REGULATORY CONTROL OF NUCLEAR SAFETY IN FINLAND

Annual report 1999

Kirsti Tossavainen (ed.)
This report concerns the regulatory control of nuclear energy in 1999. Its submission to the Ministry of Trade and Industry by the Finnish Radiation and Nuclear Safety Authority (STUK) is stipulated in section 121 of the Nuclear Energy Decree. STUK's regulatory work was focused on the operation of the Finnish nuclear power plants as well as on nuclear waste management and safeguards of nuclear materials.

The operation of the Finnish nuclear power plants was in compliance with the conditions set out in their operating licences and with current regulations, with the exception of some inadvertent deviations from the Technical Specifications. No plant events endangering the safe use of nuclear energy occurred. The individual doses of all nuclear power plant workers remained below the dose threshold. The collective dose of the workers was low, compared internationally, and did not exceed STUK's guidelines at either nuclear power plant. The radioactive releases were minor and the dose calculated on their basis for the most exposed individual in the vicinity of the plant was well below the limit established in a decision of the Council of State at both Loviisa and Olkiluoto nuclear power plants.

STUK issued statements to the Ministry of Trade and Industry about the environmental impact assessment programme reports on the possible nuclear power plant projects at Olkiluoto and Loviisa and about the continued operation of the research reactor in Otaniemi, Espoo. A Y2k-related safety assessment of the Finnish nuclear power plants was completed in December.

In nuclear waste management STUK's regulatory work was focused on spent fuel storage and final disposal plans as well as on the treatment, storage and final disposal of reactor waste. No events occurred in nuclear waste management that would have endangered safety. A statement was issued to the Ministry of Trade and Industry about an environmental impact assessment report on a proposed final disposal facility for spent fuel.

Nuclear material safeguards verified that the use of nuclear materials was in accordance with current regulations and that the whereabouts of every batch of nuclear material were always known.

International co-operation continued, with financing both from STUK's budget and external sources. The focus of externally financed co-operation was on safety improvements at Kola and Leningrad nuclear power plants, the enhancement of the organisations of nuclear safety authorities in Eastern Europe as well as the development of the nuclear material control systems of Ukraine, the Baltic Countries and Russia.

The total costs of the regulatory control of nuclear safety in 1999 were FIM 36.4 million and the income was FIM 30.2 million. The total costs of operations subject to a charge were FIM 30.1 million, the full amount of which was charged to the users of nuclear energy.
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1 REGULATORY GUIDES

In co-operation with the Ministry of Trade and Industry, STUK prepared a draft for amendments to the Nuclear Energy Act and Decree, which were necessary because the pressure equipment legislation had changed. A draft for the general safety regulations governing the final disposal of spent fuel was given the finishing touches.

Finland's pressure equipment legislation was revised in 1999 to comply with the requirements of the EU's pressure equipment directive. The Nuclear Energy Act prescribes the control of pressure equipment in nuclear facilities as belonging to the Finnish Radiation and Nuclear Safety Authority (STUK). Previously, pressure vessel legislation was complied with as applicable. Because the revised pressure equipment legislation excludes pressure equipment in nuclear facilities it was necessary to amend the nuclear energy legislation to include in more detail than before the control of pressure equipment in nuclear facilities. During 1999, in co-operation with the Ministry of Trade and Industry, a draft for amendments to the Nuclear Energy Act and Decree was prepared. The amendments, (870/1999) and (1069/1999), respectively, came into force on 29 November 1999.

In accordance with section 55, second paragraph, point 3 of the Nuclear Energy Act (990/1987), STUK is responsible for preparing proposals for general regulations that, in accordance with section 81 of the Nuclear Energy Act, deal with the safe use of nuclear energy as well as physical protection and emergency preparedness. During 1999, a draft for the general safety regulations governing the final disposal of spent fuel was completed. The Council of State made a decision (478/1999) about the matter on 25 March 1999.

In addition, it is prescribed in the Nuclear Energy Act (990/1987) and the Council of State Decision (395/1991) on the general regulations for the safety of nuclear power plants that STUK is responsible for preparing detailed safety regulations for nuclear facilities. The YVL guides published by STUK serve this purpose. They give the safety requirements to be applied to nuclear facilities as well as STUK’s regulatory procedures.

STUK decides case by case how new guides apply to and bind those facilities already in operation.

The revision and updating of the YVL guides was continued. A total of 31 guides were under preparation in 1999. In addition, ten guides were assessed for their need of revision. By the end of 1999, six guides were revised and five published in English. The number of Finnish-language guides annually published is given in Fig 1. and the working time annually used for the preparation of other regulations in Fig 2. In 1999, the development of regulations took 2.9 man-years, i.e. 3.8% of total working time.

![Fig 1. Number of published YVL guides.](image1)

![Fig 2. Time used for work on regulations.](image2)
A development project concerning the YVL guides, launched in 1998, was completed. As a result, a strategy for rule-making was drawn up and the practices of implementing and applying the YVL guides to operating nuclear facilities were reviewed.

The nuclear and radiation safety rules and regulations essential for STUK’s operation have been made available on STUK's Intranet and on the Internet. A database containing the fundamental rules and regulations in STUK’s field (Ydintieto in Finnish) is in use in STUK as well as in the organisations of Teollisuuden Voima Oy and Fortum Oyj.
2 THE SCOPE OF NUCLEAR SAFETY REGULATION

The regulation of nuclear safety was focused on nuclear facilities, waste management and nuclear materials. The scope was the same as in the previous years.

The regulation of nuclear safety was mostly focused on Loviisa nuclear power plant (the units Loviisa 1 and 2), owned by Fortum Power and Heat Oy, and on 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. Other objects of regulation included the research reactor FiR1 operated by the Technical Research Centre of Finland, small-scale users of nuclear materials as well as the transport of radioactive materials. This chapter gives an overall account of the control exercised by STUK, and regulatory statistics. The objects of regulation are described in more detail in chapters 3, 4 and 5.

The regulation of nuclear power plants is comprised of inspections of the periodic inspection programme and topical inspections that the licensee is obliged to request in connection with measures carried out at the facility or that are conducted by STUK at its discretion. The periodic inspection programme was revised in 1998 and introduced in its revised form at the beginning of 1999. The programme includes inspections at three levels: assessment of the licensee management methods from a safety point of view (Level A), assessment of the main functions of the nuclear power plant organisations (Level B) and inspections specific to functional units and fields of know-how (Level C). The inspections contained in the inspection programme are given in Appendix 1 and the objects of topical inspections in Appendix 2. In addition to the topical inspections and inspections included in the periodic inspection programme, STUK also assesses the safety of nuclear power plants among other things on the basis of operating experience, safety analyses, reports and plans submitted by the utilities as well as by making inspections onsite and at the component manufacturers’ premises.

The regulation of nuclear waste was focused on spent fuel storage and the preparation for its final disposal as well as the handling, storage and final disposal of reactor waste.

Nuclear material safeguards mainly included regulation of the procurement, importation, exportation, transport, storage, handling and operation of fuel.

Table I gives the distribution of the working time annually spent on various duty areas by staff whose main task is nuclear safety regulation. The main functions in this area include those basic

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<td>Basic operations subject to a charge</td>
<td>25.0</td>
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<td>29.1</td>
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<td>Basic operations not subject to a charge</td>
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<td>Rule-making and support functions</td>
<td>24.8</td>
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<td>Holidays and days of absence</td>
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<td><strong>Total</strong></td>
<td>76.5</td>
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operations that are subject to a charge and those that are not. In addition to these operations, certain services are provided. The basic operations subject to a charge are comprised of the regulation of nuclear facilities, the costs of which are charged to the licensees. Those basic operations not subject to a charge include international and domestic co-operation as well as emergency response. In the state budget, funds are allocated to the basic operations not subject to a charge. The costs and income of the basic operations are accounted for in chapter 9. The services mostly include the development of nuclear safety in countries of Central and Eastern Europe, with funding external to STUK. This is described in more detail in chapter 8. The costs of rule-making and those of support functions (administration, development of the nuclear regulatory effort, training, maintenance and development of expertise as well as reporting) are included in the costs of the basic operations and of services, in relation to the number of working hours spent on these functions. The work relating to rule-making is described in chapter one and some support functions in chapter 7.

The time spent on the regulation of Loviisa nuclear power plant was 11.4 man-years, which is 14.7% of the total working time of the personnel. The time spent on Olkiluoto nuclear power plant was 10.9% man-years, i.e. 14.1% of the total working time. In addition to the regulation of nuclear power plants, the figures also include nuclear material safeguards. The time spent on nuclear waste regulation was 2.8 man-years, i.e. 3.6% of the total working time. Fig 3 gives the distribution of working time spent on the main functions.

The number of inspection days onsite and at the component manufacturers’ premises totalled 1047. In addition to inspections at nuclear power plants, the figure also includes nuclear waste management and safeguards inspections. The inspection days at Loviisa nuclear power plant totalled 472 and those at Olkiluoto nuclear power plant 513. In addition, 1-2 resident inspectors worked at both Loviisa and Olkiluoto nuclear power plants. The number of inspection days over the past years is given in Fig 4.

Topical reports for 13 events at Loviisa nuclear power plant and for 10 events at Olkiluoto nuclear power plant were submitted to STUK. The number of topical reports over the past years is given in Fig 5. The utilities also regularly submitted to STUK the following documents: daily reports, quarterly reports, annual reports, outage reports, annual reports on environmental radiation safety, monthly reports on individual radiation doses, annual reports on operational experience feedback and safeguards reports.

The total number of plans, documents and reports submitted to STUK for review in 1999 was 1237. The number of documents submitted in 1999 or earlier, whose review was completed, was 1481. The figure includes also licences granted by STUK in accordance with the Nuclear Energy Act.

![Fig 3. Working time spent on STUK main functions.](image-url)
The average document review time was 123 days. The average handling time has grown, as compared with previous years, mostly because the completion of the handling of older documents was enhanced in 1999. The annual number and average handling time of documents are given in Figure 6. Figs 7 and 8 give the distribution of handling times for documents concerning Loviisa and Olkiluoto plant units that were under review for approval.

The Finnish nuclear power plants were operated according to the conditions set in their operat-
ing licences and valid regulations. Nuclear waste management and the use of nuclear materials were in compliance with valid rules and regulations. On the basis of the inspections, additional documentation and measures were requested from the utilities to further enhance the safety of the plants.

**Fig 6.** Number of documents received and handled as well as the average document handling time.

**Fig 7.** Distribution of time spent on preparing decisions concerning the Loviisa plant units.

**Fig 8.** Distribution of time spent on preparing decisions concerning the Olkiluoto plant units.
3 REGULATORY CONTROL OF NUCLEAR FACILITIES

The Finnish nuclear power plant units were safely operated. In addition to their normal operation, STUK oversaw safety improvements carried out at the plant units. The research reactor of the Technical Research Centre of Finland (VTT) was also safely operated. STUK gave a statement in favour of extending its operating licence.

3.1 Loviisa nuclear power plant

3.1.1 Operation

Both units of Loviisa nuclear power plant operated reliably. The load factor of Loviisa 1 was 91.0% and that of Loviisa 2 was 93.2%. The duration of the annual maintenance outages was 19 days at both plant units. There were no other interruptions in power generation at Loviisa 1. At Loviisa 2 there was a brief interruption in generation owing to the repair of a small leakage from the primary circuit to the steam generator space through two successive valves in a drainage line. No scrams occurred at either plant unit. Production losses arising from component failures were 1.7% at Loviisa 1 and 4.1% at Loviisa 2. Fig 9 gives the daily average gross power of the plant units in 1999. The reasons for interruptions in power generation and the causes of power reductions have been reported in the STUK publications STUK-B-YTO 194, 196, 197 and 199 (the last two in Finnish). The load factors and the number of scrams over the past years are given in Figs 10 and 11.

3.1.2 Significant operational events

None of the events at the Loviisa plant units in 1999 endangered safety. The highest level assigned to them was INES Level 1. Partial decrease in the performance of the emergency cooling systems at Loviisa 2 in September was Level 1. Other events at the Loviisa plant units had no significance for nuclear or radiation safety. The number of events at INES Level 1 and higher at the Finnish plant units is given in Fig 12.

The hydrogen leak that occurred from a hydrogen unit outside the turbine hall at Loviisa 2 in October attracted the most media attention. The event was classified INES Level 0. This and the aforementioned INES Level 1 event at Loviisa 2 are briefly described below. A description of the events is also in the publication STUK-B-YTO 199 (in Finnish).

Partial decrease in the performance of emergency cooling systems at Loviisa 2 (INES 1)

During a periodic test at Loviisa 2 on 4 September 1999 the tags of the system symbols of two valves of the nitrogen blowing system, which cleans the strainers of the emergency cooling systems, were found to have changed places. Because of this, the reactor cooling systems would not have been available quite according to design in accidents. The situation has prevailed since the installation of the nitrogen blowing system, i.e. from 1994.

The reactor emergency cooling system and the containment decay heat removal system have their own strainers. Both systems comprise two parallel subsystems both of which are capable of alone cooling the system.

The purpose of nitrogen blowing is to ensure the operation of the emergency cooling systems in an accident caused by a primary circuit pipe rupture. In such an accident, to remove decay heat, the emergency cooling systems recirculate via strainers water accumulating in the containment building sumps to the reactor and the containment spray system. The strainers of the systems’ suction pipes are cleaned by nitrogen blow-
Fig 9. Daily average gross power of the Loviisa and Olkiluoto plant units in 1999.
**Fig 10.** Load factors of the Loviisa and Olkiluoto plant units.

The power uprates of the plant units in 1997 and 1998 have been taken into account in the calculation of load factors such that the increased electrical power was used as of the day following the power uprating day.

**Fig 11.** Number of reactor scrams at the Loviisa and Olkiluoto units, scram tests excluded (reactor power exceeds 5%).
ing, should they get clogged up by heat insulation peeling off the piping during an accident situation. The strainers are designed to handle without clogging the heaviest possible load arising from insulation material, but, for added reliability, they have also been fitted with a nitrogen blowing system. The nitrogen blowing function is manually actuated, separately for each strainer, if necessary. Actuation is required later in an accident, but, depending on the situation, it may not be needed even then.

