

REGULATORY CONTROL OF NUCLEAR SAFETY IN FINLAND

Annual report 2002

Kirsti Tossavainen (ed.)

ISBN 951-712-720-0 (print)
ISBN 951-712-721-9 (pdf)
ISSN 0781-2884

Dark Oy, Vantaa/Finland 2003

TOSSAVAINEN Kirsti (ed.). Regulatory control of nuclear safety in Finland. Annual report 2002. STUK-B-YTO 224. Helsinki 2003. 41 pp. + Appendices 22 pp.

Keywords: nuclear energy, nuclear facility, nuclear waste, regulatory control

Abstract

This report covers regulatory control of nuclear safety in 2002. Its submission to the Ministry of Trade and Industry by the Radiation and Nuclear Safety Authority (STUK) is stipulated in section 121 of the Nuclear Energy Decree. Nuclear safety regulation focused on the operation of Finnish nuclear facilities as well as on nuclear waste management and nuclear materials.

No events occurred at the nuclear power plants that would have endangered the safe use of nuclear energy. No significant events occurred at the research reactor either. The doses of all nuclear power plant workers were below the individual dose limit. The collective occupational dose was low internationally. Radioactive releases were low and the dose calculated on their basis for the most exposed individual in the vicinity of Loviisa and Olkiluoto nuclear power plants was well below the limit established by the Government. In addition, occupational radiation doses at the research reactor and radioactive releases from it into the environment were well below set limits.

The regulation of nuclear waste management focused on spent fuel storage and final disposal plans as well as the treatment, storage and final disposal of reactor waste. No events occurred in nuclear waste management that would have endangered safety. In the field of nuclear material safeguards, the use of nuclear materials in accordance with current regulations and the completeness and correctness of nuclear material accounting were verified.

The operation of Finnish nuclear power plants, nuclear waste management and the use of nuclear materials complied with current rules and regulations, as verified by regulation. In addition, STUK verified that nuclear liability in the event of nuclear damage has been taken care of according to legislation.

The total costs of nuclear safety regulation in 2002 were 7.6 M€. The total costs of operations subject to a charge were 6.1 M€, the full amount of which was charged to the licensees and licence-applicants.

Contents

ABSTRACT	3
1 PREFACE	7
2 NUCLEAR SAFETY REGULATION	8
2.1 Safety and performance indicators	8
2.2 Finances	11
2.3 Development projects	11
3 REGULATORY GUIDES	13
4 NUCLEAR FACILITIES REGULATION	14
2.1 Nuclear safety regulation	14
4.2 Loviisa power plant	16
4.2.1 Operation and operational events	16
4.2.2 Non-compliance with the Technical Specifications	17
4.2.3 Event investigation	18
4.2.4 Safety improvements	19
4.2.5 Probabilistic safety analyses	19
4.2.6 Radiation safety	19
4.3 Olkiluoto power plant	22
4.3.1 Operation and operational events	22
4.3.2 Plant events in non-compliance with the Technical Specifications	24
4.3.3 Event investigation	24
4.3.4 Safety improvements	25
4.3.5 Probabilistic safety analyses	25
4.3.6 Radiation safety	26
4.4 Fifth reactor in planning	27
4.5 FiR 1 research reactor	28
4.6 Other nuclear facilities	28
5 NUCLEAR WASTE MANAGEMENT REGULATION	29
5.1 Spent nuclear fuel	29
5.2 Reactor waste	30
5.3 Other regulatory activities	30

6	SAFEGUARDS	31
6.1	Safeguards at Finnish nuclear facilities	31
6.2	Overall safeguards renewal	31
6.3	Control of radioactive materials transport	32
7	SAFETY RESEARCH	33
8	EMERGENCY RESPONSE	35
9	COMMUNICATIONS	36
10	INTERNATIONAL CO-OPERATION	37
11	THE ADVISORY COMMITTEE ON NUCLEAR SAFETY	41
APPENDIX 1	STUK'S SAFETY AND PERFORMANCE INDICATORS	42
APPENDIX 2	LICENCES AND APPROVALS IN ACCORDANCE WITH THE NUCLEAR ENERGY ACT	44
APPENDIX 3	PERIODIC INSPECTION PROGRAMME	45
APPENDIX 4	SAFETY IMPROVEMENTS	46
APPENDIX 5	ANNUAL MAINTENANCE OUTAGES	51
APPENDIX 6	SIGNIFICANT OPERATIONAL EVENTS	53
APPENDIX 7	EFFECT OF COMPONENT INOPERABILITY ON ACCIDENT RISK AT NUCLEAR POWER PLANTS	60
APPENDIX 8	STUK'S SAFETY RESEARCH PROJECTS COMPLETED IN 2002	62

1 Preface

The Radiation and Nuclear Safety Authority (STUK) regulates the use of nuclear energy in Finland as prescribed in the Nuclear Energy Act (990/1987). STUK's responsibilities also include control of physical protection, and emergency planning as well as control of the use of nuclear energy necessary to prevent nuclear proliferation. This is a report on regulatory control in the field of nuclear energy submitted by STUK to the Ministry of Trade and Industry once a year as stipulated in section 121 of the Nuclear Energy Decree.

It covers the regulatory control of nuclear facilities, nuclear waste management and nuclear materials, which is the task of the STUK Departments of Nuclear Waste and Materials Regulation (YMO) and Nuclear Reactor Regulation (YTO).

The report's section dealing with the regulation of nuclear facilities describes plant operation and operational events as well as safety improvements. It also addresses radiation safety by giving occupational radiation doses, collective doses and

release data as well as environmental radiation monitoring results.

The nuclear waste management section discusses the final disposal of nuclear fuel and reactor waste treatment. It gives the end-of-year volumes of nuclear fuel and reactor waste stored at the plant sites.

Nuclear material safeguards at Finnish nuclear facilities and regulation of radioactive materials transport are described as well.

The report gives STUK's indicators describing regulatory activities and the safety performance of nuclear power plants.

In addition, the report discusses the development of regulatory guides and some support functions in nuclear safety regulation, such as safety research, emergency preparedness, communication and development projects. Participation in international co-operation in the field of nuclear safety is described as well.

2 Nuclear safety regulation

2.1 Safety and performance indicators

Nuclear safety regulation mostly focused on the Loviisa 1 and 2 nuclear power plant units owned by Fortum Power and Heat Oy and the Olkiluoto 1 and 2 units owned by Teollisuuden Voima Oy as well as on their nuclear waste management and nuclear materials. The planning and later implementation of the final disposal of nuclear fuel, which is part of nuclear waste management, is taken care of by Posiva Oy. Subject to regulatory control were also the research reactor operated by the Technical Research Centre of Finland, the small-scale users of nuclear materials as well as the transport of radioactive materials. In addition, matters relating to the fifth reactor in planning were dealt with.

STUK has a safety and performance indicator system for acquiring data and trends on the development of regulated activities. Indicators are used to follow the effectiveness and efficiency of regulatory activities. The indicator system is given in Appendix 1. This chapter describes the indicators on regulatory efficiency; the indicators on regulatory effectiveness are described in Chapter 4.

The duty area of nuclear safety regulation included basic operations subject and not subject to a charge. Basic operations subject to a charge were mostly comprised of the regulatory control of nuclear facilities, with their costs charged to those subject to control. Those basic operations not subject to a charge included international and domestic co-operation as well as emergency response and communications. Basic operations not subject to a charge are publicly funded. The overheads due to rule-making and support functions (administration, development projects in support of regulatory activities, training, maintenance and development of expertise, reporting as well as contribution to nuclear safety research) were carried for-

ward into the costs of both types of basic operation and of contracted services in relation to the number of working hours spent on each function.

The distribution of working hours of the regulatory personnel in each duty area is given in Table I.

The time spent on the inspection and review of Loviisa nuclear power plant was 12.1 man-years, which is 14.8 % of the total working time of the regulatory personnel. The time spent on Olkiluoto nuclear power plant was 12.4 man-years, i.e. 15.1% of total working time. These figures include not only regulation of the nuclear power plants but also nuclear material regulation. The time spent on nuclear waste management regulation was 2.3 man-years, i.e. 2.8% of total working time. The inspection and review of the FiR 1 research reactor took 0.1 man-years and the compiling of a preliminary safety evaluation and the preparing for the regulatory control of the fifth reactor in planning 0.8 man-years. The regulatory control of small-scale users of nuclear materials took 0.01 man-years. Fig. 1 gives the distribution of working time spent on the main functions in 1998–2002.

The number of inspection days onsite and at the component manufacturers' premises totalled 679. In addition to inspections focusing on the safety of domestic nuclear power plants, the figure includes nuclear waste management and nuclear materials inspections. Two resident inspectors worked at Olkiluoto nuclear power plant and one at Loviisa plant. The number of inspection days for 1998–2002 is given in Fig. 2.

The total number of documents submitted to STUK for review in 2002 was 1486. The number of documents submitted in 2002 and earlier, whose review was completed in 2002, was 1519. The figure includes licences granted by STUK in accordance with the Nuclear Energy Act, which are

Table I. Distribution of working hours of the regulatory personnel in each duty area.

Duty area	1998	1999	2000	2001	2002
Basic operations subject to a charge	24.7	25.3	26.4	26.3	27.6
Basic operations not subject to a charge	4.6	5.5	7.5	7.4	6.9
Contracted services	6.9	7.0	5.4	4.4	3.8
Rule-making and support functions	25.1	24.6	25.5	28.5	27.1
Holidays and absences	13.9	14.8	15.0	16	16.2
Total	75.2	77.2	79.8	82.6	81.6

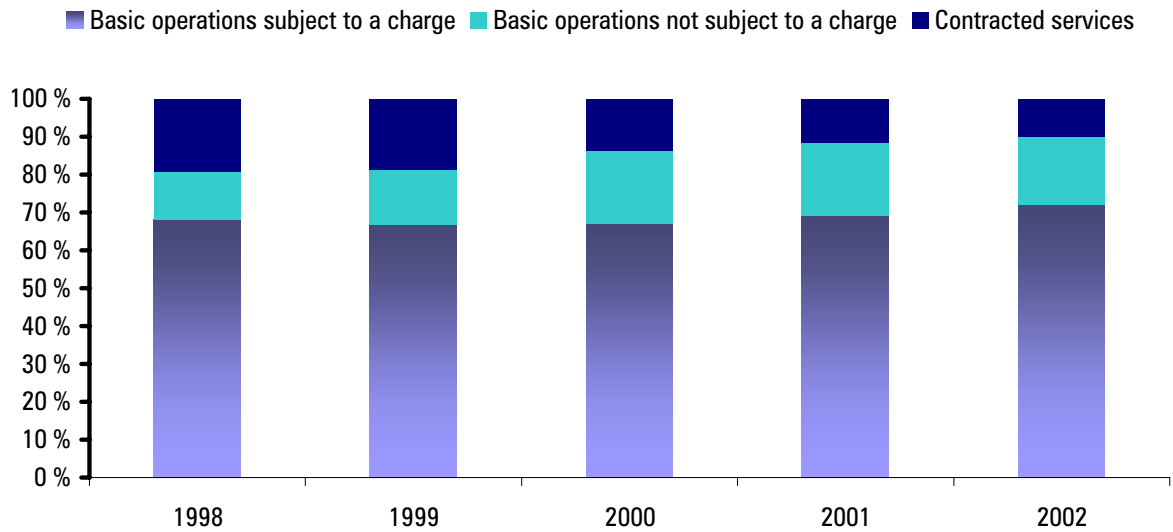


Figure 1. Working time spent on main functions.

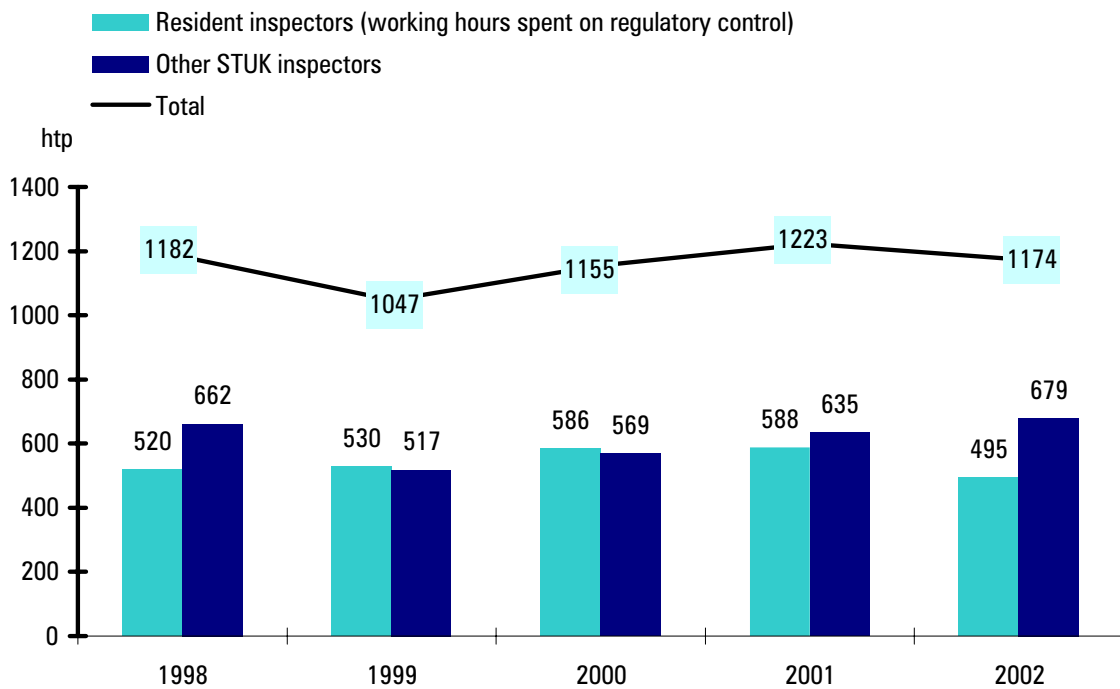


Figure 2. Number of inspection days onsite and at component manufacturers' premises.

Number of received documents Number of reviewed documents Average document review time (days)

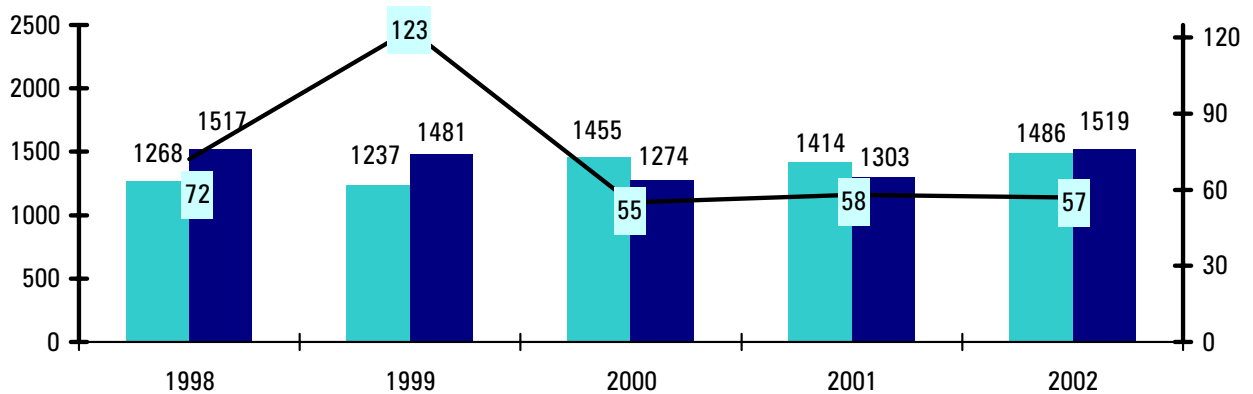


Figure 3. Number of documents received and reviewed as well as average document review time.

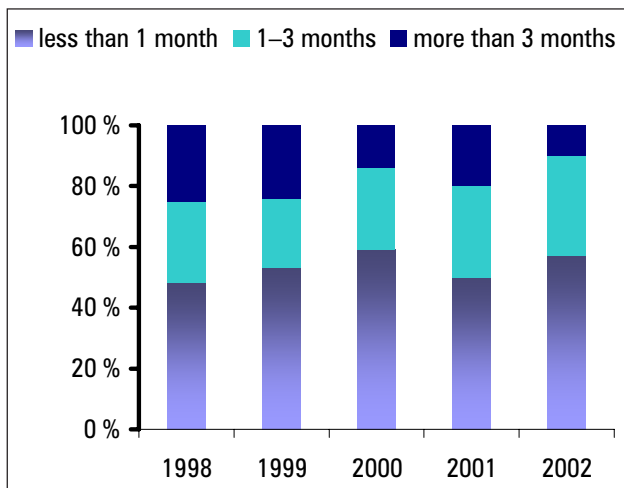


Figure 4. Distribution of time spent on preparing decisions about the Loviisa plant units.

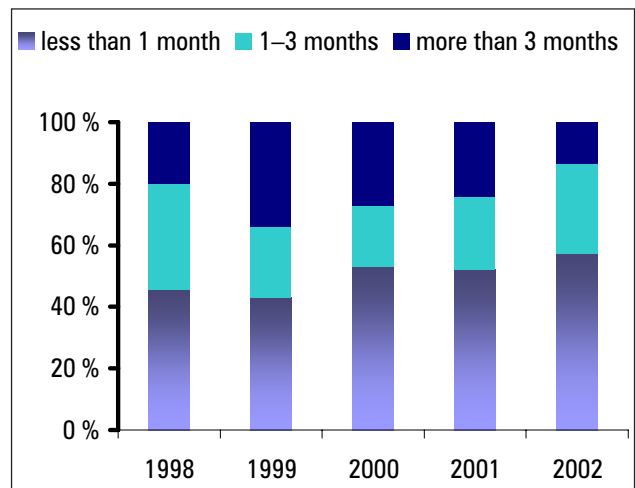


Figure 5. Distribution of time spent on preparing decisions about the Olkiluoto plant units.

Regulatory control income Costs of regulatory control subject to a charge Regulatory control total costs

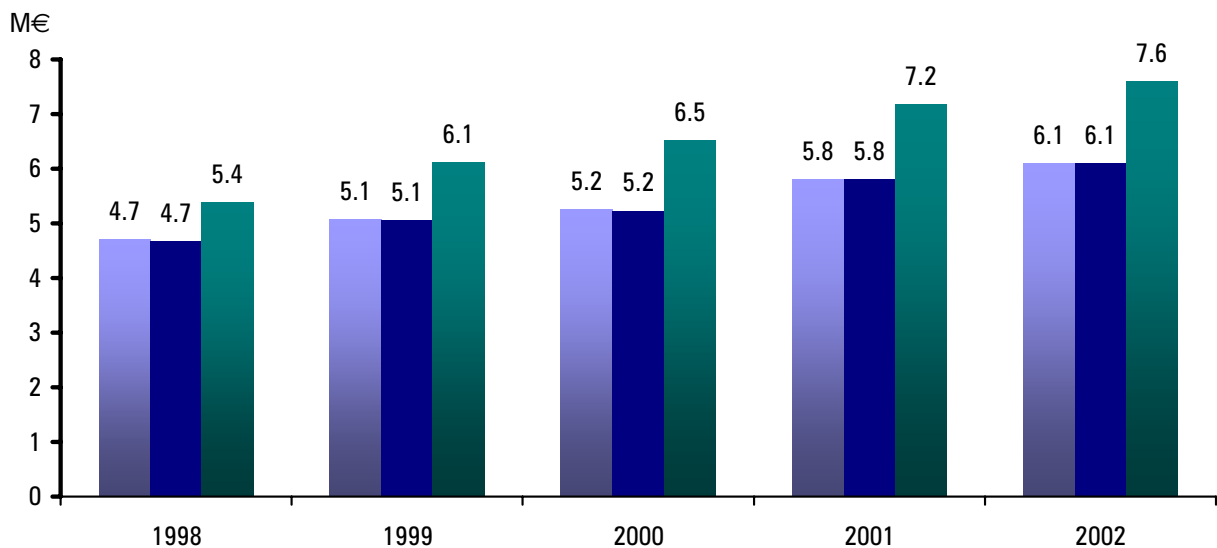


Figure 6. Income and costs of nuclear safety regulation.

listed in Appendix 2. Average document review time was 57 days. The yearly number of documents and their average review times in 1998–2002 are given in Fig. 3. Figs 4 and 5 give the distribution of the review times of documents on Loviisa and Olkiluoto plants.

2.2 Finances

In 2002, the costs of the regulatory control of nuclear safety subject to a charge were 6.1 M€. The total costs of nuclear safety regulation were 7.6 M€. Thus the share of activities subject to a charge was 81%.

The 2002 income from nuclear safety regulation was 6.1 M€. Of this, 2.5 M€ and 2.7 M€ came from the inspection and review of Loviisa and Olkiluoto nuclear power plants, respectively. The regulation of Posiva Oy's operations yielded 0.8 M€. The income from other objects of regulation (i.a. regulation of the FiR 1 research reactor, preparation of a preliminary safety evaluation for and preparation of the regulatory control of the fifth reactor in planning, regulation of small-scale users of nuclear materials) was 0.1 M€. Figure 6 gives the annual income and costs of nuclear safety regulation in 1998–2002.

2.3 Development projects

Development of own operation

The development of STUK's own operation focused on two themes: processes and competence. Processes were the object of development in the whole of STUK. During 2002 the nuclear safety regulation processes were identified, a process map was drawn up, process owners were assigned, and process descriptions were initiated. In the next phase, a renewed process-based management system is due for implementation.

In the first phase of the competence analysis, the target state and current state of substance competence directly pertaining to nuclear safety regulation were analysed. In the second phase, the state of "general competence", shared by all STUK employees, was analysed. The analysis results will be utilised in competence management and in particular in internal training and new employee orientation.

A project involving regulation of the fifth reactor in planning was prepared for by setting up a

project group to co-ordinate regulatory activities and by drawing up a draft project plan. Experiences gained from the project will be utilised in other regulatory work as well.

A set of indicators in accordance with the BSC Model was introduced for evaluation of own operation. As regards the indicators, international co-operation in two OECD/NEA working groups was continued.

Development of information management

The development of information management pertaining to nuclear safety regulation was continued. The focus in 2002 was in the practical testing of portals suitable for information management. In early 2002, testing of the Sharepoint Portal Server (SPS) software was completed and after that the SAP Enterprise Portal software was tested at STUK. In spring 2003, when the testing will be over, the final choice for STUK's information management portal will be made.

A uniform documents management project plan was drawn up for STUK into which are gathered all on-going or planned information management related development projects of STUK's departments. The project is headed by STUK's information management director whose office was established in early 2002. Similarly, the IT support and development personnel of STUK's departments were moved in early 2003 to the Information Management Unit directly subordinate to the head of information management.

In addition to the software comparisons and tests made, discussions with the licensees about the implementation of shared "Extranet solutions" were continued. All technical basic documents for Loviisa facility, which inspectors can now access on STUK's Intranet were provided by Fortum Power and Heat Oy. The data communications links to STUK's Helsinki Intranet, used by STUK's resident inspectors who work at the plant sites and by other personnel, were upgraded and made faster by new technical solutions.

