+02

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



	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
OL1	2.80E+01	7.00E+03	9.00E+03	4.00E+02	2.00E+02	4.30E+02	8.20E+01	5.80E+01	2.00E+02	2.70E+01
OL2	1.11E+03	5.12E+02	2.00E+02	1.00E+02	1.50E+03	9.00E+01	1.49E+03	4.00E+03	4.00E+03	2.30E+02

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



	2003	2004	2005	2006	2007
OL1	8.20E+03	2.00E+02	0.00E+00	3.60E+05	0.00E+00
OL2	0.00E+00	0.00E+00	3.44E+04	3.08E+05	3.70E+04

Number of leaking fuel bundles

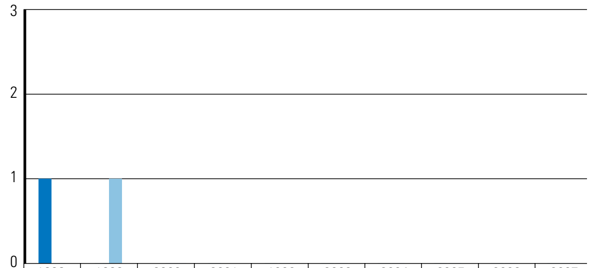
Interpretation of indicators (Loviisa)

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

Interpretation of indicators (Olkiluoto)

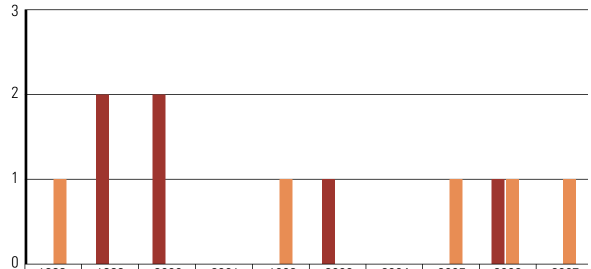
Fuel leakages have occurred almost every year at the Olkiluoto plant units. Leaks have been small and the leaking bundles have been removed in annual maintenance outages following leak detection. A fuel leak is often created when a small loose part such as a metallic chip carried by the reactor coolant gets stuck on the fuel assembly. The coolant flow may make the loose part vibrate and break the fuel cladding. Loose parts may enter the reactor in work carried out during outages, when the reactor and primary circuit are open. In 2005, STUK required that the licensee deliver a report on the needs for development of working methods to avoid the access of loose parts into the reactor. As a result, the licensee improved, for example, instructions and the work order and purchases procedures. In addition, information on dangers related to loose parts is given in the initiation training and various meetings to both internal and contractor personnel. People are also reminded of a careful and attentive attitude when working with open components. The effects of these measures remain to be seen in future years. In the operating cycle after the 2006 annual outages, the plant units have had one fuel leak. After the annual outages of 2007, there were no fuel leaks by the end of the year.

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



	1998	1999	2000	2001	1002	2003	2004	2005	2006	2007
LO1	1	0	0	0	0	0	0	0	0	0
LO2	0	1	0	0	0	0	0	0	0	0

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



	1998	1999	2000	2001	1002	2003	2004	2005	2006	2007
OL1	0	2	2	0	0	1	0	0	1	0
OL2	1	0	0	0	1	0	0	1	1	1

A.III.2 Primary circuit integrity

Definition

The water chemistry indicators are:

- Chemistry performance indices used by the utilities, depicting the effectiveness of water chemistry control in the secondary circuits of PWRs and in the reactor circuits of BWRs. The indicator for the Olkiluoto plant is the international index used by the utility. The indicator for the Loviisa plant 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 the Loviisa plant with a higher degree of sensitivity than the corresponding international index for VVER plants. The index for the Loviisa plant observes corrosive factors and the concentrations of corrosion products in steam generator blow-down and the feedwater. For steam generator blow-down, the calculation includes the chloride, sulphate and sodium concentrations and acid conductivity; for feedwater, it includes the iron, copper and oxygen concentrations. The chemistry index of the Olkiluoto plant consists of the chloride and sulphate concentrations of the reactor water and the iron concentration in the feedwater. The indices for both plants only cover the aforementioned values during power operation.
- The maximum chloride concentration of the steam generator blow-down (Loviisa) and the reactor water (Olkiluoto) during operation compared with the Tech Spec limit in the monitoring period. At the Olkiluoto plant, the maximum sulphate concentration 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 feedwater (maximum values for the monitoring period) are followed. For the Olkiluoto plant, the iron concentration of feedwater (maximum value for the monitoring period) is followed. In addition, the maximum Co-60 activity concentration in the reactor coolant while bringing the plant to a cold shutdown or after a reactor 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 can also be 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 following selected corrosive impurities and corrosion products. The water chemistry indices combine a number of water chemistry parameters and thus give a good overview of the water chemistry conditions. STUK indicators are also used to monitor the fluctuation of certain parameters in more detail. The utilities use parameters described here and also several other parameters to monitor the plant units' water chemistry conditions.