Because the system symbol tags of the strainer cleaning system had been mixed up, the nitrogen to be blown to the reactor emergency cooling system from one pair of subsystems could have ended up in the containment building decay heat removal system, and vice versa. This malfunction would not have affected the operation of the other pair of subsystems.

In an accident situation, nitrogen blown to a wrong system could have lead to the failure of the system's pumps. At the same time, the clogged strainers would have been left uncleaned. Consequently, both emergency cooling functions of one pair of subsystems could have been lost.

The system tags were corrected and corresponding systems tags at both plant units were checked. The event has made necessary the re-evaluation of the implementation of plant modifications and of pre-operational testing procedures.

A leak from a hydrogen unit outside the turbine hall of Loviisa 2 (INES 0)

On 5 October 1999, hydrogen leaked to the atmosphere from a hydrogen unit outside of the wall of the turbine building. The generators of Loviisa nuclear power plant are cooled by hydrogen because it has good heat transfer properties. The leak started during the replacement of hoses connecting fixed hydrogen piping and the hydrogen units according to a preventive maintenance programme. The coupling of a shut-off valve between a hydrogen unit and fixed hydrogen piping started to leak during the detachment of a hose.

After having detected the leak, the maintenance staff left the point of leak and informed the plant unit's control room. The leak was announced via the plant's loudspeaker system in consequence of which the plant fire brigade left for the point of leak. A curfew was imposed on the leak area and inside the turbine hall because of the inflammability of hydrogen. The leaking hydrogen unit was allowed to continue emptying under the fire brigade's supervision. To ensure safety the utility alerted two fire brigade units from Loviisa town. The valve of the leaking hydrogen unit could be closed in about six hours after the leak had started. Ca. 120 m³ of hydrogen leaked to the atmosphere.

The event has significance for personnel safety.

Fig. 12. INES Level 1 and higher events at the four Finnish plant units.
It has no significance for nuclear safety, however, since the hydrogen leaked to the atmosphere and was well mixed with air. Due to the windy weather, the risk of hydrogen ignition was small. The event attracted a great deal of media attention, however (subsection 6.3).

### 3.1.3 Event investigation

STUK initiates an investigation into events particularly when the licensee's organisation has not operated as planned or when an event is assessed to lead to significant modifications in the plant technical structure or regulations. The utilities themselves also assess events that have occurred at their plants, taking action, if necessary. STUK assesses these licensee measures as part of safety regulation. A STUK investigation team is also set up in case of events evaluated at INES Level 2 or higher.

In 1999, of the events that occurred at Loviisa plant, the one that took place on 31 December 1998—a disturbance in the operation of the intermediate cooling circuit—was investigated. A degradation in the circuit's operation occurred during the isolation of a leak in the service water system. Consequently, the temperature of the sealing water of the primary circulation pumps exceeded set limit. The investigation focused on how matters were handled at Loviisa nuclear power plant and on decision-making procedures during the event. Of special interest was the fact that the plant operating procedures were ignored. The system's operation was also investigated.

The event was initiated when a plastic valve in the service water system broke during the falling down of a supporting pillar of a cable shelf. The pillar's anchor screws had rusted through and it collapsed when a fitter leaned on it for support. The leak was incorrectly localised first, which is why the control room ordered wrong valves to be closed. In consequence, cooling by the intermediate cooling circuit totally ended and the temperature of the sealing water of the primary circulation pumps increased.

The closed valves were opened without delay but one of two manually operated butterfly valves was too much turned turned and was thus almost reclosed. This was possible because there was no mechanical limit to assure that they stay open. In accordance with instructions, an attempt was made to prevent the temperature of the sealing water of the primary circulation pumps from increasing. The pumps were not stopped since the situation was considered to be under control and a decision was made to see what effects the corrective measures taken would have. It would have been possible to stop the pumps anytime. The temperature decreased to normal only after the intermediate cooling circuit had be returned to service by opening the valve of the auxiliary service water system, which was in the wrong position. The situation lasted ca. 1.5 hrs in all. Due to the action taken by the operating personnel, the plant unit safety was not significantly compromised during the event. The event also did not bring about any faults or damage in the systems or components of the unit. The event was assigned Level 0 on the INES scale. It has been described also in the publication STUK-B-YTO 199 (in Finnish).

The investigation revealed needs for improvement, which STUK required the licensee to pay attention to. STUK requested the licensee to review the relevant procedures and how binding their instructions are, as well as the procedures used by the control room for registering important decisions. STUK also required the licensee to consider, among other things, the sufficiency of the adjustment properties of the service water system and the intermediate cooling circuit. Attention was also to be paid to the surveillance of the anchor screws, plastic valves and the position of butterfly valves. Room lighting and equipment tags needed improvement as well. The utility has partly implemented the corrective measures and has plans in place for making the rest of them.

### 3.1.4 Deviations from the Technical Specifications

The state of the Loviisa plant units was in violation of the Technical Specifications during the following six situations.

- A work order was given at Loviisa 2 on 7 April 1999 to repair a containment spray system pump while the plant unit was operating at full power. At the same time, a second work order was issued from the control room to repair a diesel generator of the stand-by electric supply
system. The diesel generator in question supplies electricity to a parallel pump of the containment spray system in situations where the external grid has been lost. The spray system comprises two parallel subsystems, one of which was now inoperable. The plant unit state was in violation of the Technical Specifications for 30 minutes. The event is Level 0 on the INES scale. A more detailed description can be found in the publication STUK-B-YTO 196.

- On 26 August 1999 the reactor power of Loviisa 1 erroneously increased to 4% during startup from annual maintenance outage and preparations for tests at low power. During the reactor startup errors were made in the dilution of the primary circuit boric acid concentration and, as a result of this, the reactor power tended to increase beyond the 1% power level required for the tests at low power. It increased to 4% when, during the homogenisation of the cooling circuit prior to the testing at low power, cooling water from various sections of the cooling circuit, which had a lower boric acid concentration, mixed with the coolant. The event is Level 0 on the INES scale. A more detailed description is in the publication STUK-B-YTO 197 (in Finnish).

- On 28 August 1999 a filter of the auxiliary building ventilation system of Loviisa 2 was removed from operational readiness in violation of the plant unit's Technical Specifications. The plant unit was being shut down for annual maintenance. The filter can be removed from service for three days for repairs during plant operation; however, a filter fit for operation may not be removed from service. The event is Level 0 on the INES scale. A more detailed description is in the publication STUK-B-YTO 197 (in Finnish).

- During a periodic test at Loviisa 2 on 4 September 1999 it was detected that the tags of the system symbols of two valves of the nitrogen blowing system, which cleans the strainers of the emergency cooling systems, had changed places. Because of this, the reactor cooling systems would not have been available quite according to design in accident. This situation had prevailed since the installation of the nitrogen blowing system, i.e. since 1994. The event was classified INES Level 1. A more detailed description can be found in subsection 3.1.2 and the publication STUK-B-YTO 199 (in Finnish).

- On 8 September 1999 it was found that the continuous-operation monitoring of the radioactivity of liquid effluents released from Loviisa 1 to the sea was out of service. The measuring function can be isolated from the sea discharge line by a shut-off valve, which was in the closed position against instructions. The event's INES Level is 0. A more detailed description is in the publication STUK-B-YTO 197 (in Finnish).

- On 27 October 1999 one back-up diesel generator at Loviisa 1 was erroneously removed from operational readiness when preparing for maintenance, with the plant unit operating at full power. The removal from operational readiness lasted for two hours. The event was classified INES Level 0. A more detailed description is in the publication STUK-B-YTO 197 (in Finnish).

The utility has planned and partly implemented measures to prevent recurrence. Figure 13 shows the number of onsite situations in violation of the Technical Specifications in recent years. Deviations from the Technical Specifications have been on the increase, on account of which STUK has started an investigation.

The utilities deviated from the Technical Specifications also by submitting to STUK applications for exemptions in advance. In 1999 STUK granted a total of ten such exemptions for the Loviisa plant units. The number of exemptions granted annually is given in Fig. 14.

### 3.1.5 Safety improvements

#### Mitigation of the consequences of severe accidents

A project dealing with provision for severe accidents is under way at Loviisa nuclear power plant. In 1991 pressure management inside the containment by external sprinklers and in 1996 the reduction of primary pressure were implemented. In addition, the licensee has submitted conceptual design plans for the arrangement of the external cooling of the reactor pressure vessel, hydrogen
management inside the containment and those modifications to electrical and automation systems required by severe accident management. STUK has reviewed and approved the plans. The system's detailed pre-inspection documents have also been reviewed and approved.

In 1999 STUK evaluated the acceptability of catalytic recombiners related to hydrogen management. The recombiners are intended for burning, without flames or explosions, into water hydrogen released inside the containment building during a severe accident. A document submitted by the licensee on the qualification of the recombiners for accident conditions was reviewed and approved. Problems have appeared onsite in their pre-operational testing and final installation will be carried out once the problems have been solved. The ignition plugs previously in use for hydrogen ignition will be kept in the steam generator space.

There are plans to increase the number of the

![Fig. 13. Number of onsite situations in violation of the Technical Specifications at Loviisa and Olkiluoto nuclear power plants.](image)

![Fig. 14. Number of exemptions from the Technical Specifications at Loviisa and Olkiluoto nuclear power plants.](image)
manual actuations of containment isolation signals needed to maintain containment leaktightness. The manually actuated isolation functions ensure containment leaktightness against leaks through piping. STUK reviewed the implementation plans but some further clarifications are needed prior to final approval.

STUK reviewed and approved the pre-inspection documentation for the lowering mechanism of the thermal shield of the reactor pressure vessel and the pre-inspection documentation for the opening mechanisms of the doors of the containment ice condenser system. The thermal shield ensures sufficient cooling water supply on the outer surface of the reactor pressure vessel and the controlled cooling of a core melt formed inside the pressure vessel during a severe accident. Overpressurisation of the containment during an accident is restricted by means of the ice formed inside the ice condenser system. The opening mechanisms of the doors of the ice condenser system ensure a sufficient supply of air inside the containment building, which is needed in the catalytic burning of hydrogen released in a severe accident. Both systems will be installed at Loviisa 1 during the year 2000 and at Loviisa 2 during 2002.

At Loviisa nuclear power plant, the construction of a separate control room for accident management was started. STUK reviewed and approved the construction plans.

**Ensured operation of direct current power supply systems**

During the annual maintenance outages of both Loviisa plant units, modifications were completed at both units to assure power supply to the rectifiers of batteries important to safety even from the diesel generators of a spray system external to the containment building. The back-up power supply connections are used if offsite and onsite alternating current power supply is lost for such a long time that battery capacity could diminish and compromise the performance of important direct current power systems onsite. The supply of back-up power is designed not to endanger the performance of the containment vessel external spray system. The possible taking into service of back-up power supply will be according to operational procedures and as ordered by the control room.

STUK has reviewed the documents relating to the back-up power supply connections and supervised the implementation of the project and systems pre-operational testing during annual maintenance outages.

**Measures taken due to high temperatures of the steam generator room**

Temperature measurements in the steam generator rooms of the Loviisa plant units have shown that, over the past years, the electrical and I&C components and cables have been subjected to a stronger-than-planned thermal stress during plant operation. The high temperatures accelerate the ageing of the cables and components.

During the 1999 annual maintenance outages of Loviisa 1 and 2, the utility continued measurements in the steam generator room to assure the performance of, and to reduce the temperatures around, the electrical and I&C cables as follows:

- During shutdowns prior to annual maintenance, temperature measurements were continued to identify critical points
- Electrical and I&C cables were inspected both visually and by inspections of cable specimen. Some cables were replaced and some installations improved. Cable routings were altered as well.
- The lighting in the steam generator spaces was improved and some electricity supply cabling was renewed.
- Valve actuators were checked and some of their electrical cabling was replaced.
- Aged thermal insulation around piping and other hot components was replaced and additional insulation fitted.
- Cooling systems efficiency was increased to reduce the steam generator temperatures during operation. Temperature monitoring was improved by adding new temperature measurements.

Owing to the measures taken, the overall temperatures inside the steam generator rooms of the Loviisa plant units have already decreased. Furthermore, additional confidence has been obtained in the maintenance of the performance of the elec-
trical and I&C components and cabling in possible accident situations. More measures to improve the steam generator rooms will be taken in the forthcoming annual maintenance outages.

STUK reviewed and approved the improvements and supervised their implementation in the annual maintenance outages of 1999.

The motors of the pumps of the reactor intermediate circuit were replaced

The design temperature of the electric motors of the pumps of the intermediate cooling circuit was increased as a result of safety analyses made in connection with a modernisation and power uprating project carried out at Loviisa nuclear power plant. The raising of the design temperature set more stringent demands than before for the thermal endurance of the motors. It was also necessary to ascertain the availability of the motors even in the event of a potential long-term undervoltage situation.

The licensee decided to replace all original old motors still in service with new modern short circuit motors, which meet more stringent operating and environmental qualification requirements. The motors were replaced in the annual maintenance outages of 1998–1999. The work was completed in the 1999 Loviisa 1 annual maintenance outage during which the last two motors were replaced.

STUK has reviewed and approved the pre-inspection documents relating to the motor replacements and has also supervised their installation and pre-operational testing during the 1998–1999 annual maintenance outages.

New fuel type was commissioned

Six fuel assemblies manufactured by BNFL (British Nuclear Fuel Limited) were loaded into the Loviisa 1 reactor in the 1998 annual maintenance outage and have been in the reactor since. Previously, all Loviisa fuel was delivered from Russia. The new fuel is almost identical in structure with the Russian fuel currently in use. The most important differences are in the cladding material and that the new assemblies can be disassembled for inspection.

