STUK-B-YTO 145

Operation of Finnish nuclear power plants

Quarterly report
3rd, quarter 1995

Tuulikki Sillanpää (ed.)

MAY 1996

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Finnish Centre for Radiation and
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STUK-B-YTO 145
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ABSTRACT

Quarterly Reports on the operation of Finnish nuclear power plants describe events and observations relating to nuclear and radiation safety which the Finnish Centre for Radiation and Nuclear Safety (STUK) considers safety significant. Safety improvements at the plants are also described. The Report includes a summary of the radiation safety of plant personnel and of the environment and tabulated data on the plants' production and load factors.

Except for the annual maintenance outages of Loviisa plant units and for TVO II's brief outage to repair a failed component, Finnish nuclear power plant units were in power operation in the third quarter of 1995. The load factor average of all plant units was 90.4 %.

Events in this quarter were level 0 on the INES scale.

Occupational doses and radioactive releases off-site were below authorised limits. Radioactive substances were measurable in samples collected around the plants in such quantities only as have no bearing on the radiation exposure of the population.

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1 INTRODUCTION

According to the Nuclear Energy Act (990/87), regulatory control of the use of nuclear energy belongs to the Finnish Centre for Radiation and Nuclear Safety (STUK). The Centre's functions also include regulatory control of physical protection, emergency preparedness and nuclear material safeguards. The scope of nuclear power plant regulatory control and inspections is given in Appendix 1 and general information about Finnish plants in Appendix 2.

STUK publishes quarterly a report on the operation of Finnish nuclear power plants. In this report, plant events and observations in each quarter are described, tabulated data on the plants' production and availability factors are given and the radiation safety of plant personnel and the environment is summarised. Safety improvements made at the plants and are also reported.

The report is based on information submitted to STUK by the utilities and on observations made by the Centre during its regulatory activities. The events described in the report are classified on the International Nuclear Event Scale (INES).

2 OPERATION OF NUCLEAR POWER PLANTS IN JULY—SEPTEMBER 1995

Except for the annual maintenance outages at Loviisa plant units and the brief break in production at TVO II to repair a failed component, Finnish nuclear power plant units were in power operation in the third quarter of 1995.

2.1 Production data

Nuclear's share of total electricity production was 35.2 %. The load factor average the plant units was 90.4 %.

Detailed production and availability figures are given in Tables I ja II.

Power diagrams describing electricity generation at each plant unit and the causes of power reductions are given in Figs 1—4.

Table I. *Plant electricity production and availability.*

	Electricity production (gross, TWh)		Availability factor (%)		Load factor (%)	
	Third quarter 1995	From beginning of 1995	Third quarter 1995	From beginning of 1995	Third quarter 1995	From beginning of 1995
Loviisa 1	0.77	2.79	80.5	93.4	75.0	91.4
Loviisa 2	0.78	2.62	81.2	87.9	76.3	86.1
TVO I	1.61	4.53	100.0	95.4	98.9	94.0
TVO II	1.53	4.33	98.2	92.8	94.5	90.0

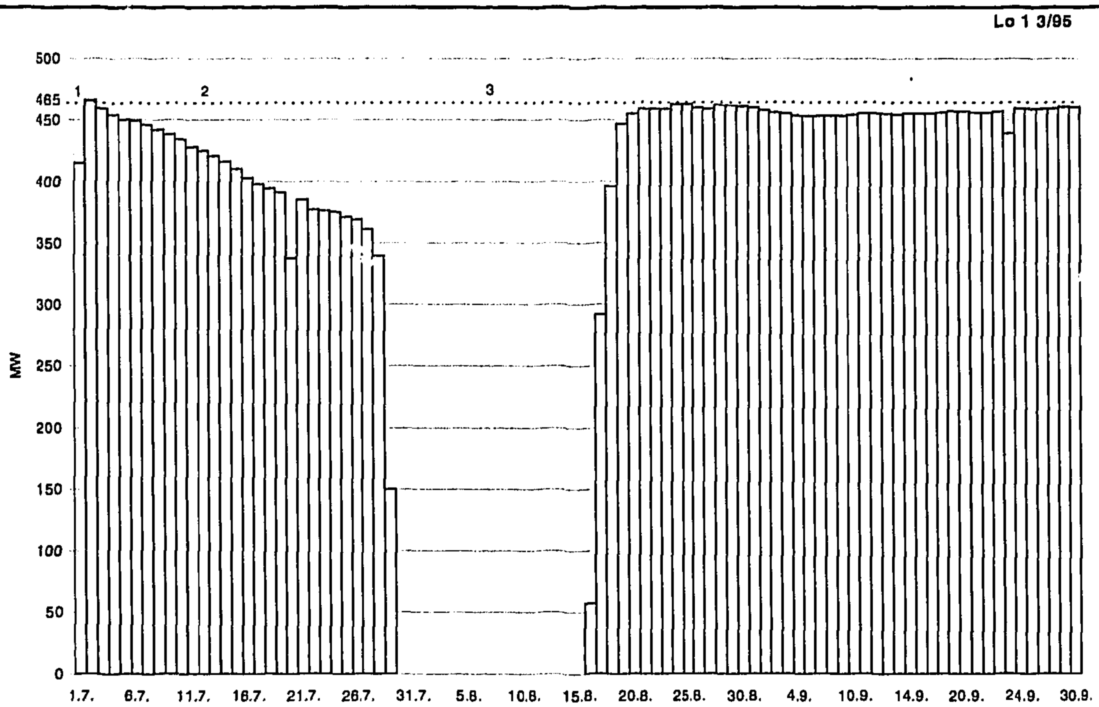
$$\text{Availability factor} = \frac{\text{generator synchronized (h)}}{\text{calendar time (h)}} \cdot 100\ \%$$