The corrosive substances monitored 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) are followed for the Loviisa plant units. At the Olkiluoto plant units, the STUK indicator system includes the maximum chloride concentration of the reactor water. Chloride concentration limits are included in the Technical Specifications. In addition, chloride concentrations lower than the Technical Specifications limit are controlled according to the target values and action level limits set by the utilities.

In previous years, the Olkiluoto plant units have had the problem of a sulphate concentration being 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 purification filters. Temperature is one of the factors in the release of sulphate from the filter resins. Modifications have been made at the plant units to reduce the temperature of the water entering the condensate purification filters by changing the place of the condensate system pre-heater. The relocation was carried out at OL2 in 2003 and at OL1 in 2004. In addition to temperature, the replacement interval of filter resins also has an effect on the sulphate concentration. The purpose of the indicator is to monitor the success of the utility's actions related to the use of purification systems in keeping the sulphate concentration below the target value (5 µg/l).

The corrosion products followed in the indicator system are iron and radioactive Co-60. The goal is to minimise the iron concentration in the secondary circuit feedwater and primary coolant at the Loviisa plant units and the reactor feedwater at the Olkiluoto plant units. This is to prevent the formation of excess crust on the surface of the fuel or steam generator pipes. Radioactive cobalt-60 isotope is generated as an activation product of materials containing cobalt in components within the reactor circuit. The 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

Reactor and Safety Systems (REA),
Kirsti Tossavainen (chemistry indicators)
Organisations and Operations (OKA), Jarmo Konsi (primary circuit leaks)

Water chemistry conditions

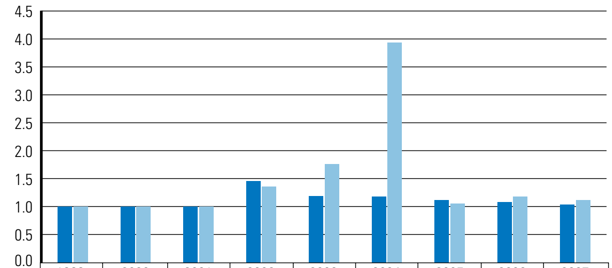
Interpretation of indicators (Loviisa)

There were no significant changes in the indicators describing the integrity of the primary or secondary circuit at either Loviisa plant unit in 2007. Based on the indicators, the structural integrity of the barriers limiting the dispersion of radioactive substances has remained good.

Individual water chemistry indicators of the secondary circuit showed temporary deviations from the utility's target values. Both LO1 and LO2 overstepped the limits for the chloride concentration of steam generator blow-down and the iron concentration of the secondary circuit feedwater. These cases produced the maximum values for the whole year in STUK's monitoring. Technical Specification values were not exceeded in 2007. The LO1 chemistry index was nearly at the optimum value of 1.00. The LO2 value was brought up by impurities in the secondary circuit during the start-up after the annual outage.

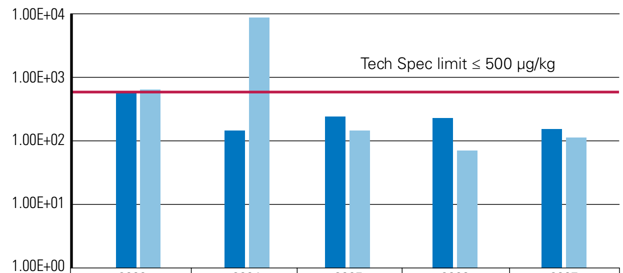
The iron concentration of primary coolant remained compliant with the utility's target value except for individual deviations caused by the annual outage. These deviations were the maximum values for the year in STUK monitoring. Based on the indicator, there were no significant changes in the iron concentration of primary coolant. Primary coolant's Co-60 activity concentration trend also showed no change in the dissolution of cobalt from structures into the primary coolant.