Before the new fuel type was loaded into the reactor STUK reviewed documents relating to its feasibility study. According to the study, the new fuel can be used simultaneously with the Russian VVER fuel at Loviisa nuclear power plant. The irradiation of a limited batch of fuel in the reactor before the loading of a full reload batch is an essential part of the licensing of a new type of fuel. The use of a small fuel batch will reveal possible fuel design failures before full reloading of a new fuel type. The operating experience obtained during 1998–1999 and inspections conducted during the annual maintenance outage, which followed this operating cycle, ascertained that the new fuel behaves according to design. In the 1999 annual maintenance outage, one of the new fuel assemblies was removed from the reactor for further investigation. The results are not yet available. The operation of the other five assemblies is continued for the operating cycle of 1999–2000.

Removal of decay heat in connection with a potential fire

In connection with the handling of operating licence applications for the Loviisa plant units in 1998 STUK paid attention to the fact that the reactor cannot be brought to a cold shutdown by means of the back-up emergency feed water system alone. This system is used in situations where the secondary circuit normal feed water system and the emergency feed water system have been lost. Such a situation could occur for example during a catastrophic turbine hall fire. The back-up emergency feed water system is used to remove decay heat as steam produced by the steam generators. Problematic with the operation of the system is that steam formation in the steam generators requires a temperature exceeding 100 °C. It would thus not be possible to cool the primary circuit below this temperature.

The licensee has drawn up a conceptual design plan, as requested by STUK, on how to assure reactor cooling to a cold shutdown state in case of a turbine hall fire. According to the plan, a new heat exchanger will be constructed that is to be connected to the plant’s normal decay heat removal system. It will be located in a way to avoid its exposure to possible turbine hall fires. Its sea water cooling will be implemented in a manner making decay heat removal possible even in case
of loss of normal service water supply to the plant due to clogging caused by, for example, frazil ice or seaweed. STUK reviewed and approved the plan. Some additions were requested to it.

**Improved lightning protection**

An exceptionally violent thunderstorm occurred in July 1998, causing at Loviisa nuclear power plant disturbances (STUK-B-YTO 185) that revealed weaknesses in the onsite lightning protection system. Particularly deficient was the earthing system of a communication mast located in the vicinity of the plant site, which probably caused many disturbances in the nearby information and simulator building, in the final repository for reactor waste located underneath the mast as well as in systems connected to the mast by cable.

The lightning protection system of Loviisa nuclear power plant has been improved in 1990 and 1993 but, due to deficiencies that emerged in the summer of 1998, the licensee decided to improve the lightning protection of the communication mast and to reassess the earthing systems. The measures improving the communication mast were completed in the spring of 1999 after which it was significantly better connected to the plant earthing systems. The utility has checked the earthing arrangements in connection with maintenance operations and has ascertained them to be in order. In addition, it has re-evaluated the lightning protection of buildings. Based on this, the earthing protection of some buildings will be improved. The work on this has been started in the spring of 2000. The lightning protection, earthing systems and overvoltage protection of I&C systems have also been significantly improved in 1999. Most improvements were made in the telephone connections and communication, the access control equipment and the automation systems of the final repository for reactor waste. STUK has overseen the carrying out of the improvement measures at Loviisa nuclear power plant.

**Renewal of the fire detection systems and the halon extinguishing system**

At Loviisa nuclear power plant the fire detection systems have been in operation for approximately 20 years. The equipment are obsolete and do not meet updated requirements for system performance and reliability. In addition, all needed spare parts are not available. The fire detection systems do not meet the requirements of the new STUK guide YVL 4.3, Fire protection at nuclear power plants. Owing to this, the licensee has decided to install a new fire detection system at both plant units.

The designing of Loviisa 1's new fire detection system began in 1997 and its construction in 1998. The work was completed and the system commissioned in 1999. STUK conducted the commissioning inspection. The new system's detectors are more sensitive and reliable and a fire alarm can be identified at least to an individual room or detector location. The designing of Loviisa 2's new fire detection system began in 1999. The system is due for commissioning by the end of the year 2000.

The Council of State Decision (262/1998) stipulated abandonment of the use of halons by the end of 1999. The Decision also applies to halons used as extinguishers in fire extinguishing systems, with the exception of some granted exemptions. The halon extinguishing systems had to be removed and replaced with new systems or other complementary fire protection arrangements.

The large cable rooms in the control buildings of Loviisa 1 and 2, which are located below the control room level, had been protected with a halon extinguishing system and a manually actuated water sprinkler system. There was not available a gas extinguisher system to replace the halons, which would be feasible for such large cable spaces and would have been acceptable from the viewpoint of personal safety. When the halon extinguishing systems were removed from service in December 1999 the only extinguisher system that remained was the existing manually actuated water sprinkler system. Risk analyses indicate that the removal of the systems does not compromise the safety of the plant units. Risk analyses have considered the improvement in safety provided by the new fire detection system and the status of the newest propagation models for cable fires.

The new, more sensitive and efficient system facilitates the prompt detection, localisation and suppression of a fire in its early stages. In addition, the number of detectors will be significantly
increased in those cable rooms that were previously provided with halon extinguishing systems.

**Provision against the Y2k problem**

Loviisa nuclear power plant uses computerised systems for administrative tasks, in expert systems and in the units’ modernised I&C systems. The systems most important to the safety of the plant units, such as the protection automation, use conventional technology, with no date processing problems.

To solve Y2k-related computer problems, a company-level Millennium project had been set up at Fortum Oyj in the autumn 1997 and, towards the end of the same year, a Year 2000 project was launched at Loviisa nuclear power plant. The licensee made an inventory of computer-based systems at both of its plant units. Even the systems of Ahvenkoski power plant, which provides reserve power, were included. Components were repaired or replaced before the turn of the Millennium, where necessary. All computer-based safety-significant systems and components were tested and repaired, if necessary.

The licensee conducted also a probabilistic safety analysis (PSA) of the reactor core melt risk. There was no indication of any of the programmable systems having a significant effect on the probability of a core melt.

The licensee reported to STUK about the progress of its Year 2000 project. STUK conducted onsite inspections to assess the measures taken. STUK also evaluated the reports that had been submitted on the Year 2000 compatibility of systems and components important to safety. In addition, STUK reviewed and approved the licensee’s Millennium contingency plan. According to a safety evaluation made by STUK, the basic automation of the plant units, together with measures taken by the licensee, assured that the operation of the plant units would not pose a danger at the turn of the Millennium.

The Millennium change did not cause any disturbances in the operation of the plant units. All communication between STUK and Loviisa nuclear power plant functioned and the process computers of both reactor units transmitted data to STUK without any problems.

### 3.1.6 Probabilistic safety analyses

#### Outage risk analysis

In an outage risk analysis the licensee has looked into the most important risks of plant outages, with the exception of fires and floods. Among the most significant risk factors are the hoisting of heavy loads and the loss of power supply due to busbar failures in a situation including the loss of direct current power supply, drained batteries and the simultaneous servicing of a parallel section of the power supply system. Loss of ventilation in the instrumentation area and a consequent excessive increase in temperature can lead to a partial loss of plant unit control.

Several changes have already been made in the startup, shutdown and testing instructions of the plant units to eliminate identified risk factors. To reduce risk related to heavy hoists, several procedures have been altered; among other things as follows: further requirements have been placed on the containment leaktightness for the duration of hoists involving loads in excess of 150 tonnes and the inspection of the reactor lid unit will be conducted in a location less risk prone than previously.

STUK reviewed the outage risk analysis and made some remarks to which the licensee responded acceptably. Loviisa nuclear power plant was urged to further plan and implement sufficient and appropriate measures to reduce the risks involved in heavy hoists. The licensee will complement its outage risk analysis by conducting analysis into fires and flooding during outages.

#### Weather risk analysis

A weather risk analysis for the Loviisa plant units has been updated and it corresponds to the condition of the plant units after the modernisation project that ended in 1998. The core melt risk caused by weather phenomena is $4.3 \times 10^{-5}$/year. The analysis identified seaweed (72.5%), strong winds and related phenomena (10.8%) and frazil ice accumulating in the service water circuit (4.8%) as some of the most important weather-related phenomena that could clog up the service water circuit. The core melt risk indicated by an analysis made in 1994 was ca. ten times larger.
than in this one. Modifications to reduce the risk of clogging of the service water circuit were carried out at Loviisa nuclear power plant based on the results of the 1994 risk analysis. STUK’s most important remarks during the inspection at the time concerned the exclusion from the analysis of frazil ice and the sea water filters of diesel generators. Frazil ice related risk has been dealt with in the updated analysis.

Any estimates of the frequency of extreme weather conditions are highly uncertain and it is difficult to reliably evaluate the probability of events caused by them and the successfulness of any management measures. Weather risk analysis still lacks in sensitivity and uncertainty analyses.

**Level 2 PSA**

Level 2 PSA evaluates the probability of accidents leading to a release of radioactive materials from the containment to the environment. A Level 2 PSA review was completed in 1999. The results indicated that the greater part of the calculated risk (ca. 70%) is caused by primary-to-secondary circuit leaks and other containment bypasses. The rest of the risk is a result of high-energy phenomena causing containment damage, which could follow a reactor core melt. The calculated risk already includes some of the improvements planned at Loviisa nuclear power plant to prevent the consequences of severe accidents. The Level 2 PSA risk analysis has not, for the time being, considered the risk arising from offsite initiating events (fires, floods, extreme weather). It will be completed in this respect in the forthcoming years. Improvement needs related to the quality of the analysis were identified in the review conducted in cooperation with a consultant.

**3.1.7 Radiation safety**

The radiation doses of those working at Loviisa nuclear power plant in 1999 were below the annual limit of 50 mSv. The highest individual dose was 17.5 mSv. The distribution of individual doses in 1999 is given in the report STUK-B-YTO 199 (in Finnish). Radiation dose may not exceed the dose limit of 100 mSv in any period of five years. The highest individual dose to a Finnish nuclear power plant worker in the 5-year period 1995-1999 is 83.6 mSv.

The collective occupational radiation dose for both Loviisa plant units in 1999 was 1.36 manSv. Collective occupational doses over the past years are given in Fig. 15. According to Guide YVL 7.9 issued by STUK, the threshold guideline for the collective dose for one plant unit is 2.5 manSv per 1 GW of net electrical power averaged over two successive years. The combined collective dose threshold value for the Loviisa plant units is 2.44 manSv.

Radioactive releases into the environment from Loviisa nuclear power plant in 1999 were well below authorised limits. The releases of gaseous radioactive effluents were 0.03% of authorised limits. In the releases of radioactive noble gases, the activation product of argon-40, i.e. argon-41, originating in the air space between the reactor pressure vessel and the biological shield, was dominant. The releases of radioactive iodine were 0.02% of the annual release limit. The tritium content of liquid effluents, 14 TBq, is ca. 9% of the release limit. The total activity of other liquid effluents was 0.1 GBq, i.e. ca. 0.01% of the release limit. Detailed information about the releases and set limits are given in the report STUK-B-YTO 199 (in Finnish).

The function of release limits is to keep the annual individual exposure of the population in the vicinity of nuclear power plants, arising from the operation of the plants, clearly below the threshold value of 100 µSv defined in the Decision of the Council of State (395/1991). The dose to the most exposed individual in the environment of the nuclear power plants, calculated on the basis of releases, was ca. 0.6% of the set limit. Calculated annual radiation doses are given Fig. 16.

The total number of samples collected in 1999 in accordance with the environmental radiation monitoring programme of Loviisa nuclear power plant was 297. In addition, external radiation measurements were conducted. Radioactive substances originating from Loviisa nuclear power plant were measurable in the samples in such quantities only as have no bearing on the population radiation exposure. The observations are explained in more detail in the reports STUK-B-YTO 194, 196, 197 and 199 (the last two in Finnish).
Fig 15. Collective occupational doses at Loviisa and Olkiluoto nuclear power plant.

Fig 16. Calculated radiation dose estimates for an individual of the most exposed population group in the vicinity of Loviisa and Olkiluoto nuclear power plants.
3.2 Olkiluoto nuclear power plant

3.2.1 Operation

Both units of Olkiluoto nuclear power plant operated reliably. The load factor of Olkiluoto 1 was 96.9% and that of Olkiluoto 2 was 96.6%. The duration of the annual maintenance outage of Olkiluoto 1 was nine days and that of Olkiluoto 2 was 10 days.

One reactor scram occurred at Olkiluoto 1, on 24 September 1999 during the filling of the water seals of the floor drains of the reactor building. The plant unit was operating at full power at the time of the event. In connection with the filling of one water seal, water was allowed to run for too long. Only two litres are required per sump and any superfluous water flooded onto the floor. An alarm signal for this was received in the main control room and the individuals filling the water seals were contacted. Enough water ended on the floor to trip the detectors of two floor drains, however. An automatic scram was actuated. The plant unit’s safety systems functioned as planned and the event was classified INES Level 0.

An unnecessary scram function was initiated at Olkiluoto 2 on 3 May 1999 while the plant unit was being brought to shutdown state for the annual maintenance outage. The scram function was actuated towards the end of the shutdown, with all control rods already inserted into the core and the reactor near atmospheric pressure. The event was caused by temporarily high reactor level measurement values received from two measurement channels simultaneously. Such temporary high values could be caused for example by uncondensed gases released in the level measurement system during reactor pressure reduction. The scram function actuates when the measurement signals of two channels exceed the set limit. An actual reactor scram did not occur because the control rods had been inserted into the reactor. No scrams occurred at Olkiluoto 2 during the time the unit was generating electricity to the grid.

The only interruptions in electricity generation at the Olkiluoto plant units were the annual maintenance outages and the reactor scram at Olkiluoto 1. Production losses caused by component failures were 0.2% at Olkiluoto 1 and 0.1% at Olkiluoto 2. Fig. 9 gives the daily average gross power of the plant units in 1999. The interruptions in power generation and the causes of power reductions have been reported in the STUK publications STUK-B-YTO 194, 196, 197 and 199 (the last two in Finnish). The number of load factors and scrams over the past years can be found in Figs 10 and 11.

3.2.2 Significant operational events

None of the events at the Olkiluoto plant units in 1999 endangered safety. The highest INES level assigned to them was Level 1. The events described below were assigned Level 1. They have also been described in the publications STUK-B-YTO 194, 197 and 199 (the last two in Finnish). The other events at the Olkiluoto plant units had no significance for nuclear or radiation safety. The number of INES Level 1 and higher events at the Finnish plant units is given in Fig 12.

