STUK-B-YTO 110

Operation of Finnish nuclear power plants

Quarterly report 1st quarter, 1993

Kirsti Tossavainen (Ed.)
SEPTEMBER 1993

SÄTEILYTURVAKESKUS
Strålsäkerhetscentralen
Finnish Centre for Radiation and Nuclear Safety

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ABSTRACT

Quarterly Reports on the operation of Finnish nuclear power plants describe events and observations, relating to nuclear safety and radiation protection which the Finnish Centre for Radiation and Nuclear Safety considers safety significant. Safety-enhancing modifications at the nuclear power plants and issues relating to the use of nuclear energy which are of general interest are also reported. The reports include a summary of the radiation safety of plant personnel and the environment, as well as tabulated data on the production and load factors of the plants.

In the first quarter of 1993, a primary feedwater system pipe break occurred at Loviisa 2, in a section of piping after a feedwater pump. The break was erosion-corrosion induced. Repairs and inspections interrupted power generation for seven days. On the International Nuclear Event Scale the event is classified as a level 2 incident. In 1990, a feedwater pipe break occurred at Loviisa 1 which was also attributed to erosion-corrosion.

Other events in the first quarter of 1993 had no bearing on nuclear safety and radiation protection.

In the first quarter of 1993, the load factor average of the four Finnish nuclear power plant units - two units in Loviisa and two in Olkiluoto - was 98.4 %.

Occupational doses and radioactive releases into the environment remained below authorised limits. In samples collected in the vicinity of the nuclear power plants, only quantities of radioactive material insignificant to radiation exposure were detected, originating in the plants.

The construction on the site of the Loviisa nuclear power plant of a repository for medium and intermediate level waste has been started. The facility is being excavated in bedrock, at over 100 meters' depth; it is due for completion in 1996.

CONTENTS

1 INTRODUCTION

As prescribed by the Nuclear Energy Act (990/87), regulatory control of the use of nuclear energy rests with the Finnish Centre for Radiation and Nuclear Safety. The Centre's functions also include regulatory control of physical protection, and emergency preparedness and nuclear material safeguards. The scope of regulatory control and inspections of nuclear power plants is specified in Appendix 1. General information relating to the Finnish nuclear power plants is given in Appendix 2.

The Finnish Centre for Radiation and Nuclear Safety publishes a quarterly report on the operation of the Finnish nuclear power plants. The report describes events and observations at the plants in each quarter, tabulated data on the production and availability factors of the plants and also a summary of the nuclear safety of plant personnel and the environment. The report also describes safety enhancing modifications at the plants and matters of general interest relating to the use of nuclear energy. The fourth Quarterly Report also contains a summary of the information reported in the year in question.

The Report is based on information submitted to the Finnish Centre for Radiation and Nuclear Safety by the utilities and on the Centre's observations during regulatory activities. The events described in the report are classified on the International Nuclear Event Scale.

2 OPERATION OF NUCLEAR POWER PLANTS IN JANUARY-MARCH 1993

The Finnish nuclear power plants were in operation for the most part of the first quarter of 1993. A feedwater pipe break at Loviisa 2 and a reactor scram at TVO I caused breaks in production.

2.1 Production data

In this annual quarter, nuclear electricity accounted for 30.2 % of total electricity production in Finland. The load factor average of the plant units was 98.4 %. Production and availability figures are presented in more detail in Tables I and II.

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

Table I. Electricity production and availability of units.

	Electricity production (gross, TWh)		Availability factor (%)		Load factor (%)	
	First quarter 1993	Whole 1992	First quarter 1992	Whole 1992	First quarter 1993	Whole 1992
Loviisa 1	1.00	3.29	100.0	81.8	100.1	80.5
Loviisa 2	0.93	3.67	92.4	90.3	92.9	89.8
TVO I	1.59	6.02	99.4	93.9	100.0	93.3
TVO II	1.60	6.01	100.0	94.6	100.6	93.1

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

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

Table II. Nuclear energy in Finnish electricity production.

	First quarter 1993	Whole 1992	1991
Nuclear electricity production (net, TWh)[a]	4.9	18.2	18.4
Total electricity production in Finland (net, TWh)[a]	16.2	54.7	55.2
Nuclear's share of total electricity production (%)	30.2	33.3	33.3
Load factor averages of Finnish plant units (%)	98.4	89.2	90.9

a Source: Statistics compiled by the Finnish Association of Electricity Supply Undertakings.