$$\text{Load factor} = \frac{\text{gross electricity production}}{\text{rated power} \cdot \text{calendar time (h)}} \cdot 100\ \%$$

Table II. Nuclear energy in Finnish electricity production.

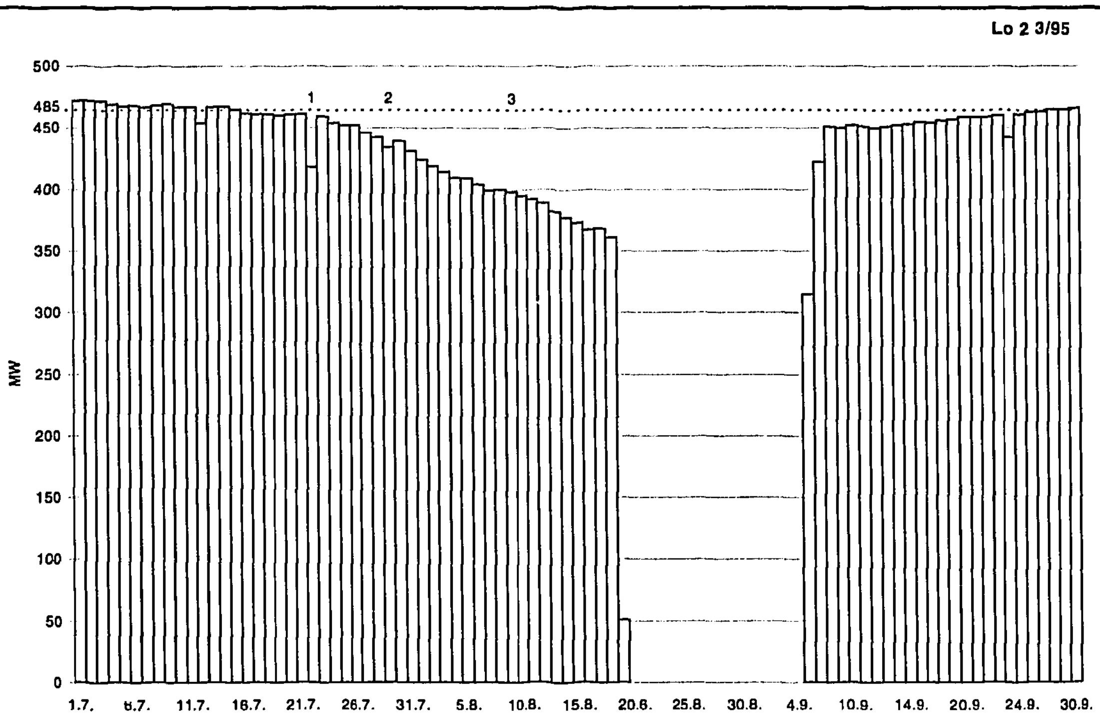
	Third quarter 1995	From beginning of 1995	1994	1993
Nuclear electricity production (net, TWh)*	4.5	13.7	18.3	18.8
Total electricity production in Finland (net, TWh)*	12.8	44.1	62.1	58.1
Nuclear's share of total electricity production (%)	35.2	31.1	29.5	32.3
Load factor averages of Finnish plant units (%)	86.2	90.4	90.0	92.8

* Source: Statistics compiled by the Association of Finnish Electric Utilities.