A significant part of the computer equipment used by the inspectors was upgraded and, by the end of 2002, almost all of them were using the Win 2000 operating system. Browser-based user-interfaces for use on STUK's Intranet were developed for several earlier-established data bases.

Safety culture

STUK's objective is to develop safety culture in Finland to cover the whole of the nuclear field.

STUK met with the licensees to discuss important, safety culture related issues. The meeting was based on data yielded by a study commissioned by STUK and the discussions aimed at establishing a common view of the contents of Finland's national safety culture. A common basis for the discussion was that the safety liability of the licensees is indivisible. STUK is developing its guidelines and regulatory procedures to facilitate the setting of requirements such that the licensees' liabilities are unambiguous and that sufficient documentation avoiding bureaucracy is assured. This is a challenge even for the licensees. Change of generation, updating of know-how and maintenance of personnel motivation place great challenges on all organisations in the nuclear field and require enhancement of work, work environment, equipment and procedures as well as personnel participation. The discussion was considered productive and plans are to resume it in the coming years.

Finnish safety authorities continued to discuss safety-culture related questions. On STUK's initiative, five meetings were held, which, in addition to STUK, were attended by the representatives of the Civil Aviation Administration, the Finnish Maritime Administration, the Finnish Rail Administration, the Safety Technology Authority TUKES and the occupational safety unit of the Ministry of Social Affairs and Health. The discussions dealt with the regulatory bases and practical procedures of the above authorities concerning management of safety and safety culture.

Development of risk-informed regulation

In 2002 the essential elements of risk-informed regulation were identified and the regulatory effort was focused on the most risk-significant objects.

Requirements pertaining to risk-informed safety management at nuclear power plants are set forth in Guide YVL 2.8. The new guide sets particularly detailed requirements for the probabilistic

safety analysis (PSA) of the design phase and for risk-informed safety management. Even before, the PSA has been widely used to assess modifications and justify applications for exemptions from the Technical Specifications. In addition, the guide requires that the PSA be used to assess the need to modify the Technical Specifications and safety classification, to evaluate system and component testing programmes, to assess the risk-importance of preventive maintenance and to develop periodic inspection programmes of piping, for example.

Even STUK's regulatory control activities have a risk-informed focus, which has been taken into account while reviewing the YVL guides. In the revised Guide YVL 2.0, which is about nuclear power plant systems design, the consideration and assessment of safety principles as early as possible in the design phase in connection with the conceptual design plans is underlined. The same principle is applied in Guides YVL 5.2 and YVL 5.5, which are about the electrical and I&C systems of nuclear facilities. In addition, the principles of regulatory control that apply to pressure equipment as well as to electrical and I&C components are redefined in the YVL guides. At component level, STUK's control focuses on the working of the licensee and the independent inspection organisation; only the most important components are inspected by STUK.

The risk-informed focusing of STUK's regulatory effort continues in connection with the development of YVL guides and STUK's quality management system and processes.

In addition to technical oversight, oversight of the functioning of the utilities' organisations, as carried out in particular in connection with inspections contained in the periodic inspections programme and during event investigation, was emphasised in regulatory work. At component level, work focused on safety-significant failures, common-cause failures and recurrent failures, utilising STUK's safety and performance indicators. To develop functional processes, anticipatory yearly collective assessments pertaining to the operation of nuclear power plants are employed in the planning of regulatory activities.

3 Regulatory guides

The revision and updating of YVL guides continued. The guides are detailed safety regulations for nuclear facilities issued by STUK on the basis of the Nuclear Energy Act (990/1987) and the Government Resolution (395/1991) on the general safety regulations for nuclear power plants. The guides describe STUK's regulatory procedures as well. STUK decides, case by case, how new guides apply to facilities already in operation.

A total of about 45 guides were prepared or reviewed in YVL guide working groups, with ten guides completed by the end of 2002. The number of Finnish language YVL guides published in 1998–2002 is given in Fig. 7. Seven guides were published in English and three in Swedish. The guides were issued in print and on the Internet.

The project for the revision of rule making strategy, started in 2001, was revised by incorporating the principles of YVL guide revision in the STUK strategy and also in a separate action plan for guidelines. At departmental level, only a separate, guide-specific work plan will be drawn up.

After the Parliament's decision to leave in force the Government's decision-in-principle approving the construction of a fifth nuclear power plant, an assessment was made of the most significant needs for change for consideration in the revision of YVL guides in the near future. This assessment was sent to the licensees for information. Specific memoranda were prepared on three guides dealing with safety classification, failure criteria and physical protection. Described in detail was the interpretation of the requirements of the guides to clarify design criteria for the fifth plant in planning in particular.

In 2002 STUK did not prepare any significant amendments to the Nuclear Energy Act or Decree, nor did any such take force in Finland. No amendments were prepared to the general nuclear safety requirements, given in the form of Government Resolutions, either. Nuclear safety recommendations are also given by international organisations, such as the EU, the IAEA, the OECD/NEA and the national authorities of various countries. They did not give any cause to update the Finland's nuclear legislation.

STUK prepared to the IAEA national statements on eight draft safety guides.

In early 2002 the Commission of the European Communities sent to the Member States for comment a proposal for a new safeguards regulation. The revision of the Regulation (Euratom 3227/76), mainly dated from the year 1957, has become topical due to safeguards control in accordance with the Model Protocol Additional, the expansion of the EU and the modernisation of the reporting format. STUK actively contributed to the work of the Atomic Questions Group (AQG). Work will continue in 2003.

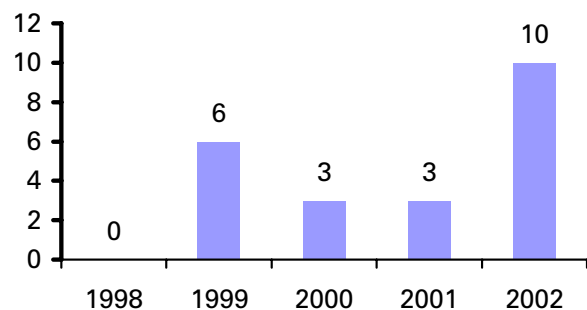


Figure 7. Number of published YVL guides.

4 Nuclear facilities regulation

2.1 Nuclear safety regulation

The regulatory control of nuclear power plants comprised periodic inspections, plant modifications oversight, event investigation and inspections the licensee was obliged to separately request during measures carried out at the plant, or that STUK conducted at its discretion. In addition, STUK assessed the safety of the nuclear power plants on the basis of, among others, operating experience, safety analyses as well as reports and plans submitted by the licensee, and by inspections onsite and at component manufacturers' premises.

Regulation showed that the plants were operated in compliance with the regulations.

Periodic inspections

In 2002 there were 12 periodic inspections at Loviisa plant and 14 at Olkiluoto plant. The plants' management and procedures, the functioning of their organisational units and the technical acceptability of their systems were looked into. How the contents of licensee documents correspond to regulations and also that licensee operations comply with own quality management systems, among others, were verified by the inspections. The inspections comprised interviews with the plant personnel, document reviews and walk rounds to verify facts and oversee tests, among others. As a rule, inspections in accordance with the programme are repeated yearly; the contents of individual inspections vary yearly, however. The annual inspection programme was brought to the knowledge of the licensees in early 2002 and inspection dates were agreed upon with the representatives of the licensees.

STUK presented 54 requirements based on the inspections. Measures have been, and will be, taken at Loviisa and Olkiluoto plants to correct detected shortcomings. None of the observations

made by STUK would have essentially affected the safety of the plant units.

Inspections contained in the periodic inspection programme are listed in Appendix 3.

Plant modifications

The regulatory control of plant modifications comprised the following: definition of the scope of regulatory control, review of modification documents, and supervision of the implementation and commissioning of modifications. Modifications to improve plant safety are described in sub-sections 4.2.4 and 4.3.4 and Appendix 4.

STUK oversaw the implementation of component and structural modifications by inspections onsite and at component manufacturers' premises and by licensee reports. In consequence of the modifications several documents on plant operation and layout, such as the Technical Specifications, the Final Safety Analysis Report and operating procedures were revised. STUK reviewed these document revisions and generally followed the updating of plant documentation after the modifications.

One part of regulation were meetings between STUK and the licensee. In the meetings licensee's representatives clarified planned modifications, those due in the next annual maintenance outage and those to be implemented in the long-run as well as the status of ongoing modification projects. In 2001 a new practice was started at STUK, with the arrangement of internal follow-up meetings on modifications. Modifications under review at STUK and those to be reviewed later plus their status as regards their planned date of implementation were discussed at the meetings. In 2002 there was one such meeting per each plant site.

The progression of safety-significant modifications was followed in a computer-based plant modifications register. In 2002 the number of

modifications entered in the register was 12. Numerous unfinished modifications, registered in earlier years, were monitored by means of the register as well. The plant modifications register was utilised specifically in monitoring the realisation of modification-related document amendments. As a result of the follow-up it was noted that document changes made after plant modifications in 2001, and monitored in the plant modifications register, were completed as follows: 77% at Olkiluoto plant and 81% at Loviisa plant by the next annual maintenance. All modifications to the Technical Specifications were carried out at both plant sites prior to the implementation of each modification.

Annual maintenance outages

During annual maintenance outages regulatory control focused on, among others, work administration during outages, the activities of the operating and maintenance personnel, refuelling, inspections and tests by the licensee and subcontractors. Attention was also paid to radiation protection and control room activities and house-keeping in general. STUK supervised the shutdown of the plant units and their start-up after the outages. Prior to the beginning of a new fuel cycle, STUK reviewed the safety analyses made for each plant unit for fuel reloading. The loading of fuel assemblies into the reactor according to plan was also assured. The nuclear material inventory was ascertained prior to the closing of the reactor pressure vessel head.

Inspections, as required in Guide YVL 3.0, were carried out by STUK or by an inspection organisation approved by STUK during the annual maintenance outages. In addition, periodic inspections of pressure equipment and other pressure-bearing components were monitored by reviewing programmes pertaining to them and by witnessing inspections onsite.

The outages are described in more detail in Appendix 5.

Event investigation

Two event investigation teams were set up at STUK in 2002. STUK appoints a team to investigate a plant event especially when the licensee's organisation has not operated as planned or when an event is assessed to lead to significant modifi-

cations in the plant or its procedures. A STUK investigation team is also set up if the licensee has not investigated an event's root causes well enough.

The licensees assess their plant events, taking action, if necessary. STUK assesses these licensee measures as part of regulatory control. STUK assesses also its own activities in connection with plant events.

Event investigations under way in 2002 are described in sub-sections 4.2.3 and 4.3.3.

Personnel competence

STUK assessed the appropriateness and adequacy of organisations available for use by the licensees as well as their personnel training programmes. On request of the licensees STUK authorised new responsible managers, as referred to in the Nuclear Energy Decree, for the nuclear power plants, the research reactor and one small-scale user of nuclear materials. On licensee requests, their personnel were authorised to work as shift managers or operators at a nuclear power plant and as operators at the research reactor. These were mainly individual authorisations for a new 3-year period, granted to 26 persons at Loviisa facility and 33 persons at Olkiluoto facility. Five operators were authorised to work with the research reactor.

On the request of Fortum Power and Heat Oy and Teollisuuden Voima Oy, STUK authorised also testing organisations and their employees to inspect and test mechanical equipment in nuclear power plants. On the request of Fortum Power and Heat Oy, the applicant's employees were authorised to conduct commissioning inspections after the repair and modification of electrical and instrumentation components at Loviisa nuclear power plant. In addition, on the request of both licensees, STUK authorised their inspection organisations to conduct inspections of mechanical equipment and structures.

Nuclear liability

The Nuclear Energy Act prescribes STUK's responsibility to ascertain that the liability for damages of a nuclear facility's owner in case of nuclear damage has been arranged as stipulated. The Insurance Supervisory Authority reviews the contents of liability arrangements. The regulatory procedure is described in detail in Guide YVL 1.16,

Control of nuclear liability insurance policies. The licensees submitted to STUK the necessary documents as described in the guide. STUK has established that the liability arrangements were as prescribed in legislation.

4.2 Loviisa power plant

4.2.1 Operation and operational events

Both units of Loviisa nuclear power plant operated reliably. The load factor of Loviisa 1 was 89.3% and that of Loviisa 2 was 82.2%. The duration of the annual maintenance outages was 28 days at Loviisa 1 and 50 days at Loviisa 2. The course of the outages and the actions taken are described in Appendix 5. In addition to the annual maintenance outage, there were two brief breaks in electricity generation at Loviisa 2. The plant unit's turbines tripped in August in consequence of a fault in a card for control electronics of the plant protection system, which caused a few hours' break in production. In March the plant unit was brought to shutdown state for about five days to repair a valve in the pressuriser spray line. These were the only production breaks at the plant units. In the second quarter of 2002, both Loviisa plant

units were operating in lowered power mode for a few days due to Finland's energy situation.

Production losses due to component failures were 0.7% at Loviisa 1 and 1.3% at Loviisa 2.

Figure 8 gives the daily average gross powers of the plant units in 2002. Load factors and the number of reactor scrams in 1993–2002 are given in Figures 9 and 10.

The Loviisa plant units reported ten operating events to STUK. The number of event reports in 1993–2002 is given in Fig. 11. Event-specific reports are special reports, which in 2002 were provided for events mentioned in sub-section 4.2.2, as well as transient reports and scram reports. In addition to event-based reports, Loviisa power plant submitted to STUK the following reports: daily reports, quarterly reports, annual reports, outage reports, annual environmental radiation safety reports, monthly individual dose reports, annual operational event feedback reports and safeguards reports.

One event at the Loviisa plant units was classified INES Level 1. During the annual maintenance outage, the boric acid concentration of the Loviisa 1 primary circuit went below the limit of the Technical Specifications. Other events had no

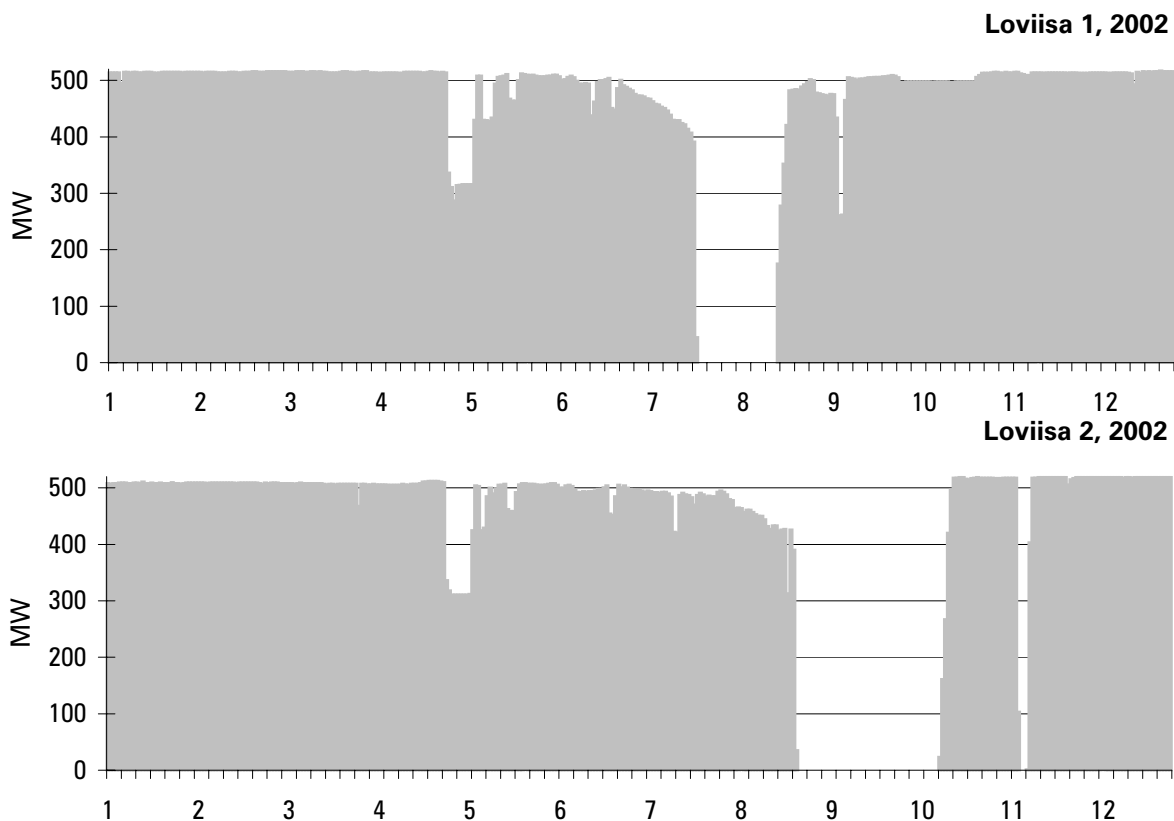


Figure 8. Daily average gross power of the Loviisa plant units in 2002.

bearing on radiation and nuclear safety. Appendix 6 gives the most significant events at the plant units in 2002. The numbers of INES Level 1 and above events in 1993–2002 are given in Fig. 12.

The effect of component unavailability on accident risk at the Loviisa plant units is dealt with in Appendix 7. STUK did not require specific meas-

ures from the licensee due to the unavailabilities.

The causes of the events at Loviisa nuclear power plant, divided into technical and non-technical, i.e. human or organisational, are presented in Fig. 13. The number of human-based events has been decreasing after 2000.

4.2.2 Non-compliance with the Technical Specifications

The three below events at the Loviisa plant units were in non-compliance with the Technical Specifications:

- Preventive maintenance work not in compliance with the Technical Specifications
- Two isolation valves were not tested at Loviisa 1 in 2001 (the situation was detected in 2002)
- The primary circuit boric acid concentration at Loviisa 1 went below the limit of the Technical Specifications

Detailed descriptions of the events are given in Appendix 6.

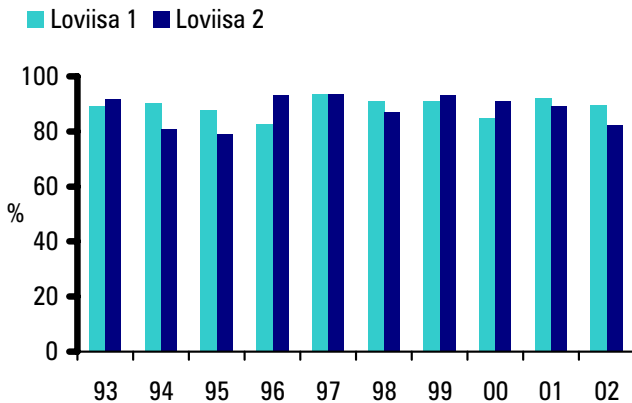


Figure 9. Load factors of the Loviisa plant units.

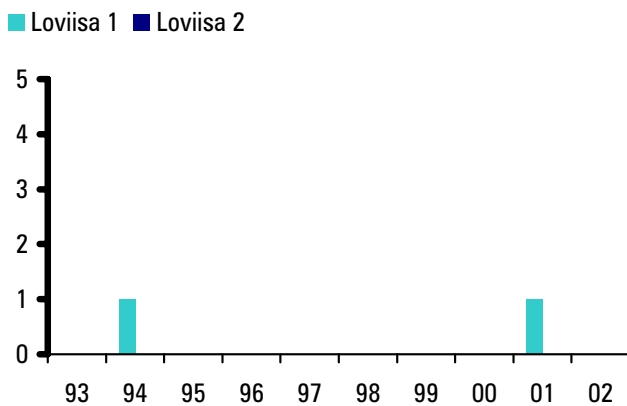


Figure 10. Number of reactor scrams at the Loviisa units, scram tests excluded (reactor power exceeds 5%).

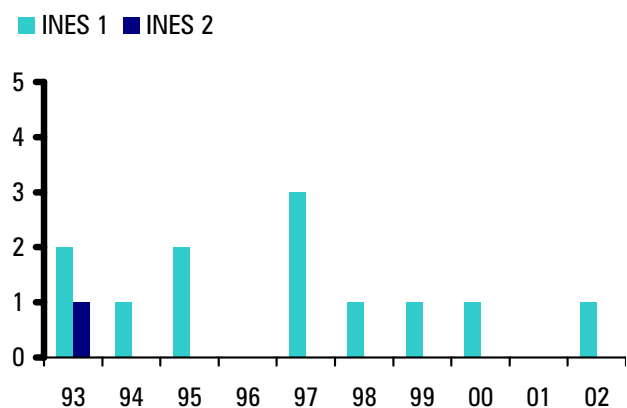


Figure 12. INES Level 1 and above events at Loviisa nuclear power plant.

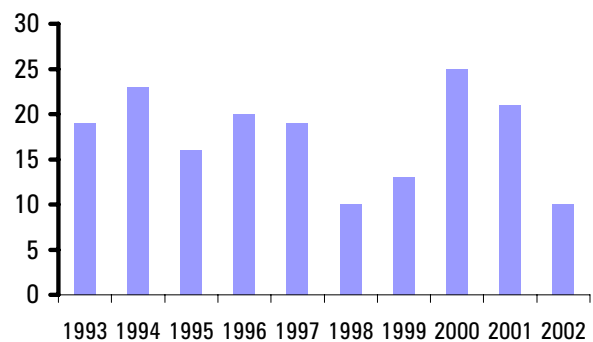


Figure 11. Number of event-specific reports from Loviisa plant.

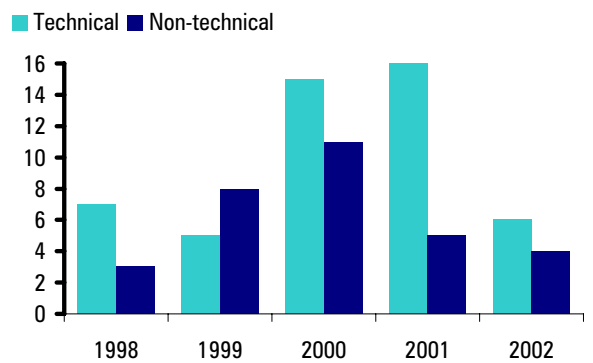


Figure 13. The causes of events at Loviisa nuclear power plant.

The number of non-compliances with the Technical Specifications at the plant units has remained unchanged compared with the previous year, and has decreased in comparison to the turn of the millennium. It has not given cause to any special regulatory measures. The licensee has planned and partly implemented measures to prevent recurrence. The number of non-compliances with the Technical Specifications in 1993–2002 are given in Fig. 14.

In addition, the licensee applied in advance for STUK’s approval for an exemption from the Technical Specifications. In 2002 the licensee applied for exemption for 13 situations deviating from the Technical Specifications. STUK granted all applied exemptions as such. Nine of the exemptions dealt with deviations from the Technical Specifications due to modifications, repairs and maintenance work. Two exemptions were granted for deviations due to testing. One exemption authorised the postponement of a testing date and one the skipping of a modification, which was due to belated deliveries. The yearly number of exemptions in 1993–2002 is given in Fig. 15.