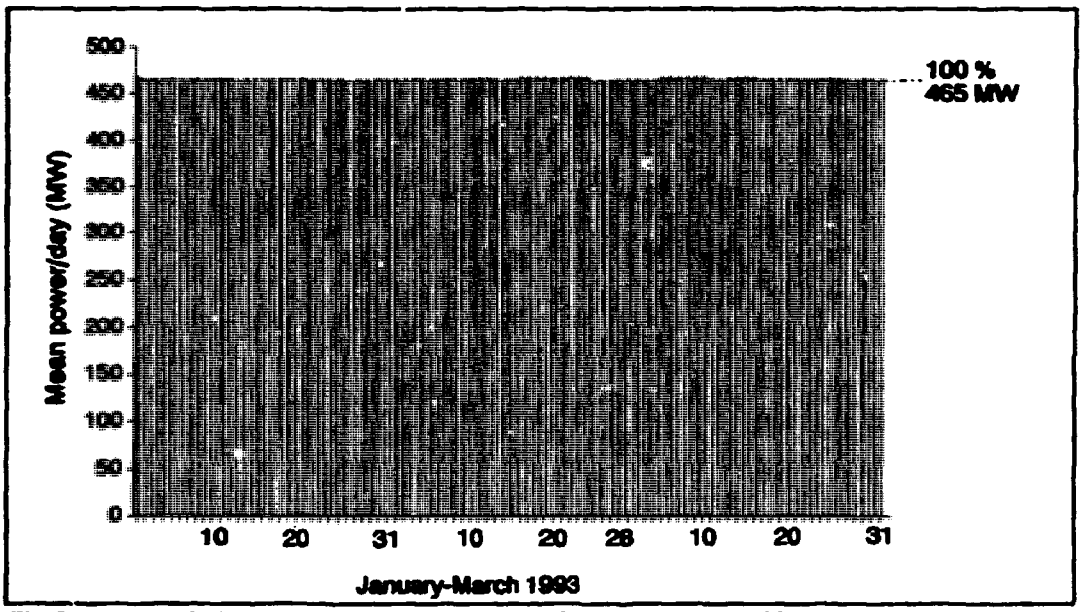

Fig 1. Average daily gross power of Loviisa 1 in January-March 1993.

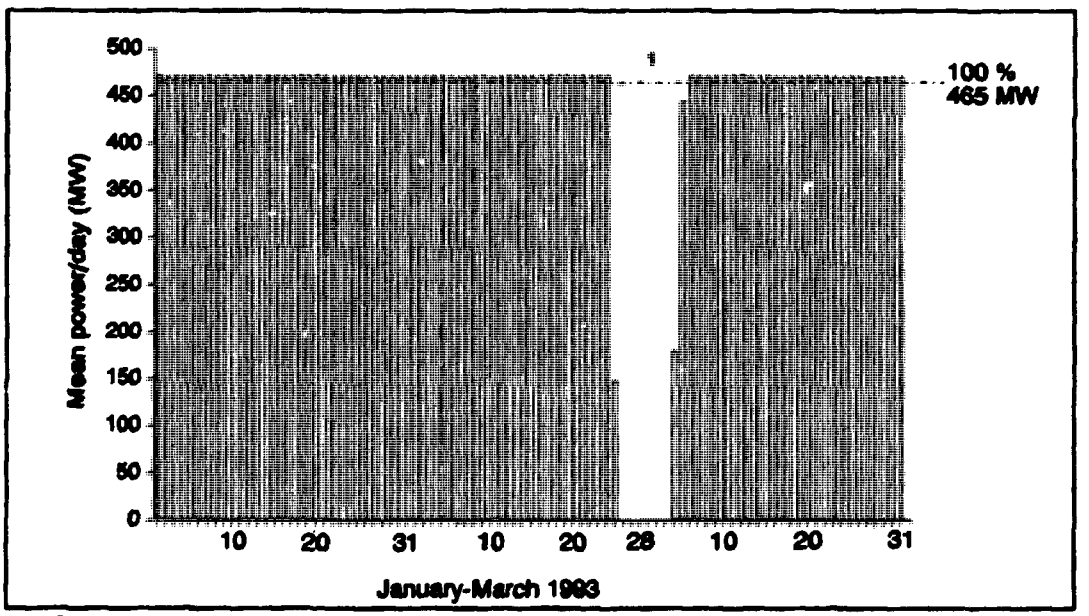

Fig 2. Average daily gross power of Lovitsa 2 in January-March 1993.