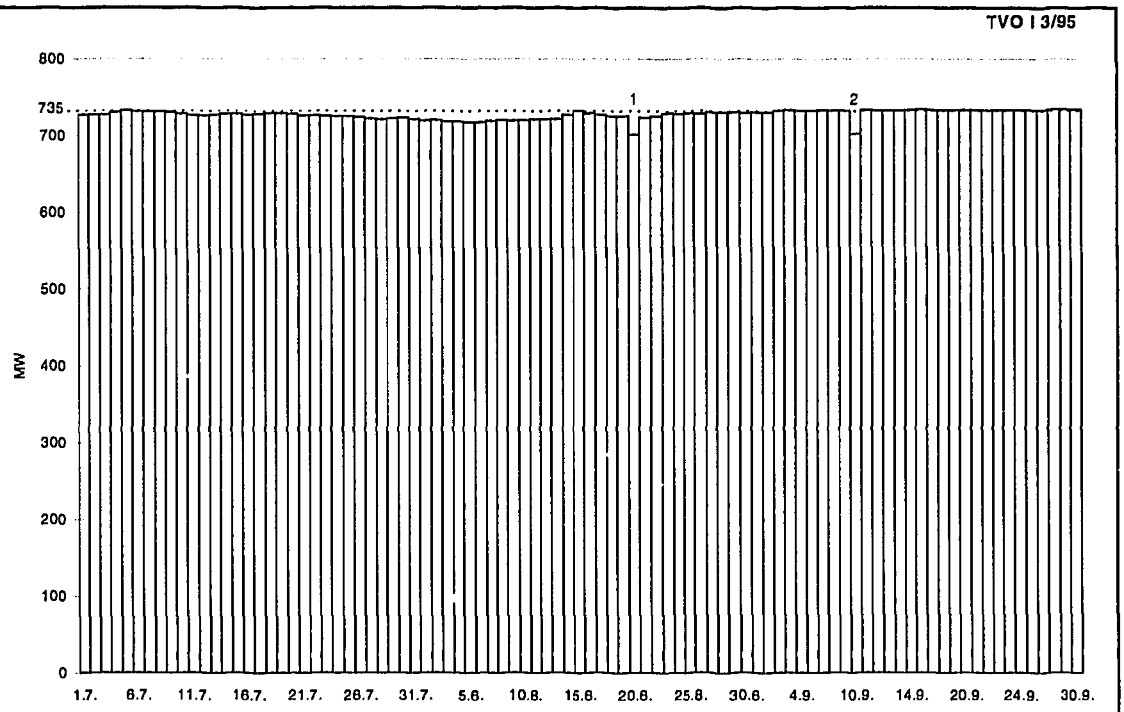
1 Steam line safety valve tests, reactor operating at 71 % power.
2 Stretch-out operation
3 Annual maintenance (see chapter 2.2).

Fig 1. Daily average gross power of Loviisa 1 in July—September 1995.



1 Steam line safety valve tests, reactor operating at 76 % power.
2 One control rod dropped due to a low frequency converter failure, reactor to operate at 87 % power.
3 Stretch-out operation.
4 Annual maintenance (see chapter 2.3).

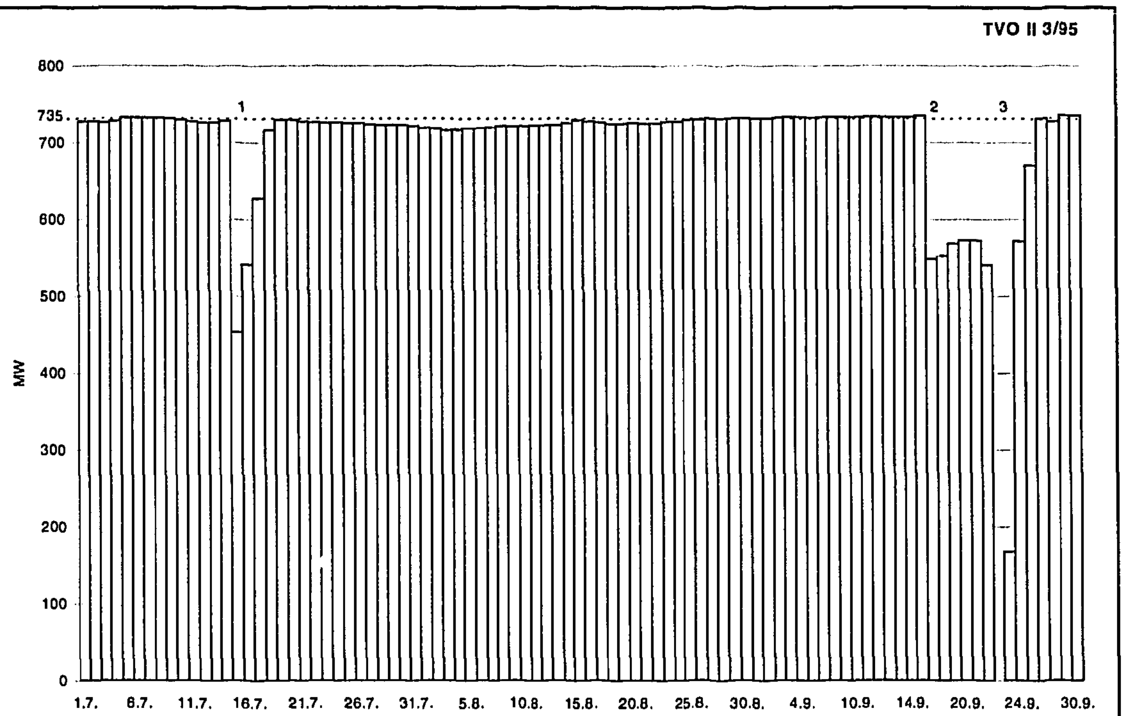
Fig 2. Daily average gross power of Loviisa 2 in July—September 1995.