4.2.3 Event investigation

Non-compliances in the approval procedures of a non-destructive testing company at Loviisa power plant

An investigation team was set up in STUK in October to look into licensee procedures to assure the appropriate preparation and granting of requests submitted to STUK for the approval of organisations conducting non-destructive testing and monitoring of the validity of the approvals. Included in

the investigation are Loviisa power plant’s negligences in adhering to time limits given in STUK’s decisions as regards requests for additional information on the qualification of inspection systems. The team’s further task was also to find out about the view of Fortum Power and Heat Oy on the handling of the qualification procedure for inspection systems and the resources required by it. The investigation extended to 2003.

In accordance with section 113 of the Nuclear Energy Decree (161/1988), non-destructive testing of a nuclear power plant’s structures and components may only be carried out by a testing company or a tester approved by the Radiation and Nuclear Safety Authority (STUK). The licensee has to submit an application in writing for approval of the testing company or tester mentioned in subsection one for their duties.

A STUK-inspector had noticed at the beginning of the 2002 annual maintenance outages of the Loviisa plant units, towards the end of July, that STUK’s authorisation of one testing company to conduct inspections at both plant units had expired. The inspector orally notified the plant’s representative of the matter. Loviisa power plant did not apply for renewal of the approval in question after the starting of the annual maintenance, or during it, but during the annual maintenance of Loviisa 2, after a reminder had been sent.

While processing the application for authorisation of the testing company in question, STUK noticed that the company had carried out inspections at both Loviisa plant units already in 2000 even though the authorisation had expired on 1 August 1999.

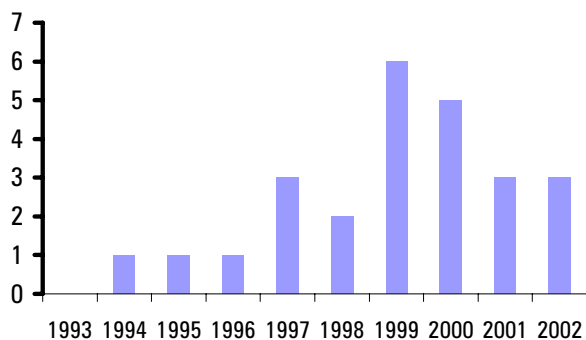


Figure 14. Number of non-compliances with the Technical Specifications at Loviisa plant units.

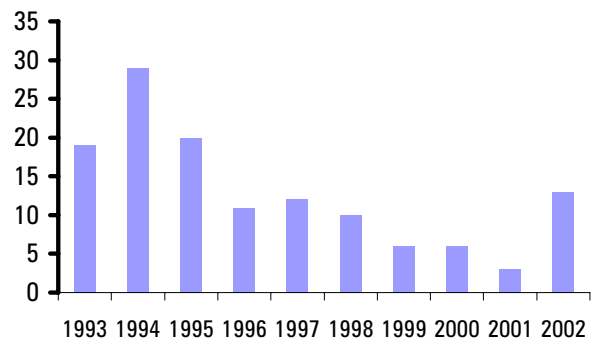


Figure 15. Number of exemptions from the Technical Specifications at Loviisa plant units.

4.2.4 Safety improvements

The safety of Loviisa power plant was further enhanced based on new, post-commissioning safety requirements given in YVL guides, the results of probabilistic safety analyses and, to some extent, operating experience.

Several measures to mitigate the consequences of severe accidents were implemented at Loviisa 2. The most important of them was assuring reactor pressure vessel external cooling in a situation involving a core melt in the bottom of the pressure vessel in consequence of a severe accident. After the modifications have been completed the hot corium melt formed in a severe accident can be contained inside the reactor pressure vessel.

Modifications have been continued at both plant units to decrease the risk of leaks exceeding 5 kg/s from the primary circuit to outside the containment through different systems. In addition, the risk of leaks below 5 kg/s to outside the reactor containment through primary and secondary systems has been decreased by means of plant modifications.

Loviisa 1 commissioned 58 new fixed radiation monitors that replaced the most part of the plant's system for monitoring of external radiation, air activity and process activity. Radiation measurement data is transmitted to the radiation situation monitoring points onsite more efficiently than before.

Pump replacements in the low pressure emergency coolant system and also piping modifications were completed at both plant units. Structural weaknesses in the old pumps were thus eliminated and mechanical stresses from piping to pumps reduced. The new type of pump is more efficient than the original pump type and is capable of injecting water against a higher pressure, which improved the capacity of the low pressure emergency cooling system as well.

Safety improvements are described in more detail in Appendix 4.

4.2.5 Probabilistic safety analyses

No additions were made to the probabilistic safety analysis of Loviisa nuclear power plant in 2002.

4.2.6 Radiation safety

Occupational radiation doses

The radiation doses of those who worked at Loviisa nuclear power plant in 2002 were below the 50 mSv annual limit. The distribution of individual doses in 2002 is given in Table II. The highest individual dose at Loviisa nuclear power plant was 20.8 mSv. It accumulated during work at Loviisa and Olkiluoto nuclear power plants. The highest individual dose incurred at Loviisa nuclear power plant alone was 19.5 mSv.

Individual radiation doses did not exceed the dose limit of 100 mSv defined for any period of five years. The highest individual dose to a Finnish nuclear power plant worker in the 5-year period 1998–2002, 84.6 mSv, was received at Loviisa nuclear power plant.

The collective occupational radiation dose at Loviisa plant in 2002 was 2.61 manSv. The collective occupational dose was 1.04 manSv at Loviisa 1 and 1.57 manSv at Loviisa 2. STUK guidelines state that the threshold for one plant unit's collective dose averaged over two successive years is 2.5 manSv per one gigawatt of net electrical power. This means a radiation dose of 1.22 manSv per one Loviisa plant unit. This value was not exceeded at either plant unit. The collective occupational doses incurred at Loviisa and Olkiluoto power plants in 1993–2002 are given in Fig. 16. The yearly collective dose is mostly incurred in outage work. Radiation doses incurred during annual maintenance outages are described in Appendix 5.

Radioactive releases from Loviisa nuclear power plant were well below authorised limits in 2002. Releases of radioactive noble gases were ca. 5 TBq, i.e. 0.02% of authorised limit. The releases of radioactive noble gases were dominated by argon-41, i.e. the activation product of argon-40, originating in the air space between the reactor pressure vessel and the biological shield. The releases of radioactive iodine isotopes were ca. 1 MBq, i.e. ca. 0.0005% of authorised limit. Aerosol releases were ca. 67 MBq, tritium releases ca. 0.2 TBq and carbon-14 releases ca. 0.4 TBq into the air. The tritium content of liquid effluents, 13 TBq, was

Table II. Occupational radiation dose distribution by employment relationships at Loviisa and Olkiluoto plant units in 2002.

Dose range (mSv)	Number of persons by dose range		
	Loviisa	Olkiluoto	total*
< 0,5	210	427	576
0.5–1	118	227	308
1–2	153	209	347
2–3	86	85	165
3–4	50	42	98
4–5	41	16	61
5–6	35	14	49
6–7	30	2	35
7–8	18	0	26
8–9	11	5	25
9–10	14	2	12
10–11	10	1	17
11–12	8	–	15
12–13	9	–	11
13–14	7	–	11
14–15	3	–	5
15–16	7	–	6
16–17	9	–	11
17–18	6	–	5
18–19	2	–	3
19–20	5	–	5
20–21	–	–	1
21–25	–	–	1
> 25	–	–	–

* The data in these columns also include Finnish workers who have received doses at Swedish nuclear power plants. The same person may have worked at both Finnish nuclear power plants and in Sweden.

Source: STUK's dose register

ca. 9% of the release limit. The total activity of other nuclides released into the sea was 85 MBq, i.e. ca. 0.01% of the release limit. Information about noble gas and iodine releases into the air in 1993–2002 are given in Fig. 17 and information about liquid releases in 1993–2002 can be found in Fig. 18. The numerical value of the release limit shows the nuclide-group specific release limit for the plant site, assuming that other releases would not occur. The total release limit is calculated such that the sum of the release limit shares of the various groups does not exceed 1.

The release limits are designed to maintain individual annual radiation exposure in the surrounding population from plant operation clearly below the threshold value of 100 microSv, as determined by the Government Resolution (395/1991). The calculated radiation dose of the most exposed individual in the environment of the facility was ca. 0.05 microSv, i.e. less than 0.1% of the set limit. The radiation doses calculated for 1993–2002 are given in Fig. 19.

Environmental radiation monitoring

Environmental radiation monitoring around a nuclear power plant comprises on- and offsite measurements as well as the determination of radioactive substances to establish public exposure and radioactive substances present in the environment.

In the environment of Loviisa nuclear power plant, 310 samples were analysed in accordance with a monitoring programme. Radioactive substances originating in Loviisa plant were measurable in two samples of deposition, one sample of bottom fauna, ten samples of aquatic plants and nine samples of sinking matter. The dominating power plant-based radioactive substance, cobalt-60, was measured in all of the aforementioned samples. The total number of observations was 21. The next most dominant were the radioactive isotopes of manganese and silver (silver-110m, 14 observations and manganese-54, 13 observations). Also tritium was detected in some samples (9 observations) as well as a radioactive isotope of cobalt (Co-58, 9 observations), antimonium (Sb-

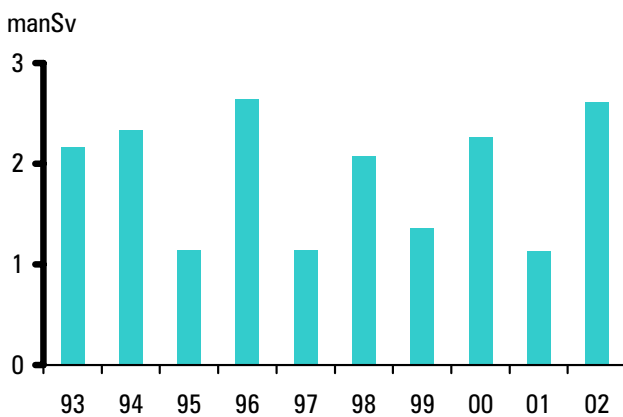
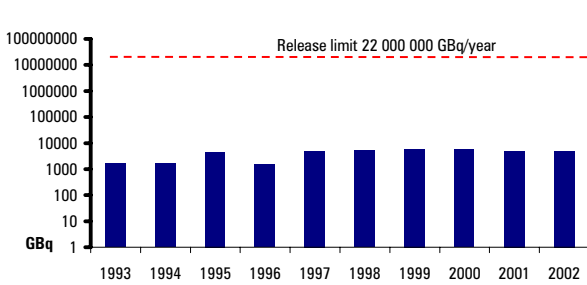
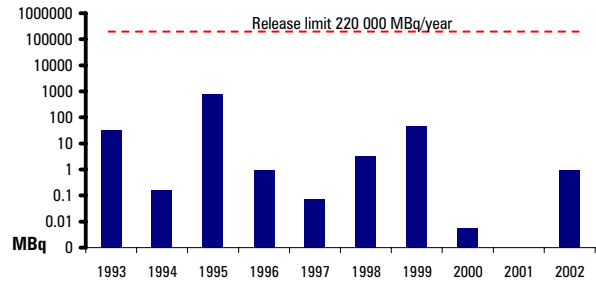


Figure 16. Collective occupational doses at Loviisa nuclear power plant.

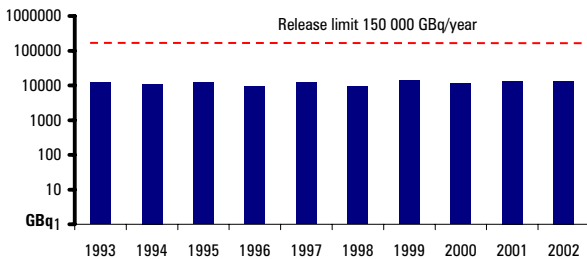


Noble gas releases (as Krypton-87 equivalents)

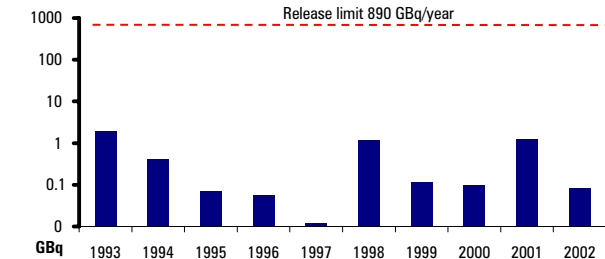


Iodine (as Iodine-131 equivalents). Iodine releases into the air in 2001 were below the detection limit.

Figure 17. Radioactive releases into the air from Loviisa nuclear power plant.



Tritium



Nuclides other than tritium

Figure 18. Radioactive releases into the sea from Loviisa nuclear power plant.

124, 8 observations), zirconium (Zr-95, three observations) and tellurium (Te-123m, one observation).

All the detected concentrations were low and had no bearing of radiation exposure.

Radioactive strontium and caesium isotopes (strontium-90, caesium-134 and -137) as well as plutonium isotopes (plutonium-238 and 239, 240) originating from the Chernobyl accident and the fallout from nuclear weapons tests are still measurable in environmental samples. Natural radioactive substances (i.a. beryllium-7, potassium-40 and uranium plus thorium with their decay products) are also detected. Their concentrations usually exceed those of nuclides originating from the power plant or fallout.

Dosimeters for external radiation measurement have been placed in about 20 locations in the vicinity of domestic nuclear power plants, at a distance of 1–10 kilometres from the plants; and there are also 25 continuous-operation radiation dose rate measuring stations at about five kilometres' distance from the plants. The measurement

data from these stations are transferred to the power plants' control rooms and to the national radiation-monitoring network. Monitoring is complemented by dose rate monitoring measurements and spectrometric measurements. In the environment of Loviisa facility, 12 such external radiation measurements were made.

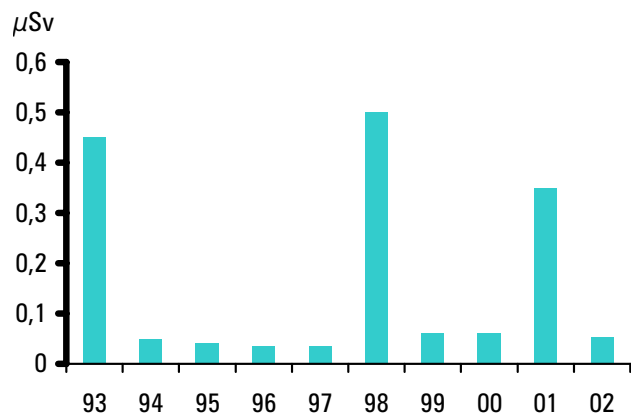


Figure 19. Individual radiation doses calculated for the most exposed population group in the environment of Loviisa nuclear power plant.

4.3 Olkiluoto power plant

4.3.1 Operation and operational events

Both units of Olkiluoto nuclear power plant operated reliably. The load factor of Olkiluoto 1 was 95.3 % and that of Olkiluoto 2 was 96.6%. The duration of the annual maintenance outage of Olkiluoto 1 was 13 days and that of Olkiluoto 2 seven days. The measures taken during the outages are described in Appendix 5.

In consequence of a transient in the national 400 kV transmission grid, a reactor scram occurred at Olkiluoto 1 on 20 April 2002. The event is described in more detail in Appendix 6. There was a brief production break at Olkiluoto 2 to replace valves of low pressure turbines. Sub-section 4.3.3 describes the cause of the valve replacements. In addition, electricity generation at Olkiluoto 2 was discontinued for about a day to check relief system valves. There were no other breaks in electricity generation, apart from the annual maintenance outages.

Production losses from component malfunctions were 0.6% at Olkiluoto 1 and 0.7% at Olkiluoto 2.

Fig. 20 gives the daily average gross powers of the plant units in 2002. Load factors and the number of reactor scrams in 1993–2002 are given in Figs. 21 and 22.

Olkiluoto plant reported 13 operational events to STUK. The number of event reports in 1993–2002 is given in Fig. 23. Event-based reports include special reports, which in 2002 were provided for events mentioned in sub-section 4.3.2, as well as transient reports and scram reports. In addition to event reports, Olkiluoto power plant submitted to STUK the following reports: daily reports, quarterly reports, annual reports, outage reports, annual environmental radiation safety reports, monthly individual dose reports, annual operational event feedback reports and safeguards reports.

One event at the Olkiluoto plant units was classified INES Level 1. It occurred at Olkiluoto 1

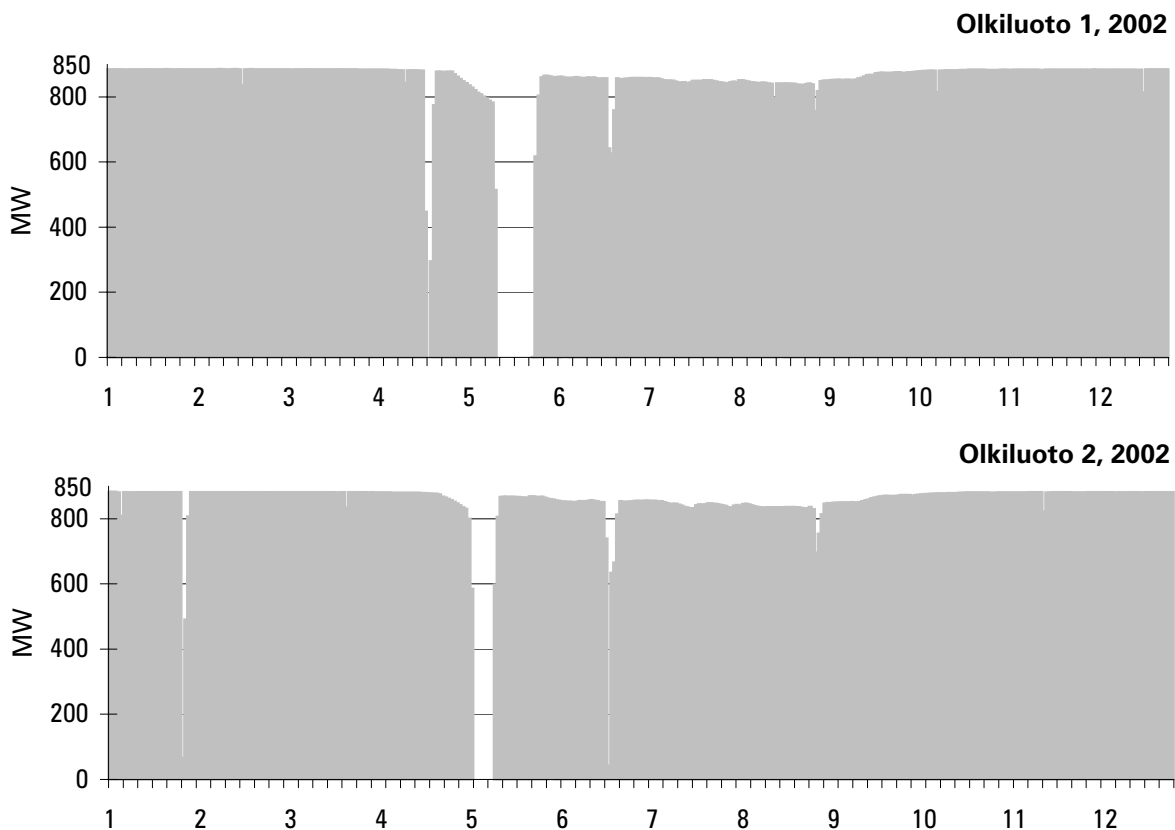


Figure 20. Daily average gross power of the Olkiluoto plant units in 2002.

where, in tests following the annual maintenance outage, it was detected that two safety limits of the neutron flux measuring system were not operating as designed. Other plant events had no bearing on radiation and nuclear safety. Appendix 6 gives the most significant events at the plant units. The number of INES Level 1 and above events in 1993–2002 are given in Fig. 24.

The effect of component inoperability on accident risk at the Olkiluoto plant units is dealt with in Appendix 7. STUK did not require specific measures from the licensee due to the inoperabilities.

The causes of the events at Olkiluoto facility, divided into technical and non-technical, i.e. human or organisational, are presented in Fig. 25. The number of human-induced events has been on the increase during the last two years.

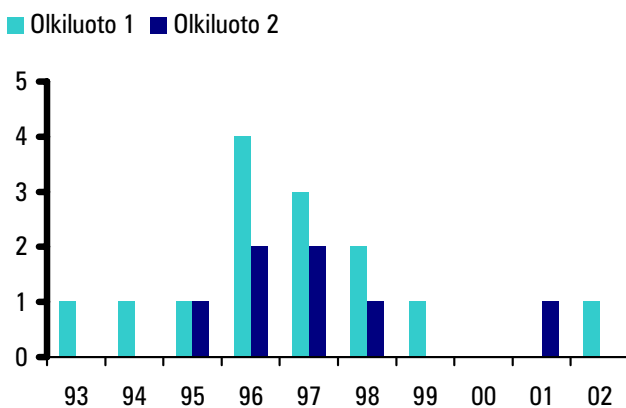


Figure 22. Number of reactor scrams at the Olkiluoto units, scram tests excluded (reactor power exceeds 5%).

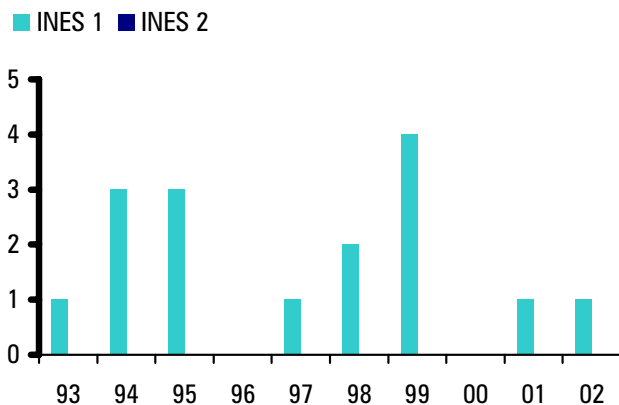


Figure 24. INES Level 1 and above events at Olkiluoto nuclear power plant.

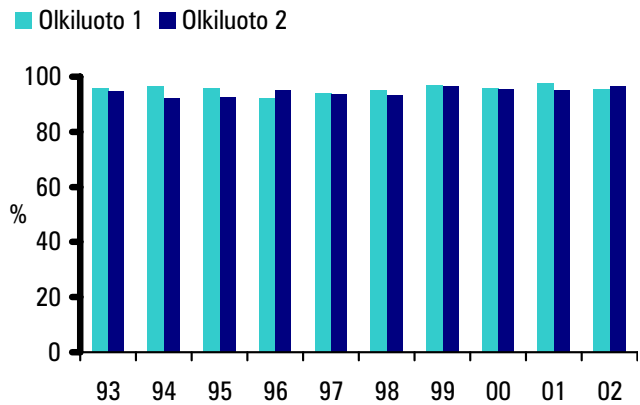


Figure 21. Load factors of the Olkiluoto plant units.