1 Cold shutdown attributed to a main feedwater system pipe break (see Chapters 2.2 and 3.2)

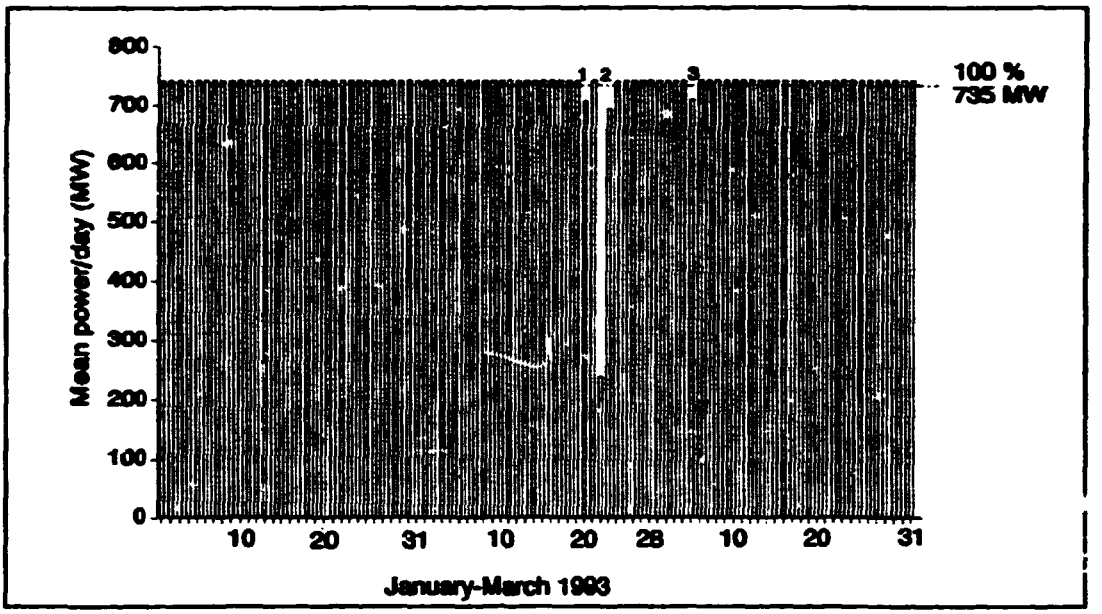

Fig 3. Average daily gross power of TVO I in January-March 1993.

1 Periodic tests and reactor stability measurements, lowest reactor power level was 62 %
2 Reactor scram in consequence of feedwater control system malfunctions (see Chapters 2.3 and 3.3)
3 Main circulation pump tripped due to a fault in the voltage regulator of a DC/AC transducer, lowest reactor power level was 60 %