Degraded operability of the containment gas treatment system of Olkiluoto 1

During a periodic test of the containment gas treatment system at Olkiluoto 1 on 18 June 1999 it was found out that a butterfly valve in the system’s other circuit was open when it should have been closed. According to the preventive maintenance programme, the valve’s actuator had been replaced in the annual maintenance outage, which ended on 25 May 1999, and the angle transmission connecting the actuator to the valve had been serviced. When the angle transmission was fitted back it was not noticed that its position had changed from open to closed during servicing. The valve’s post-installation functional test did not reveal its incorrect position.

Owing to the installation error, however, the opening of the valve, which must be done in an accident situation, would have lead to its closing and to the overheating of the recombiner of the gas treatment system. The recombiner burns into water hydrogen formed inside the containment building during an accident situation. During an accident the closed valve would have resulted in
the inoperability of one circuit or at least to a significant degradation of its capacity. The operation of one circuit is sufficient in an accident situation.

The position of the angle transmission was corrected and the system was tested. In addition, the utility checked corresponding valves. A revision of the valves' maintenance instructions is under way and a test was added to the containment gas treatment system test that ascertains the correct functioning of the position indication of the butterfly valves of the recirculation line.

**Reactor containment personnel access opening open in violation of the Technical Specifications at Olkiluoto 2**

The door of a reactor containment lower access opening at Olkiluoto 2 was open for about an hour in violation of the Technical Specifications. The event occurred during the annual maintenance outage on 6 May 1999 in connection with the replacement of the motor of one main circulation pump.

During part of the pump servicing time, reactor cooling water is kept inside the pressure vessel by means of a plug or cap installed in the pump shaft hole in the bottom of the reactor pressure vessel. The closed door ensures that, should the plug or cap fail, the water leaking from the reactor through the open shaft hole would not escape from the containment via an open door but would be available for the reactor emergency core cooling system, for recirculation into the reactor pressure vessel.

The door of the lower access opening was left open during the replacement of the main circulation pump motor because a break occurred in the flow of information. Work was stopped for the night and, according to the shift supervisor, there was no need to open the lower access opening. In the morning the men servicing the pump entered the containment via the upper access opening to continue their work, trusting that the access opening was closed. The morning shift supervisor had, however, authorised the opening of the lower access opening for other work. The shift supervisor should have been told that maintenance work was continued so that he could have ordered the lower access opening to be closed.

The measures taken because of the event are described in subsection 3.2.3.

**Two fuel assemblies not properly inserted into the reactor of Olkiluoto 2**

During an annual maintenance outage refuelling two fuel assemblies were not completely inserted into the reactor core. The slightly elevated position of the assemblies was detected on 13 May 1999 during post-outage start-up when the flow measurements of the neutron flux measuring system were being calibrated. If a fuel assembly is not properly inserted, part of the coolant flow intended for it could bypass it via the gap between the lower end of the assembly and the reactor's supporting structures; in such a case the coolant flow would not contribute to the cooling of the assembly. In this case no limitations were required in plant unit operation because of the mispositioned assemblies.

The event was caused by the following matters, among others: deficiencies in decision-making concerning the termination of the refuelling phase and in preparing for the final inspection of the refuelling as well as in the exchange of information between those participating in the inspection. In addition, the existing instructions did not require that the video tape, which had been made during the final inspection of the refuelling, be viewed prior to the closing of the reactor pressure vessel lid. The elevated rods would probably have been visible on it.

After the event the utility increased the monitoring of the coolant flow and the stability characteristics of the elevated fuel assemblies. In addition, procedures ensuring full insertion of fuel assemblies into the reactor were made more specific. The new procedures were introduced in the 1999 annual maintenance of Olkiluoto 1 already, which started after the Olkiluoto 2 annual maintenance. The utility has revised its refuelling and related instructions so that the deficiencies are eliminated when action is taken according to the instructions.
**Inoperable containment building isolation valve at Olkiluoto 1**

It was discovered at Olkiluoto 1 on 12 October 1999 that, due to the incorrect settings of the torque switching of its actuator, an isolation valve in a pipeline penetrating the containment building would not have closed in all situations requiring valve closure. The valve is situated outside the containment, in a suction line of the shut-down cooling system. The valve actuator had been replaced with a repaired and serviced actuator in the annual maintenance outage of 1998. The actuator’s torque switching settings should have been tested in a test bench prior to installation. This had not been done, however.

The settings were corrected the same day and the valve’s operation was tested. The correctness of torque settings is usually verified in a test bench. The settings can be adjusted even with the actuator connected to process, but with less accuracy. STUK approved a torque settings adjustment to be made during process operation. Not later than in the annual maintenance outage of 2000, the actuator will be replaced with an actuator that has been tested in a test bench.

The utility checked also the torque switching settings of all isolation valve actuators at both plant units. One actuator with incorrect settings was found at both units. The actuators were in valves that are in a closed position during plant operation and the incorrect settings thus had no significance for the valves’ isolating function. The utility will develop procedures to make it impossible to check out untested actuators from store, for installation in a process.

### 3.2.3 Event investigation

Of the events in Olkiluoto, STUK investigated the one that occurred at Olkiluoto 2, involving a containment access opening open in violation of the Technical Specifications. It occurred during an annual maintenance outage while a main circulation pump was being serviced and was caused by a break in the flow of information. The event is described in more detail in subsection 3.2.2 and in the report STUK-B-YTO 196. It was classified INES Level 1.

The investigation focused on how servicing of the main circulation pumps has been administered, and on the related instructions as well as on the flow of information between service point and control room. Based on the investigation, the licensee was requested to submit a safety assessment on the sufficiency of administrative measures in a situation where work is resumed after a temporary interruption. A reassessment of work administration and of safety was requested as regards maintenance work that could cause a coolant leak from the reactor pressure vessel below the reactor core. According to STUK, the results of the assessments are to be submitted prior to the annual maintenance outages of the year 2000. In addition, the licensee was required to better provide information to those working on the main circulation pumps about the opening and closing of the lower personnel access opening. Attention was to be paid also to the explicitness of work orders.

The utility itself proposed corrective measures on the basis of the lessons learnt from the event. It considered necessary a review of the instructions for document procedures relating to maintenance work and for administration of work on the main circulation pumps; a review of the procedure for testing the auxiliary crane of the refuelling machine, which lifts the plug from the shaft hole of the main circulation pump, was also considered necessary. According to STUK, the licensee is to submit a description of the implementation status of the procedures that will be changed prior to the annual maintenance of the year 2000. The utility has reviewed the maintenance documents of the main circulation pumps. The revised documents were in use in the annual maintenance of Olkiluoto 1, which started after that of Olkiluoto 2 had ended.

### 3.2.4 Deviations from the Technical Specifications

Three events occurred at Olkiluoto during which the plant unit state was in violation of the Technical Specifications. They were as follows:

- Reactor containment access opening was open in violation of the Technical Specifications at Olkiluoto 2
- Degraded operability of the containment gas treatment system at Olkiluoto 1
Inoperable containment building isolation valve at Olkiluoto 1.

These INES Level 1 events are described in subsection 3.2.2.

The utility has planned, or has already implemented, measures to prevent recurrence, as is explained in subsections 3.2.2. and 3.2.3. Fig 13 presents the number of plant events that violated the Technical Specifications over the past years. Because their number has been on the increase STUK has launched investigations into the matter.

The deviations that were planned to the Technical Specifications were made on the basis of exemptions granted by STUK. Five such exemptions were granted for the Olkiluoto plant units in 1999. The number of exemptions annually granted is given in Fig 14.

3.2.5 Safety improvements

Provision against severe accidents

The assurance of reactor pressure reduction during severe accidents was improved at both Olkiluoto plant units. A core melt through the reactor pressure vessel at high pressure and resulting containment damage must be prevented to keep open the valves of the primary circuit pressure control system during an accident. In 1998 two valves of the pressure control system were connected with nitrogen and water injection systems external to the containment by which the valves can be kept open at a pressure so low that it closes other valves in the same system. However, there were pneumatic valves in the control lines of the valves inside the containment that could not be guaranteed to stay open in the ambient conditions of a severe accident. To eliminate this defect the pressure control valves were provided with a new nitrogen and water injection line in the 1999 outage, with the valves required in their operation placed outside the containment. STUK assessed the design documents for the modification and the renewed system's pre-operational testing programme as well as supervised the modification's implementation and pre-operational testing.

In addition, modifications have been implemented at the Olkiluoto plant units ensuring the containment of fission products, iodine in particular, released from the reactor core during an accident, in the filter of the pressure reduction line penetrating the containment. The amount of chemicals in the filter water has been increased to ensure filter efficiency even in case chlorine would be transported to it from the containment owing to damaged cables. STUK approved the change to the Technical Specifications required by the modification. STUK has contracted to the Technical Research Centre of Finland (VTT) tests ensuring the adequacy of the modification.

On an earlier occasion the licensee has revised the plant units' emergency operating procedures in such a way that, during severe accidents, the reactor's condition can be monitored by withdrawing low power neutron flux detectors from the reactor. Since the detectors were not designed for use in this way, STUK required a more detailed description of their operation in an accident. The licensee analysed their operation both by calculations and tests during operation. According to the results, the detectors will indicate the recriticality of the reactor during an accident. The analysis is under review by STUK.

Modifications have also been planned to the containment spray system, the sampling system and the containment lower access opening to assure the containment function during accidents. Modification makes possible the addition of chemicals to the water of the spray system during accidents to prevent the evaporation of radioactive iodine from the containment water pools. The modification of the containment sampling system extends the system's scope in a way making its use possible even under high containment pressure. The modified lower access opening for its part increases the containment's resistance against pressure shocks that could occur in consequence of a reactor pressure vessel rupture. The relevant documents are under review by STUK.

Reliability of the neutron flux measuring system was improved

The reliability of the monitoring of the filtered neutron flux signal was assured at both Olkiluoto
plant units. This signal is formed by filtering quick, noise-type variations from the neutron flux signal given by measuring sensors. The monitoring of the filtered neutron flux signal actuates the trip function that protects the reactor even from a smaller variation than the monitoring of the unfiltered signal coming direct from the measuring sensors.

The reactor neutron flux measuring systems of both Olkiluoto plant units have been renewed in 1996–1998 using programmable technology. The trip signal formed by programmable technology direct from the neutron flux signal from measuring sensors had back up by parallel hardwired technology already in the original delivery. Now also the trip condition of the filtered signal was equipped with back up by hardwired technology to improve protection reliability against slow variations in the neutron flux.

STUK reviewed the system modifications pre-inspection documents and witnessed the associated inspections and tests. There have been restrictions on the operation of the system and the documents containing the qualification of the system's programmable part are under review by STUK.

Renewal of the electric drives of the main circulation pumps

In the 1999 annual maintenance outage, two main circulation pumps of the Olkiluoto plant units were equipped with new electric drives. Previously commissioned equipment were improved as well. All six main circulation pumps of both plant units have now been equipped with new electric drives. The first pump was modified in 1996 and, on the basis of the experience gained, modification work was continued on the other pumps.

The work was a necessary precaution due to the anticipated ageing of the pumps' original frequency converters. The procurement of spare parts was also getting harder. The electric drives have also been modified to extend the time the pumps' complete stopping takes after a power failure. Changes occurring in the flow of primary coolant caused by the stopping of the pumps are thus slowed down, obtaining a larger-than-before safety margin against fuel failures. Programmable technology has been employed in the control units of the system's frequency converters. Protection functions for controllably tripping the pumps have been implemented by parallel control units based on hardwired technology.

STUK reviewed and approved amendments to the pre-inspection documents of modifications due for implementation in the 1999 annual maintenance outages. In addition, STUK oversaw the implementation of modifications and pre-operational tests during the outages. STUK granted permission to operate the main circulation pumps until the annual maintenance of the year 2000. The permit was a temporary one because the final approval of the acceptability of the new electric drives is under way in STUK because of for example analyses relating to possible common cause failures in an electric drive's control system.

Replacement of the halon extinguishing system

At the Olkiluoto plant units measures were taken to remove the halon extinguishing system because the Council of State Decision (262/1998) stipulates abolition of the use of halons by the end of 1999. There are halon extinguishing systems in the cable cross-connection space, which is located below the control room main control board, where the cables of redundant subsystems important to safety are all in the same cross-connection cable room. The control room of the intermediate store for spent fuel had a halon extinguishing system as well.

The halon extinguishing system was removed from the cross-connection cable room in May 1999 and was replaced with a halotron extinguishing system that works in a way similar to the halon system. Halotron is a colourless, odourless and tasteless gas mixture that chemically suppresses fires. The planned concentration of 12 percentages by volume is not harmful to man. This was one reason for its choice as the new extinguishing substance since the quarters above the cross-connection space are continually manned. This modification has been considered not to affect plant unit safety.

The halon extinguishing system in the control room of the spent fuel store was removed from service in December 1999 and a replacement system has not been installed. The system's removal
has been compensated for, among other things, by increasing the number of sensitive fire detectors in the control room and in its instrumentation coupling cabinets. The fire brigade's prerequisites for extinguishing cabinet fires there have been improved as well. The cabinets' inspection gaps have been enlarged to make possible the spraying of extinguisher agent via them direct into the cabinet by hand-held carbon dioxide extinguishers. This modification has been considered not to affect the safety of the spent fuel intermediate store.

STUK reviewed and approved the plans for the replacement of the halon extinguishing system.

**Provision against the Y2k problem**

Olkiluoto nuclear power plant uses computer-based systems for administrative tasks, in expert systems and in modernised I&C systems. In connection with a modernisation project, systems used for the measuring of reactor power and the control of pressure had been replaced with programmable technology. These systems contribute also to the reactor protection functions. According to the analyses and tests conducted, the renewed systems were not prone to the problem associated with computers during the Millennium change. In addition, the safety functions of the renewed systems had been assured using hardwired technology as early as during the modification projects. The systems most important to plant safety employ hardwired technology, with no date processing problems.