Integrity of the secondary circuit: Chemistry index, Loviisa NPP



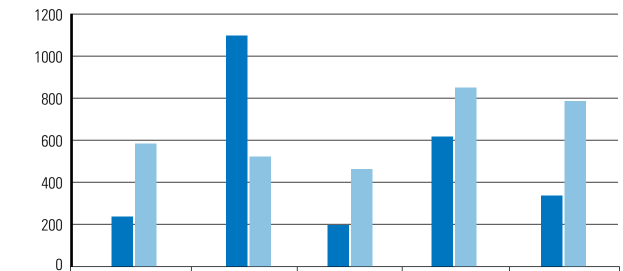
	1999	2000	2001	2002	2003	2004	2005	2006	2007
LO1	1.00	1.00	1.00	1.45	1.19	1.18	1.11	1.08	1.03
LO2	1.00	1.00	1.00	1.36	1.76	3.93	1.05	1.18	1.11

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



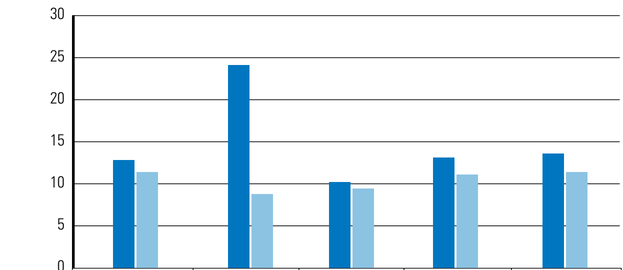
	2003	2004	2005	2006	2007
LO1	5.12E+02	1.34E+02	2.24E+02	2.18E+02	1.38E+02
LO2	6.09E+02	8.20E+03	1.34E+02	6.63E+01	1.11E+02

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



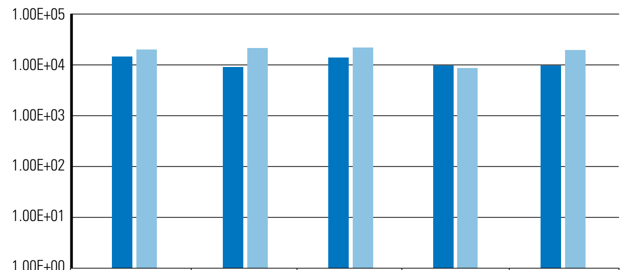
	2003	2004	2005	2006	2007
LO1	236.0	1097.0	195.3	617.5	337.4
LO2	583.0	522.0	462.9	849.4	786.2

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



	2003	2004	2005	2006	2007
LO1	12.8	24.1	10.2	13.1	13.6
LO2	11.4	8.8	9.4	11.1	11.4

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



	2003	2004	2005	2006	2007
LO1	1.50E+04	9.70E+03	1.50E+04	9.60E+03	1.09E+04
LO2	2.10E+04	2.30E+04	2.30E+04	9.00E+03	2.30E+04

Water chemistry conditions

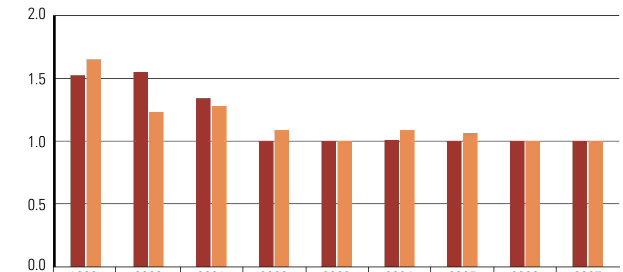
Interpretation of indicators (Olkiluoto)

There were no significant changes in the indicators describing the integrity of the reactor circuit at either Olkiluoto plant unit in 2007. Based on the indicators, the structural integrity of the barriers limiting the dispersion of radioactive substances has remained good.