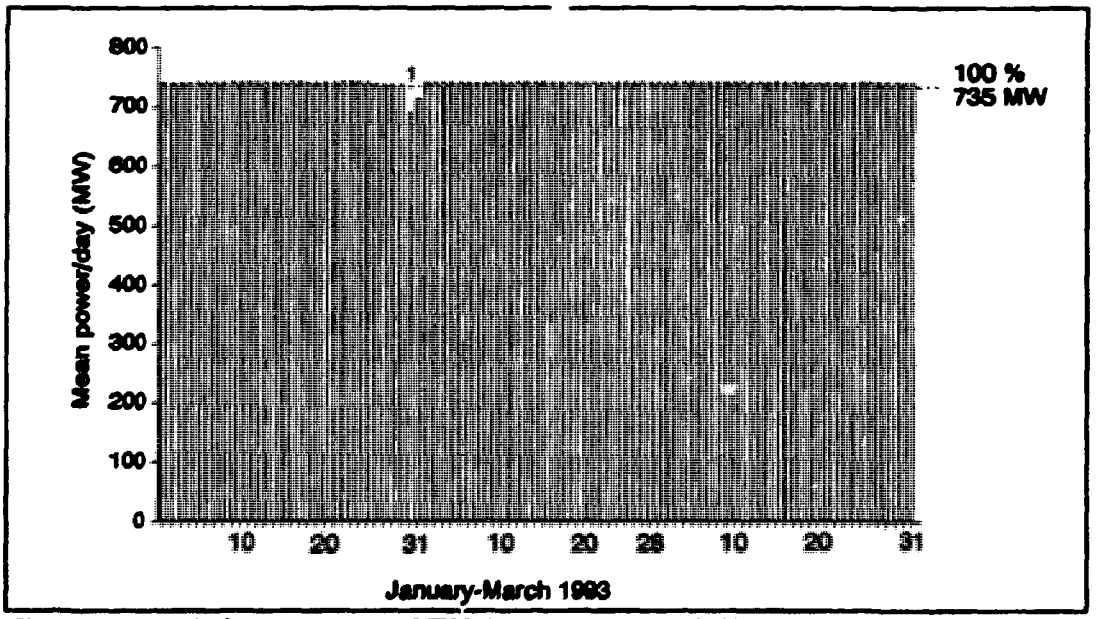

Fig 4. Average daily gross power of TVO II in January-March 1993.

1 Decreased efficiency attributed to a fault in the steam reheater system; periodic tests and reactor stability measurements, lowest reactor power level was 63 %

2.2 Cold shutdown of Loviisa 2 to repair a main feedwater system pipe break

A pipe break in the main feedwater system of Loviisa 2 occurred on 25 February 1993 as a consequence of which the plant unit was placed in cold shutdown. The incident is described in Chapter 3.2. After repairs and inspections the plant unit was brought back on line on 4 March 1993.

2.3 Reactor scram at TVO I

A reactor scram occurred at TVO I on 22 February 1993. The event is described in Chapter 3.3. After the scram the plant unit was put back on line the next day.

3 EVENTS AND OBSERVATIONS

Loviisa 1

In the first quarter of 1993, in a periodic test conducted at the Loviisa nuclear power plant, it was noted that the cooling circuit in a system providing for a severe accident was not in full operational readiness. This event is classied as level 0/below scale on the International Nuclear Event Scale.

3.1 Cooling of the steel containment external spray system was partly inoperable

Power supply to one circulating water pump (there are two) of the cooling circuit of the steel containment external spray system, which had been switched off for repairs, had not been reconnected. The pump was without power supply for five days. However, the event would not have prevented the pump's operation in an accident; the pump is started manually and i.a. the checking up of the power supply of pumps precedes startup as a preliminary measure.

The spray system, which cools the steel containment externally, helps remove residual heat from the containment building in severe accidents. In an accident, sprayed water condenses the steam generated inside the containment building, preventing over-pressurization. The system was installed at both Loviisa plant units in 1991.

The spray systems are completely independent of the plant units' other systems. Both units have their own tanks from which water is injected to spray nozzles above the steel containment in accidents; this water is cooled in the heat exchanger in which sea water flows. Two pumps are available to circulate sea water; they are shared by the plant units and are located in the sea water pumping station of Loviisa 2.

Periodic testing of circulating water pumps, which is performed every four weeks, was conducted on 2 February 1993. While ensuring the energized state of the pumps' power supply units, it was found out that one pump's power supply was not on. It was switched on and a test run of the pump was conducted in which the pump operated flawlessly.

An overhaul of a panel screen had been conducted at Loviisa 2's circulating water pumping station; as a safety measure, power supply to one of the two circulating water pumps of the spray system cooling circuit was switched off. One pump may be rendered inoperable for a while for repairs. No switching plan in accordance with the work permit procedure was made as regards the switching off of the power supply; measures were recorded only in the work order. The pump's power supply unit was appropriately tagged as an indication of the switching off of electrical power. The overhaul was concluded on 28 January 1993. Because of inaccuracies in the recording of safety measures, power supply to the circulating water pump was not switched on. The pump's operability should have been tested after the overhaul, in which case the deficiency would have been detected.

Owing to the event, Imatran Voima Oy will make work permit and testing procedures more specific to avoid recurrence.