Teollisuuden Voima Oy launched towards the end of 1997 measures to solve any Millennium-change related problems. The project plan was completed in the autumn of 1998. The licensee collected information about all computer-based systems and components of the plant units. If necessary, the components were repaired or replaced before the Millennium change. All computer-based systems and components important to safety were tested and repaired, if necessary.

In spite of the precautions that had been taken, the licensee also prepared for possible problems at the turn of the year. It made provision against the following offsite events: unstability in the main grid, the loss of telephone and data communication as well as possible weather-induced disturbances.

The licensee reported to STUK about the measures that had been taken owing to the Millennium change and their progress. STUK made onsite inspections to assess implementation. Reports submitted about the Year 2000 compatibility of components important to safety were also assessed. In addition STUK reviewed and approved the licensee's Millennium contingency plan. According to a STUK safety assessment, the plant units' basic automation, together with the measures taken by the licensee, ensured that the operation of the plant units does not pose a danger during the Millennium change.

The Millennium change did not bring about any disturbances in operation. All communications between STUK and Olkiluoto nuclear power plant functioned and the process computers of the reactor units of the plant transmitted data to STUK without any problems.

### 3.2.6 Probabilistic safety analyses

Probabilistic safety analyses indicate a significant reduction in fire risks. This is due to improved fire protection arrangements in rooms housing components from two different systems as well as to a more precise overall plant model employed in the analysis. No particularly significant fault combinations have been identified since the 50 most important fault combinations cover 48% of the risk. The most important risk factor is fires in cable and pump spaces.

The licensee has assessed that the fire risk during outages is ca. 5% of the total core melt risk caused by fires during power operation. None of the fault combinations alone is particularly significant. The most important risk is posed by fires in cable spaces (ca. 21%).

Fire risks have been analysed in detail. The layout and fire protection arrangements of the plant units are good. The cable routes, tunnels, etc, including electrical and I&C systems, have been modelled in detail in the analysis. The most essential risk factor both during power operation and maintenance outages is the system-to-system spreading of fires. The most essential factors
contributing to a successful analysis are an advanced fire model and the evaluation of the spreading of fires. On the basis of STUK’s sensitivity analyses and VTT’s newest fire studies, the assumptions presented in the most important fire scenarios can be considered realistic.

### 3.2.7 Radiation safety

The radiation doses of those working at Olkiluoto nuclear power plant in 1999 were below the annual limit of 50 mSv. The highest individual dose was 15.4 mSv. The distribution of individual doses in 1999 is given in the report STUK-B-YTO 199 (in Finnish). Radiation dose may not exceed a dose limit of 100 mSv in any period of five years. The highest individual dose to a Finnish nuclear power plant worker in the 5-year period 1995–1999 is 83.6 mSv.

The collective occupational dose for both Olkiluoto units in 1999 was 0.94 mSv. Collective occupational doses over the past years are given in Fig. 15. According to a guide issued by STUK, Guide YVL 7.9, the threshold guideline for the collective dose for one plant unit is 2.5 mSv per 1 GW of net electrical power averaged over two successive years. The combined collective dose threshold value for the Olkiluoto plant units is 4.20 mSv.

Radioactive releases into the environment from Olkiluoto nuclear power plant in 1999 were well below authorised limits. The releases of gaseous radioactive effluents were 0.0003% and iodine releases 0.01% of authorised limits. The total activity of liquid effluents was 1.1 GBq, i.e. ca. 6% of the release limit. The total activity of other liquid effluents was 1.8 GBq, which is ca. 0.6% of the plant-specific release limit. Detailed information about the releases and set limits has been given in the report STUK-B-YTO 199 (in Finnish).

The radiation exposure of the most exposed individual in the environment of the nuclear power plants, calculated on the basis of releases, was ca. 0.1% of the limit (100 µSv) stipulated by the Council of State. Calculated annual radiation doses are given Fig. 16.

The total number of samples collected in 1999 in accordance with the environmental monitoring programme of Olkiluoto nuclear power plant was 309. In addition, external radiation measurements were conducted. Radioactive substances originating from Olkiluoto nuclear power plant were measurable in the samples in such quantities only as have no bearing on the population radiation exposure. The observations are explained in more detail in the reports STUK-B-YTO 194, 196, 197 and 199 (the last two in Finnish).

### 3.3 Other nuclear facilities

In addition to the nuclear power plants, STUK regulates 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 the following activities: fabrication of radioactive tracers, activation analysis, training of students and the treatment of brain tumours by neutron irradiation (BNCT, Boron Neutron Capture Therapy).

STUK’s regulatory work is focused on the following matters, among others: the reactor’s QA, operation, radiation protection, radioactive releases, fire protection, emergency preparedness, physical protection and safeguards. No significant problems were observed in 1999. Occupational radiation doses and radioactive releases into the environment in 1999 were clearly below the set limits.

The previous operating licence that was granted to FiR 1 in 1989 expired at the end of 1999. In 1998 VTT had filed an application with the Ministry of Trade and Industry for a new operating licence until 2011. STUK gave the Ministry a statement on the application. In connection with the statement, a safety assessment was made for the purpose of which inspections were conducted, meetings between STUK and the licensee were arranged and the documents referred to in the Nuclear Energy Decree were reviewed. In addition, the use of the reactor for the treatment of brain tumours by irradiation was considered (a separate safety licence in accordance with the Radiation Act is required). STUK’s statement was in favour of granting the operating licence. The licence issued by the Council of State expires at the end of 2011.

The control of nuclear waste facilities is dealt with in Chapter 4.
4 NUCLEAR WASTE REGULATION

In nuclear waste management, STUK's regulation was focused on the storage of and final disposal plans for spent fuel as well as on the treatment, storage and final disposal of reactor waste.

4.1 Spent nuclear fuel

STUK monitored the storage of spent nuclear fuel by regular inspections and by reviewing plans and surveying work relating to storage equipment. No events occurred in spent fuel storage that would have endangered safety. The volumes of spent fuel annually stored onsite are given in Figure 17.

Work on an extension to a pool storage for spent nuclear fuel was continued at Loviisa nuclear power plant. Finishing work on the building and pre-operational tests were carried out in 1999. STUK reviewed among other things the piping, ventilation and electrical plans as well plans for and reports on pre-operational testing. The new storage extension is due for completion in 2000.

Posiva Oy, a company owned by Fortum Power and Heat Oy and Teollisuuden Voima Oy, carries out R&D and planning into spent fuel disposal and prepares for implementation at a later date. The company targets are to choose a disposal site by the end of the year 2000 and to begin the operation of a disposal facility in 2020.

In May 1999 Posiva Oy completed an environmental impact assessment report pertaining to the final disposal project and submitted an application to the Council of State for a decision in principle about the facility, proposing Olkiluoto as the site of the repository. These documents are supported by about 20 years of extensive R&D and

![Fig 17. The amount of spent nuclear fuel onsite at the end of the year.](image)
planning. STUK issued a statement on the environmental impact assessment report to the Ministry of Trade and Industry and drew up a preliminary safety appraisal on the application for a decision in principle in accordance with section 12 of the Nuclear Energy Act. The submission of the safety appraisal to the Ministry was postponed until early 2000 due to its review by the Advisory Committee on Nuclear Safety.

The most important issue in the environmental impact assessment was whether the proposed repository concept was the most appropriate method of nuclear fuel management, various viewpoints considered. According to STUK’s statement, when environmental impact issues relating to nuclear and radiation safety are considered, the method to be recommended is final disposal in bedrock.

The basis for STUK’s preliminary safety appraisal concerning the application for a decision in principle on a disposal facility for nuclear fuel was to apply the safety requirements contained in a decision made by the Council of State in 1999. STUK obtained numerous external expert assessments in support of its own assessment. These included detailed assessments from ten high quality experts from outside Finland and statements and assessments on special issues from four domestic research institutes. This preliminary safety appraisal, which was submitted to the Ministry of Trade and Industry in early 2000, included, among others, the below conclusions:

- Prerequisites stipulated in the Nuclear Energy Act as regards the making of a decision in principle have been fulfilled in STUK’s sphere of authority.
- Based on the research conducted so far, Olkiluoto is suited for a disposal site.
- There are no significant safety risks related to the operation of the disposal facility.
- The research work carried out so far suggests that requirements concerning long-term safety can be fulfilled; confirmation of this requires further R&D in the long term, however.
- The manner of implementation and timing of the final disposal includes a wealth of flexibility and, therefore, the modification of the disposal concept, the recovery of waste from it and even the employment of a completely different strategy is possible in case technical advances support them.

4.2 Reactor waste

The construction of the first compartment of the repository for reactor waste arisings from Loviisa nuclear power plant was completed in 1998 and a tunnel was commissioned for the storage of waste by virtue of an operating permit issued by STUK. By the end of the year, 660 m³ of low level radioactive maintenance waste had been moved to the tunnel end in question. In May 1999 STUK conducted a commissioning inspection in accordance with section 20 of the Nuclear Energy Act on the basis of which the facility's completed compartments were approved for final disposal. The extension, construction and commissioning of a cavern for solidified waste require separate approvals by STUK in accordance with the facility’s operating licence and section 112 of the Nuclear Energy Decree.

A corresponding repository has been in operation in Olkiluoto for about eight years now. By the end of 1998, it contained ca. 3300 m³ of medium and low level waste, with a total activity of 44 TBq. STUK reviewed the repository’s updated bedrock research and follow-up programme.

Fortum Power and Heat Oy intends to build a solidification facility for medium level waste on the site of Loviisa nuclear power plant because the plant’s onsite storage for liquid waste will fill up in the next few years. A Preliminary Safety Analysis Report for the facility was submitted to STUK for review.

By STUK’s permission, scrap metal, maintenance waste, waste oil and concrete blocks from nuclear power plants were cleared from regulatory control. Originally classified as nuclear waste, these were later deemed practically free from radioactive substances. The licences issued by STUK are listed in Appendix 3.

No safety-related problems occurred in the handling, storage and final disposal of reactor waste. The annual waste volumes are given in Figure 18.
4.3 Decommissioning

By virtue of a decision made by the Ministry of Trade and Industry in 1991, decommissioning plans for domestic nuclear power plants are to be maintained and the updated plans are to be reported every five years. Such plans were last reported in late 1998 and STUK gave a statement about them to the Ministry in 1999.

According to the updates, the utilities have been working on their decommissioning plans, owing to which the estimated occupational doses are significantly lower than in the earlier plans. The decommissioning plans of both utilities include a strategy in which the reactor pressure vessels are removed and disposed of in a final repository as such, without being cut into pieces. STUK’s statement finds this an appropriate solution and recommends that the method be further developed.

The decommissioning plan for Olkiluoto nuclear power plant is based on the facility's decommissioning after 30 years of monitored storage. In its statement STUK proposes that at least the facility's partial decommissioning should be considered quite soon after its service life has ended.

4.4 Other control 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 utilities’ nuclear waste management measures and plans as well as a statement, as referred to in section 90 of the Nuclear Energy Decree, about making financial provision for the costs of nuclear waste management. These regular statements assess if, in preparing for nuclear waste management, the utilities have proceeded according to the goals set out by the government and if the future costs of nuclear waste management have been appropriately provided for.

![Graph](image-url)

The volumes of reactor waste include unsolified wet waste, solified waste and packed dry waste, excluding metal scrap, unpacked scrap and ventilation filters.

Fig 18. The volume of reactor waste at the end of the year.
5 NUCLEAR MATERIAL SAFEGUARDS

Nuclear material safeguards assure the safety of operations and that nuclear materials are not diverted from licensed, peaceful uses and also that operations comply with current rules and regulations, and international agreements signed by Finland.

5.1 Safeguards control at the Finnish nuclear facilities

As regards nuclear power plants, the safeguards control exercised by STUK focused on the import, storage, transfer in Finland and reloading of fuel. The utilities submit to STUK the necessary annual plans, advance notices and reports in compliance with safeguards requirements.

The number of safeguards inspections at Loviisa nuclear power plant in 1999 was nine and at Olkiluoto nuclear power plant it was 21. Euratom participated in 27 of them, using 37 man-days. The IAEA took part in 22 inspections, using 26 man-days. Both reactor units of Loviisa nuclear power plant, the fresh fuel storage and the two spent fuel storages comprise one unit in nuclear material accounting, i.e. a material balance area. Olkiluoto nuclear power plant has three material balance areas: Olkiluoto 1, Olkiluoto 2 and the spent fuel storage.

In addition to the nuclear power plants, minor amounts of nuclear material can be found at other facilities. The most significant of these is F"or 1, the research reactor operated by the Technical Research Centre of Finland. Also the following are in possession of small amounts of nuclear materials: the Laboratory of Radiochemistry at the Department of Chemistry of the University of Helsinki, VTT Manufacturing Technology, the Laboratory of Isotope Geology of the Geological Survey of Finland and STUK. In 1999 one inspection was conducted on F"or 1.

Various methods of verification are used in safeguards control to ascertain that the data on nuclear materials given by the users, such as burn-out and cooling time, are correct and complete. Even other matters relating to nuclear safety, ranging from operational safety to final disposal, can be verified by measurements. In 1999 STUK verified by NDT measurements some leaking fuel rods to be placed into hermetic shroud tubes and 64 spent fuel assemblies at Olkiluoto nuclear power plant. At Loviisa nuclear power plant, 180 spent fuel assemblies were verified.

International safeguards control is implemented by the International Atomic Energy Agency (IAEA) and the Euratom Safeguards Directorate (Euratom). IAEA safeguards are based on the Non-Proliferation Treaty and the Safeguards Agreement signed by non-nuclear member states, Euratom and the IAEA (INFCIRC/193). Euratom safeguards are based on the Euratom Treaty and Commission Regulation 3227/76 given by virtue of the Treaty. STUK always takes part in inspections carried out by international organisations.

Euratom and the IAEA have agreed on cooperation in the field of inspections (New Partnership Approach, NPA). At practical level, Euratom and the IAEA conduct inspections in co-operation in all material balance areas. Euratom carries out routine inspections at Olkiluoto 1 and 2 but the inspections of the KPA storage, which are made in the same connection, have participants from both Euratom and the IAEA.