The water chemistry of the reactor water and the reactor circuit feedwater has met the target values set by the utility, with the exception of the reactor water sulphate concentration and feedwater iron concentration. The sulphate concentration exceeded the target value (< 5 µg/l) at OL1 for one weekend in August. This value is the maximum value for the year in STUK's monitoring. The high value was caused by the decomposition of the ion exchange resin of the purification filters due to fairly long running times, and by the condensate temperature, which was higher than usual in August. The target value for iron concentration was exceeded at both plant units in some individual cases, but the action threshold was not exceeded. The chemistry index including both the sulphate and iron concentration has been optimal (1.00) for both plant units.

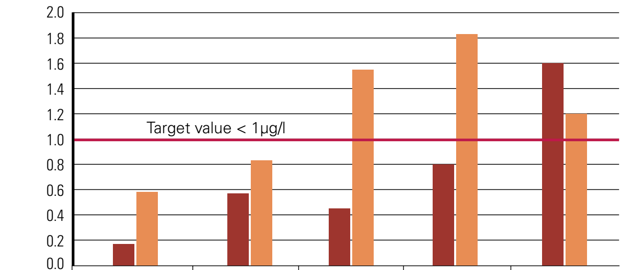
A moderate increase has been observed in

Integrity of primary circuit: Chemistry index, Olkiluoto NPP



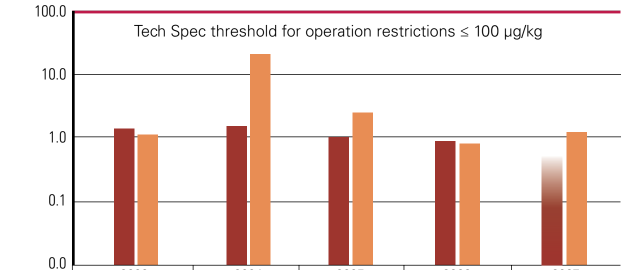
	1999	2000	2001	2002	2003	2004	2005	2006	2007
OL1	1.52	1.55	1.34	1.00	1.00	1.01	1.00	1.00	1.00
OL2	1.65	1.23	1.28	1.09	1.00	1.09	1.06	1.00	1.00

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



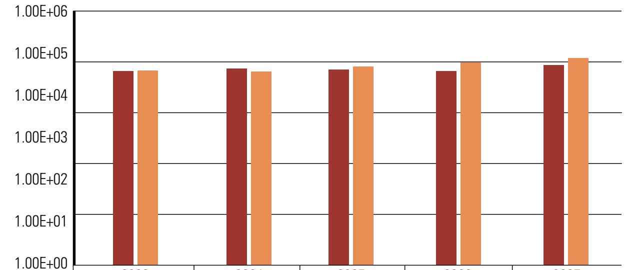
	2003	2004	2005	2006	2007
OL1	0.17	0.57	0.45	0.80	1.60
OL2	0.58	0.83	1.55	1.83	1.20

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



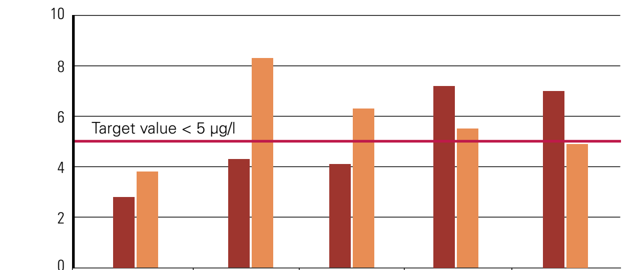
	2003	2004	2005	2006	2007
OL1	1.4	1.5	1.0	0.9	< 0.5
OL2	1.1	21.3	2.5	0.8	1.2