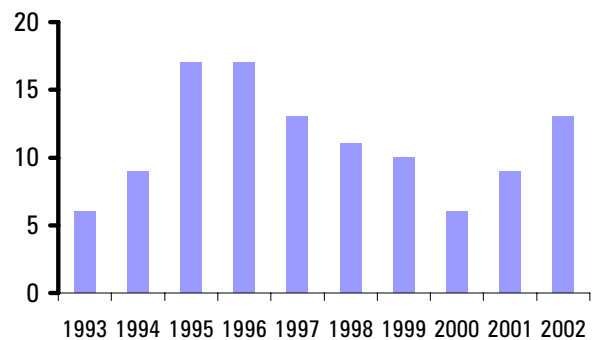


Figure 23. Number of event-specific reports from Olkiluoto nuclear power plant.

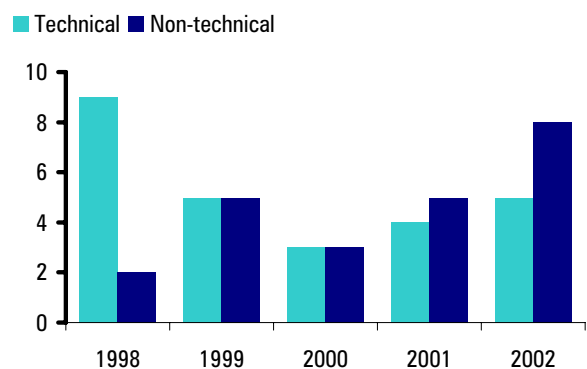


Figure 25. The causes of events at Olkiluoto nuclear power plant.

4.3.2 Plant events in non-compliance with the Technical Specifications

The following seven events at the Olkiluoto plant units were in non-compliance with the Technical Specifications:

- Diesel fuel oil cloud point limit in storage tank was exceeded at both plant units
- Moving of plotter displays from the main control room to the relay room was not in compliance with the Technical Specifications at both plant units
- Two fuel assemblies were erroneously moved at Olkiluoto 1
- Partial inoperability of the neutron flux measuring system at both plant units.

Detailed descriptions are given in Appendix 6.

The number of plant events in non-compliance with the Technical Specifications has clearly increased from 2002. This is essentially due to the fact that three of last year’s events were caused by the same reason at both plant units. The quality management measures intended to prevent the events had been insufficient. The licensee has planned, or has already implemented, measures to prevent recurrence. The number of non-compliances with the Technical Specifications in 1993–2002 are given in Fig. 26.

The licensee applied in advance for STUK’s approval for exemptions from the Technical Specifications. In 2002 the licensee applied for exemption for 11 situations deviating from the Technical Specifications. STUK granted eight applications as such. In three cases a decision not to process the application was made. Four of the exemptions dealt with deviations from the Technical Specifications due to modifications. Two exemptions were

granted for a deviation due to a situation induced by a failed component and, similarly, two for an inspection or testing. The yearly number of exemptions in 1993–2002 is given in Fig. 27.

4.3.3 Event investigation

Degradation of low pressure turbine valves at Olkiluoto 2 and a temporary turbine protection system modification

STUK set up an investigation team in January to look into and assess the licensee’s decision-making and procedures in the handling of low pressure turbine valve degradation at Olkiluoto 2 and in the implementation of a temporary modification to I&C systems due to worsening valve problems. The team gave the licensee several recommendations pertaining to the operation of the organisation and the flow of information.

The control and shutdown valves of the low pressure turbine of Olkiluoto 2 failed for the first time in a functional test of the valves in September 2001. Despite several attempts to close them, one valve in two steam lines remained partially open. Functional testing takes place every two months. Periodic tests indicated the condition of the valves was deteriorating with time. At the end of January it was unclear how well steam lines leading to the low pressure turbine would have closed. The remaining fully open of two low pressure lines would raise turbine revolutions clearly above the revs limit recommended by the turbine plant vendor. It is also obvious that, in case of load rejection, the turbine control system would not have been capable of driving the plant to the house load operation mode.

Assisted by the turbine vendor, the licensee

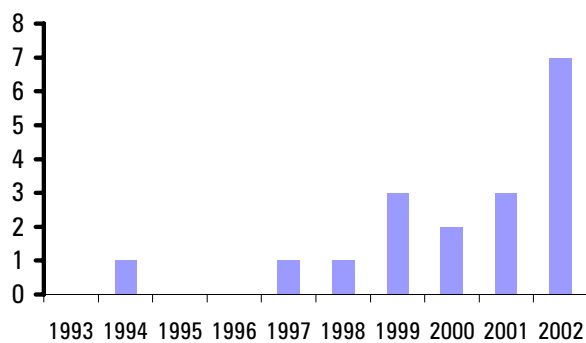


Figure 26. Number of non-compliances with the Technical Specifications at Olkiluoto plant units.

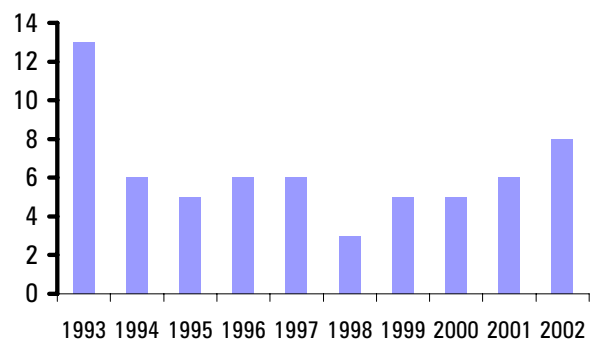


Figure 27. Number of exemptions from the Technical Specifications at Olkiluoto plant units.

designed a temporary modification to the turbine protection system, which initiates a turbine trip when a plant circuit breaker or a generator breaker opens. In addition, the time-delay to post-turbine trip vacuum breaking was made shorter. These modifications are designed to limit turbine overspeeding and to reduce the risk of its damaging in the situations in question.

On 22 January 2002 the licensee decided to implement the modifications. This was done on 24 January 2002 with the facility in full power operation, and plans are to keep them in force until the 2002 annual maintenance. It was discovered later that the modifications would not have protected the turbine due to the worsening of the valve problems. In consequence of the modifications, the plant unit would not have been capable of changing over to house-turbine operation in any situation, i.e. the plant unit would have fallen short of its original design basis. The licensee thus decided to replace the defective valves. For this purpose the plant unit was brought into hot shutdown state, which lasted for about one day, on 26 January 2002. The turbine's protection system was restored to its pre-modification state. The removed valves were dismantled and their roller bearings were discovered to have become jammed due to dried up lubricating grease. The drying was caused by a new type of grease unsuited for this purpose, which was used after original grease had become unavailable.

In an investigation report STUK gave recommendations on the licensee's organisation, quality management, safety culture and I&C system modifications and also required the licensee to report on them. STUK's review of the report has not yet been completed since actions presented by the licensee on account of STUK's recommendations have not been completed.

The recommendations on STUK's own operation given in the investigation report focused on the analysis and registration of safety-significant faults as well as the clarification of the process of enacting new YVL guides or those under revision. During normal regulatory work STUK had learned about the failure observations made during valve testing. However, STUK lacked sufficient information about their significance to be able to anticipate their safety significance. STUK learned about the modification to the automation

systems only during the implementation phase and thus could not give its view on it prior to its implementation. An action plan has been drawn up for the implementation of improvements recommended to STUK's operation.

4.3.4 Safety improvements

Further improvements in the safety of Olkiluoto power plant were made, based on new, post-commissioning safety requirements established in YVL guides, results of probabilistic safety analyses and partly on operating experience.

Several measures to mitigate the consequences of severe accidents were implemented at the Olkiluoto units. The personnel lock of the Olkiluoto 2 containment building was strengthened in 2002. After the modification the containment building withstands better than before occasional heavy pressure shocks that might occur in a severe accident.

The main control room desks of both plant units were provided with valve-specific selector switches for changing the operating range of the reactor core spray system, which is dependent on the reactor level, to ascertain emergency cooling in some accident conditions.

The reactor control rod manoeuvring and position indication system of Olkiluoto 1 was upgraded. The upgrading made control of the rods more accurate, improved their position data and test reporting, and reduced malfunctions. It also reduces the probability of erroneous control rod withdrawal.

The replacement of ageing rotating direct/alternating current converters with modern UPS equipment was completed. The converters were replaced due to increased maintenance costs, low efficiency and ageing-induced malfunctions.

The oldest computers in the Olkiluoto 1 process computer system plus their process interface equipment were upgraded and provided with user interfaces.

Safety improvements are described in more detail in Appendix 4.

4.3.5 Probabilistic safety analyses

The review of a weather risk analysis for Olkiluoto power plant was completed. It says that the risk from weather phenomena and sea-water related phenomena is almost solely due to the loss of sea

water cooling caused by seaweed, mussels in the sea water tunnel and frazil ice. The share of weather phenomena and similar environmental phenomena of the plant's total core damage frequency is about 5%.

Very high uncertainties were noted to be related to the analysis. These concern the occurrence frequencies of extreme weather conditions on one hand and the success probability of counter-measures on the other. The review underlined the dependence of Olkiluoto power plant on the availability of sea water cooling.

Studies commissioned in 2000–2001 by the Finnish Meteorological Institute and the Finnish Institute of Marine Research were utilised in reviewing sections of the analysis pertaining to actual weather phenomena and sea water levels.

The results of the weather risk analysis do not give cause for immediate measures at the plant. Based on the review, however, the licensee was required to process several additional questions in the next update of the weather risk analysis.

4.3.6 Radiation safety

Occupational radiation doses

The radiation doses of those who worked at Olkiluoto nuclear power plant in 2002 were below the 50 mSv annual limit. The distribution of individual doses in 2002 is given in Table II. The highest individual dose at Olkiluoto nuclear power plant was 10.4 mSv. Individual radiation doses in 1998–2002 were also below the 100 mSv dose limit determined for a 5-year period.

In 2002 the collective occupational dose was 0.81 manSv at Olkiluoto 1 and 0.31 manSv at Olkiluoto 2; the total for both plant units being 1.12 manSv. STUK guidelines state that the threshold for one plant unit's collective dose averaged over two successive years is 2.10 manSv. This value was not exceeded in either plant unit. The collective occupational doses incurred at Olkiluoto power plant in 1993–2002 are given in Fig. 28. The radiation doses incurred during annual maintenance outages are described in Appendix 5.

Radioactive releases

Radioactive releases into the environment from Olkiluoto nuclear power plant in 2002 were well below authorised limits. The releases of noble gas-

es into the air were ca. 0.03 TBq, i.e. 0.0002% of authorised limits. The releases of iodine into the air were ca. 10 MBq, i.e. ca. 0.009% of authorised limit. Aerosol releases into the air were ca. 30 MBq, tritium releases into the air ca. 0.4 TBq and carbon-14 releases into the air ca. 1 TBq. The tritium content of liquid effluents to the sea, 1 TBq, was ca. 6% of the annual release limit. The total activity of other nuclides released into the sea was 0.8 GBq, i.e. ca. 0.3% of the plant-site specific release limit. Information about noble gas and iodine releases into the air in 1993–2002 are given in Fig. 29 and information about liquid releases in 1993–2002 can be found in Fig. 30. The numerical value shows the nuclide-group specific release limit for the plant site assuming that other releases would not occur. The total release limit is calculated such that the sum of the release limit shares of the various groups does not exceed 1.

The calculated radiation dose of the most exposed individual in the environment of the Olkiluoto plant was ca. 0.07 microSv, i.e. less than 0.1% of the limit prescribed by the Government. The radiation doses calculated for 1993–2002 are given in Fig. 31.

Environmental radiation monitoring

In the environment of Olkiluoto nuclear power plant, 294 samples were analysed in accordance with a monitoring programme. Radioactive substances originating in Olkiluoto nuclear power plant were measured in one sample of air, one sample of deposition, one sample of fish, two samples of bottom fauna, 15 samples of aquatic plants and 14 samples of sinking matter. The dominating power plant-based radioactive substance, cobalt-

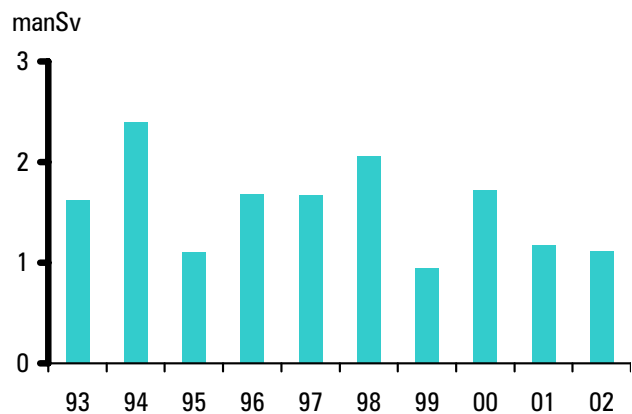
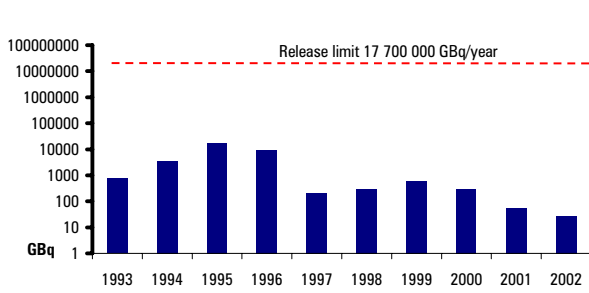
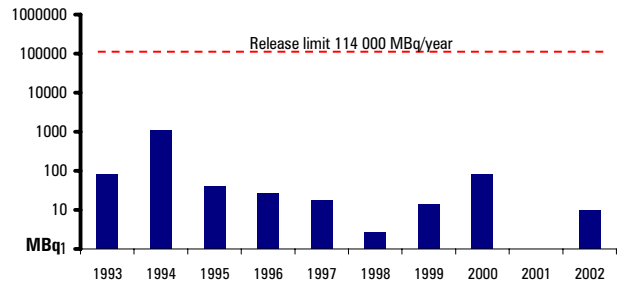


Figure 28. Collective occupational doses at Olkiluoto nuclear power plant.

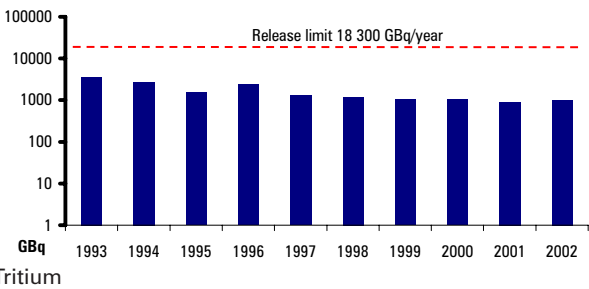


Noble gas releases (as Krypton-87 equivalents)

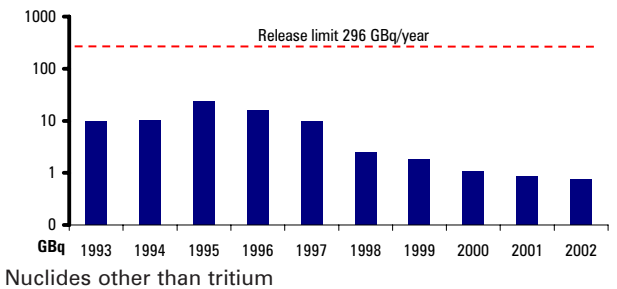


Iodine (as Iodine-131 equivalents). Iodine releases into the air in 2001 were below the detection limit.

Figure 29. Radioactive releases into the air from Olkiluoto nuclear power plants.



Tritium



Nuclides other than tritium

Figure 30. Radioactive releases into the sea from Olkiluoto nuclear power plants.

60, was measured in all of the aforementioned samples. The total number of observations was 34. Apart from cobalt, the radioactive isotopes of manganese (manganese-54) were detected in one sample of deposition and in two samples of aquatic plants. In addition, elevated tritium concentrations were measured in two samples of deposition and in one sample of sea water.

All the detected concentrations were low and had no bearing on radiation exposure.

In addition to the above, 12 external verification measurements were made in the environment of Olkiluoto nuclear power plant.

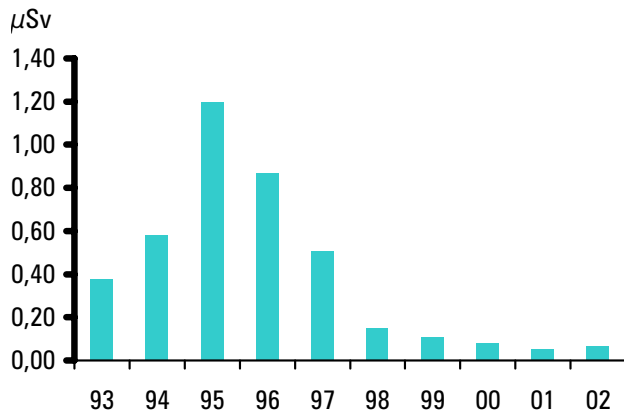


Figure 31. Individual radiation doses calculated for the most exposed population group in the environment of Olkiluoto nuclear power plant.

4.4 Fifth reactor in planning

The preliminary safety assessment on the new nuclear power plant by STUK of February 2001 was complemented in January 2002 as regards external threats, such as aircraft impact. The supplement was added because of the terrorist attack on New York's WTC on September 11. The supplement states that it is technically possible to build the new nuclear power plant such that it withstands an aircraft impact. Contained in the supplement are general safety requirements for impact resistance and also some other safety requirements to provide more extensively than before for an external attack.

The Government on 17 January 2002 made a decision-in-principle in favour of the construction of a fifth reactor and appended to the decision a statement according to which it calls for adherence to strict safety requirements in the construction of the new nuclear power plant. The decision-in-principle was thereafter submitted to the Parliament. It's preparation was lead by the Parliamentary Economic Committee, which requested statements from seven other committees. STUK's experts and management spoke both at committees and to the media. In the final reading of the matter in the Parliament on 24 May 2002 votes

were cast 107–92 in favour of the decision-in-principle, which remained in force.

STUK began preparing for the regulatory control of the new plant project after the making of the Parliamentary decision. The schedule for preparatory work is based on a plan of Teollisuuden Voima Oy in which the processing of the construction permit application for the new plant takes place in 2004 and the plant's completion at the end of the current decade.

In 2002 STUK prepared a preliminary regulatory project plan, set up a regulatory co-ordination project group and prepared the first regulatory working load assessments for the plant project. The need to revise STUK's YVL guides was assessed and re-prioritisation was applied. Since safety and risk are of vital importance when defining quality criteria and in focusing regulatory control, STUK's views on the safety classification of systems and components as well as on their diversity principles were further defined.

STUK's competence and resources, which are required in the processing of the construction permit application, were mapped. On this basis, the initial phase of recruiting new experts was started, which relates to the new plant project first of all but also to other significant projects, such as modifications planned to the I&C systems of the operating plant units.

4.5 FiR 1 research reactor

STUK regulates electricity-generating nuclear power plants as well as the FiR 1 research reactor operated by the Technical Research Centre of Finland (VTT). The reactor is located in Otaniemi, Espoo, and its maximum thermal power is 250 kW. The reactor is used for fabrication of radioactive tracers, activation analysis, student training and treatment of brain tumours by neutron irradiation (Boron Neutron Capture Therapy - BNCT) as well as development of BNCT therapy.

STUK's periodic inspections focused on the reactor's quality management, operation, radiation protection, radioactive releases, fire protection, emergency preparedness and physical protection, and safeguards. No significant safety problems were observed in the reactor's operation in 2002. Occupational radiation doses and radioactive releases into the environment in 2002 were clearly below set limits.

VTT's organisation changed on 1 January 2002 when VTT Energy and VTT Chemical Technology formed a new research unit called VTT Processes. The FiR 1 reactor was made directly subordinate to the field manager of VTT Processes. On the request of VTT Processes, STUK in July 2002 authorised FiR 1's new responsible manager and in December five reactor operators.

4.6 Other nuclear facilities

The regulatory control of nuclear facilities pertaining to nuclear waste management, such as storage space, is dealt with in Chapter 5.

5 Nuclear waste management regulation

5.1 Spent nuclear fuel

STUK monitored the storage of spent nuclear fuel by regular inspections and by reviewing plans and witnessing work pertaining to storage equipment. No storage-related events occurred that would have endangered safety. The yearly volumes of spent fuel stored onsite are given in Figure 32.

Posiva Oy, a company owned by Teollisuuden Voima Oy and Fortum Power and Heat Oy, carries out R&D and planning into spent fuel disposal and prepares for its implementation at a later date. On the company's application the Government has made a decision-in-principle on the construction of a final disposal facility in Olkiluoto. Posiva is in the process of implementing an extensive R&D and planning project to ascertain suitability of the repository site and to obtain the research data needed to assure the safety of final

disposal. The research programme includes, among others, the construction of an underground research facility in Olkiluoto as of 2004. The facility may be later used as part of the final repository proper, a fact which needs to be considered in the regulation of the research facility's implementation.

Posiva Oy continued to carry out geological research programmes to determine the baseline of the local bedrock and to support the design of the underground research facility. STUK has set up four follow-up teams to monitor these pieces of research, which also include independent experts from Finland and abroad. In 2002 the follow-up teams assessed in particular the bedrock structural model, the research facility access route designs, geohydrological studies and modelling as well as GPS measurements of rock movements.

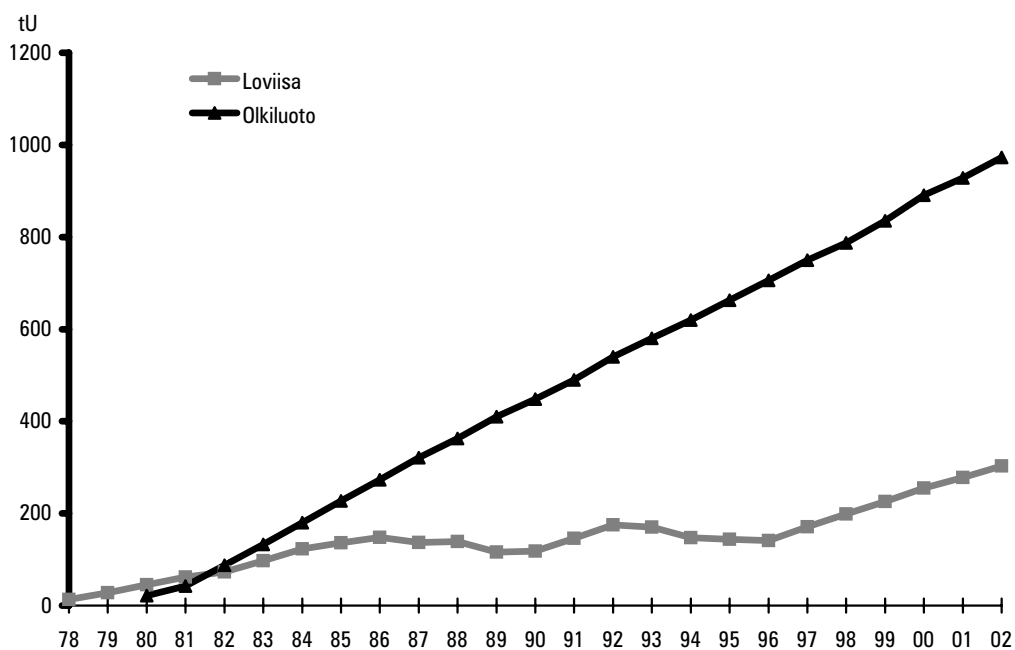


Figure 32. The volumes of spent nuclear fuel at the Loviisa and Olkiluoto plant sites.