Operation in all material balance areas was in accordance with manuals approved by STUK, facilitating the implementation by STUK of the obligations of international agreements in the nuclear field signed by Finland. Euratom and the IAEA delivered 28 Euratom inspection reports and IAEA reports to STUK in 1999. According to the reports national obligations had been fulfilled in compliance with INFCIRC/193.

A detailed description of nuclear material safeguards is in the report STUK-B-YTO 187 (in Finnish).
5.2 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 transport of nuclear materials requires a licence granted by STUK. A prerequisite for the licence is, among other things, that nuclear liability insurance and sufficient physical protection are in place. STUK granted two nuclear transport licences in 1999 (Appendix 3). The most important forms of nuclear material transport in 1999 were the imports of fresh nuclear fuel, a total of 460 fuel assemblies, from Germany, Spain and Russia for use at the Finnish nuclear power plants.

The importation of radioactive and nuclear materials is subject to licence as well. No attempts at nuclear smuggling were observed at the Finnish borders in 1999 but a few cases surfaced that were obviously inadvertent.

In 1999 seven shipments containing radioactive material were turned back at the border. Four of them were scrap metal for industrial use and three were lumber carriages that had a contaminated metal structure. In addition, minor radioactivity due to natural radiation was detected in three consignments of scrap metal after they had been passed by the customs. According to current usage, consignments that have entered Finland cannot be turned back. The border control also observed, among other things, a group of children coming by bus from the area of Chernobyl to a summer camp in Finland. Their thyroids had been treated with radioactive iodine.

In 1998 nine shipments containing radioactive material were turned back at the border. Figure 19 gives the number of consignments annually turned back at the border. The number has partly been reduced by the fact that both consignors and consignees have, through training and experience, learned to understand that consignments of scrap metal might contain radioactivity. The control at borders has been enhanced as well.

Fig 19. The number of consignments containing radioactive materials turned back at the border.
6 OTHER MAIN FUNCTIONS

On request STUK gave statements on matters dealing with its sphere of authority. Accident preparedness was maintained among other things by participating in various emergency exercises. Public information was provided about important issues in nuclear safety regulation.

6.1 Significant statements

STUK issued to the Ministry of Trade and Industry statements on the environmental impact assessment reports (EIA reports) of the Loviisa 3 nuclear power plant project and the Olkiluoto nuclear power plant extension project. STUK assessed the reports from the radiation and nuclear safety point of view. The following issues, among others, were assessed: how the applicants fulfil current safety requirements, radioactive releases and their spreading during normal operation and during severe accidents as well as how cooling water discharges affect the condition of sea water in the vicinity of the plant sites. STUK also assessed the environmental impacts of fuel procurement as well as of nuclear and low and medium level waste management.

In the assessments relating to the statements, no factors emerged concerning environmental radiation safety that would prevent the construction of a new reactor facility in the Hästholmen site, Loviisa, or the Olkiluoto site, Eurajoki. The most significant environmental impacts of a new nuclear power plant would arise from the cooling water discharged from the facility, which would increase the temperature of sea water in its vicinity.

STUK will make a safety analysis report only in case a decision in principle of the Council of State, required in the Nuclear Energy Act, is applied for the new nuclear power plant.

STUK also gave statements to the Ministry of Trade and Industry on Posiva Oy’s application for the environmental impact assessment of a nuclear waste repository (subsection 4.1) and on the application from the Technical Research Centre of Finland for an operating licence for the FiR 1 research reactor operated by it (subsection 3.3). Other statements given in 1999 are listed in Appendix 4.

6.2 Emergency response

In addition to the regulatory control of the operation of nuclear power plants, STUK inspects the preparedness of the operating organisations of the nuclear power plants for unusual situations and maintains its own emergency preparedness. No situations requiring real response occurred in 1999.

Emergency response procedures at the nuclear power plants have been continuously developed along with the operation of the plants; they have been regularly tested in emergency exercises that are part of the plants’ emergency preparedness training. STUK has approved the emergency plans of Loviisa and Olkiluoto nuclear power plants and reviews every year the implementation of the emergency preparedness regime, including training and emergency exercises. In 1999, the most important items in emergency response were commissioning of the computer-based alarm systems of the preparedness organisations of the utilities and the development of emergency response on the basis of self-assessment and experiences gained during emergency exercises. In addition, STUK arranged emergency training for experts from foreign authorities.

STUK arranged several training events and exercises to test and develop its emergency response capability. STUK participated in the annual emergency exercise of Loviisa nuclear power plant on 26 November 1999 and in fire drills at both plant units. In addition to domestic emergency exercises, STUK participated in two emergency exercises organised at two facilities abroad. An international emergency exercise was arranged in Canada on 28–29 April 1999, which was the last in a series of four international exercises of the same type co-ordinated by the OECD/NEA. STUK also
participated in the emergency exercise at Barsebäck nuclear power plant, Sweden, on 25 November 1999.

### 6.3 Communication

STUK took the initiative in communicating to the general public matters relating to the safety, nuclear waste management and safeguards of nuclear power plants and also responded to questions from the media. STUK issued bulletins on over 30 different topics.

STUK gave information on issues of nuclear safety regulation, among other things on events at Loviisa and Olkiluoto nuclear power plants. Information was given about the following events at Olkiluoto 1: an access opening was inadvertently open during an annual maintenance outage and the settings of the actuator of a containment isolation valve were incorrect. Of the Olkiluoto 2 events, the incorrect position of a valve in the containment gas treatment system after annual maintenance was communicated to the public. These events were INES Level 1.

Of all the events that occurred at the nuclear power plants, a hydrogen leak outside of the turbine hall of Loviisa 2 in October, which was INES Level 0, attracted the most media attention. STUK extensively provided information about the event, both in Finland and abroad, since incorrect information had appeared about its severity and safety significance. Owing to the event STUK was presented with a written question signed by four members of parliament about the provision of information on nuclear power plant accidents to neighbouring countries. In its response STUK pointed out that information had been comprehensively provided in accordance with agreements.

In addition to these events, public information was provided about the annual maintenances of the plant units and about the stopping of Loviisa 2 to repair a minor primary circuit leak. The media were also given quarterly reports describing the operation of the Finnish nuclear power plants.

STUK disseminated information about statements it gave to the Ministry of Trade and Industry. The statements in question were the ones given on reports concerning an environmental impact assessment for the Olkiluoto and Loviisa nuclear power plant projects and a disposal facility for reactor waste as well as the one on an application for an operating licence for a research reactor in Otaniemi, Espoo.

In early 1999 STUK published summary reports for 1998 on the regulatory control of the operation of nuclear power plants and nuclear waste management as well as on the control of radioactive substances at the eastern Finnish border.

In early December information was provided about the Y2k compliance of the Finnish nuclear power plants and the precautions that had been taken with a view to possible computer problems during the Millennium change. Prior to the change, STUK made public how it had prepared for the change, and immediately after it, reported how the nuclear power plants in Finland and those in other countries had managed it.

STUK provided public information on the preparations made for the final disposal of nuclear fuel, about which an application for a decision in principle had been submitted to the Council of State by Posiva Oy. In a press conference, background for the repository project and information about safety requirements were given. In addition, information was given about assessments made by international experts concerning the research into final disposal of spent fuel.

As regards the enhancement of nuclear safety in Eastern Europe, STUK communicated to the general public information about a removable container that is being developed for radioactive wastes generated at the Murmansk naval base as well as about the establishment of a direct alarm communications link from Lithuania's Ignalina nuclear power plant to STUK. As regards nuclear safety in Eastern Europe, STUK issued also a bulletin about a nuclear safety report drawn up by the safety authorities of the EU countries and about the activities of the safety authorities of the EU membership applicants operating nuclear power plants.

Of the events that occurred at nuclear facilities outside Finland, public information was provided particularly on the criticality accident that took place at the nuclear fuel fabrication plant in Tokaimura in late September.

Information was disseminated in the form of bulletins and Teletext pages of the Finnish Broadcasting Corporation and on STUK’s website.
7 SUPPORT FUNCTIONS

In support of its nuclear safety regulation effort, STUK purchased, among others, safety research and developed the methods used in regulatory activities.

7.1 Research

STUK continued its safety research activities by outsourcing research into the safety and nuclear waste management of nuclear power plants.

STUK’s research focus had been assessed during the planning of FINNUS, the national nuclear power plant safety research programme for 1999–2002. The focus of research was revised in 1999. The management of physics and of various phenomena was emphasised in the field of accident studies. A new object of risk management studies was research into the passive systems of new nuclear power plant concepts as well as the assessment of the probability of human error in connection with fires. The transfer of know-how and experience as well as an understanding of the design fundamentals of nuclear power plants have been considered important in all projects involving the training of young people.

Abreast with research that maintains and promotes expertise in 1999, also projects were implemented dealing with the development and assessment of the regulatory control effort.

The focus of research into nuclear waste management was similar to that of JYT 2001, a state-financed nuclear waste programme. Research focused on geosciences, engineered barriers, the migration of radioactive substances, safety analyses and engineered solutions. The JYT 2001 programme covers the period 1997–2001.

Appendix 5 presents, by research field, purchased research financed by STUK, which was completed in 1999 or was under way in 1999–2001. Part of this research is closely related to nuclear safety regulation and is kept apart from the FINNUS programme. STUK’s research programme includes also projects dealing with the development and assessment of regulatory control activities. The annual cost of nuclear safety research is given in Figure 20.

![Figure 20](image-url)

**Figure 20.** The costs of nuclear safety research.

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**Fig 20.** The costs of nuclear safety research.
7.2 Development projects

Assessment of operating licence renewal process

The re-licensing process assessment project launched in 1998 was completed. The process of preparing statements about the re-licensing of Loviisa and Olkiluoto nuclear power plants was assessed during it. The project examined how systematic STUK’s operations were, the support given by management, how successful work co-ordination has been and the quality of the outcome, i.e. statements issued on the re-licensing applications. Data was collected and stored for utilisation during corresponding extensive licensing procedures. At STUK the data was gathered by questionnaires and at the plants by interviews.

The information thus gathered and its final analysis gave source material for the updating of Guide YVL 1.1, the Finnish Centre for Radiation and Nuclear Safety as the regulatory authority for the use of nuclear energy, and in the drawing up of STUK's internal guidelines for the licensing procedure.

The safety indicator system

By means of the safety indicator system developed in STUK, the appropriateness of nuclear power plant safety and licensee operations can be followed. It also helps monitor how appropriate STUK’s own operations are. The data yielded by the safety indicator system has been utilised in the Figures of this report. A total of 42 indicators are currently being followed.

A database application for the indicator system and the method of collecting safety indicators were developed.

Quality management

A development project was started to clarify the working processes in safety regulation. Process-based consideration has already been applied to some STUK functions (rule-making, document processing, etc.). There are plans to extend process orientation to cover other functions essential for nuclear safety regulation. The aim is to focus the regulatory organisation's resources and functions more than at present on the maintenance and development of STUK’s main and support processes. One aim is to determine procedures for use in the assessment of identified processes. Some of the development work was outsourced.

Focusing of inspections using risk-based assessment

The risk-based procedure in question facilitates the onsite focusing of licensee inspections as well as inspections and tests ordered by STUK on items essential for risk management. The method also ensures sufficient preconditions for the safe operation of the nuclear power plants.

The focusing of piping inspections, which employ risk-based assessment, combines PSA-based and deterministic information and experience. Safety classification is irrelevant in these piping inspections. The 3-stage procedure is roughly as follows:

- Using the importance measures of a probabilistic safety analysis (PSA), systems that carry the most safety significance are chosen for further analysis.
- A risk matrix is drawn up for each system, presenting each piping segment’s failure category that represents how prone it is for rupturing on one hand, and its consequence category representing its conditional reactor core melt probability on the other hand.
- Based on the risk matrixes, the piping segments are divided into three inspection classes on the basis of the inspection need. The final objects of inspection will be decided upon on the basis of recommendations given by a panel of experts from various disciplines.

By way of an example, the aforementioned procedure has been applied to the decay heat removal system of the Olkiluoto plant units and to the high pressure emergency cooling system of the Loviisa plant units. Some piping segments were identified that require more inspections than are made at the present.
8 INTERNATIONAL CO-OPERATION

Within the framework of international co-operation, information was exchanged on experiences gained in the use of nuclear energy, on the results of safety research and the development of safety regulations. STUK contributed to the work of several international co-operation groups and, with external financing, to safety improvement projects in Central and Eastern Europe.

Co-operation with the IAEA

The IAEA continues to revise its nuclear safety regulations (NUSS Guides). The aim is that the revised regulations would be completed during the year 2000. STUK prepared for the IAEA several statements on draft guides that had been requested from Finland. STUK's experts also participated in the work of one group preparing a draft guide.

The IAEA arranged in Vienna the first joint meeting of contracting parties for the evaluation of national reports in accordance with the International Nuclear Safety Convention. The Convention came into effect in late 1996 and has been ratified by 50 states. At the Vienna meeting Finland belonged to a group of representatives of nuclear countries that included Russia, Sweden, Mexico and Slovenia as well as Austria and Poland who only have research reactors. Finland was the group chairman. The safety of the Finnish nuclear power plants and the work to ensure their safety was generally considered good. During the meeting, attention was paid, among other things, to the high degree of detail of the Finnish safety regulations and how this affects the development of safety. Based on what was discussed at the meeting, STUK has launched actions for systematically making expert assessments of the modification plans for the nuclear power plants.


The IAEA and the OECD/NEA maintain a nuclear power plant Incident Reporting System (IRS). IRS reports have also been stored in the AIRS database (Advanced Incident Reporting System), which contained about 2800 event reports at the end of 1999. By means of the system, nuclear power plant operational events and observations, which may give an impulse to safety improvements at other nuclear power plants, are communicated to the participating countries. STUK is Finland's co-ordinating organisation. The system yielded 124 reports on nuclear power plant events in various countries in 1999. The reports were assessed by STUK and the utilities. The reports analysed did not give any reason to make significant changes to the operational practices in use at the Finnish nuclear power plants. In 1999, the following incidents at the Finnish nuclear power plants were reported to the IRS System:

- Enhanced localised cladding corrosion at Olkiluoto 2 in 1997 and 1998
- Dilution of primary circuit coolant boric acid concentration at Loviisa 1 during start-up after the refuelling outage in 1998
- Ageing of cables in the steam generator space of the Loviisa reactors.