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



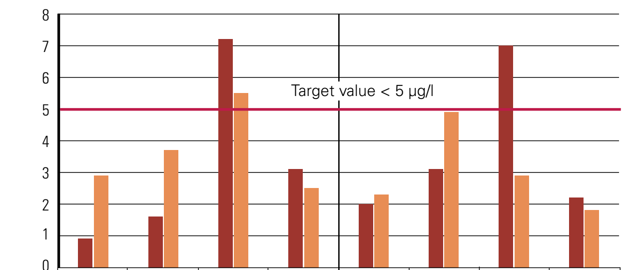
	2003	2004	2005	2006	2007
OL1	5.70E+04	6.80E+04	6.24E+04	5.70E+04	7.08E+04
OL2	5.90E+04	5.70E+04	7.63E+04	9.67E+04	1.46E+04

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



	2003	2004	2005	2006	2007
OL1	2.8	4.3	4.1	7.2	7.0
OL2	3.8	8.3	6.3	5.5	4.9

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



	I/06	II/06	III/06	IV/06	I/07	II/07	III/07	IV/07
OL1	0.90	1.60	7.20	3.10	2.00	3.10	7.00	2.20
OL2	2.90	3.70	5.50	2.50	2.30	4.90	2.90	1.80

the maximum Co-60 activity concentration of the reactor water during shutdown at OL2. The annual concentrations have still remained within the same area. The average Co-60 activity concentration of OL2 reactor water during power operation has shown an increase in recent years, which has also resulted in an increase of the concentration in shutdown situations. However, the activity concentration during power operation was lower in 2007 than in the previous year. Thus, the shutdown maximum activity of 2007 is most likely due to fluctuations in the solid materials concentration of the reactor water. Co-60 activity concentration is followed using the indicator, which has so far given no basis for special measures.

Primary circuit leakages (Olkiluoto)

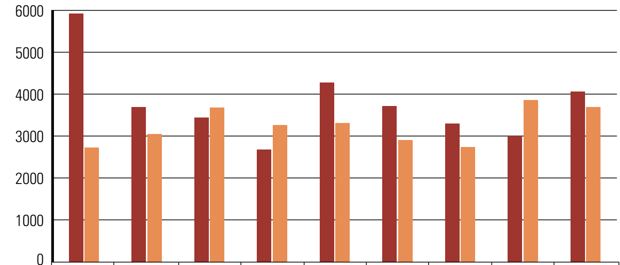
Interpretation of indicator

In the operating cycle 2006–2007 identified containment leakages totalled at 4,058 m³ at OL1, resulting in an upward trend. No single reason has been found for the increasing trend. However, the leakage volume for OL2 was 3,696 m³, which is slightly below the previous operating cycle.

In the operating cycle 2006–2007 the volume of unidentified leaks remained very small at 2.52 m³ (OL1) and 3.84 m³ (OL2). This created a moderately downward trend.

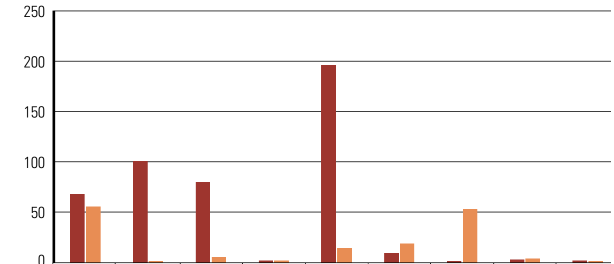
In the operating cycle 2006-2007 the ratio of the greatest containment internal leakage volume to the allowed leakage volume in the Tech Specs was low for both plant units; 0.21% at OL1 and 0.09% at OL2. This was the fourth consequent operating cycle with hardly any leaks from the primary circuit to the containment atmosphere.

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



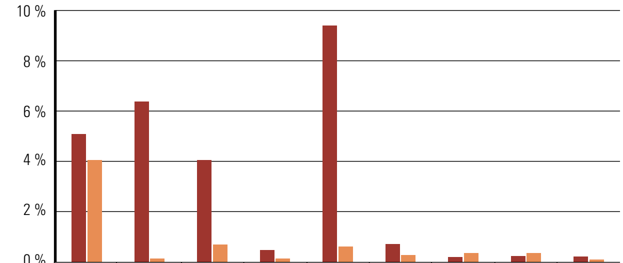
	1999	2000	2001	2002	2003	2004	2005	2006	2007
OL1	5924	3694	3443	2678	2481	3716	3300	3004	4058
OL2	2731	3047	3677	3262	3307	2908	2741	3862	3696