1 Periodic test, reactor operating at 70 % power.

2 Leaking flanged joints in the level measurement of the steam line drainage tanks were repaired, reactor operating at 60 % power.

Fig 3. Daily average gross power of TVO I in July—September 1995.



1 Control rod sequence was changed, reactor operating at 56 % power.

2 Periodic test, reactor operating at 60 % power.

3 Repair of feedwater line check valve (see chapter 2.4).

Fig 4. Daily average gross power of TVO II in July—September 1995.

2.2 Annual maintenance outage at Loviisa 1

Loviisa 1's 18th refuelling and maintenance outage was from 29 July to 16 August 1995. The plant unit was off the national grid for 18 days.

Apart from Imatran Voima Oy's own personnel, the maximum number of contract personnel participating in this annual maintenance outage was about 800. The collective radiation dose incurred in outage work was 0.37 manSv (0.63 manSv in 1994). The highest individual dose was 7.2 mSv.

At the turbine plant, work to replace pipes and components continued and, at the same time, their structure and materials were changed to better withstand erosion-corrosion. On the primary side, major components were inspected according to programmes.

Modifications made during the outage to improve safety are described in chapter 5.

After the annual maintenance outage the plant unit was brought back on line 16 August 1995.

2.3 Annual maintenance outage at Loviisa 2

Loviisa 2's 15th refuelling and maintenance outage was from 19 August to 5 September 1995. The plant unit was off the national grid for 17 days.

Apart from Imatran Voima Oy's own staff, the maximum number of contract personnel participating in this outage was about 800. The collective radiation dose incurred in outage work was 0.34 manSv (1.53 manSv in 1994). The highest individual dose was 9.8 mSv.

Modifications made during the outage to improve safety are described in chapter 5.

In the 1994 annual maintenance, all primary circuit surfaces were chemically cleaned. The plant had been in operation for about one month after the annual maintenance when the coolant outlet temperatures of bundles with zirconium spacers loaded into the centre of the reactor core began to rise. The temperatures in some other fuel bundles also rose slightly. The bundles with zirconium spacers were test bundles of a new type. At the end of January, the facility was brought down and the bundles with zirconium spacers were replaced with regular bundles having steel spacers. The rise in temperatures was caused by deposits accumulating on the lower surfaces of the bundles' spacers. It is possible that the deposits have accumulated in consequence of the chemical cleaning of the primary circuit carried out in the 1994 annual maintenance outage.

The temperatures of some other bundles continued to rise even after the bundles with zirconium spacers had been removed. Set limits were not exceeded however and the matter was taken care of in the 1995 annual maintenance outage. To indentify the bundles on which the deposits accumulated, special equipment to measure the flow resistance was constructed at the plant to inspect the over 80 fuel bundles which were to be re-loaded to the reactor. About 30 bundles were rejected based on these measurements and they were replaced with bundles which had been removed from the reactor earlier and which had an equal burn-up.

The causes underlying the phenonmena relating to the accumulation of the deposits are not yet known. Investigations continue, however. Bundle temperatures and the amount of primary circuit impurities are under intensified monitoring.

When this annual maintenance was completed the plant unit was brought back on line 5 September 1995.

2.4 Cold shutdown at TVO II

TVO II was brought to cold shutdown on 23 September 1995 to find out and repair a feedwater line check valve failure. The valve is in a pipeline penetrating the containment wall. During an accident condition, the valve's closure would prevent any release of radioactive substances outside the containment. The line also has another valve serving the same purpose.

Periodic tests had been performed on the valve on 17 September 1995. These did not give full confidence of valve closure and, therefore, the other valve in the pipeline was closed and the plant unit's power was reduced.

Examinations during the outage gave no definite explanation for the valve failure. It was also noted that the pressure differential across the valve disc would be larger under a potential accident condition than during the test, which would have brought about the valve's correct closure. The valve's inner parts were replaced, except for the position indication mechanism. The repaired valve did not pass the leaktightness test and was re-opened. The new disc fitted into the valve was replaced with the old disc. The surfaces of the valve's disc and chamber were ground, whereafter the valve operated flawlessly.

The plant unit was brought back on line 24 September 1995.

3 EVENTS AND OBSERVATIONS

Loviisa 1

In the third quarter of 1995, a deviation from the Technical Specifications occurred during Loviisa 1 start-up. This event did not significantly decrease the plant's safety level and was assigned level 0 on the INES scale.