STUK acts as a contact organisation in an information exchange system maintained by the IAEA for the classification of nuclear power plant events on the INES. The system has been developed to facilitate the dissemination of public information. Reports are submitted to the IAEA on events classified Level 2 and higher on the INES scale, or which arouse, or are deemed to arouse, international interest. The IAEA provides event information to the countries in the system, which, at the end of 1999, numbered 60 in all. In 1999 the IAEA communicated information about 26 events, half of which had occurred at nuclear power plants and half at other nuclear facilities or during the handling of radioactive materials. The highest level assigned to the events occurred at nuclear power plants was Level 2. Of events at other nuclear
facilities, the criticality accident at Japan’s Tokaimura fuel fabrication plant has been classified Level 4. Other events that occurred during the handling of radioactive materials were Level 3 at their highest. Finland did not send any reports to the INES system in 1999.

Under IAEA funding, the vice-chairman of the Bulgarian nuclear safety authority visited STUK for a week to familiarise himself with the process of nuclear power plant regulation in Finland.

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 between authorities about the need to develop nuclear safety regulations and the contents of individual regulations. STUK was represented in all of the organisation’s main committees:

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

A representative from STUK acted as the chairman of the first-mentioned main committee. In addition, STUK took part in the work of permanent working groups set up by the committees.

The 7-day OECD/NEA seminar “International Workshop on Fire Risk Assessment” was arranged in STUK’s premises. About 90 fire experts from various countries attended. Fire risk assessment procedures were compared and an attempt was made to harmonise current usage to increase the reliability of the assessments.

Co-operation with the EU

STUK participated in the work of the Nuclear Regulators Working Group (NRWG), the Reactor Safety Working Group (RSWG) and the Working Group on Codes and Standards (WGCS). At these meetings, the members of the working groups inform one another of domestic developments and their background. The NRWG consists of nuclear safety authorities only. The RSWG and WGCS also include experts from utilities and manufacturers of nuclear power plant components. STUK contributed to the work of three topic-specific subgroups set up by the NRWG, namely “Task Force on Risk Based In-service Inspection and Testing”, “Task Force on Non-Destructive Testing Qualification Programmes” and “Task Force on Safety Critical Software—Licensing Issues”.

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 the exchange of information and ideas to authorities, researchers and nuclear power plant operators. In 1999 STUK was chairman of ESARDA and its steering committee, with duties including the arrangement of ESARDA’s 30th anniversary expert meeting, among others.

STUK’s participated in the work of the Commission’s expert group that handles documents submitted by the member states to fulfil their obligations under article 37 of the Euratom Treaty. The article obliges all member states to send to the Commission general information on their radioactive waste disposal plans. This enables the group to assess whether the implementation of the plans could lead to the contamination of water, soil or air within the territory of another member state.

Funded by the European Union, STUK continued to assist radiation and nuclear safety authorities in Central and Eastern Europe. In early 1999 the European Union’s assistance programmes in Lithuania, Slovakia, the Czech Republic, Ukraine, Hungary and Russia, that had been started a few years ago, were completed. STUK implemented these projects together with other authorities from several EU countries. STUK participated also in the preparation of new projects aimed at the above countries as well as to Estonia and Lithuania. The projects will be started when approved by the Commission of the European Communities after its reorganisation.
NKS co-operation

The ongoing Nordic nuclear safety research programme (NKS), covers the years 1998–2001. The main research areas are SOS (nuclear safety and radiation protection), BOK (emergency response and environmental impacts) and SBA (projects dealing with nuclear threats and dissemination of information), which further divide into seven projects.

The most important tasks of the SOS programme at the present are the assessment of risks and safety culture in the operation of nuclear power plants as well as severe accident management. The BOK programme for some parts and the SBA projects were not yet started quite fully in 1999. STUK participated in the work of the various parts of the NKS programme.

Bilateral co-operation

A representative from STUK was an invited member of the Reactor Safety Committee assisting SKI. A representative of SKI was a permanent expert in the Advisory Committee on Nuclear Safety that functions in conjunction with STUK. Co-operation with SKI was continued by meetings during which current questions relating to the safety regulation of nuclear power plants were discussed. With the Swedish radiation safety authority SSI, information exchange was continued about doses to those Finns who had worked at nuclear power plants in Sweden and to Swedes who had worked at the Finnish plants. In addition to this, a STUK representative worked at SSI for a period of four months.

Within the framework of an agreement of co-operation with the US NRC, and as in previous years, a wealth of reports in written form were exchanged. In addition, a visit was paid on the NRC’s invitation during which a 1-day bilateral seminar on the enhancement of safety regulation was held and a panel discussion was attended at an NRC-arranged international annual safety research meeting.

The most important form of co-operation with the Belgian nuclear safety authority AIB Vincolette Nuclear (AVN) was taking part in the work of an international nuclear safety committee that provides support to AVN.

STUK’s representative provided consultation to the Swiss nuclear safety authority (HSK) during a working visit of about one year. This was related to the PSA analyses of Swiss nuclear power plants. Living PSA software developed by STUK for the calculation of large PSA models was completed on the basis of the HSK’s order.

Co-operation meetings on PSA and fire studies were arranged with the French nuclear safety authority (DSIN).

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

STUK consulted the nuclear safety authority of Hungary about the approval of BNFL-manufactured fuel for use at Paks nuclear power plant.

Safeguards co-operation with the Australian authority (ASO) was continued. In accordance with an established practice, STUK provided ASO with information about nuclear materials of Australian origin imported to and kept in Finland.

A permanent representative from STUK was nominated to the Advisory Committee on Nuclear Safety providing support to the Lithuanian nuclear safety authority (VATESI).

Co-operation in the neighbouring areas

STUK administered Finnish-Russian co-operation in the field of radiation and nuclear safety, funded from the Finnish government’s budget for co-operation in the neighbouring areas. Kola and Lenin-grad nuclear power plants are the main objects of co-operation. STUK plans the projects together with the recipients, invites offers and participates in the control of the projects. In addition to consultants, also STUK’s experts have actively participated in the making of safety improvements at the plants in question. The projects are continuation to a long-term programme having an emphasis on the quality of plant operations, fire safety and the integrity of safety-relevant piping. Further information on the projects can be found in the report “Finnish Support Programme for Nuclear Safety, Annual Summary 1999 (STUK 2000)”.

With funding for co-operation with the neighbouring areas from the Ministry for Foreign Affairs, bilateral co-operation programmes were
maintained with the nuclear safety authorities of Russia, Estonia, Latvia, Lithuania and Ukraine. A significant project was an independent assessment, together with the Russian authority, of a probabilistic safety assessment made for Leningrad nuclear power plant. Close contacts were maintained with the resident inspectors of Leningrad and Kola nuclear power plants. They regularly drew up quarterly reports on plant events and reported to STUK about the situation at the plants in question during their visits to Finland.

With funding for co-operation with the neighbouring areas, a seminar was arranged related to computer problems during the Millennium change. The measures taken by the authorities and the Y2k compliance assessment methods used in Finland were looked into. The seminar was attended by representatives from Kola, Leningrad and Ignalina nuclear power plants as well as the Russian and Lithuanian authorities.

STUK's representatives worked in expert groups of the EU and the European Bank for Reconstruction and Development (EBRD), which assessed the appropriateness of some nuclear safety improvement projects for which financing has been sought.

STUK was active in a team of experts (Contact Experts Group, CEG) set up to co-ordinate international projects for the improvement of nuclear waste management in Russia; it participated in the meetings and working groups of CEG as well as in its assessment and consultation work. In direct bilateral co-operation with GAN and the Radon combine, STUK continued the implementation of programmes for the exchange of information and experience relating to nuclear waste management.

Finland participated in an international project aiming at the development of a mobile storage cask for naval radioactive waste on the Kola Peninsula. The cask will be a prototype that meets modern safety requirements.

STUK participated in the work of the PIERG (Paldiski International Expert Reference Group) group of experts supervising decontamination and radioactive waste handling at the nuclear submarine training centre in Paldisk, Estonia. Finland assisted the Estonian radiation safety authority, the Kiirgus Centre, by way of bilateral co-operation.

Radiation monitoring in the vicinity of Leningrad nuclear power plant was enhanced with the installation of additional automatic monitoring devices. The network now comprises over 20 measurement stations, making possible an almost real-time monitoring of data by STUK. A corresponding system is being developed for Kola nuclear power plant as well.

Funded by the Ministry for Foreign Affairs, STUK assisted Ukraine, Russia and the Baltic Countries in the field of nuclear material safeguards. The programmes assist recipient countries in establishing a functional national nuclear material control system on both regulatory and on facility level, so that they would be able to fulfil the requirements of international agreements. In addition, training is given and component deliveries are made to prevent smuggling of nuclear substances and radioactive materials at the borders.

The Comprehensive Nuclear Test Ban Treat (CTBT)

Finland ratified the Comprehensive Nuclear Test Ban Treaty on 15 January 1999. In the Treaty STUK was given the duties of a National Data Centre, i.e. a responsibility for the obligations of the treaty binding the Ministry for Foreign Affairs and for those binding the international authority, i.e. the Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO). The National Data Centre officially opened on 4 October 1999. Finland's was the first National Data Centre to officially accept CTBT monitoring responsibility. The Centre also prepared to give training to personnel from other data centres and radiation monitoring stations. Further details can be found in the report STUK-B-YTO 187 (in Finnish).

Other forms of co-operation

The nuclear safety authorities of Western Europe have set up a body of mutual co-operation, the Western European Nuclear Regulators' Association (WENRA). In 1999 WENRA published a report on the state of safety in the EU membership applicant countries and launched co-operation for the establishment of a common European safety approach in the field of both reactor safety and
nuclear waste management. STUK was active in the work of WENRA. On assignment by WENRA, STUK’s representative lead the team of experts conducting an inspection at Bohunice, Slovakia and Kozloduy, Bulgaria to assess the safety of their oldest plant units.

Safety authorities in countries with a small-scale nuclear programme have set up a body of co-operation called NERS (Network of Regulators of Countries with Small Nuclear Programmes). Authorities in Argentina, Belgium, the Czech Republic, Finland, Hungary, the Netherlands, Slovakia, Slovenia, South Africa and Switzerland contributed to its work. The intention is to exchange experiences and ideas on how authorities with a small organisation could handle their duties appropriately and efficiently. Also possible mutual assistance in regulatory control issues is discussed. NERS met once in 1999, and also STUK attended.

STUK has contributed to the VVER Forum, a form of co-operation among countries operating VVER-type nuclear facilities. The other participants were Armenia, Bulgaria, the Czech Republic, Hungary, Russia, Slovakia and Ukraine. Operating experiences and safety improvements of VVER-type facilities are discussed and experience exchanged. In 1999 the VVER Forum held one meeting, which STUK was unable to attend.

The utilities operating the Finnish nuclear power plants have participated in the co-operation carried out by power utilities from EU countries to establish common requirements for new nuclear power plants, called “European Utility Requirements for LWR Nuclear Power Plants (EUR)”. In order for the plant concepts fulfilling the EUR requirements to be acceptable in different countries, a consensus is aimed at with the safety requirements common to the EU countries. STUK has previously assessed the EUR requirements and a working group consisting of authorities from several countries has discussed them. In 1999 the first meeting of the working group of authorities and the EUR organisation was held. STUK participated in it.
9 THE COSTS AND INCOME OF NUCLEAR SAFETY REGULATION

According to the 1999 budget, the costs of nuclear regulatory control subject to a fee are to be charged from the users of nuclear energy.

In 1999, the costs of nuclear regulatory control subject to a charge were FIM 30.1 million. The total costs of nuclear regulatory control were FIM 36.4 million. Thus the share of activities subject to a charge was 83%.

The 1999 income from nuclear regulatory control was FIM 30.2 million. Of this, FIM 11.8 million and FIM 12.7 million came from the regulatory control of Loviisa and Olkiluoto nuclear power plants, respectively. The regulatory control of Posiva Oy's operations accounted for FIM 5.5 million. The income from other objects of regulation was FIM 0.1 million. The income from operations not subject to a charge was FIM 0.1 million. The annual income and costs of nuclear regulatory control over the past years are given in Figure 21.
10 THE ADVISORY COMMITTEE ON NUCLEAR SAFETY

The Committee gave STUK statements about the matters of the re-licensing of the research reactor and the final disposal of nuclear fuel. In addition, the Committee acquainted itself with the EIA reports on new plant projects (OL 3, LO 3 and Posiva’s KPA repository) as well as with the nuclear liability system and with its international development prospects in particular. At STUK’s request the Committee gave a statement on five YVL guides and began the assessment of three draft guides. The Committee regularly followed and assessed the operation of the Finnish and Swedish nuclear power plants. It assembled ten times in 1999.

On 9 November 1999 the Committee arranged in co-operation with the Advisory Committee on Nuclear Energy a nuclear energy seminar, which has become a tradition. The seminar focused on safety culture in offshore operations, the results of the first review meeting of the International Nuclear Safety Convention, the treatment of brain tumours by neutron irradiation (BNCT, Boron Neutron Capture Therapy) using the FiR 1 reactor and regulatory control employing risk-based assessment.

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, which functions in conjunction with STUK. Its term of office is three years. The current Committee’s term of office began on 1 May 1997 and ends on 30 April 2000. Its Chairman is Research Professor Lassie Mattila (Technical Research Centre of Finland). Regular members are Professor Pentti Lautala (Tampere University of Technology), Legislative Counsellor Tarja Oksanen (Ministry of the Interior), Head of Research Rauno Rintamaa (Technical Research Centre of Finland), Professor Jaakko Siivola (University of Helsinki), Industrial Counsellor Sirkka Vilkamo (Ministry of Trade and Industry) and Secretary General Matti Vuorio (Ministry of Defence); Director General of STUK, Professor Jukka Laaksonen is a permanent expert to the Committee. Invited experts are Doctor of Technology Antti Vuorinen, and Director Christer Viktorsson of the Swedish Nuclear Power Inspectorate.