Posiva continued technical R&D into nuclear fuel encapsulation and final disposal as well as safety research, most of it in co-operation with the Swedish nuclear waste company SKB. The company submitted reports on three alternative technical designs for an encapsulation facility; STUK assessed the designs from the safety point of view and informed Posiva about its views.

5.2 Reactor waste

The utilities in 2002 followed earlier practices in carrying out their medium and low-level waste maintenance activities. A solidification facility is Loviisa power plant's most important nuclear waste project, the Preliminary Safety Analysis Report of which STUK approved in March 2001. The facility's construction was postponed, however, and is due to start in 2003 according to current plans, in which case it would be completed by the end of 2006.

STUK inspected the handling and storage of reactor waste at both plant sites. The inspections

dealt with, among others, the definition of the radionuclide inventory of waste drums and waste accounting as well as the concrete and rock structures of the disposal facilities for reactor waste.

No safety-related problems occurred in the treatment, storage and final disposal of reactor waste. Yearly waste volumes are given in Figure 33.

5.3 Other regulatory activities

STUK gave to the Ministry of Trade and Industry a statement, as referred to in section 78 of the Nuclear Energy Decree, about the licensees' nuclear waste management measures and plans. The statement assesses how, in preparing for nuclear waste management, the licensees have proceeded in relation to the goals set out by the Government. STUK also gave statements, as referred to in section 90 of the Nuclear Energy Decree, about making financial provision for the costs of nuclear waste management, which assess the technical plans based on which financial provision is made.

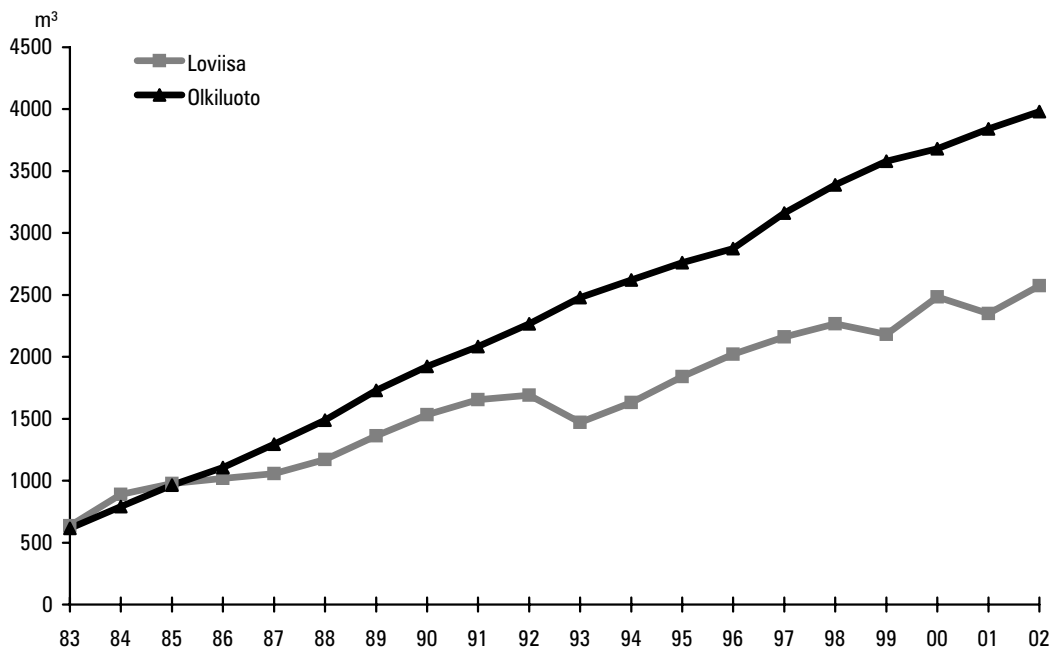


Figure 33. The volumes of reactor waste at the Loviisa and Olkiluoto plant sites.

6 Safeguards

6.1 Safeguards at Finnish nuclear facilities

As regards nuclear power plants, STUK's safeguards focused on the import, transport, storage and domestic transfer of nuclear fuel, and refuelling. The licensees submit to STUK the necessary annual plans, advance notifications and reports in compliance with safeguards requirements.

STUK granted Teollisuuden Voima Oy four licences for the import of fresh nuclear fuel. In addition, Teollisuuden Voima Oy was granted two other licences for the import and one licence for the import/export of nuclear material. Fortum Power and Heat Oy was granted two licences for the import of nuclear material. VTT Processes was granted a licence for the import from England of uranium oxide pellets of enriched uranium and also a licence for the export to and re-import from the USA of control rod drive mechanisms for use as spare parts. A list of the licences granted can be found in Appendix 2.

A total of nine inspections were made at Loviisa power plant and 17 inspections at Olkiluoto power plant in 2002. Euratom and the International Atomic Energy Agency IAEA participated in 23 of these inspections.

In addition to the domestic nuclear power plants, minor amounts of nuclear material can be found at other facilities. The most significant of these is FiR 1, the research reactor operated by the VTT where one inspection was conducted in 2002. STUK, the IAEA and Euratom participated in the inspection. Regulatory control also covers the Laboratory of Radiochemistry at the Department of Chemistry of the University of Helsinki, OMG Kokkola Chemicals and STUK.

Nuclear material safeguards employ several

methods to verify that data on nuclear materials reported by the operator, such as burn-out and cooling time, are correct and complete. Other nuclear-safety related data, from operational safety to final disposal, can be verified also by measurements. In 2002 STUK verified by non-destructive methods at Olkiluoto and Loviisa power plants 94 and 10 spent fuel assemblies respectively.

Every material balance area operated in compliance with STUK-approved manuals and in a way facilitating STUK's fulfilling of the obligations of international agreements signed by Finland.

In 2002 STUK authorised 16 Euratom and 11 IAEA inspectors to make inspections at Finnish nuclear facilities.

6.2 Overall safeguards renewal

International safeguards were implemented by the IAEA and the Euratom Safeguards office of the EU. IAEA safeguards are based on the Non-Proliferation Treaty and the Safeguards Agreement (INFCIRC/193) signed by virtue of the Treaty by non-nuclear EU member states, Euratom and the IAEA. Euratom safeguards are based on the Euratom Treaty and Commission Regulation 3227/76 given by virtue of the Treaty.

In connection with safeguards activities based on the Model Protocol Additional (INFCIRC/540), which deals with the strengthening of the IAEA safeguards system, STUK participated in information exchange and consultation meetings arranged by the IAEA and Euratom. The field testing of safeguards implementation in accordance with the Protocol at VTT Chemical Technology was completed for Finland's part. The IAEA on 11 of October 2002 carried out a field-test-related com-

plementary access to VTT. By virtue of the Protocol, the IAEA is entitled to complementary access onsite at 24 hrs' notice. The test showed that the connections between the IAEA and STUK are operational: without delay STUK received inspection data via the emergency preparedness system and was able, for its own part, to contribute to the progress of the inspection. Euratom received an inspection notice from the IAEA but was unable to participate in the complementary access. In addition, STUK has contributed, on the request of Sweden's SKI, to discussions and meetings pertaining to the definition of the concept of site area.

The final disposal of nuclear fuel in underground facilities places new challenges on safeguards implementation since encapsulation makes nuclear material verification impossible in practice. STUK started preparatory work for the establishment of national requirements for an encapsulation and final disposal facility. The aim is to create regulatory criteria to cover the needs of both national and international regulatory organisations.

6.3 Control of radioactive materials transport

About 20 000 radioactive packages are transported in Finland every year. STUK is not aware of any transport accidents involving radioactive materials, or of any other safety hazards. The most important forms of nuclear material transport were imports of fresh nuclear fuel from Germany, Sweden and Russia. STUK approved the relevant plans and two types of package for use in Finland. Of the consignments of nuclear material transported in 2002, one batch was picked up for detailed inspection.

The importation of radioactive and nuclear materials is subject to licence, too. In 2001 and 2002 no shipments containing radioactive material were turned back at the border. The highest number, 23 consignments, was turned back in 1997. The number is smaller now than in previous years, partly because consignors and consignees have, through training and experience, come to understand the possibility of radioactivity in consignments of scrap metal. Control at the borders has been enhanced and, at the same time, consignments of scrap metal to Finland have decreased.

7 Safety research

STUK-financed safety research focuses on two areas: development of safety assessment methods and expertise as well as research in direct support of regulatory decisions. The former benefits first of all from the national nuclear power plant safety and waste research programmes FINNUS and KYT. Excluded from these programmes is research commissioned by STUK pertaining to STUK's own decisions, which must be independent of similar research by licensees or licence-applicants. In addition to these two main areas, STUK also commissions independent research that serves to develop regulatory control.

STUK's experts controlled and monitored the FINNUS and KYT research programmes and contributed to the planning of the SAFIR programme that is continuation for the FINNUS programme. The framework of SAFIR is based on the safety challenges to nuclear power plants identified for the current decade, of which there are several owing to the ageing of operating facilities and to the fifth reactor in planning.

The general research topics of the FINNUS programme, which ended in 2002, were nuclear power plant ageing, reactor accidents and various risks. The programme was arranged into eleven research projects whose results are available at www.vtt.fi/pro/pro1/indexe.htm. Information about the new SAFIR programme can be found at www.vtt.fi/pro/tutkimus/safir.

One of the most important tasks of the national programmes is to follow international co-operation projects. In the field of reactor safety, STUK contributed to several projects within the OECD/NEA and also worked with the US NRC. Of STUK-commissioned research projects outside the

FINNUS programme, the most significant in 2002 pertained to fire safety and threats external to nuclear power plants.

The focus of the KYT programme in 2002 was similar to that of the earlier JYT2001 programme, i.e. earth sciences, technical barriers, migration of radioactive substances, safety analyses and technical solutions. Information on the programme can be found at www.vtt.fi/pro/tutkimus/kyt (in Finnish).

In 2002 STUK commissioned nuclear power plant safety and waste management research to the following external organisations: VTT Industrial Systems, VTT Processes, VTT Building and Transport, VTT Information Service, the Geological Survey of Finland, the Finnish Institute of Marine Research, Helsinki University of Technology (HUT), Department of Mathematics/Mechanics of Materials, HUT Material Science and Rock Engineering, HUT Surveying, Helsinki University Laboratory of Radiochemistry, Helsinki University Department of Seismology, Uppsala University, Enterpris Ltd (England), Enviros consulting Ltd (Scotland), Geosigma Ab (Sweden), Royal School of Mines, Imperial College (England), NEMKO Product Services Oy and Serco Assurance (formerly AEA Technology plc) Inspection Validation Centre (IVC).

Appendix 8 lists STUK-financed safety research completed in 2002. The cost of nuclear safety research in 1998–2002 is given in Fig. 34.

Current nuclear safety research and publications are reported in STUK's web pages at www.stuk.fi/tutkimustoiminta in Finnish. Research publications can be found at www.stuk.fi/english/publications/.

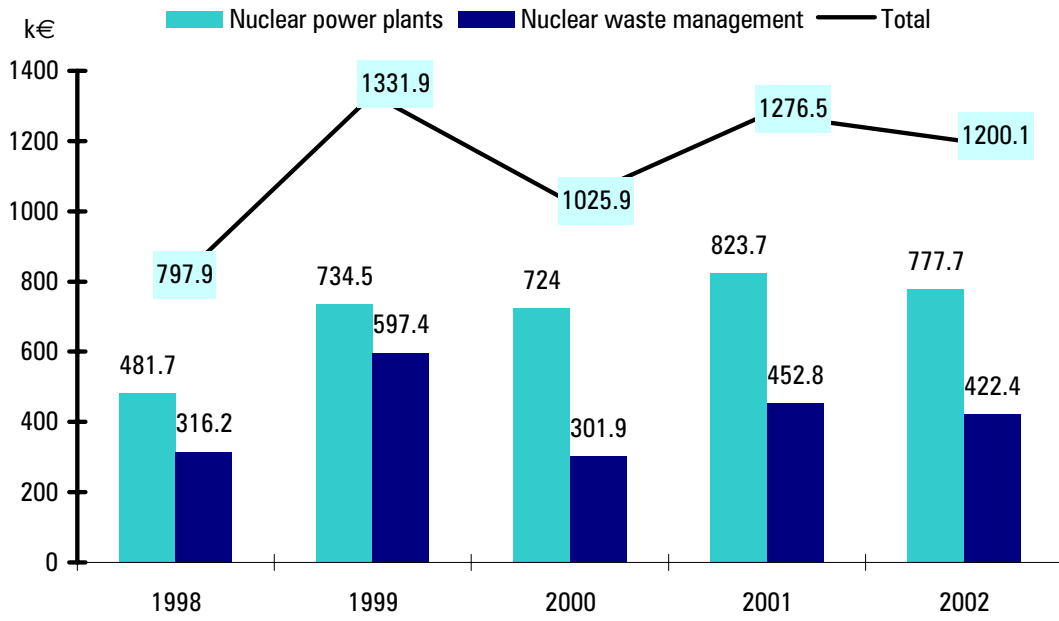


Figure 34. The cost of nuclear safety research.

8 Emergency response

STUK arranged several training events and exercises to test and develop its own emergency response. In addition, STUK controls the preparedness of the operating organisations of nuclear power plants to act in unusual situations. No such situations occurred in 2002.

Emergency response at nuclear power plants is under continuous development during plant operation and regularly tested in emergency exercises as part of emergency preparedness training. STUK has approved the emergency plans of Loviisa and Olkiluoto nuclear power plants and annually reviews the implementation of the emergency preparedness regime, including training and emergency exercises.

Two emergency exercises involving domestic nuclear power plants were arranged in Finland in 2002 into which STUK participated. Several domestic authorities from local government, regional administration and central government participated in an emergency exercise at Olkiluoto nuclear power plant on 15 October 2002. The exercise tested inter-authority co-operation, the forming an overall picture of the accident situation and the dissemination of information to the public and the media. In addition, Nordic radiation and nuclear

safety authorities followed how STUK communicated an overall picture of the accident situation. An emergency exercise at Loviisa nuclear power plant was held on 22 November 2002 and STUK participated in it in accordance with the plant's emergency plan. Essential for STUK in the exercise was the setting up in practice of the emergency organisation and the launching of its operation since those taking part in the exercise were not assigned in advance and were not told its date. A fire drill was held at Loviisa plant on 29 May 2002 and on 4 December 2002. The fire drill of Olkiluoto plant was arranged on 25 November 2002.

STUK also participated in nuclear power plant emergency exercises of international scale, which in 2002 contained no actual analysis of plant situations. The main topic of an emergency exercise at the Russian Bilibino on 21 August 2002 was international information exchange in an accident. A series of four emergency exercises under EU financing, on 27 February and 28 May 2002, tested were the support systems to decision-making employed during a nuclear power plant accident for assessment of the accident's ill effects in the plant environment and also the benefits of protective measures.

9 Communications

STUK took the initiative in communicating to the general public matters relating to nuclear safety regulation and also responded to media questions. STUK issued bulletins or press releases on 13 topics. The material was published on the Teletex pages of YLE (the Finnish Broadcasting Company) and on STUK's web site. In addition, the matters were discussed in the quarterly STUK-publication ALARA. The media and liaison groups were provided with quarterly reports on nuclear safety in Finland and in the neighbouring countries.

As regards events at Finnish nuclear power plants, STUK informed the media when the primary circuit boric acid concentration of Loviisa 1 went below set limit during the annual maintenance outage. It also reported an accident at work that occurred during the outage. In addition to reporting events at the plants, STUK issued bulletins on the annual maintenance outages of the Loviisa and Olkiluoto plant units as well as on three other breaks in power generation. A bulletin

was put out on the supplementing of the preliminary safety analysis report for the fifth reactor in planning.

Information was published about issues relating to international co-operation as follows: the meeting to assess the International Nuclear Safety Convention, a STUK director's appointment as chairman of the IAEA's committee on safety regulation, and training on the monitoring of the Nuclear Test Ban Treaty given to experts in STUK. In addition, a bulletin was issued on the development of a potential method for detecting undeclared nuclear activity.

The bulletins issued by STUK are available to read on STUK's Internet site (in Finnish and in Swedish).

On STUK's web site, under Reader's Link, citizens made questions to STUK's experts. In 2002, 250 questions were made 6% of which were about the use of nuclear energy.

10 International co-operation

Co-operation with the IAEA

The IAEA continued revision of its nuclear safety guidelines (formerly Nuclear Safety Series NUSS Guides). The revision is almost done and is expected to be completed in the coming years. STUK prepared for the IAEA several statements on draft guidelines requested from Finland. It also contributed to the work of teams preparing the draft guidelines. A representative of STUK was invited as chairman of the NUSSC (nuclear safety) committee. In addition, STUK-representatives were active in the WASSC (waste safety) and RASSC (radiation safety) committees.

The International Nuclear Safety Convention requires the submission, every three years, of a report on how the Convention's obligations have been met. The second review meeting was in 2002. Finland's report was prepared under STUK's supervision. The review meeting was held in spring 2002 and Finland's representation included representatives from the Ministry for Foreign Affairs, STUK, Teollisuuden Voima Oy and Fortum Power and Heat Oy. The task of STUK's representative at the meeting was to report on it. Finland's report was positively received. No remarks were made on it that would require reporting by Finland in the next review meeting in 2005.

STUK was Finland's liaison organisation for the below information exchange systems for nuclear facilities maintained by the IAEA:

- Incident Reporting System (IRS)
- Incident Reporting System for Research Reactors (IRSRR)
- International Nuclear Event Scale (INES)
- Power Reactor Information System (PRIS).

No events reportable to the IRS, INES and IRSRR systems occurred in Finland in 2002. Yearly information was submitted to the PRIS system on the operation of Finland's nuclear power plants.

Funded from the IAEA's safeguards support programme, a STUK-representative worked as a co-ordinator to East and Middle European assistance programmes. The programme is financed by the Ministry for Foreign Affairs and executed by STUK. Its objectives include development of the IAEA's safeguards procedures, training of inspectors and provision of expert assistance

In IAEA expert capacity, a STUK representative participated in the IRRRT assessment of the Slovakian nuclear safety authority. STUK-experts lectured in France and Germany on IAEA-courses on nuclear safety and regulation conducive to the proficiency of the representatives of East European regulatory authorities. STUK's experts had participated in the planning of these courses as well. STUK-experts lectured also at an IAEA course on radiation protection in waste management in the Republic of Moldova; at a course on communication and transparency in the field of nuclear safety in Slovenia; and at a course in Poland on the provision of notification of the Central European nuclear power situation.

Co-operation with the OECD/NEA

International co-operation in nuclear safety research was mostly channelled through the OECD/NEA. The organisation also facilitated an exchange of opinions about current nuclear safety questions. STUK was represented in all of the organisation's main committees dealing with radiation and nuclear safety. The main committees are as follows:

- Committee on the Safety of Nuclear Installations (CSNI),
- Committee on Nuclear Regulatory Activities (CNRA),
- Committee on Radiation Protection and Public Health (CRPPH), and
- Radioactive Waste Management Committee (RWMC).

STUK's Director General acted as chairman of the CNRA. In addition, STUK took part in the work of the Working Group on Inspection Practices (WGIP), the Working Group on Public Communication (WGPG) and the below six CSNI working groups:

- Working Group on Operating Experience (WGOE)
- Working Group on Integrity of Components and Structures (IAGE)
- Working Group on Accident and Analysis (GAMA)
- Working Group on Risk Assessment (WGRISK)
- Special Expert Group on Human and Organisational Factors (SEGHOF)
- Special Expert Group on Fuel Safety Margins (SEGFSM).

A representative of STUK was chairman of the CRPPH working group EGRO (Expert Group on Effluent Release Options).

Co-operation with the EU

STUK participated in the work of the ad hoc Working Party on Nuclear Safety (WPNS), set up by the Atomic Questions Group (AQG) subordinate to the Council of the European Union, assessing the status of nuclear safety in EU applicant countries. The working party first assembled in the spring 2001. The assessment for 2001 contained for each applicant country recommendations whose implementation status was assessed in the spring 2002. The evaluation considered nuclear safety in Slovakia, Slovenia, Hungary and the Czech Republic and to be on a par with that of the EU. Lithuania would have room for development in the implementation of some important safety improvements. Bulgaria and Romania have room for improvement as well.

STUK contributed to the work of the advisory Expert Group A31 of the Commission of the European Union. It's main duties pertain to radiation protection. In December 2002 it issued a statement on a draft nuclear safety directive proposed by the Commission ("Nuclear Package").

STUK contributed to the work of the NRWG Task Force on Non-Destructive Testing Qualification Programmes. The task force has been assigned to exchanging experiences on the imple-

mentation and development of qualification in various European countries and to following and assessing the qualification of inspections from a regulatory point of view. The group made a survey among its members and the EU applicant countries to exchange experiences.

In addition, STUK participated in the work of the NRWG Safety Critical Software working group assigned to collecting common EU regulatory views on safety-critical software requirements.

In the field of nuclear material safeguards, STUK participated in the operation of the European Safeguards R&D Association (ESARDA). ESARDA's duty is to promote and harmonise European R&D relating to nuclear material control. ESARDA offers a forum for information and ideas exchange to authorities, researchers and nuclear power plant operators.

Via the activities of the Regulatory Assistance Management Group (RAM-G) of the EU, STUK participated in Phare/Tacis co-operation in support of East European regulatory organisations and their support organisations. STUK's Director General was RAM-G Chairman and a STUK-representative a member. The group assessed the appropriateness of projects prepared by the EU to support regulatory work. In addition, STUK contributed to the then-ongoing Tacis projects. STUK also participated in the work of the CONCERT working group consisting of the heads of nuclear safety authorities of the EU member states and applicant countries. The group assembled twice to discuss EU-related questions touching on regulatory work.

NKS co-operation

The new programme of NKS, Nordic co-operation in nuclear safety, was launched in 2002. It is directed by two responsible programme managers instead of the former seven project managers. STUK heads the new programme's sub-area pertaining to reactor safety and also participates in the planning of the emergency preparedness and environmental safety programme. In addition, STUK has a representative in the NKS steering group.

In the new programme, work is not planned for more than four years ahead. This change facilitated in principle the launching of research work in

good time in the first programme year, and its success in practice. The on-going projects relating to reactor safety relate well to Finland's national research programme and needs. Several experts from STUK work with the emergency preparedness and environmental safety programme that includes focus areas important to Finland.

The new programme's content in its entirety serves well co-operation between the Nordic authorities, which is a permanent objective of NKS co-operation.