3.1 Deviation from the Technical Specifications during Loviisa 1 start-up

In a control room inspection on 15 August 1995 during the start-up of Loviisa 1 it was detected that one plant make-up system valve had remained in an intermediate position after the tripping of its actuator's torque protection. Operators closed the valve and separated its power supply from the switchplant and also coupled the necessary water supply by opening a corresponding valve in the parallel subsystem. They interpreted these two valves as equals in terms of safety functions and thought the measures taken met the requirements of the Technical Specifications. After administrative readiness inspections relating to start-up, the plant unit was given permission to switch from hot standby to start-up state.

Later in the evening when the valve's limits were checked, it was found out that the valve itself, not the actuator, had failed. Having assessed the situation the operators decided to proceed with the plant's start-up. They interpreted that the requirements of the Technical Specifications were fulfilled by the same corrective measures as previously. The valve's repair was postponed until the following morning. The plant switched to power operation on 16 August 1995 and the valve repair was accomplished on 17 August 1995.

Three days are allowed in the Technical Specifications for the repair of a failed valve during operational states. If attempts to repair the failure are not successful within this time, the plant must be brought to shutdown state. According to the Technical Specifications, switching from hot standby to start-up state and from start-up state to power operation is not allowed during repairs. The Technical Specifications were deviated from twice during the repair of this valve. Compliance with the Technical Specifications would have required the valve's repair in the operational state in which the plant was when the failure was detected, i.e. in hot standby. The Technical Specifications do not allow the use of an optional process coupling to switch from one plant operational state to another for fault repair.

The failure was not disclosed until the checking of the administrative readiness for start-up prior to applying for a "dilution permit" which includes a review of the monitoring and inspection locations and items relating to safe plant start-up. When reviewing the results of control room inspection, the deviating basic states of plant make-up system valves had been detected but their causes were not adequately examined and, therefore, the valve's failure was not observed by those carrying out the inspection. Since the work order concerning the failure was only made after the dilution permit had been granted, so, on the basis of the work order system, checking what work was unfinished could not reveal the valve's failure.

This valve failure did not significantly reduce the plant safety level. The required safety functions would have taken place with the existing couplings almost as if the situation had been normal, and the Finnish Centre for Radiation and Nuclear Safety would have granted a temporary deviation permit on request on the basis of which the facility could have been started up in due compliance with even the administrative requirements.

Loviisa 2

In the third quarter of 1995, the oxygen content in the ADP and control rooms of Loviisa 2 decreased momentarily when the carbon dioxide extinguisher system for putting out fires erroneously tripped. The event is level 0 on the INES scale. When the Loviisa 2 annual maintenance ended, and immediately after start-up, a fuel leak was observed in the reactor. This event is level 0 on the INES scale.

3.2 Carbon dioxide extinguisher system tripped and the oxygen content in the ADP and control rooms was reduced in consequence

Two control building fire detection system main cables inside the outer wall of the Loviisa 2 control building were cut off when a hole was bored in the wall. Consequently, some of the control building fire dectection circuits gave an alarm signal which, for its part, tripped the carbon dioxide extinguisher system into the shallow instrumentation duct below the floor of the ADP room. The "elevated" floor of the room is not leaktight and some carbon dioxide escaped from the instrumentation duct to the ADP room and, to a lesser extent, also to the control room. This event occurred on 25 July 1995 in connection with modifications to improve safety.

The fire detection circuits which gave an alarm signal were disconnected from operation for the duration of the repair of the main cables. The repair took 12 hours. To ensure plant fire safety, fire guards checked rooms which had no fire circuits in operation. Also additional initial extinguishing equipment were brought to the rooms.

Half of the carbon dioxide extinguisher system's ten bottles became empty. The empty bottles were filled up the next day and the system was operational again in 22 hours from the event.

The tripping of the carbon dioxide extinguisher system to below the ADP room floor did not endanger personnel safety. After the system's tripping, oxygen content measurements were conducted in the ADP room and the main control room next to it. The oxygen content in the computer room was observed to have reduced so much that staying there would have been highly dangerous. The oxygen content in the main control room fell only 1—2 percentage units, so working there could be continued.

In connection with corresponding repairs and modifications, Imatran Voima Oy aims to find methods for locating cables inside concrete structures. To ensure personnel safety, the company investigates whether the carbon dioxide systems can be replaced with other fire extinguisher systems in the vicinity of quarters with continuous manning.

3.3 Nuclear fuel cladding leaks

After the annual maintenance outage at Loviisa 2, a fuel leak was observed in the reactor. Towards the end of September, it was assessed, on the basis of primary coolant fission product activity concentrations, that there may be more than one leaking fuel rod in the reactor.