Loviisa 2

In the first quarter of 1993, a main feedwater pipe, thinned by erosion-corrosion, broke at Loviisa 2. The incident is classified as level 2 on the International Nuclear Event Scale.

3.2 Main feedwater system pipe break

The main feedwater system supplies water to the plant unit's six steam generators. By means of heat generated in the primary circuit, water is transformed to steam and directed to turbines. Five pumps are available to inject feedwater; four of them are in service during the plant unit's operation and one is on stand-by. Feedwater is pumped into a common collector pipe from where it is directed via two preheater lines to steam generators. The main feedwater system is in the plant unit's secondary circuit and its water is not radioactive. The system's basic functional diagram is given in Fig 5.

During the pipe break, on 25 February 1993, a feedwater pump, which had been removed from service, was being warmed up for startup. The actual startup had not been performed yet. The pipe breaking point was after a feedwater line check valve, at a welded connection joining a flange and an expansion collar (see Fig 6). At the connection, the pipe's diameter was 200 mm. The broken pipe is in the plant unit's turbine hall.

The operation of the feedwater system is essential for the removal of residual heat after reactor shutdown. Supply of water to the steam generators has been ensured by means of emergency feedwater pumps which start automatically if the feedwater pumps proper stop. The plant unit has also a separate back-up emergency feedwater system which is completely independent of other systems and by the means of which water can be injected direct to four steam generators, where necessary.

The pipe break also reduced pressure on the pressure side of operating feedwater pumps; as a consequence, the pumps stopped immediately. After the pumps had stopped, the emergency feedwater pumps started to feed

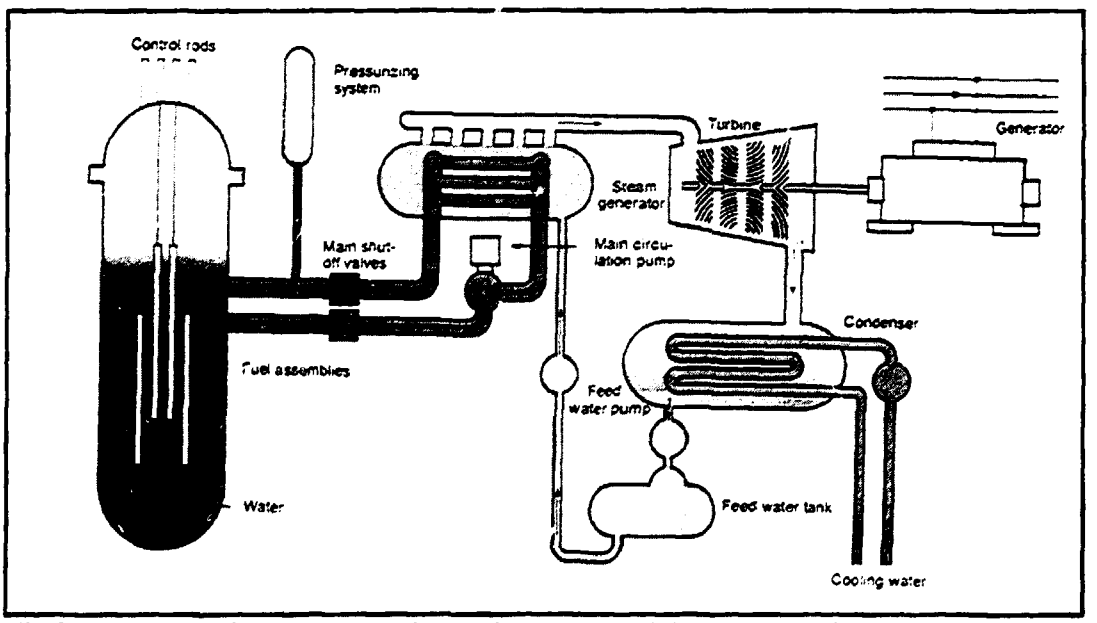

Fig 5. A diagram of the primary and secondary circuits of the Loviisa nuclear power plant units.

water to the steam generators. Simultaneously, an operator tripped the reactor. The leakage was isolated in about nine minutes from the occurrence of the pipe break. The valves required to perform the isolation had been fitted with motor-operated actuators in 1992, which made it possible to close them from the control room. No personal injuries resulted from the event. After repairs and inspections the plant unit was brought back on line on 4 March 1993.