Bilateral co-operation

A representative from STUK was an invited member of the Reactor Safety Committee assisting the Swedish Nuclear Power Inspectorate (SKI). A representative of SKI was an invited expert in the Advisory Committee on Nuclear Safety that functions in conjunction with STUK. Co-operation with SKI was continued with regular meetings during which current questions of nuclear safety regulation were discussed. Information exchange with the Swedish Radiation Safety Authority (SSI) was continued as regards doses to Finns who had worked at nuclear power plants in Sweden and to Swedes who had worked at Finnish plants.

A representative of STUK was chairman of a nuclear safety committee that supports the Belgian nuclear safety authority and participated as a permanent member in the work of a corresponding Lithuanian advisory committee.

STUK's co-operation with the USNRC focused on information exchange in nuclear safety matters of interest to both parties. A STUK-representative worked at the USNRC as a visiting expert for one year. In addition, STUK continued, in cooperation with the USNRC and VTT, development of the FRAPTRAN/GENFLO code for fuel transients. The USNRC and STUK drew up and signed a co-operation agreement on the matter. The first programme version was installed at PNNL (Pacific North-West National Laboratory) and commissioned at VTT. Additionally, and in co-operation with Fortum Service, ANL (Argonne National Laboratory) was provided with Zr1%Nb cladding material for the USNRC's LOCA tests.

STUK continued co-operation with the French nuclear safety authority support organisation IRSN regarding probabilistic safety analysis (PSA)

related information exchange and development of fire risk analysis methods.

Co-operation between STUK and the Russian nuclear safety authority (GAN) in the field of nuclear material and waste control continued based on a co-operation arrangement signed in 1998.

Safeguards co-operation between STUK and the Australian Safeguards and Non-proliferation Office (ASNO) was continued. STUK provided ASNO with information about nuclear materials imported to and kept in Finland.

The Comprehensive Nuclear Test Ban Treaty (CTBT)

The National Data Centre (NDC), which operates in conjunction with STUK, is based on the Comprehensive Nuclear Test Ban Treaty. It contributed to the work of the preparatory commission for the Comprehensive Nuclear-Test-Ban Treaty Organisation (CTBTO) to establish a cost-effective organisation that is functional also from the Finnish point of view. Personnel from radiation monitoring stations belonging to the international observation network to verify compliance with the Treaty were trained to assure the operation of the stations. The NDC's own automatic, routine monitoring was in operation for the whole year. An alarm system was developed for use in routine monitoring, to transmit data on unusual observations to the NDC's personnel. The NDC observed no abnormal activity in 2002.

The suitability of the analysis programme used by the DNC to analyse radioactive noble gas samples was assured.

STUK signed an agreement with the makers of the analysis programme about its handing over to the national data centres of other countries for use in CTBT work.

Other forms of co-operation

STUK participated in the work of the Western European Nuclear Regulators' Association (WENRA) and arranged the Association's meeting in Helsinki in November. The development and feasibility testing of a method for use in the harmonisation of nuclear safety requirements was completed in 2002. A pilot-type assessment of harmonisation needs with recommendations on six safe-

ty topics was completed. The representatives of the nuclear safety authorities of eight West European countries participated in the work. A more extensive project was proposed to WENRA, consisting 15 new safety topics.

The VVER Forum, a form of co-operation of safety authorities of countries operating WWER-type nuclear facilities, assembled in Hungary in July. The Forum's working group on Equipment and Building Structures Ageing Management for WWER type nuclear power plants had completed its work on the ageing phenomena of steam generators. The group's final report was presented at the Forum's meeting. Under the leadership of STUK, a new working group was set up at the meeting to compare probabilistic safety analyses. STUK was also assigned the task of arranging a seminar on regulators' inspection practices pertaining to plant operation and their comparison as continuation to similar seminars in Russia and Ukraine.

STUK participated in the work of the Network of Regulators of Countries with Small Nuclear Programmes (NERS). Topics of special importance

in 2002 were validity of regulatory guides, independence of computer software used by regulators and licensees for safety analysis as well as qualification of non-destructive testing methods. In 2002 NERS met once in Bratislava.

Vivid information exchange took place and two expert meetings were arranged within the DOCUMENT Project designed to develop regulations applicable to the service life management of nuclear facilities (PLIM). A STUK expert assessment of PLIM information systems specifically suited for Russian nuclear facilities, based on operational experience feedback on Finnish nuclear facilities, was handed over to the Russian International Nuclear Safety Centre (RINSC). The DOCUMENT Project having thus ended, an assistance project for the realisation of PLIM information systems was launched, with financing from the budget on co-operation with neighbouring countries of the Ministry for Foreign Affairs, the target of which is Leningrad nuclear power plant. Implementation is based on a pressure equipment inspection data management system developed by Fortum Engineering.

11 The Advisory Committee on Nuclear Safety

In accordance with section 56 of the Nuclear Energy Act, the preliminary preparation of matters related to the safe use of nuclear energy is vested with the Advisory Committee on Nuclear Safety. The Government appoints the Committee that functions in conjunction with STUK. The term of office is three years. The Committee was reinstated on 16 August 2000 and its current term of office ends 15 August 2003.

The Committee's Chairman is Professor Pentti Lautala (Tampere University of Technology) and its Vice-Chairman is Head of Research Rauno Rintamaa (Technical Research Centre of Finland, VTT). In 2002 the members were Senior Researcher Riitta Kyrki-Rajamäki (VTT), Professor Ulla Lähteenmäki (Centre for Metrology and Accreditation), Director Olli Pahkala (Ministry of the Environment), Professor Rainer Salomaa (Helsinki University of Technology), Branch Manager Paavo Vuorela (the Geological Survey of Finland). Professor Jukka Laaksonen, Director General of STUK, is a permanent expert to the Committee. Invited experts are Doctor of Technology Antti Vuorinen and Director Christer Viktorsson (the Swedish Nuclear Power Inspectorate). The Com-

mittee convened seven times in 2002. Professor Lähteenmäki retired during the year and Director Ulla Koivusaari from the Pirkanmaa Regional Environment Centre was assigned in his place by the Government.

The Committee has three divisions for preparatory work: a Reactor Safety Division, a Nuclear Waste Division as well as an Emergency Preparedness and Nuclear Material Division. In addition to the Committee members proper, distinguished experts from various fields have been invited to the Divisions. A total of five Division meetings were held in 2002.

In 2002 the Committee processed eight YVL draft guides submitted by STUK for comment. Statements were issued on six draft guides, two statements were postponed to 2003. The Committee regularly followed operating events at domestic and Swedish nuclear power plants and acquainted itself with, among others, changes in nuclear liability, renewed national safety research programmes, progress of the project on a fifth reactor, on-going nuclear safeguards enlargement and international activities in the field of nuclear safety (OECD/NEA, WENRA, the EU).

APPENDIX 1 STUK's safety and performance indicators

A Indicators on safety of nuclear power plants (regulatory effectiveness)

- A.I SAFETY AND QUALITY CULTURE
 - A.I.1 Failures and their repair
 - A.I.1a Failures of components subject to the Technical Specifications
 - A.I.1b Maintenance of components subject to the Technical Specifications
 - A.I.1c Repair time of components subject to the Technical Specifications
 - A.I.1.d Human-based maintenance errors
 - A.I.1.e Common-cause failures preventing operation
 - A.I.1.f Potential common-cause failures
 - A.I.1.g Capability loss due to failures
 - A.I.2 Exemptions and deviations from the Technical Specifications
 - A.I.3 Unavailability of safety systems
 - A.I.4 Occupational radiation safety
 - A.I.4.a Annual collective doses
 - A.I.4.b Average of the ten highest individual doses
 - A.I.5 Releases
 - A.I.5.a Radioactive releases into the atmosphere
 - A.I.5.b Radioactive releases into the sea
 - A.I.5.c Individual radiation doses calculated for the most exposed population group in the environment of the nuclear power plant
 - A.I.6 Keeping documentation current
 - A.I.7 Investments on facilities
- A.2 OPERATIONAL EVENTS
 - A.II.1 Number of events
 - A.II.2 Risk significant of events
 - A.II.3 Causes of events
 - A.II.4 Number of fire alarms
- A.3 STRUCTURAL INTEGRITY
 - A.III.1 Integrity of nuclear fuel
 - A.III.2 Integrity of primary circuit
 - A.III.3 Integrity of containment

B Indicators on regulatory activities (regulatory efficiency)

B.I WORKING PROCESSES

- B.I.1 Methods of directing and processes
- B.I.2 Requirements on the safety of nuclear facilities
 - B.I.2a Share of updated YVL guides compared to annual plan
 - B.I.2b Share of YVL guides over five years old
 - B.I.2c Share of YVL guides over ten years old
- B.I.3 Compliance with the Quality System
 - B.I.3a Implementation of results plan
 - B.I.3b Quality non-conformances observed by management review
 - B.I.3c Timely decision-making
 - B.I.3d Implementation of the inspection programme
 - B.I.3e Steering of contracted safety research
 - B.I.3f Focusing of resources
- B.I.4 Efficiency of emergency response
 - B.I.4.a Number of individuals contacted during liaison testing
 - B.I.4.b Number of individuals participating in emergency exercises
- B.I.5 Customer feedback

B.II RESOURCE MANAGEMENT AND FINANCES

- B.II.1 Structure of financing
- B.II.2 Cost awareness of operations
- B.II.3 Resource management

B.III RENEWAL AND WORKING ABILITY

- B.III.1 Wellbeing of personnel
 - B.III.1.a Work satisfaction
 - B.III.1.b Work load
 - B.III.1.c Absences
- B.III.2 Know-how
 - B.III.2a Participating in training
 - B.III.2b Implementation of training programme
- B.III.3 Availability of information required at work
 - B.III.3a Development of YTV Quality Manual

APPENDIX 2 Licences and approvals in accordance with the Nuclear Energy Act

C214/232, 5 March 2002, Teollisuuden Voima Oy
Import from /export to Sweden of zirconium tubes (48 kg). Valid until 31 December 2002.

C214/233, 5 March 2002, Teollisuuden Voima Oy
Import of control rods (12 pcs) from Sweden. Valid until 31 December 2002.

A214/35, 25 June 2002, Fortum Power and Heat Oy
Import of connecting rods (10 pcs) and a control rod mechanism protection pipe (1 pcs) from the Czech Republic. Valid until 31 December 2002.

C214/234, 16 October 2002, Teollisuuden Voima Oy
Import of zirconium tubes (5 pcs, 10 kg) from Sweden. Valid until 31.12.2002.

P214-8/2, 7 November 2002, VTT Processes
Import from England of uranium oxide pellets made of enriched uranium. Valid until 31 January 2003.

A214/38, 11 November 2002, Fortum Power and Heat Oy
Import of a control rod drive mechanism guide tube from Hungary. Valid until 31 December 2002.

C214/235, 13 November 2002, Teollisuuden Voima Oy
Import of fresh nuclear fuel from the Federal Republic of Germany. Max 15 100 kg of enriched uranium. Provided with the Euratom control stamp "P". Obligations of the Finnish-Russian co-opera-

tion agreement on the peaceful uses of nuclear energy apply to the uranium. Valid until 31 December 2003.

C214/238, 9 December 2002, Teollisuuden Voima Oy
Import of fresh nuclear fuel from the Federal Republic of Germany. Max 5 750 kg enriched uranium. Provided with the Euratom control stamp "P". Valid until 31 December 2003.

C214/239, 11 December 2002, Teollisuuden Voima Oy
Import of fresh nuclear fuel from Sweden. Max 18 200 kg of enriched uranium. The obligations of the exchange of notes pertaining to the peaceful uses of nuclear materials between the authorities of Finland and the People's Republic of China apply to 73 fuel bundles. Provided with the Euratom control stamp "P". Valid until 31 December 2002.

F214/13, 13 December 2002, VTT Processes
Export to and import from the USA of control rod drive mechanisms (3 pcs) for use as spare parts. Valid until 31 December 2005.

C214/240/, 19 December 2002, Teollisuuden Voima Oy
Import of fresh nuclear fuel from Sweden. Max 2 250 kg of enriched uranium in the form of fresh nuclear fuel (number of bundles is tentatively 12). Provided with the Euratom control stamp "P". Valid until 31 December 2002.

APPENDIX 3 Periodic inspection programme

Basic programme	Inspection programme 2002	
	Loviisa power plant	Olkiluoto power plant
A Safety management		X
B Main functions		
B1 Assessment and improvement of safety		
B2 Operation	X	
B3 Plant maintenance		X
C Inspections by functional unit and field of competence		
C1 Plant safety functions	X	X
C2 Electrical and I & C systems	X	X
C3 Mechanical engineering	X	X
C4 Construction engineering and structural engineering		X
C5 PSA and utilisation of fault statistics	X	X
C6 Information management		X
C7 Chemistry	X	X
C8 Nuclear waste	X	X
C9 Radiation protection	X	X
C10 Fire protection	X	X
C11 Emergency preparedness	X	X
C12 Physical protection	X	X
C13 Quality assurance	X	

APPENDIX 4 Safety improvements

Loviisa power plant

Mitigation of severe accidents at Loviisa 2

A large number of measures to mitigate the consequences of severe accidents were carried out during the Loviisa 2 annual maintenance outage of 2002. Similar actions were carried out at Loviisa 1 in 2000–2001. They are part of an on-going Loviisa power plant project providing for severe accidents, which is nearing completion.

The technically most extensive of these actions was the implementation of plant modifications required by the reactor pressure vessel's external cooling. For this purpose, flow routes between the steam generator room and the reactor pit were opened and configured; and the lowering equipment of the reactor pressure vessel's heat shield was fitted in place. STUK oversaw the modifications and the associated site acceptance tests. After the completion of these modifications, the hot corium melt that would form in a severe accident could be contained inside the reactor pressure vessel by vessel external cooling.

Hydrogen is released inside the containment in severe accidents. Plans are to install catalytic recombiners inside the containment to burn hydrogen without quick explosive fires. For the same purpose, opening mechanisms have been planned for the doors of the ice condenser compartment located inside the containment. The opening mechanisms assure supply of air to all parts of the containment for the catalytic burning of hydrogen released in a severe accident. They also limit local hydrogen concentrations, making flaming unlikely. The installation of the opening mechanisms and their nitrogen operating system were completed at Loviisa 2. The acquisition of catalytic recombiners has started and installation at both plant units is due in 2003.

Several new measurements and displays were

installed to monitor measures relating to reactor pressure vessel external cooling and hydrogen management. A small part of the measurement installations were not completed because the components received were not up to the requirements. The scope of installations implemented is sufficient for temporary use and any shortcomings will be put right in 2003.

In addition, several modifications relating to I&C technology were made at the plant unit and new I&C systems were installed to facilitate centralised severe accident management. The option of manually tripping containment isolation signals necessary for the maintenance of containment leak tightness was provided, among others. These manually tripped special functions assure containment leak tightness against potential system leaks.

Replacement of radiation measurements at Loviisa 1

The replacement of fixed radiation measurements is underway at Loviisa plant. Loviisa 1 commissioned 58 new radiation monitors in the annual maintenance outage. Replacement of radiation monitoring devices in the ventilation stack was started towards the end of 2002. The renewed monitors will be commissioned in early 2003. The fixed radiation measurement system of Loviisa 2 is due for renewal in the 2003 annual maintenance outage.

The measurement system of Loviisa nuclear power plant comprises a total of ca. 140 independently operating monitoring devices that follow the radiation loads in the plant's rooms and processes. Some of the devices are capable of functioning even in severe accidents.

The system's upgrading became necessary because of the difficulty of getting spare parts for the old equipment that had been in service for over 20

years; consequently, repair times were getting longer. New radiation monitoring technologies yield data more versatile and accurate than before on the radiation loads of measured objects. Besides the control room and the monitors' local displays, data from the monitoring devices can be directly utilised in the work locations of those responsible to control radioactivity and to maintain radiation monitoring and monitoring devices. Some of the new devices can be easily moved if needed, facilitating an improved focusing of radiation measurements.

Reduction of risk from containment external leaks

Modifications to reduce the risk of leaks exceeding 5 kg/s from the primary circuit to outside the containment via different systems, which were started at both Loviisa plant units in 2000, were continued. The need for the modifications surfaced during the updating of the plant units' probabilistic safety analysis. In connection with the updating, the utility assessed leak routes and analysed the consequences of leaks, among others. The most significant consequences are a rising temperature and humidity caused by steam discharged for example in the transmitter rooms in the ground floor of the reactor building. Elevated temperatures and humidity can cause instrumentation malfunctions.

The major part of potential primary circuit leaks to outside the containment are through the primary water purification system. These leaks are isolated by the closure in three phases of the primary water purification system valves. In the first phase the operator can close the shut-off valves and assure a continued supply of sealing water to the primary coolant pumps by opening a supply route from the normal make-up water system. The continued supply of sealing water is also assured by the automatic starting up of the emergency sealing water system. In the second phase, the shut-off valves of the primary circuit purification system close from a protection signal generated by a pressuriser level that is too low. The supply of sealing water to the primary coolant pumps is then assured by a changeover of supply. In the third phase, the aforementioned shut-off valves close from another protection signal caused by the pressuriser level and generated by the plant protection system. The modifications were

completed in the 2002 annual maintenance outage.

The suction line of the emergency sealing water system was moved from the primary circuit to the sealing water line in the 2002 outage. After the modification emergency sealing water leak-throughs and heat exchanger ruptures are automatically isolated by the closing of the primary circuit purification system valves from a low pressuriser level signal. The supply of emergency sealing water is automatically assured by the opening of a supply route from the normal make-up water system and by starting the system's other pump abreast with the running pump.

After the modification has been completed a heat exchanger tube rupture in the primary coolant pump sealing water system is automatically isolated by the closure from a pressure difference signal of the valves of the cooling circuit of the leaking heat exchanger.

Reduction of risk from minor containment external leaks

Modifications have been implemented at both Loviisa plant units to reduce the risk of leaks less than 5 kg/s from the primary circuit to outside the containment through primary and secondary systems. The need for the modifications surfaced during the updating of the plant units' probabilistic safety analyses. According to the analyses, the most significant initiating events are the rupturing of measuring and sampling lines as well as of the control rod cooling coil, which could cause the malfunctioning of transmitters important to safety due to quick temperature increases in the reactor building transmitter rooms.

In the 2002 annual maintenance outages the shut-off valves of the control rod drive cooling system were moved from a plant protection group tested once a week to a protection group tested once a year. The modification reduces the testing-related risk of a leak through the cooling coils to the cooling system. In addition, the sampling lines of the steam generator were moved from the I&C room to another room to prevent the warming up of the I&C room and penetrations.

In a measuring or sampling line break, the functioning of the flow limiters of leaking lines significantly affect ambient conditions and risk. When the capacity of the flow limiters of measur-

ing lines was looked into, a need for further testing was found. The tests were carried out in spring 2002. The results showed that the capacity of the flow limiters needs to be reassessed.

The installation of additional flow limiters to the impulse lines of reactor measurements, due for implementation at Loviisa 1 in 2002, has been postponed to 2004.

Replacement of low pressure emergency cooling system pumps

The replacement of the pumps of the low pressure cooling system of Loviisa 1 was begun in the 2000 annual maintenance outage: two pumps were replaced and the necessary piping modifications were made. Pump replacements and piping modifications were completed at both plant units in the 2002 annual maintenance outages. At Loviisa 1, the remaining two low pressure emergency system pumps and at Loviisa 2 all four pumps were replaced.

The low pressure emergency cooling system is only used in accidents to refill the reactor and maintain long-term core cooling. The system comprises two redundant, independent sub-systems with two redundant pumps in each (four pumps in all). Even one operating pump can handle the cooling function during an accident.

The replacement of the old pumps was necessary because of their structural deficiencies. In connection with their replacement, the mechanical stresses from piping to the pumps could be reduced as well. The new type of pump is more efficient than the original and capable of injecting water against a pressure higher than before; the capacity of the low pressure emergency cooling system was thus improved as well.

Removal of water seal cross-tie lines from the primary circuit of Loviisa 2

The water seal cross-tie lines of the primary loops of Loviisa 2 were removed in the annual maintenance outage. This small-diameter piping was located in three of the plant unit's six loops between bends in the cold and hot legs of primary piping. The cross-tie lines were installed in the early 1980s to ward off the water seal phenomenon, which was assumed to compromise reactor core cooling during a primary circuit leak. Current

knowledge, based on experimental studies and analyses, considers the cross-tie lines unnecessary. Their removal eliminated the possibility of a primary circuit leak through them. Grounds for the removal of the cross-tie lines are given in the annual report 2000 (STUK-B-YTO 208).

The water seal cross-tie lines of Loviisa 1 were removed in 2000.

Olkiluoto power plant

Upgrading of the reactor control rod manoeuvring and position indication system of Olkiluoto 1

The reactor control rod manoeuvring and position indication system of the Olkiluoto 1 reactor was upgraded in the 2002 annual maintenance outage. The upgrading made control of the rods more accurate, improved their position data and test reporting, and reduced failures. The modification also reduced the probability of erroneous control rod withdrawal.

An upgrading of the same system was carried out in the Olkiluoto 2 annual maintenance outage of 2001 already. The system's implementation was changed for some parts, based on experience, but its layout and operation corresponds to the description given in the 2001 annual report (STUK-B-YTO 216). Similar repairs were made at Olkiluoto 2 in the annual maintenance outage.

The personnel lock of the Olkiluoto 2 containment building was strengthened

Over the past years modifications have been implemented at the Olkiluoto units to improve preparation for severe accidents. In the 2002 annual maintenance outage, the personnel lock of the containment building of Olkiluoto 2 was strengthened. After the modification the containment building withstands significantly heavier individual pressure shocks than before. Such shocks could occur in a severe accident involving a core melt penetrating the reactor pressure vessel walls and ending up in the water pool of the containment building drywell. Under specific circumstances, the interaction of core melt and water could cause a steam explosion. A similar modification was made at Olkiluoto 1 in 2001.

The opening condition of the valves of the core spray system was changed

The desks in the main control rooms of the Olkiluoto plant units were fitted with valve-specific selector switches by which the operating range of the core spray system, which is dependent on the reactor water level, can be changed to assure emergency cooling under certain accident conditions.

The core spray system takes care of reactor emergency cooling in the event of the breaking of large-diameter piping inside the containment. Water intake for the system's pumps is from the condensation pool of the containment building's wet well, through the strainers of the pool. New accident analyses conducted in connection with the power uprates of the plant units in the late 90s revealed that, in certain rare accident situations, the functioning of the core spray system could be in jeopardy when the condensation pool level decreases to strainer level. The analyses indicate that this would be possible if a pipe breaks in the gap between the reactor and its thermal shield. The greater part of the leak water would then trickle down to the containment building drywell below the reactor; it would become trapped there and would not be available for use by the core spray system.

Reactor cooling in such a situation is assured by altering, if the accident situation so requires, the operating range of the core spray system, which is dependent on the reactor water level. If the condensation pool level decreases so much in an accident that it approaches the upper edge of the core spray system strainers, the operator can, by valve-specific selector switches, alter the system's operating mode such that water injection into the reactor is stopped when the condensation pool level goes below normal level. In an accident situation water is injected into the reactor also by the auxiliary feed water system, whose water intake is external to the containment building. The system has sufficient capacity to cool down the reactor after the initial phase of an accident as well as to maintain the reactor level high enough to keep the core spray system from injecting water into the reactor. If the reactor level decreases close to the upper edge of the core, however, the core spray system automatically starts water injection into the reactor.