A minor fuel cladding leak observation was made at Loviisa 2 in early 1995 which was based on primary water activity (STUK-B-YTO 135). In conjunction with the reactor's shutdown for annual maintenance outage, distinct releases of iodine and caesium isotopes were observed indicating a slighly larger fuel leak. On the basis of the ratio of activity concentrations of the caesium isotopes, the leaking bundle was assessed to have a high burn-up. Leak detection was carried out before refuelling and two leaking fuel bundles were detected. Both had been in the reactor for three cycles and were due for removal from the reactor. The leaking bundles were removed from service.

After completion of the annual maintenance fuel was observed to leak again. On the basis of the fission product activities of primary circuit water the leak was first attributed to a small cladding failure through which only noble gases were released. After mid-September, noble gas and iodine activities began rising faster than before, however, and their behaviour deviated from previous experience. By the end of September, the concentrations of the noble gas isotope xenon-133 and of the iodine-131 isotope were ca. tenfold compared with values measured immediately after start-up. The noble gas total concentration, however, was less than one tenth and that of iodine isotopes less than a hundredth part of the limits set in the Technical Specifications.

On the basis of the primary circuit activities, the fuel leak was assessed to be an open cladding failure which allowed primary coolant contact with uranium dioxide. It was assessed there were several leaking fuel rods.

The propagation of the fuel leak was monitored by continuous activity measurements and laboratory measurements of the primary coolant specific acitivity once a day.

If significant unexpected changes do not occur in the extent of the fuel failure and if the primary circuit water fission product concentrations do not exceed the limits set in the Technical Specifications, the fuel leak does not prevent the safe operation of the plant unit.

The fuel bundles containing leaking fuel rods were located and removed from the reactor in an additional maintenance outage held in the fourth annual quarter and which is reported for in the respective quarterly report.

TVO I

No reportable events occurred at TVO I in the third quarter of 1995.

TVO II

No reportable events occurred at TVO II in the third quarter of 1995.

4 RADIATION SAFETY

Individual doses to nuclear power plant personnel were below the dose limit. Also environmental releases were well below the release limits. Only such quantities of radioactive substances originating from the plants were measurable in samples collected around Finnish nuclear power plants as have no bearing on the radiation exposure of the population.

4.1 Occupational exposure

The highest individual dose at a Finnish nuclear power plant in this annual quarter was 17.0 mSv and it was received at Loviisa nuclear power plant. The Radiation Decree stipulates that the effective dose caused by radiation work to a worker shall not exceed 50 mSv in any single year. The dose may not exceed 20 mSv per year as an average over five years. This monitoring of the annual average was started at the beginning of 1992. Radiation doses at Loviisa and TVO nuclear power plants have been below authorised limits.

Occupational dose is mainly incurred during annual maintenance outages. The annual maintenance outages of both Loviisa plant units were in this annual quarter.

The individual dose distribution of nuclear power plant personnel is given in Table III which specifies the number of exposed individuals by dose range and plant site. This information is from STUK's central dose register.

Collective occupational dose at the Loviisa plant units was 0.74 manSv and 0.8 manSv at the TVO units. According to a STUK Guide, the collective dose limit for one plant unit is 2.5 manSv per one gigawatt of net electrical power averaged over two successive years; this means a total annual collective dose of 2.22 manSv/year and of 3.56 manSv/year for the Loviisa and TVO units respectively.

4.2 Radioactive releases into the environment

In Table IV, the releases of radioactive effluents measured at each plant site and the annual release limits are given. During this report period, releases into the environment were well below authorised limits.

4.3 Environmental monitoring

Radiation safety in the vicinity of Finnish nuclear power plants is monitored by regular sampling and analysis programmes. Environmental dispersion of radioactive releases is monitored and it is ensured that the releases remain below authorised limits. According to the programmes, a total of 171 samples were analysed in this quarter. Also a total of 26 external radiation measurements were made.

Radioactive substances originating in Loviisa nuclear power plant were measurable in four samples of air, three samples of fallout, five samples of algae and two samples of sinking matter. The most common plant-based nuclides were cobalt -58, cobalt-60 and silver-110m; also chromium-51, manganese-54 or antimony-124 were measured in some samples.

In samples collected in the vicinity of TVO nuclear power plant, plant-based radioactive substances were measurable in one sample of deposited material, in one sample of sea water

Table III. Occupational dose distribution in the third quarter of 1995 and from beginning of 1995.