The Committee was assisted by a Reactor Safety Division, a Nuclear Waste Division and a Emergency Preparedness and Nuclear Material Division, which were set up on 15 October 1997. The Divisions met 11 times in 1999. Their main task is to prepare statements requested from the Committee. The divisions heard the opinions of several STUK experts when reviewing documents submitted to the Committee.
A. Safety management
• Definition, maintenance and development of safety culture
• Quality management
• Verification of fulfilment of safety regulations
• Co-operation with authorities

B. Main functions
• Methods employed in working processes and their functionality
• Interfaces between the various stages of working processes
• Feedback contained in the functions and their utilisation
• Support functions, such as training, quality assurance and document administration, relating to the main function under inspection

B.1. Safety assessment and improvement
• Responding to changing safety requirements
• Utilisation of safety research
• Utilisation of operating experience feedback in safety assessment and development
• Modification process and its functionality

B.2. Operations
• Operation
• Supervision of operations
• Management of operational disturbances
• Periodic tests

B.3. Plant maintenance
• Maintenance
• Life time management
• Annual maintenance management
• Procurement
• Administrative work control

C. Inspections by functional unit and field of know-how
C.1. Plant safety functions
C.2. Electrical and I & C systems
C.3. Mechanical engineering
C.4. Construction engineering and structural engineering
C.5. PSA and utilisation of fault statistics
C.6. Information management
C.7. Water chemistry
C.8. Nuclear waste
C.9. Radiation protection
C.10. Fire protection
C.11. Emergency preparedness
C.12. Physical protection
• Updates of safety documents
• Competence of personnel
• Abnormal events
• Outage planning and execution
• Reactor reloads
• Conduct and results of in-service inspections
• Inservice examinations of pressure equipment

• Modifications, repairs and preventive maintenance
• Post-outage plant start-up
• Nuclear fuel procurement
• Nuclear material safeguards
• Nuclear waste cleared from regulatory control
APPENDIX 3

Licences and approvals in accordance with the Nuclear Energy Act granted by STUK in 1999

- A214/28,29, 15 April 1999
Fortum Power and Heat Oy

- A214/28,29, 15 April 1999
Fortum Power and Heat Oy
Transport within the Finnish territory relating to the imports and exports of fresh nuclear fuel and fission chambers. Max. 250 tonnes of fresh nuclear fuel and max. 50 fission chambers. Valid until 31 December 2007.

- C214/211, 22 December 1999
Teollisuuden Voima Oy
Importation from and, if necessary, exportation to the Federal Republic of Germany of fresh nuclear fuel. Max. 15 600 kg of uranium provided with the Euratom control stamp “P”, and part of which is of Russian origin. Valid until 31 December 2000.

- C214/214, 22 December 1999
Teollisuuden Voima Oy
Importation from and, if necessary, exportation to Spain of fresh nuclear fuel. Max. 13 000 kg of uranium provided with the Euratom control stamp “N” of Chinese origin. Valid until 31 December 2000.

- Y214/37, 30 April 1999
RSB Logistic GmbH, Germany
Through transport of uranium hexafluoride via Hamina harbour. Max. transport number is 15, each consignment containing max. 61 600 kg of uranium. Valid until 31 December 1999.

- C214/211, 22 December 1999
Teollisuuden Voima Oy
Importation from and, if necessary, exportation to Sweden of fresh nuclear fuel. Max. 6 100 kg provided with the Euratom control stamp “P”. Valid until 31 December 2000.

- C821/52, 15 March 1999
Teollisuuden Voima Oy
The handing over to Ekokem Oy of a 9.5 m³ batch of waste oil to be cleared from regulatory control. The oil is from Olkiluoto nuclear power plant and will be used for saw chain oil. Valid until 31 December 1999.

- C214/215, 22 December 1999
Teollisuuden Voima Oy
Importation from and, if necessary, exportation to Spain of fresh nuclear fuel. Max. 9 600 kg of uranium provided with the Euratom control stamp “P” of Russian origin. Valid until 31 December 2000.

- C821/58, 10 November 1999
Teollisuuden Voima Oy
The handing over to Ekokem Oy of a 9 m³ batch of waste oil to be cleared from regulatory control. The oil is from Olkiluoto nuclear power plant and will be used for saw chain oil. Valid until 31 December 2000.
APPENDIX 4  STATEMENTS AND IMPORTANT DECISIONS BY STUK

- Y22-5/1, 15 January 1999  
  A statement to the Ministry of Trade and Industry about the Loviisa 3 environmental impact assessment programme

- 43/750/98, 28 January 1999  
  A statement to the IAEA about the guide Safety Standards Series, Safety Guide: Software for computer based systems important to safety in nuclear power plants

- 8/774/99, 15 February 1999  
  A statement to the Ministry of Trade and Industry about MINATOM's request for the provision of financing to a safety analysis of a nuclear waste project in Novaja Zemlja

- 12/700/99, 15 February 1999  
  A statement to the Ministry of Social Affairs and Health drafting the Finnish stand on safety and nuclear waste management at Russian nuclear power plants

- 12/770/99, 15 February 1999  
  A statement to the Ministry for Foreign Affairs about a draft on the provision of authorisation for the conclusion of agreements concerning funds allocated for co-operation in the neighbouring area in 1999

- A811/22, 3 March 1999  
  A statement to the Ministry of Trade and Industry about the Finnish utilities' nuclear waste management programme for 1999

- 49/750799, 23 June 1999  
  A statement to the IAEA about the guide IAEA Safety Series, Safety Guide: Instrumentation and control systems important to safety in nuclear power plants

- 48/750/99, 24 June 1999  
  A statement to the IAEA about the guide IAEA Safety Series, Safety Guide: Safety Assessment and Verification

- 6/754/99, 23 July 1999  
  A statement to the Ministry of Trade and Industry about the continuation of the Finnish-Russian treaty of co-operation in the peaceful uses of nuclear energy (SopS 39/69)

- Y810/9, 20 August 1999  
  A statement to the Ministry of Trade and Industry about an environmental impact assessment report on a project for the final disposal of spent nuclear fuel

  A statement to the Ministry of Trade and Industry about drafts for a Ministry decision on the safety and electrical safety of electrical equipment

- 11/400/99, 24 August 1999  
  A statement to the Ministry of Trade and Industry about treaty negotiations under way at the OECD concerning nuclear liability

- F213/23, 30 September 1999  
  A statement to the Ministry of Trade and Industry about the application for an operating licence for VTT's research reactor FiR 1

- 42/000/99, 19 October 1999  
  A statement to the Ministry for Social Affairs and Health about an amendment to the Nuclear Energy Act; updating of decision in principle and plant licensing procedures
• A841/5, 2 November 1999
A statement to the Ministry of Trade and Industry about the decommissioning plans for Loviisa nuclear power plant and about the safety assessment of a repository for decommissioning waste

• C841/6, 2 November 1999
A statement to the Ministry of Trade and Industry about the decommissioning plan for Olkiluoto nuclear power plant

• Y22-5/6, 11 November 1999
A statement to the Ministry of Trade and Industry about an environmental impact assessment report for the construction of a third plant unit at Olkiluoto nuclear power plant

• Y22-5/7, 11 November 1999
A statement to the Ministry of Trade and Industry about an environmental impact assessment report for the Loviisa 3 nuclear power plant project

• A812/24, 10 November 1999
A statement to the Ministry of Trade and Industry about the financial provision for nuclear waste management made by Fortum Power and Heat Oy

• F812/19, 10 November 1999
A statement to the Ministry of Trade and Industry about the financial provision made by VTT for the management of nuclear waste generated by the research reactor FiR 1

• C812/25, 11 November 1999
A statement to the Ministry of Trade and Industry about the financial provision for nuclear waste management made by Teollisuuden Voima Oy

• 63/750/99, 18 November 1999
A statement to the IAEA about the guide IAEA Safety Standards Series, Safety Guide: Plant modifications

• 69/750/99, 28 December 1999
A statement to the IAEA about the guide IAEA Safety Standards Series, Safety Guide: External human induced events in relation to the siting of nuclear power plants
Research projects completed in 1999 (some belong to long-term research programmes)

Nuclear power plant structural safety:

Studies in concrete technology for the construction, inspection and repair of nuclear power plant structures; a continuation project

Development of NDT systems qualification: co-operation in NDT systems qualification in Finland; plant-specific tasks

Development of systems for the LBB analysis of plant piping

Development of NDT systems qualification: co-operation in the qualification of NDT systems in Finland, the qualification of in-service inspections

Flow calculations in the assessment of loads exerted on the structures of nuclear power plants

Development of NDT systems qualification; qualification variables

Reactor safety

Development of facilities for criticality safety calculations

The TRAB-PLIM computer code; verification of the TRAB-3D code

Generation of organic iodine during severe accidents; bubbling experiments

Water chemistry at high temperatures: oxide films in high temperature water; properties of and transfer phenomena in the porous oxide layer

ATWS analyses in relation to the modernisation of TVO nuclear power plant

The effect of uncondensed gases on natural circulation in the primary circuit of Loviisa nuclear power plant

The Monte Carlo technique; application to complex geometries

Development of fuel analysis facilities; by utilisation of the FRAPCOM-3/FRAPTRAN software package

Safety management

Cable tunnel fire safety analysis

Development of a numerical fire model for rooms; a continuation project

An assessment of the characteristics and applicability of importance measures for use in regulatory processes based on risk-informed nuclear power plant analysis

The IST/ISI programme for nuclear power plants; Development of methods to support the drawing up of the programme

Reference analyses and studies

The TVO-MODE/PUMU; failure mode and effect analysis for embedded software

OL 1&2 risk analysis; fire PSA assessment
SAFETY RESEARCH COMMISSIONED BY STUK IN 1999

APPENDIX 5

Nuclear waste management

Palmottu—Natural analogue project

DECOVALEX II. Coupled Thermo-Hydro-Mechanics in fractured rock

Natural analogues of bentonite. Planning meeting for the BARRA project

Mechanically Equivalent Continuum Models for fractured rock masses

Geophysical alteration phenomena in and around a repository for spent nuclear fuel

An international review related to Posiva’s application for a decision in principle (ten experts)

A review of the manufacturing technology of the spent fuel canisters

Literature survey on pitting corrosion, stress corrosion cracking and creep of copper

Electric and electrochemical properties of surface films on copper in the presence of bicarbonate anions

The development and validation of physical methods of characterising a rock matrix and their application in site investigations, natural analogue studies and performance assessments

Geochemical barriers in nuclear waste repositories; the behaviour of high-FeO olivine rock

Theoretical treatment of single features in H-3 and C-14 PMMA autoradiography

The rock porosity and porosity structure as a relevant parameter for matrix diffusion

A Rock 3D model for a repository

An assessment of the focus of geological investigations related to the final disposal of spent fuel

Development of regulatory control

Development of the periodic inspection programme

An independent assessment of the procedures for the investigation of operational events at Finnish nuclear power plants

Research projects under way or in reporting stage in early 2000

Reference analyses and studies

The development of a human error assessment method for outage risk analysis

The environmental significance of the results of PSA-based safety analyses at Level 2

Review of Loviisa level 2 PSA

TVO, an independent analysis of the “Multiverter” frequency converters

Structural safety

Environmental-stress induced rupturing of nuclear power plant materials

Studies in concrete technology for the construction, inspection and repair of nuclear power plant structures; a continuation project

Development of methods for the determination of the structure toughness properties of irradiated steels

Development of NDT system qualification; qualification body documents

Reactor safety

Transport and capture of insulation impurities

Turbulent mixing in fuel assemblies
APPENDIX 5

The effect of fuel burn-up on safety; a continuation project

The effect of insulation impurities on fuel assemblies

Modelling of oxide film behaviour and its significance for activity build-up and various corrosion phenomena in nuclear power plants; a continuation project

The fuel cladding corrosion mechanism and its modelling

The HEXTRAN-PLIM computer code; completion of the code using a primary circuit model based on the PLIM solution method

The formation of organic iodine during a severe accident; paint experiments

The SCANAIR computer code; development and qualification of the code

Safety management

Maintenance-induced common-cause failures; phase 2

The licensing of a programmable automation (I&C) system

The licensing of a programmable automation (I&C) system; operating experience analysis

A cable fire model for a room; completion of the model

Safety culture in practice

Maintenance-related human errors; assessment of the probability of errors based on expert opinions

A method for the identification, modelling and assessment of the probability of commission errors

Modelling of fire situations for use in fire-PSA

The effect of smoke and heat on electronic equipment

Active fire protection equipment

Nuclear waste management

IAEA co-ordinated research project: The use of selected safety indicators (concentrations, fluxes) in the assessment of radioactive waste disposal

Matrix diffusion cluster: Determination of rock matrix properties and understanding of transport of radionuclides therein

Geochemical barriers in nuclear waste repositories: the behaviour of high-FeO olivine rock and sorption mechanisms of uranium

Review of the safety analysis of the disposal of decommissioning waste from Loviisa nuclear power plant

NKS project. Participation in the financing of the SOS-3 project

Matrix diffusion study: determination of the physical properties of rock mass and understanding of radionuclide migration in rock

Matrix diffusion study: evidences for the migration of radionuclides in a postglacial weathering profile

Assessment of the characterisation of VLJ waste from Olkiluoto

Development and validation of physical rock matrix characterisation methods and their application in site investigations, natural analogue and performance assessment (Tasks 3 & 4)

Development of regulatory control

Intensification of process management in STUK’s nuclear safety regulation effort
SAFETY RESEARCH COMMISSIONED BY STUK IN 1999

APPENDIX 5

Other projects

Collection and handling of data from the meteorological towers of Loviisa and Olkiluoto nuclear power plants at the Finnish Meteorological Institute; a continuation project

Review of report “LVOI-A6951M1, 9 June 1999, Estimation of seismic hazard in territory of southern Finland”