STUK approved a decision-in-principle for the management of the condensation pool level in an accident. The modification was implemented at both plant units in the 2002 outage. STUK approved the selector switches and push buttons for use until the 2003 annual maintenance outage, at which time they are due for replacement by higher quality components.

Replacement of rotating converters with UPS equipment

A modification project was launched at the Olkiluoto plant units during the 2001 annual maintenances to replace ageing rotating direct/alternating current converters with modern UPS equipment. A rotating converter unit comprised a direct-current motor rotating an alternating current generator. A UPS consists of a direct and alternating current unit as well as of a stand-by battery. The converter and the UPS handle power supply to the battery-backed 400 V alternating current system under the plant units' all operational conditions. The battery-backed 400 V alternating current system mainly supplies power to the actuators of valves important to safety.

Both Olkiluoto plant units had a total of four converters. They were replaced due to their increased maintenance costs, low efficiency and ageing-induced malfunctions.

In the 2001 annual maintenance outages, Olkiluoto 1 installed and commissioned one and Olkiluoto 2 two new UPSs. The remaining five UPSs were installed and commissioned during the plant units' 2002 annual maintenance outages.

Modernisation of the process interface of process computers at Olkiluoto 1

In the 2002 annual maintenance outage of Olkiluoto 1, the oldest computers plus their process interface equipment were upgraded and provided with user interfaces. The process interface gathers and transmits measurement and condition data to the process computer system and the process automation system user interface. For analogue data gathering, the upgraded equipment constitute a new system called "Data gathering and temperature monitoring system". The power supplies and data buses of its processors have been doubled for assured availability. The new system also conducts temperature measurement related

controls. In addition, it monitors signal limits and carries out alarm functions and further delivery of signals to the control and alarm panels of the control room, conducts operating time calculations for electric motors, and gathers and calculates trends.

The upgraded alarm computer constitutes a system of its own. It collects binary event data on processes and transmits them to the process computer through the new system.

Similar modifications will be implemented at Olkiluoto 2 in the 2003 annual maintenance. Work in preparation for these modifications was carried out in the 2002 annual maintenance outage.

The suspended ceilings of control rooms were renewed

The renewal of the suspended ceilings of control rooms at both Olkiluoto plant units was completed. The work was started after the making of a probabilistic seismic analysis for the plant units. The analysis mentioned as one risk factor that the suspended ceiling and lighting fixtures of the control rooms might fall off during a hypothetical earthquake. The plastic components of the lighting fixtures had also become brittle from heat over their 25 years of use, and they could have fallen off, placing the shift personnel at risk and damag-

ing the control desks. In addition, the control room personnel were unhappy about lighting, ventilation and the background sound level.

The renewal of the suspended ceiling of the Olkiluoto 1 control room was started in August 2002. A test installation of the scaffolding required in the construction of the suspended ceiling was conducted first. The test installation was done in the back of the Olkiluoto 1 control room where there are no equipment important to nuclear safety. At Olkiluoto 2 the renewal was carried out after that of Olkiluoto 1 and was completed in November 2002. The modifications were carried out during normal power operation when control room operations require less personnel than during outages. In addition, entry of outsiders into the control room during the work was limited.

STUK reviewed the construction and work plans and daily followed the modification process by participating in follow-up meetings arranged by the licensee and by making inspections to the work site. In addition, STUK inspected the modifications after their completion. STUK did not observe any situations endangering personnel or nuclear safety or hindering working in the control room.

APPENDIX 5 Annual maintenance outages

Olkiluoto 2 annual maintenance

Olkiluoto 2 underwent annual maintenance from 5 to 13 May 2002. This was a refuelling outage, which included minor preventive maintenance work, repairs and modifications. It lasted seven days and seven hours, i.e. about 12 hours less than planned.

A leaking fuel assembly was removed from the plant unit's reactor during the outage. The leak was discovered in February 2002. Prior to the start of the outage, on 4 May 2002, the leaking assembly was located to an area of four fuel assemblies and in the outage to a single fuel assembly by means of assembly-specific leak detection.

Safety-significant plant modifications implemented during the annual maintenance outage are described in Appendix 4.

The outage-induced collective radiation dose was 0.26 manSv. According to guidelines set by STUK, the threshold value for the collective dose for an Olkiluoto plant unit is 2.10 manSv averaged over two successive years. The highest individual dose incurred during the Olkiluoto 2 annual maintenance of 2002 was 3.95 mSv. The Radiation Decree prescribes that the annual effective dose to a radiation worker may not exceed 50 mSv.

Olkiluoto 1 annual maintenance

Olkiluoto 1 underwent annual maintenance from 14 to 27 May 2002. It was a maintenance outage during which more maintenance work, repairs and modifications are carried out than during a refuelling outage. The outage lasted 13 days and seven hours, i.e. almost 24 hours less than planned.

In addition to refuelling, the most significant work during the outage included an internal inspection of the reactor vessel nozzles using new inspection equipment, a generator repair and numerous electrical and I&C systems renovations,

among others. Safety-significant modifications are described in Appendix 4.

The outage-induced collective radiation dose was 0.712 manSv. The highest individual dose incurred during the Olkiluoto 1 annual maintenance of 2002 was 9.05 mSv and the total for both plant units was 9.25 mSv.

Loviisa 1 annual maintenance

The Loviisa 1 annual maintenance of 2002 was a medium-duration maintenance and refuelling outage from 20 July to 16 August 2002. The outage lasted 28 days, i.e. 24 hours longer than planned. In addition to refuelling plus normal inspections, maintenance and repairs, significant modifications and repairs on the primary and secondary side were carried out.

Work was continued on modifications to reduce the risk from leaks external to the containment. Pump replacements in the low pressure emergency cooling system and piping modifications were completed during the outage. In addition, renewal of the plant unit's fixed radiation measurements was started. These projects are further explained in Appendix 4.

The replacement of steam generator feed water distributors, started in mid-90s, was completed during the outage. The plant unit has a total of six steam generators. The new feed water distributors are not as prone to erosion-corrosion as were the old ones and they are easier to maintain. The sealing rings of primary coolant pumps were replaced after which oscillations, such as were observed during the plant unit's start-ups from previous outages, among others, did not occur during the start-up from this outage. The re-coating of a floor area damaged by a water leak into the steam generator room during the 2000 annual maintenance was continued. Almost a half of the floor area is re-coated now. The biggest job on the

secondary side was the replacement of a generator's excitation system.

In this outage the licensee inspected the outer surfaces of the reactor vessel head area. The inspections were performed after an eroded reactor pressure vessel head was detected in February 2002 at the US Davis Besse plant, which is a PWR plant as is Loviisa plant. No signs of erosion were detected in the inspections at Loviisa plant.

During the outage the boric acid concentration of the primary circuit briefly went a little below the threshold given in the Technical Specifications. The event is described in detail in Appendix 6.

The outage-induced collective radiation dose was 0.99 manSv. According to guidelines set by STUK, the threshold value for the collective dose for a Loviisa plant unit is 1.22 manSv averaged over two successive years. The annual collective radiation dose is mostly incurred in outage work. The highest individual dose during the Loviisa 1 annual maintenance of 2002 was 11.4 mSv. The Radiation Decree prescribes that the annual effective dose to a radiation worker may not exceed 50 mSv.

Loviisa 2 annual maintenance

Loviisa 2 underwent annual maintenance from 24 August to 12 October 2002. This was an extended maintenance outage during which all fuel assemblies were moved to the refuelling pool for reactor pressure vessel inspections. All normal refuelling, preventive maintenance, repair and modification work was carried out as well. The outage lasted for

about 50 days, i.e. about 12 days longer than planned. Its duration was extended among others by faults in the reactor pressure vessel inspection equipment, an extended reactor core inspection and an additional inspection of the gasket units of the primary coolant pumps, among others. The primary circuit's heating had to be discontinued and it had to be cooled down for the gasket unit inspections.

The making of modifications to improve severe accident management and to reduce risks from leaks external to the containment was continued. Pump replacements in the low pressure emergency cooling system of Loviisa 2 were completed. In addition, the water-seal cross-tie line of the plant unit's primary circuit was removed as redundant. These modifications are described in more detail in Appendix 4.

In the inspections carried out by the licensee during the annual maintenance outage, cracks were observed in the protection pipes of control rod drive mechanisms connecting to the primary circuit and also in the liner plate of the core basket belonging to the reactor internals. Also the fastening screws of the liner plate were damaged. These observations are described in more detail in Appendix 6.

The reactor vessel head area of Loviisa 2 was also inspected and no corrosion was detected.

The outage-induced collective radiation dose was 1.50 manSv. The highest individual dose during the annual maintenance was 15.4 mSv. The highest individual dose for both Loviisa 1 and 2 annual maintenances was 19.2 mSv.

APPENDIX 6 Significant operational events

Loviisa power plant

Preventive maintenance work not in compliance with the Technical Specifications

Preventive maintenance work was performed at the Loviisa plant units on 14 March 2002 due to which the redundant subsystems of the reactor containment external spray system at Loviisa 1 were not fully operable for about nine hours.

The external spray system prevents containment over pressurisation in severe accidents as well as potential uncontrolled radioactive releases that may follow. The system is actuated from its own control room when containment pressure reaches design pressure. Two diesel generators assure power supply to the systems. Each plant unit's diesel generator can supply power to the systems of both plant units.

The preventive maintenance of the diesel generator of the Loviisa 2 spray system was begun at 8.20 hours. During the maintenance, one Loviisa 1 spray system pump operated without diesel generator back-up. The Technical Specifications allowed a maximum of 21 days for the work. The Loviisa 1 control room was provided with copies of the work order for the maintenance work at Loviisa 2 and the shift manager entered this in the daily log. By mistake, and almost simultaneously, he gave permission to clean the filter of the system's other pump. The work was completed at 18.00 hours. The spray system's pumps were not operational during the work: the power supply of one pump had no diesel generator back-up and the other pump had been removed from service entirely. The Technical Specifications allow such a situation during a malfunction but during preventive maintenance the inoperability of only one subsystem at a time is allowed.

The event was of minor safety significance. It showed, however, that compliance with the limitations of the Technical Specifications needed improvement where preventive maintenance of systems shared by the plant units is concerned. The event is INES Level 0.

The timing of preventive maintenance work at Loviisa plant unit will be reviewed on account of the event. In addition, the specific features and meaning of systems shared by both plant units will be underlined in the training given to the operating and maintenance personnel.

Two isolation valves at Loviisa 1 were not tested in 2001

In a review by STUK in April 2002 of the result report on the leak tightness tests of the Loviisa 1 containment it was detected that two successive isolation valves of the cooling system of the reactor control rod drives had not been tested in the 2001 annual maintenance outage. This was due to an ambiguous listing of valves to be excluded from testing in the 2001 annual maintenance, which caused erroneous interpretations.

The isolation valves are usually tested once a year. The testing interval for the pair of valves in question had been extended to two years because their leak tightness had proved good in earlier tests. The valves had last been tested in the 2000 annual maintenance and had been found very leaktight. According to the Technical Specifications, they should also have been tested in 2001 because the actuator of one valve (S009) was replaced in 2000. The valves have been subjected to regular functional testing during operation and have been found to close. Since the other valve (S008) had not been modified in a way affecting its leak tightness the leak tightness of the penetration is assumed good.

The event was classified INES Level 0.

To prevent erroneous interpretations, training was given on leakage testing practices and the test monitoring software was made available to a wider group of users. In addition, Loviisa plant will pay attention to the sufficiently wide distribution of documents on maintenance work and on the timing of maintenance.

The valves were found highly leaktight in a leak tightness test conducted during the 2002 annual maintenance.

Primary circuit boric acid concentration decreased below the limit of the Technical Specifications

The boric acid concentration of the Loviisa 1 primary circuit on 29 July 2002 went below the 13 g/kg limit of the Technical Specifications (TTKE). The plant unit's annual maintenance outage was underway at the time. The clean water that was used to flush the reactor pit caused the boric acid concentration to decrease below the limit. The decrease in concentration was minor and of a brief duration. Since the water was also well mixed, the margin to criticality of the reactor remained high during the entire event.

The reactor pit is the pool space above the reactor pressure vessel that, after the head's removal, connects to the reactor and is filled with boric acid water for the duration of fuel loading. The steel lining of the walls of the reactor pit is flushed with clean water after the water level has been lowered after reactor loading. The steel lining needs washing to remove impurities causing radioactive exposure. In this case the flushing of the reactor pit had to be discontinued several times due to testing and operation of the plant systems, which is why more water than usual was used in the flushing.

In addition to control rod insertion into the reactor, reactor subcriticality is ensured by boric acid during outages. Boric acid concentration is measured by continuous analyser monitoring and by manual laboratory analyses at regular intervals. The continuous analyser monitoring function has been provided with alarm limits to indicate when the measuring value approaches the limit values of the Technical Specifications. When an alarm limit is reached an alarm appears on the process computer display. Alarms abound during

an outage, however, to the extent that, in this case, the operator did not notice the alarms indicating a low boric acid concentration. The reaching of the alarm limit was noticed in the laboratory when the results yielded by continuous analyser monitoring were followed on the process computer. The low boric acid concentration was noticed to the control room and was double-checked by an extra laboratory analysis. The analysis yielded a boric acid concentration of 12.9 g/kg, which is below the limit of the Technical Specifications. The operator immediately began injection of strong boric acid solution into the primary circuit, restoring the circuit's boric acid concentration to the allowable range of the Technical Specifications.

The event was attributed to insufficient instructions on the flushing of the reactor pit and insufficient monitoring of the boric acid concentration. A reactor physics safety evaluation showed that dilution was slow and that clean water mixed well with the boric acid water of the primary circuit. The low boric acid concentration thus had no immediate effect on safety. The event was classified Level 1 on the INES Scale.

Loviisa plant revised the instructions and procedures for reactor pit flushing after the event. The new instructions and procedures were already in use in the Loviisa 2 outage of 2002. The detectability of alarms and the re-determination of boric acid concentration limits for the Technical Specifications among others have been assessed as the long-term development needs of Loviisa plant. The licensee will assess the necessary corrective measures also in connection with the event's root cause analysis to be completed at a later date.

Cracking of the control rod drive mechanism protection pipes in the Loviisa 2 primary circuit

Areas of the protection pipes of control rod drive mechanisms containing temperature measurement devices were inspected in the Loviisa 2 annual maintenance outage since, on 18 December 2001, a small leak had been detected in one protection pipe (Annual Report 2001; STUK-B-YTO 216). Crystallised boric acid on surfaces, originating from boric acid water recirculating in the primary circuit, lead to the leak's detection. In inspections performed in the 2002 outage, non-penetrating cracks propagating from the outer surface

of two other protection pipes were detected. These and a protection pipe temporarily repaired in December 2001 were replaced with spare protection pipes. An inspection using the UT method was performed on all protection pipes.

The protection pipes of the control rod drive mechanisms, attached to the reactor pressure vessel head by bolted joints, are part of the primary coolant pressure boundary. The measuring pockets of the temperature measurement devices are welded onto the protection pipes and encased in asbestos-insulated insulation shield boxes fixed by welding. The upper end of an insulation shield box is not fully leak-proof and moisture could enter the structure. In the annual maintenance outage, a sample was taken to further investigate the protection pipe that had failed in December 2001. The cracked area ($40 \times 40 \text{ mm}^2$) was found out to contain several branched cracks the inner surface length of one of which was 3 mm. The defects are caused by chloride-induced stress corrosion cracking propagating through the grains. Water has entered the insulation shield box and dissolved chlorides contained in small amounts in the thermal insulation. The growth of the cracks has taken several years. Temperature is below 80°C but chloride-induced stress corrosion cracking is possible in oxidizing environments.

Figs A6.1 and A6.2. show the location of temperature measurement devices and leak detection by crystallised boric acid.

No inspections were carried out in the 2002 annual maintenance outage of Loviisa 1 since the

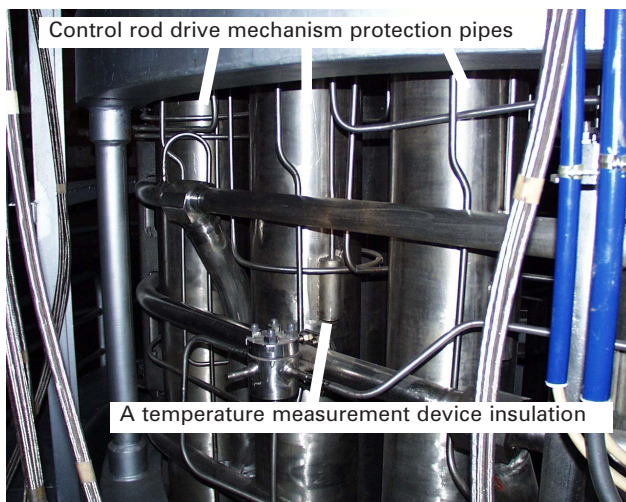


Figure A6.1. Control rod drive mechanism protection pipes and a temperature measurement device insulation shield box. The photograph was taken at ca. ten metres above the reactor vessel head area. Photo by STUK.

cracking detected in December 2001 was believed to be a single case due to the less aggressive environmental conditions inside the protection pipes. Most protection pipes in Loviisa 1 and some protection pipes in Loviisa 2 will be inspected in the 2003 outage using a UT method optimised for stress corrosion cracking detection.

The protection pipes have a wall thickness significantly higher than required in the dimensioning standard. Even if the crack grew up to the full length of the insulation shield box (135 mm) it would not lead to the rupture of the pipe but would be detected while still a small leak from the primary circuit.

After the detection of the leak in December the licensee implemented intensified leak monitoring at both plant units, which will be continued for the time being. All protection pipes are visually checked at least every two weeks. Even very small leaks are detectable by crystallised boric acid. Potential degradation would not endanger plant safety but, if a leak occurred, the plant would have to be placed in cold shutdown for repairs.

Reactor core basket failures at Loviisa 2

In inspections during the Loviisa 2 annual maintenance outage, small cracks were found in the liner plate of the core basket belonging to the reactor pressure vessel internals. In addition, some of the liner plate's fastening screws were not quite tightly screwed down and some screws were damaged.

The lower end of the fuel rests on holes of the

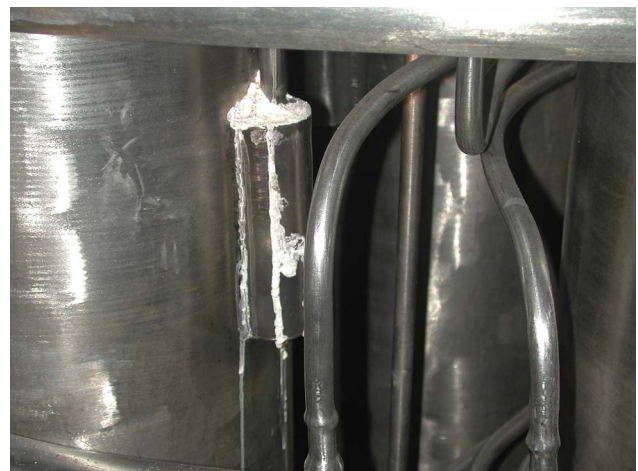


Figure A6.2. Crystallised boric acid on a temperature measurement device's insulation shield box. The photograph is of a leak at Loviisa 2 observed on 18 December 2001. Photo by Fortum Power and Heat Oy, Loviisa power plant.

core basket's bottom plate. The core basket walls are lined with a liner plate profiled to the edge of the reactor core to guide the coolant flow. The bottom part of the liner plate is welded onto the lowest support ring attached to the core basket shell. The plate is fastened to the topmost four support rings by 312 embedded screws. The screws sit on a washer onto which they were welded during installation and evened out. The structure allows vertical relative shifts between the liner plate and the core basket. Fig. A6.3 illustrates the mounting of the core basket's liner plate.

The reactor pressure vessel internals are inspected every four years. Due to the high radiation level, the core basket is inspected using a submerged TV camera. A new camera was used in the 2002 inspection, which yields a better picture than the old one. Owing to the deviations detected, the scope of the TV camera inspection was extended from 25% to all screws. In addition, screw height in relation to formed plate was measured by a special laser-based device. To assure their integrity, the screws were inspected by ultrasonic testing as well.

Some 50 screws were not quite completely tightened against the liner plate. Ultrasonic testing revealed five damaged screws, none of which was entirely broken. A dent had been made in the liner plate during installation to remove a gap between the washer and the liner plate to help keep them in place even during breaking.

Sliding between the liner plate of the core basket and the screw is likely not to have taken place as planned. At the time of the construction of Loviisa 2, the liner plate had had to be repaired, which may have contributed to the failure of the screws. In addition, irradiation-assisted stress corrosion may have contributed to the growth of the failures.

The breaking of a few screws does not risk the liner plate's staying in place. If a screw with washer comes off during an annual maintenance outage, it could end up in the reactor and, if worst comes to the worst, it could reduce coolant flow in one fuel assembly and lead to loss of fuel cladding tightness. The screws cannot fall into the reactor during the plant's operation. The licensee ascertained that the damaged screws were in place after the installation in its place of the core basket and prior to the loading of the fuel assemblies and

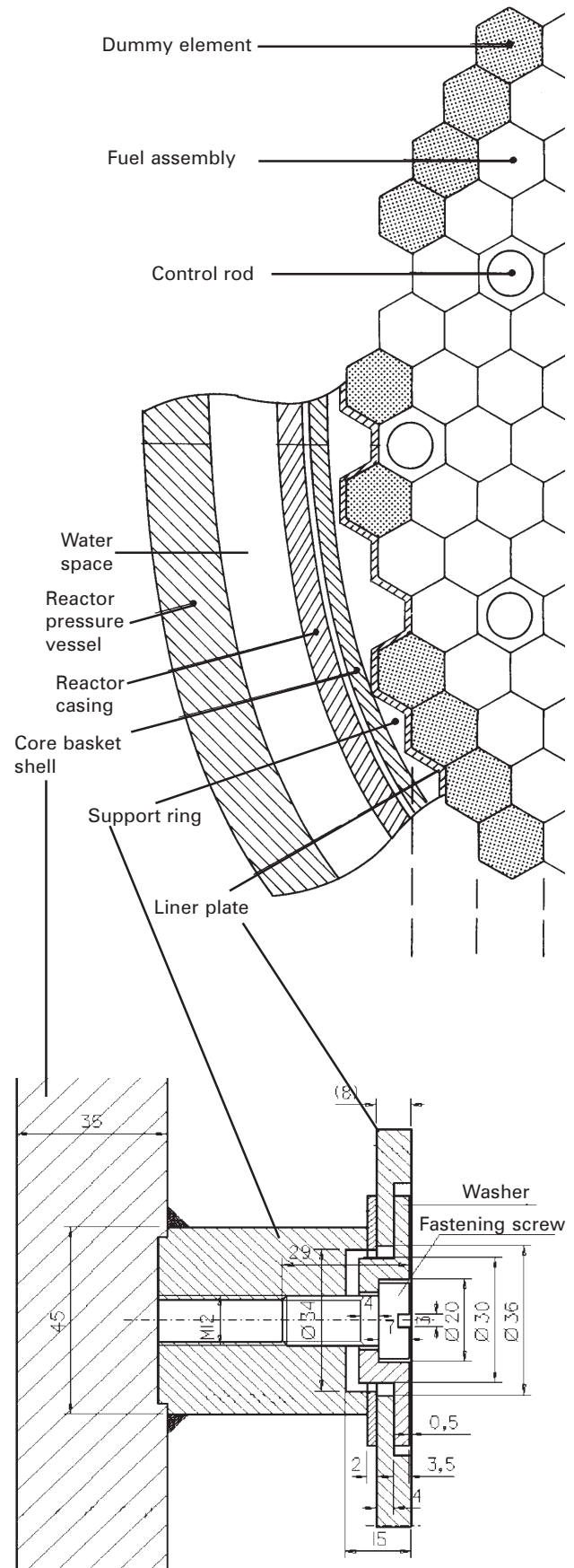


Figure A6.3. A diagrammatic drawing of the mounting of the liner plate of the reactor core basket.

dummy elements. In future annual maintenance outages at both plant units, the utility will ascertain the staying in place of the screws if an adjacent fuel assembly or a dummy element is removed during refuelling.