The feedwater pipe break was attributed to thinning of the pipe wall by erosion-corrosion. Piping was not subjected to an actual pressure shock. Pressure from the collector pipe and also stresses possibly exerted on the piping by the warming up of the feedwater pump may have contributed to the break.

In 1990, an erosion-corrosion induced feedwater pipe break occurred at Loviisa 1 (STUK-B-YTO 76, 1990). At that time, a pipe broke in a different section of the feedwater line. After the Loviisa 1 event, Imatran Voima Oy revised the inspection programme for secondary circuit piping at both plant units. An expansion collar connected to the damaged flange was inspected in the 1991 annual maintenance outage. Material on the collar's side and right next to the connecting weld was observed to be of design thickness. The flange between the expansion collar and the check valve was not inspected. When picking items for inspection in 1992, it was erroneously interpreted that the collar had been fully inspected in 1991; it therefore was not included in the inspection. In the 1992 annual maintenance outage at Loviisa 1, corresponding collars were removed and inspected and no perforations were detected which would have indicated an inspection need at Loviisa 2.

The sections of piping located on the pressure side of the Loviisa 1 feedwater pumps had been replaced in the 1992 annual maintenance outage. At Loviisa 2, this replacement was scheduled for the 1994 annual maintenance, since wall thickness measurements did not indicate a need for an earlier replacement.

In a cold shutdown after the pipe break, Imatran Voima Oy inspected corresponding sections of parallel piping. One of these sections was in an advanced state on erosion-corrosion. Sections of all five pipelines were replaced by new piping which better withstands erosion-corrosion. Work is continued at Imatran Voima Oy to ensure better reliability of secondary side piping.

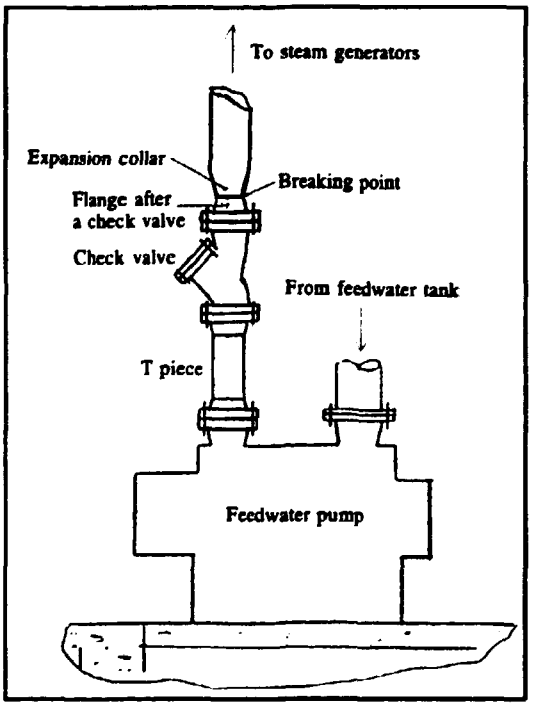

Fig 6. A diagram of the breaking point of a Loviisa feedwater pipe.

TVO I

In the first quarter of 1993, a reactor scram occurred at TVO I. The event is classifed as level 0/below scale on the International Nuclear Event Scale.

3.3 Reactor scram attributed to a disturbance in reactor feedwater control

A disturbance occurred in the reactor feedwater control system of TVO I on 22 February 1993; feedwater flow consequently decreased to about 25 %. The water level of the reactor dropped quickly, bringing about an automatic reactor scram.

The reactor feedwater control system comprises a master controller (a level and flow controller), a scram controller and a low power controller. The scram occurred when the switch protecting the feedwater control system tripped, bringing about a power supply failure which resulted in a switchover from normal to scram control.

Teollisuuden Voima Oy carried out the necessary fault finding work and repairs without delay. The tripped protective switch and other failed components were replaced. The plant unit was re-synchronized with the Finnish grid on 23 February 1993.

The reactor scram may be connected to a recent disturbance in a UPS equipment (Uninterruptible Power Supply) ensuring uninterruptible on-site power. This equipment ensures i.a. power supply to the reactor feedwater control system. The disturbance of the UPS equipment did not bring about a break in on-site power supply.