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



	1999	2000	2001	2002	2003	2004	2005	2006	2007
OL1	67.7	100.8	79.6	1.8	196.0	9.2	1.1	2.5	1.6
OL2	55.4	1.4	5.4	1.8	14.0	18.6	53.0	3.8	1.3

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



	1999	2000	2001	2002	2003	2004	2005	2006	2007
OL1	5.09	6.37	4.05	0.46	9.40	0.70	0.18	0.23	0.21
OL2	4.05	0.12	0.69	0.12	0.60	0.27	0.35	0.35	0.09

A.III.3 Containment integrity

Definition

As the indicators, the parameters below are followed: the total as-found leakage of outer isolation valves following the first integrity tests compared with the highest allowed total leakage from the outer isolation valves; 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); and the combined as-found leakage rate of containment penetrations and airlocks in relation to their highest allowed total leakage. The combined leakage rate at Olkiluoto includes leakages from personnel airlocks, the maintenance dome and the containment dome. In Loviisa, combined leakage rate is comprised of the leakage test results of personnel airlocks, the material airlock, the cable penetrations of inspection equipment, the containment maintenance ventilation systems (TL23), the main steam piping (RA) and the feed water system (RL) penetrations as well as the sealings of blind-flanged penetrations of ice-filling pipes.

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 total as-found leakages, since the reports give total leakages as they are at the end of the 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

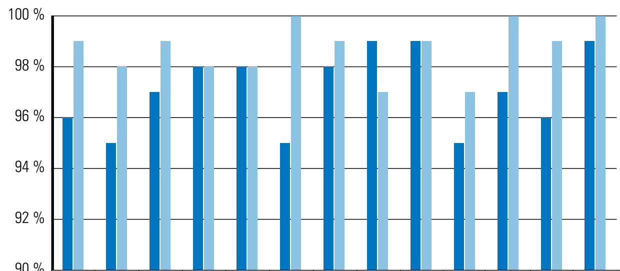
Reactor and Safety Systems (REA), Päivi Salo

Interpretation of indicator

Loviisa

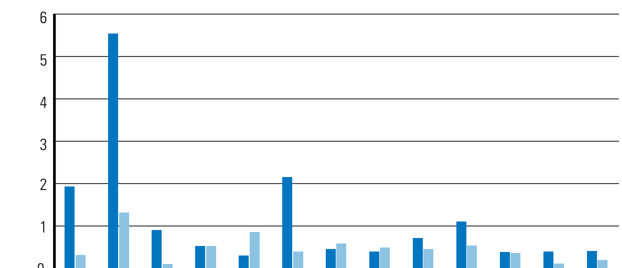
The total leakage of the Loviisa 1 outer isolation valves has remained low. The majority of the leakages were from the normal make-up water system's valve (approx. 13%) and two fuel pool cooling system valves (approx. 22.2%). The overhaul of one valve in the special sewerage system caused the most work. After repairs and leakage tests, a minor modification was done for the valve. After this, the tightness of the valve was good. The total leakage from the outer isolation valves of Loviisa 2 has increased, but is still lower than for Loviisa 1. The largest leakage volumes were from the fuel pool cooling system valve (approx. 18%), ice condenser cooling system valve (11.8%) and

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



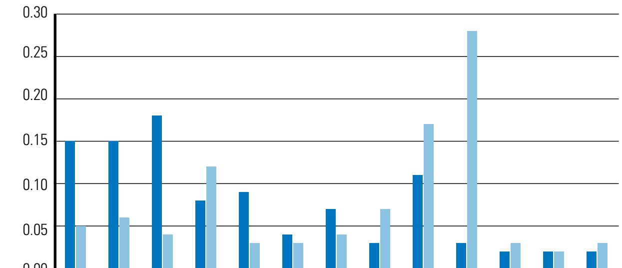
	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
LO1	96	95	97	98	98	95	98	99	99	95	97	96	99
LO2	99	98	99	98	98	100	99	97	99	97	100	99	100

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



	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
LO1	1.93	5.54	0.90	0.52	0.30	2.15	0.45	0.39	0.71	1.10	0.38	0.40	0.41
LO2	0.31	1.31	0.10	0.53	0.85	0.40	0.58	0.49	0.46	0.54	0.36	0.11	0.21

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



	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
LO1	0.15	0.15	0.18	0.08	0.09	0.04	0.07	0.03	0.11	0.03	0.02	0.02	0.02
LO2	0.05	0.06	0.04	0.12	0.03	0.03	0.04	0.07	0.17	0.28	0.03	0.02	0.03

sampling system valve (approx. 11.5%).