Dose range (mSv)	Number of persons by dose range					
	Third quarter 1995			From beginning of 1995		
	Loviisa	TVO	Total*	Loviisa	TVO	Total*
< 0.5	177	89	265	187	488	611
0.5—1	108	16	134	109	210	303
1—2	78	11	111	96	143	231
2—3	60	6	74	57	59	108
3—4	30	2	40	32	60	102
4—5	21	3	30	32	17	51
5—6	12	–	18	14	13	41
6—7	4	–	11	5	5	25
7—8	2	–	9	7	2	16
8—9	–	–	3	1	2	10
9—10	–	–	6	–	1	13
10—11	–	–	3	2	1	9
11—12	–	–	1	1	1	2
12—13	–	–	3	–	–	5
13—14	1	–	4	1	–	4
14—15	1	–	1	1	–	4
15—16	–	–	–	–	–	3
16—17	1	–	1	1	–	8
17—18	–	–	–	–	–	–
18—19	–	–	–	–	–	–
19—20	–	–	–	–	–	1
20—25	–	–	1	–	–	2
yli 25	–	–	–	–	–	–

* The highest individual dose since beginning of 1995 (23.4 mSv) was received at a nuclear power plant in Sweden.

and in all indicator organisms sampled from the marine environment (algae, bivalves and sinking matter). The detected nuclides were manganese-54, cobalt-58 and -60.

All the measured concentrations were low and require no action.

Radioactive strontium and caesium isotopes (strontium-90, caesium-134 and -137) and plutonium isotopes (plutonium-238, 239+240) originating in the Chernobyl accident and in the fallout from nuclear weapons tests are still measurable in environmental samples. Natural radioactive substances (beryllium-7, potassium-40 and the decay series of uranium and thorium) are also detected. Their concentrations in these samples are usually much higher than the concentrations of substances originating from power plants or fallout.

Table IV. Radioactive releases by plant site, third quarter 1995.

Gaseous effluents (Bq) a)

Plant site	Noble gases (Krypton-87 equivalents)	Iodines (Iodine-131 equivalents)	Aerosols	Tritium	Carbon 14
Loviisa					
Report period	$4.9 \cdot 10^{11}$ b)	$4.3 \cdot 10^{8}$	$1.3 \cdot 10^{8}$	$4.5 \cdot 10^{10}$	$3.2 \cdot 10^{10}$
Early 1995	$7.9 \cdot 10^{11}$ b), c)	$4.4 \cdot 10^{8}$	$2.0 \cdot 10^{8}$	$1.3 \cdot 10^{11}$	$1.0 \cdot 10^{11}$
Olkiluoto (TVO)					
Report period	$4.6 \cdot 10^{12}$	$6.0 \cdot 10^{5}$	$4.8 \cdot 10^{6}$	$3.6 \cdot 10^{10}$	e)
Early 1995	$9.5 \cdot 10^{12}$	$3.9 \cdot 10^{7}$	$3.0 \cdot 10^{7}$ d)	$1.0 \cdot 10^{11}$	e)
Annual release limits					
Loviisa	$2.2 \cdot 10^{16}$ f)	$2.2 \cdot 10^{11}$ f)			
Olkiluoto	$1.8 \cdot 10^{16}$	$1.1 \cdot 10^{11}$			

Liquid effluents (Bq) a)

Plant site	Tritium	Other nuclides
Loviisa		
Report period	$1.2 \cdot 10^{12}$	$5.1 \cdot 10^{7}$
Early 1995	$8.7 \cdot 10^{12}$	$5.4 \cdot 10^{7}$
Olkiluoto (TVO)		
Report period	$2.8 \cdot 10^{11}$	$4.3 \cdot 10^{9}$
Early 1995	$1.1 \cdot 10^{12}$	$2.1 \cdot 10^{10}$
Annual release limits		
Loviisa	$1.5 \cdot 10^{14}$	$8.9 \cdot 10^{11}$ f)
Olkiluoto	$1.8 \cdot 10^{13}$	$3.0 \cdot 10^{10}$

a) The unit of radioactivity is Becquerel (Bq); 1 Bq = one nuclear transformation per second.
b) The calculatory release of argon-41 from Loviisa 1 and 2 in krypton-87 equivalents was $3.3 \cdot 10^{11}$ Bq in the report period and $1.1 \cdot 10^{12}$ Bq from beginning of 1995.
c) In the previous quarterly report, there was an error in the part reporting for noble gase releases via the stack of Loviisa, which has now been corrected. The noble gas release from Loviisa nuclear power plant to the atmosphere was $2.0 \cdot 10^{11}$ Bq in the second quarter of 1995.
d) In addition to aerosol releases ($2.3 \cdot 10^{7}$ Bq) reported for the previous quarter, also a minor strontium-89 release ($1.1 \cdot 10^{6}$ Bq) occurred, which increases the release of early 1995 to $2.5 \cdot 10^{7}$ Bq.
e) The carbon-14 release-estimate based on experimental data was $1.7 \cdot 10^{11}$ Bq in Olkiluoto in the report period and $4.7 \cdot 10^{11}$ Bq from beginning of 1995.
f) The numerical value shows the release limit for the Loviisa plant site, assuming that the sum of various types of release limit shares shall be smaller than or equal to 1.