The causal link between the failure of the UPS equipment and the disturbance in feedwater control is being investigated. The failed equipment will be further examined to establish the causes of the failures. The event also leads to a further specification of the emergency operating instructions for the UPS equipment. Teollisuuden Voima Oy will also look into the present configuration of the reactor feedwater control system and whether its operation is reliable enough.

TVO II

No reportable events occurred at TVO II in the first quarter of 1993.

4 RADIATION SAFETY

Individual doses to nuclear power plant personnel remained below the dose limit. Also environmental releases remained well below the release limits. In samples collected in the vicinity of the Finnish nuclear power plants, only quantities of radioactive material insignificant to radiation exposure were detected, originating in the plants.

4.1 Occupational exposure

The highest individual dose at the Finnish nuclear power plants was 4.4 mSv and it was received at the TVO nuclear power plant. The Radiation Decree stipulates that the annual effective dose incurred in radiation work may not exceed 50 mSv. The dose may not exceed the 20 mSv annual average over a period of five years. This monitoring started at the beginning of 1992.

The individual dose distribution of nuclear power plant personnel in the first quarter of 1993, is given in Table III, which specifies the number of individuals by dose range and plant site. The information given in the Table originates in the central dose file of the Finnish Centre for Radiation and Nuclear Safety

In the report period, the collective occupational dose at the Loviisa plant was 0.04 manSv and at the TVO plant 0.06 manSv. A guide of the Finnish Centre for Radiation and Nuclear Safety, which came into force at the beginning of 1993, determines the collective dose limit for one plant unit at 2.5 manSv per one gigawatt of net electrical power averaged over two successive years; this means a collective dose of 1.11 manSv/year for the Loviisa plant unit and 1.78 manSv/year for the TVO plant unit.

4.2 Environmental releases and population exposure

Table IV gives measured environmental releases site by site. The Table shows also annual release limits. In the report period, environmental releases remained well below authorized limits.

4.3 Environmental monitoring

In this annual quarter, a total of about 140 samples of air, fallout, domestic and sea water, milk and fry were analysed according to monitoring programmes.

Radioactive material originating in the Finnish nuclear power plants was detected in only one sample. A sea water sample collected near the cooling water discharge outlet of the Loviisa nuclear power plant contained the following nuclides: manganese-54, cobalt-58, cobalt-60 and silver-110m. Concentrations were low (2 - 20 Bq/m^3) and require no action.

Table III. Occupational dose distribution in the report period and in 1992.

Dose range (mSv)	Number of persons by dose range					
	First quarter 1993			1992		
	Loviisa	TVO	Total[a]	Loviisa	TVO	Total[a]
< 0.5	64	100	164	197	412	545
0,5 - 1	10	23	33	101	240	318
1 - 2	13	11	25	134	226	328
2 - 3	2	1	3	108	113	210
3 - 4	-	-	-	70	63	112
4 - 5	-	2	2	48	48	93
5 - 6	-	-	-	50	33	72
6 - 7	-	-	-	35	22	60
7 - 8	-	-	-	28	19	48
8 - 9	-	-	-	23	15	38
9 - 10	-	-	-	21	10	39
10 - 11	-	-	-	23	9	39
11 - 12	-	-	-	14	8	29
12 - 13	-	-	-	6	6	13
13 - 14	-	-	-	13	7	19
14 - 15	-	-	-	6	1	9
15 - 16	-	-	-	4	1	8
16 - 17	-	-	-	6	2	12
17 - 18	-	-	-	1	-	1
18 - 19	-	-	-	4	-	5
19 - 20	-	-	-	3	1	6
20 - 21	-	-	-	2	-	2
21 - 25	-	-	-	-	-	2
25 - 30	-	-	-	2	-	4
> 30	-	-	-	-	-	-

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

Table IV. External releases of radioactivity by plant site, first quarter 1993.