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

The overall as-found leakage of containment penetrations, which at Loviisa includes the leakage test results for the personnel airlock, the emergency personnel airlock, the material airlock, the reactor pit, inward relief valves, cable penetrations and bellows seals (RA, RL, TL23), is small at both plant units.

Olkiluoto

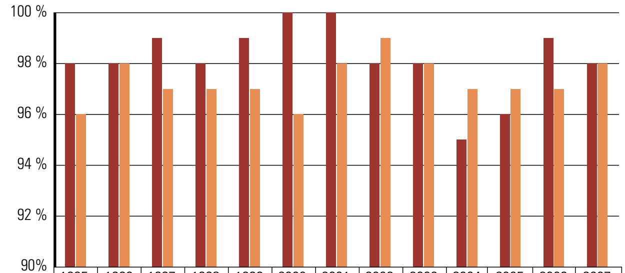
The total as-found leakage from the OL1 outer isolation valves was, as in previous years, below the limit set in the Tech Specs. The largest leakage volumes were from the main steam valve (approx. 26.8%) and the auxiliary feed water system valve (approx. 11%). In the leakage tests, the largest leaks were detected from two inner valves of the scram system.

The combined result of the leakage tests for the outer isolation valves at OL2 exceeded the limit set in Technical Specifications, but was lower than in the previous year. The largest leakage volume was from the flange cooling system valve (approx. 45.7%). In leakage tests the largest leakage detected was from one of the inner valves of the shut-down cooling system. After repairs, the total leakage met the requirements of the Technical Specifications.

The percentage of isolation valves that passed the leakage test at first attempt has slightly decreased at OL1 and remained stable at OL2.

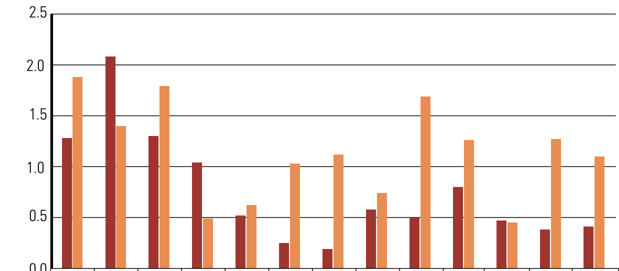
The total as-found leakage rate of containment penetrations, in which TVO includes leakages in the upper and lower personnel airlock, the maintenance dome and the containment dome, has remained small for both plant units.

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



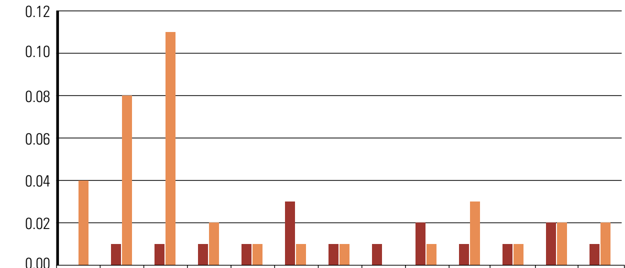
	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
OL1	98	98	99	98	99	100	100	98	98	95	96	99	98
OL2	96	98	97	97	97	96	98	99	98	97	97	97	98

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



	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
OL1	1.28	2.08	1.30	1.04	0.52	0.25	0.19	0.58	0.50	0.80	0.47	0.38	0.41
OL2	1.88	1.40	1.79	0.49	0.62	1.03	1.12	0.74	1.69	1.26	0.45	1.27	1.10

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



	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
OL1	0.00	0.01	0.01	0.01	0.01	0.03	0.01	0.01	0.02	0.01	0.01	0.02	0.01
OL2	0.04	0.08	0.11	0.02	0.01	0.01	0.01	0.00	0.01	0.03	0.01	0.02	0.02