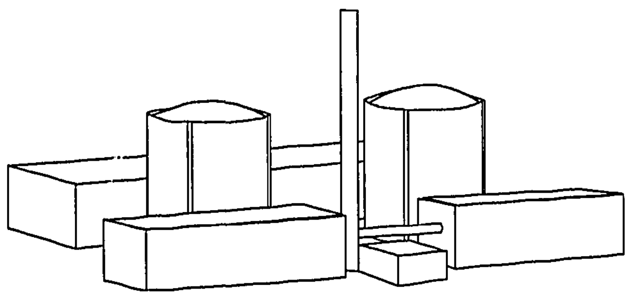
5 SAFETY IMPROVEMENTS AT NUCLEAR POWER PLANTS

In the third quarter of 1995, the annual maintenance outages of Loviisa plant units were held during which some safety-significant plant modifications were carried out. TVO's units I and II were in operation for most of the time and no significant plant modifications were made in this period.

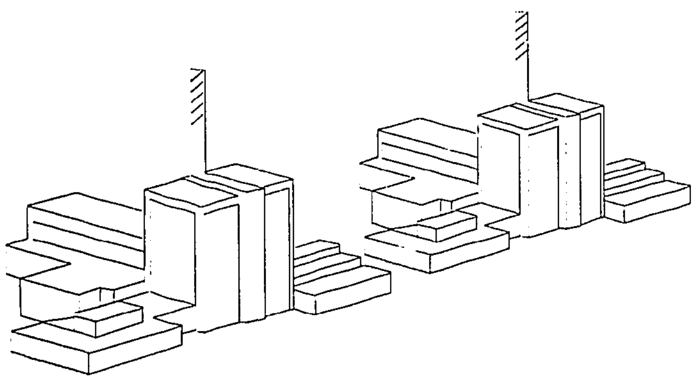
Manually operated dampers were installed downstream of the filters in the back-up diesel air-intake channels of Loviisa plant unit which enable supply of air to the diesels from the diesel rooms. This modification ensures the operation of the diesels in an event in which the filters of the air-intake channel have been blocked e.g. by a heavy snow storm The modification was carried out at both plant units, with the exception of one diesel at Loviisa 1 plant unit for whose part the modification was postponed until the next outage.

The control building cable space drainage system was improved to prevent overloading of sumps in the event of flooding. At Loviisa 2 plant unit, two new drain pipes were installed in these spaces and old drain pipes were replaced with larger pipes. At Loviisa 1 plant unit, existing drain pipes were enlarged. Furthermore, four level alarm switches were installed in the same space at both units to ensure that control room personnel receive a timely indication of possible flooding to take the necessary measures. The cable spaces may become flooded in consequence of a fire water pipe rupture or during sprikler operation if the drainage system becomes blocked.

Council of State Decisions	Regulatory control and inspections by the Finnish Centre for Radiation and Nuclear Safety
	Preparation of a nuclear power plant project • Preliminary plans for the plant and safety principles • Location and environmental impact of the plant • Arrangements for nucler fuel and nuclear waste management
Decision in Principle	
	Plant design • Preliminary safety analysis report on the planned structure and operation of the plant plus the preliminary safety analysis • Safety classification of components and structures • Quality assurance plan • Plans for nuclear fuel and nuclear waste management • Physical protection and emergency preparedness
Construction Permit	
	Construction of plant • Construction plans, manufacturers, final construction and installation of components and structures • Performance tests of systems • Final safety analysis report on the structure and operation of the plant and the final safety analyses • Probabilistic safety analysis • Composotion and competence of the operating organisation • Technical Specifications • Nuclear fuel management and safeguards • Methods of nuclear waste management • Physical protection and emergency preparedness
Operating Licence	
	Plant operation • Start-up testing at various power levels • Maintenance, inspections and testing of components and structures • Operation of systems and the whole plant • The operating organisation and management • Training of personnel • Qualifications of individuals • Operational incidents • Repairs and modifications • Refuelling • Nuclear fuel management and safeguards • Nuclear waste management • Radiation protection and safety of the environment • Physical protection and emergency preparedness • Fire protection



Plant unit	Start-up	Commercial operation	Rated power (gross/net, MW)	Type, supplier
Loviisa 1	8 Feb.1977	9 May 1977	465/445	Pressurized water reactor (PWR), Atomenergoexport
Loviisa 2	4 Nov. 1980	5 Jan. 1981	465/445	Pressurized water reactor (PWR), Atomenergoexport



Plant unit	Start-up	Commercial operation	Rated power (gross/net, MW)	Type, supplier
TVO I	2 Sept. 1978	10 Oct. 1979	735/710	Boiling water reactor (BWR), Asea Atom
TVO II	18 Feb. 1980	1 July 1982	735/710	Boiling water reactor (BWR), Asea Atom

Imatran Voima Oy owns the Loviisa 1 and 2 plant units in Loviisa and Teollisuuden Voima Oy the TVO I and II plant units in Olkiluoto, Eurajoki.

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