Some 30 cracks were detected in the liner plate near the screws, the largest being 15 mm long. Their likely cause was irradiation-assisted stress corrosion cracking. The high residual stresses and cold working, which made the degradation mechanism possible, were caused by the removal of the screw gaps. Forces caused by the pre-tightening of the screws may have further increased the stresses. Crack growth has stopped when stresses have decreased further away from the screws. Small cracks do not compromise the function of the liner plate, or its staying in place.

Olkiluoto power plant

Diesel fuel oil cloud point limit in a storage tank was exceeded

On 17 January 2002 it was found out at Olkiluoto plant that the cloud point temperature of diesel fuel oil in the fuel oil storage tank of stand-by diesel generators exceeded the limit value set in the Technical Specifications. The cloud point of oil at Olkiluoto 1 and 2 deviated from the maximum -24°C value of the Technical Specifications by one degree and five degrees, respectively. The licensee immediately undertook measures to restore the required value. The fuel oil was replaced by an oil grade whose cloud point was significantly lower than required. The cloud point values of oil complied with the Technical Specifications the next day and it was thus not necessary to stop the operation of the plant units.

Both Olkiluoto plant units have four stand-by diesel generators automatically starting up to supply the power required by the plant units in a situation where a unit's offsite and onsite power supply has been lost. There is an onsite fuel oil day tank for each diesel generator containing fuel oil up to about seven hours operation. The tanks are filled from storage tanks specific to each plant unit and located in the plant outdoor area. The storage tanks and the parts of the piping leading to the day tanks in the outdoor area are thermally insulated. In addition, the connecting

piping is equipped with heating cables to ensure the fuel oil does not solidify even in extremely cold temperatures. The cloud point value indicates the lowest fuel oil storage temperature.

The deviating cloud point value was detected on the basis of the results of biannual fuel oil analyses. When the matter was looked into it was found out that the allowable cloud point value in the chemistry manual of the licensee, against which the analysis results were compared, exceeded by one degree the limit value of the Technical Specifications. The deviation was discovered when the result of Olkiluoto 2's fuel oil analysis deviated from the limit value of the chemistry manual. The deviating values were due to the fact that in 1998 cloud point value was included in the Technical Specifications as a new limit value but the old limit value in the chemistry manual was not changed.

The event was classified Level 0 on the INES Scale.

On account of the event, an oil grade having a lower cloud point was introduced at Olkiluoto plant and the licensee checked some of the procedures for the receipt of oil deliveries. In addition, attention was paid to procedures ensuring the post-amendment uniformity of guidelines specific to different fields of technology and the Technical Specifications.

Moving of plotter displays from the main control room to a relay room was not in compliance with the Technical Specifications

In the Olkiluoto annual maintenances of 2001, the plotter displays of some measurement points had been moved from the control rooms to the adjacent I&C rooms. During the work's planning it went unnoticed that the Technical Specifications require the displays in question must be readable in the control room. The licensee detected the situation on 21 February 2002.

By means of the plotter displays moved to the relay room i.a. the containment inner pressure, temperature and radiation dose rate are monitored during an accident situation. The data yielded by the measurement points is used, for example, to assess the moment of a radioactive release in an accident situation or the radiation dose rates occurring in the environment in consequence of an

accident. These data are also readable on the control room process computer. Some of the measurement point displays are available for use also by the emergency organisation in the fallout shelter.

The event was classified INES Level 0.

The supervision of modifications at Olkiluoto plant had already been intensified before this event by the introduction of a review procedure. The procedure brings all planned modifications to the knowledge of those responsible for the Technical Specifications better than before.

On the application of the licensee, STUK later approved a change to the Technical Specifications allowing the plotter displays in question in an I&C room adjacent to the control room.

Olkiluoto 1 reactor scram

In consequence of a disturbance in the national 400 kV power transmission grid, a reactor scram occurred at Olkiluoto 1 on 20 April 2002. The plant unit was in full power operation at the time of the event. The event was attributed to the erroneous opening of feeder circuit breakers at the nearby Rauma 400 kV switchyard during the investigation of a fault alarm signal. This caused a loss of load at Olkiluoto 1.

Electrical power supply from Olkiluoto 1 had been connected to the national grid via the Rauma switchyard, along one power transmission line. The first circuit-breaker, i.e. the plant switch, is in the 400 kV switchyard of Olkiluoto plant. In addition, there are feeder circuit-breakers at both ends of the power transmission line connecting the Olkiluoto and Rauma switchyards. In case of a grid disturbance, a signal is transmitted to the protection system indicating that a plant switch has opened. In such a situation the plant unit tries to switch to house turbine operation by lowering the reactor power. In addition, when the Olkiluoto–Rauma power transmission line trips, a protective signal is obtained, making possible changeover to onsite power supply. The function is a limited one, however, and does not cover all fault situations.

When the feeder circuit-breakers at the Rauma switchyard opened, the signal to reduce reactor power after loss of load, which is essential for Olkiluoto 1's changeover to onsite power supply, was not received because the circuit-breakers had

opened due to human error and not due to an actual transmission line fault. In addition, the changing over of the plant unit's power supply to the available 110 kV offsite grid failed because there were no prerequisites for the changeover due to large voltage and frequency swings. The control valves of a high pressure turbine closed and its bypass valves opened to limit the turbine's operating speed. In consequence of the closing of the control valves, reactor pressure momentarily increased, causing reactor power to increase. Which, for its part, brought the main circulation pumps to minimum operating speed to reduce reactor power to allowable level. As a consequence, a reactor scram occurred and the isolation valves of a steam line closed. Furthermore, the reactor safety valves opened and the standby diesel generators started. For a while, power supply to safety systems was taken care of by the standby diesel generators only, until the connection to the 110 kV grid was resumed. The plant unit's all safety systems operated as designed during the transient.

The event was assigned Level 0 on the INES Scale.

One leaking valve was found in the post-scram leak tightness test of the isolation valves. The valve was repaired and the plant unit resumed electricity generation on 22 April 2002.

In the design of the plant unit's control systems the fact has not been considered that, when electric power is fed to the national 400 kV power transmission grid along one power transmission line only, the signal decreasing reactor power may not be transmitted in a loss-of-load situation. After the event the facility's power supply to the 400 kV power transmission grid was changed, for the present, to take place such that both Olkiluoto plant units feed the electric power they have generated to the power transmission grid along three 400 kV power transmission lines, making recurrence of the above event impossible. In cooperation with Fingrid Plc, the licensee has launched an investigation into the protection signals needed in a loss-of-grid situation. The implementation of possible improvements is due to start in the 2003 annual maintenance outages.

The licensee has given additional operator training due to the event.

Two fuel assemblies were erroneously moved at Olkiluoto 1

In the 2002 Olkiluoto 1 annual maintenance, the moving of two fuel assemblies did not comply with the Technical Specifications.

The reactor cores of both Olkiluoto plant units contain 500 fuel assemblies a fourth part of which is replaced yearly. In addition, the positions in the core of the remaining assemblies are rearranged. To assure the maintenance of reactor subcriticality, the fuel rearrangement order is carefully planned in advance.

Control rod drive mechanism maintenance is performed simultaneously with fuel unloading from the reactor. Control rods are withdrawn from the core for maintenance so as to detach the drive mechanisms located below them. The control rods are cruciform in cross-section and they plus their four surrounding fuel assemblies form a super cell. According to the Technical Specifications, the fuel assemblies in a super cell must not be moved while the control rod drive mechanism belonging to it is being serviced.

In this annual maintenance outage, fuel unloading from the reactor and the maintenance of control rod drives mechanisms had been started on 15 May 2002. After a shift change, fuel unloading was continued according to a fuel rearrangement list and on 16 May a.m. two fuel assemblies were removed from a super cell near to the edge of the reactor core. Since the maintenance of the control rod drive mechanism of the super cell in question was still underway, the assemblies should not have been moved as yet. This escaped the notice of the individual supervising the refuelling, however.

The event did not endanger nuclear criticality safety but, on the contrary, the removal of fuel from the reactor increased subcriticality. However, the event was an indication of the vulnerability of administrative barriers. The licensee will make procedures and training more specific to prevent similar events.

The event was classified Level 0 on the INES Scale.

Partial inactivity of the neutron flux measuring system

In tests conducted after the annual maintenance of Olkiluoto 1 on 27 May 2002 it was found out

that two safety limits of the reactor core neutron flux measuring system were not functioning as designed. The measuring system monitors the neutron flux during reactor start-up. The tests were considered necessary because of the experiences gained during start-up from the previous Olkiluoto 2 annual maintenance. One of the inactive safety limits stops control rod withdrawal from the reactor and the other trips the scram function.

Another system monitors the neutron flux during power operation and activates when reactor power exceeds 10% of rated power. Safety limits inactive in the start-up phase are designed to protect the reactor if the power operation monitoring function fails to start properly. In this case the neutron flux measuring function of the relevant power range was fully operational.

The inactivity of the safety limits was due to the signal level of the start-up monitoring system, which was too low to trip the safety limits. The signal had become less prominent because the fuel type and loading manner had been changed over the years, which had changed also the reactor power distribution. In addition, the voltage of the monitoring system's neutron detectors had been changed to improve their endurance. Tests relating to the modifications did not include checking of the correct functioning of the safety limits in question. Fuel loading had changed also at Olkiluoto 2 and the voltage of neutron detectors had been changed the same way as at Olkiluoto 1, making corresponding safety limits inoperative at Olkiluoto 2 since the annual maintenance outage that ended on 13 May 2002.

The event was classified Level 1 on the INES Scale.

The licensee calculated new values for the protection limits to make them function within the correct power range. The modified limits were programmed in the Olkiluoto 2 system before the Midsummer outage and their operation was tested during the outage. Olkiluoto 1 was similarly modified on 4 July 2002 and the functioning of the limits will be ascertained in the next outage. The protection limits of the start-up range monitoring system are only needed in the next outage.

APPENDIX 7 Effect of component inoperability on accident risk at nuclear power plants

As part of the nuclear safety indicator system, STUK follows accident risk from component unavailability at nuclear power plants. Three types of event cause component unavailability, namely: component failures, preventive maintenance, and deviations from the Technical Specifications approved by STUK. The share of assessed accident risk from component inoperabilities at the Loviisa and Olkiluoto plant units in 1995–2002 is given in Figs. A7.1–A7.6. The results for 2002 are tentative. STUK began to monitor systematic risk from component unavailability in 1995. The objective is that the effect of component unavailability on annual risk is less than 5% of the basic annual level of risk analysed for severe accidents.

To facilitate analysis, conservative assumptions and simplifications have been used for the risk calculations, which essentially weaken the usability of the results for trend monitoring and comparison-making between plants. If, over the years, the

average risk-significance of unavailability is as estimated, annual fluctuations can be ignored. If risk from the unavailability of one or more components significantly increases in comparison with how things were earlier, it will be necessary to closer examine the cause of the change.

Those component unavailabilities at Loviisa facility most significant for accident risk were mostly caused by maintenance procedures on the back-up emergency feed water system. Accident risk from component unavailability at Olkiluoto facility was mostly due to latent diesel generator defects and errors in the maintenance of the sea water system.

The component unavailabilities in 2002 did not require any specific STUK actions although the 5% target value (the sum of the aforementioned three areas) for Loviisa 1 and Olkiluoto 1 was exceeded.

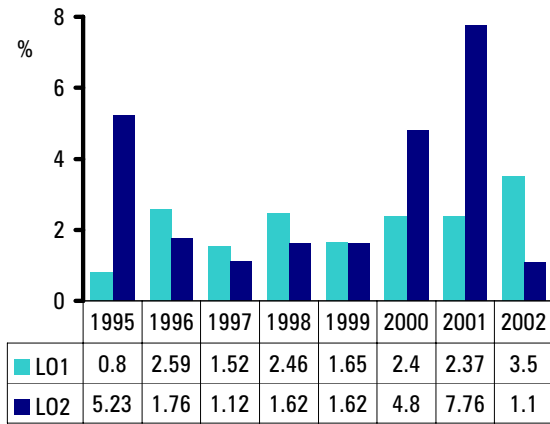


Figure A7.1. Effect of component failures on accident risk at the Loviisa plant units.

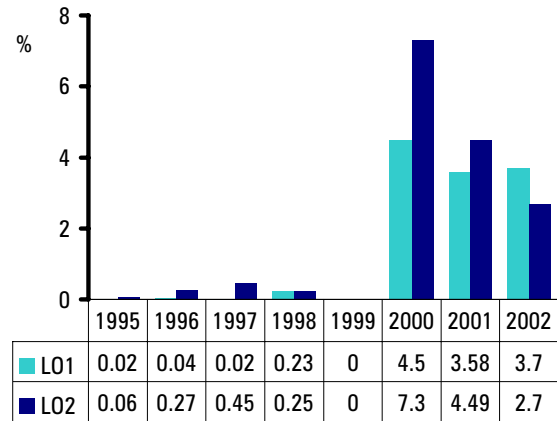


Figure A7.2. Effect of component preventive maintenance on accident risk at the Loviisa plant units.

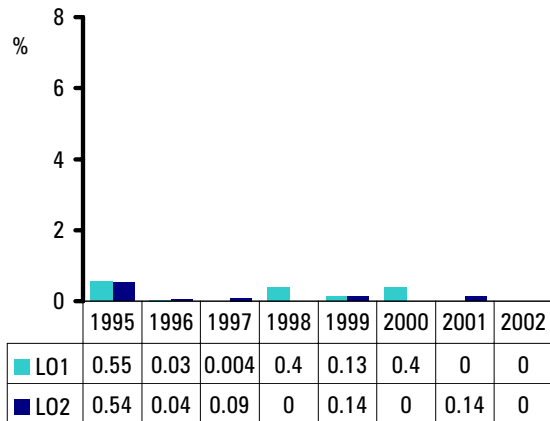


Figure A7.3. Effect of plant conditions in non-compliance with the Technical Specifications on accident risk at the Loviisa plant units.

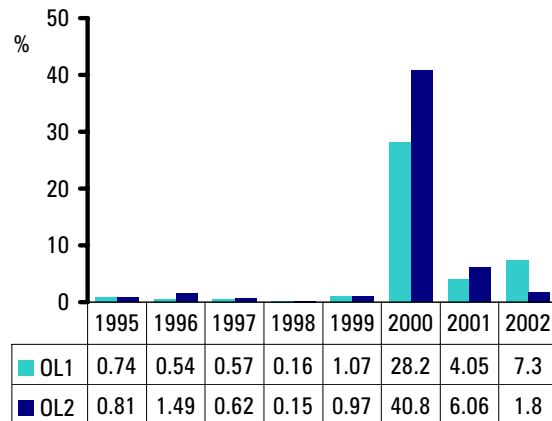


Figure A7.4. Effect of component failures on accident risk at the Loviisa plant units.

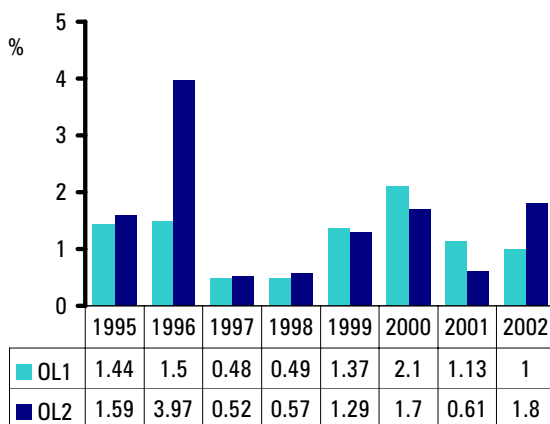


Figure A7.5. Effect of component preventive maintenance on accident risk at the Olkiluoto plant units.

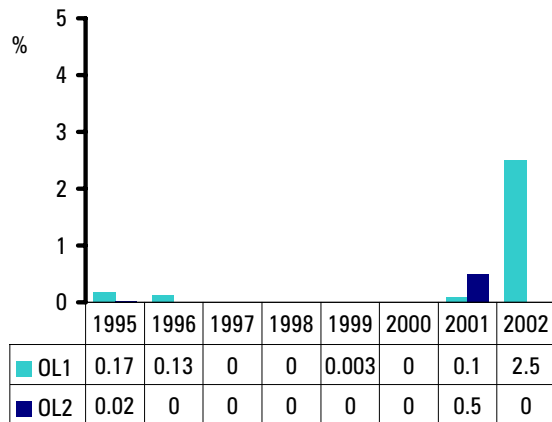


Figure A7.6. Effect of plant conditions in non-compliance with the Technical Specifications on accident risk at the Olkiluoto plant units.

APPENDIX 8 STUK's safety research projects completed in 2002

Nuclear power plants

Research projects included in FINNUS

Structural analysis of pipe experiments using Parallel Channel Test Loop (PACTEL)-facility; VTT Manufacturing Technology

FRAPTRAN-code: Development of FRAPTRAN-GENFLO code; VTT Energy

FRAPTRAN-code: Application of statistical calculation methods in the FRAPCON 3-FRAPTRAN-codes; VTT Energy

Development of fuel analysis capabilities; validation of FRAPTRAN-GENFLO-code by using a BWR-oscillation transient; VTT Energy

The application of new reactor physics models in criticality safety calculations, a continuation project; VTT Energy

Environmentally assisted cracking of NPP materials, a continuation project; VTT Manufacturing Technology

Fuel cladding corrosion mechanism and its modelling, a continuation project; VTT Manufacturing Technology

Modelling of the behaviour of oxide films with regard to their role in activity buildup and different corrosion phenomena in NPPs, a continuation project; VTT Manufacturing Technology

A survey of organizational culture in Finnish NPP maintenance; VTT Automation

Reliability assessment and FMEA of programmable automation, a continuation project; VTT Automation

Participation in the Thermal-Hydraulic Code Applications and Maintenance Program (CAMP) in 2002; VTT Energy

Risk-informed quality assurance; VTT Industrial Systems

Organizational culture in Finnish NPP maintenance; Development of an assessment method; VTT Industrial Systems

Analysis of and data collection on human errors; VTT Industrial Systems

Analysis and combination of deterministic and probabilistic data for use as a basis for decision-making; Quality requirements of PSA and qualifying as part of a risk-informed decision-making process; VTT Automation

Analysis and combination of deterministic and probabilistic data for use as a basis for decision-making; Probabilistic and deterministic decision-making criteria and their usage; VTT Automation

Risk-informed management of ageing and maintenance; Probabilistic assessment of pipe leakages and ruptures to support risk-informed decision-making; VTT Automation

Human reliability analysis (HRA); Errors of commission, gathering reliability data and analysis of fires integrated with HRA; VTT Automation

Risk-informed periodic inspections; VTT Manufacturing Technology

Usage of modelling in ultrasonic testing; VTT Manufacturing Technology

Development of dose calculation pertaining to NPP normal releases; VTT Energy

Research activities pertaining to regulatory decision-making

Development of NDT qualification; Co-operation in the qualification of NDT-systems in Finland. Review of qualification of inspection procedures for manual ultrasonic inspection of pipeline butt welds at the OL1- and OL2-NPP; Serco Assurance Ltd

Analysis of EMC-phenomena based risks at Finnish NPPs; Nemko Product Services Oy

Fire analysis of Loviisa NPP turbine hall; VTT Energy

ATRIUM 10-fuel; Assessment of behaviour during normal use with statistical methods; VTT Processes

Transient analysis related to upgrading of fuel burn-up; VTT Processes

Research to improve safety regulation

Improvement of process-oriented leadership in the nuclear safety regulation carried out by STUK; Qualitas Fennica Oy

Nuclear waste management**Research projects included in KYT**

DECOVALEX III; Bench Mark Test 2 simulations in 2001; Uppsala University

Matrix Diffusion Cluster; Treatment of geosphere retention processes in safety assessments: measurement and modeling of matrix diffusion; University of Helsinki, Laboratory of Radiochemistry.

Interpretation of disturbance structures in Holocene submarine sediments in the Olkiluoto area, the Gulf of Bothnia, Baltic Sea, using a high resolution echo-sounding profiles; laboratory analyses of sedimentary samples; Geological Survey of Finland.

IAEA coordinated research project (CRP). Natural geochemical concentrations and fluxes on the Baltic shield in Finland as indicators on nuclear waste

repository safety; year 2001 b); University of Reading

Development and validation of physical rock matrix characterization methods and their application in site investigations, natural analogue studies and performance assessment; Tasks 3 & 4. Prof. Dr. K. Meyer; BAM

Seabed gas investigations at Olkiluoto site; Geological Survey of Finland.

DECOVALEX III; The Thermo-Hydro-Mechanical modelling of bentonite; Helsinki University of Technology, Institute of Mathematics.

DECOVALEX III; Calculation method for the mechanical stability of nuclear waste canister disposal. Helsinki University of Technology, Institute of Mathematics.

DECOVALEX III; Bench Mark Test 2 simulations in 2002; Uppsala University

DECOVALEX III; Benchmark Test 2, rock mechanical simulations in 2002. Helsinki University of Technology, Department of Materials Science and Rock Engineering.

Research pertaining to regulatory decisions

Review of Posiva's R&D programme; Carrera; UPC-ETMC

Review of the GPS deformation monitoring studies commissioned by Posiva Oy on the Olkiluoto, Kivetty and Romuvaara sites, 1994-2000. Helsinki University of Technology, Department of Surveying.

Focused modelling of bedrock fracture zones in Olkiluoto; Geological Survey of Finland.

The development of 3D Rock modelling system; VTT Building and Transport.

Review of the estimation of rock movements due to future earthquakes at four candidate sites for a spent fuel repository in Finland; Helsinki University of Technology, Department of Materials Science and Rock Engineering.