	Releases into the air (Bq)[a]				
Plant site	**Noble gases (Krypton-87 equivalents)**	**Iodines (Iodine-131 equivalents)**	**Aerosols**	**Tritium**	**Carbon 14**
Loviisa					
Report period	$4.2 \cdot 10^{10}$ b)	c)	$4.4 \cdot 10^{6}$	$5.9 \cdot 10^{10}$	d)
In 1992	$2.2 \cdot 10^{11}$ b)	$2.5 \cdot 10^{7}$	$2.8 \cdot 10^{8}$	$2.3 \cdot 10^{11}$	$1.5 \cdot 10^{11}$ e), d)
Olkiluoto					
Report period	$1.1 \cdot 10^{11}$	$6.7 \cdot 10^{5}$	$1.9 \cdot 10^{7}$	$1.4 \cdot 10^{}$	d)
In 1992	$2.0 \cdot 10^{12}$	$1.5 \cdot 10^{8}$	$3.1 \cdot 10^{8}$	$3.5 \cdot 10^{11}$	d)
Annual release limits					
Loviisa	$2.2 \cdot 10^{16}$ f)	$2.2 \cdot 10^{11}$ f)			
Olkiluoto	$1.8 \cdot 10^{16}$	$1.1 \cdot 10^{11}$			

	Releases into water (Bq)[a]	
Plant site	**Tritium**	**Other nuclides**
Loviisa		
Report period	$4.0 \cdot 10^{12}$	$3.1 \cdot 10^{6}$
In 1992	$1.0 \cdot 10^{13}$	$3.5 \cdot 10^{9}$
Olkiluoto		
Report period	$8.4 \cdot 10^{11}$	$2.4 \cdot 10^{9}$
In 1992	$1.8 \cdot 10^{12}$	$1.6 \cdot 10^{10}$
Annual release limits		
Loviisa	$1.5 \cdot 10^{14}$	$8.9 \cdot 10^{11}$ f)
Olkiluoto	$1.8 \cdot 10^{13}$	$3.0 \cdot 10^{11}$

a The unit of radioactivity is Becquerel (Bq); 1 Bq = one nuclear transformation per second.
b Measured releases of fission and activation gases. In addition, the calculatory release of argon-41 from Loviisa 1 and 2 in krypton-87 equivalents was $4.2 \cdot 10^{11}$ Bq in the report period and $1.4 \cdot 10^{12}$ Bq in 1992.
c Below the detection limit.
d The carbon-14 release estimate based on experimental data was $8.6 \cdot 10^{10}$ Bq in Loviisa and $1.7 \cdot 10^{11}$ Bq in Olkiluoto in the report period. In 1992 the estimates were $2.7 \cdot 10^{11}$ Bq in Loviisa and $6.4 \cdot 10^{11}$ Bq in Olkiluoto.
e The measured carbon-14 release.
f The numerical value shows the release limit for the Loviisa plant site on the presumption that no releases of other release types occur. The release limit is set in such a way that the sum of the various types of release limit shares shall be smaller than or equal to 1.

5 SAFETY-ENHANCING MODIFICATIONS AT NUCLEAR POWER PLANTS

In the first quarter of 1993, modifications to enhance fire safety were made at the Loviisa nuclear power plant. The modifcations made at the TVO plant units help ensure fuel supply to back-up diesels and reduce the risk of clogging up of their circulating water exchangers.

A fire extinguishing system was installed in the circulating water pumping station of Loviisa 1 to improve the station's fire safety.

Both at TVO I and TVO II, the volume of day tanks which contain back-up diesel fuel was increased by resetting the tanks' liquid level limits. Further modifcations will be implemented during annual maintenance. After their completion all day tanks will have been modified in this way and the minimum amount of fuel the tanks can always take up is equal to the operating time of the diesels given in the design bases, i.e. eight hours. Fuel lasted for about seven hours before the modification. At TVO II, also fuel tubing of two back-up diesels was replaced with tubing whose material will last longer than old tubing material.

Strainers were installed in the shutdown service water systems of TVO I and II. These prevent the heat exchangers of back-up diesels from getting clogged up by mussels and other impurities which may dislodge from sea water channels. At TVO I the devices were installed in two and at TVO II in three heat exchangers; thus, all diesels have been fitted with these strainers.

6 OTHER MATTERS RELATING TO THE USE OF NUCLEAR ENERGY

In the first quarter of 1993, work on a low and intermediate level waste repository was started on the nuclear power plant site of Hästholmen in Loviisa. In the same quarter, the Nuclear Energy Decree was modified.

6.1 Waste repository for low and intermediate level waste from the Loviisa nuclear power plant

In December 1986, Imatran Voima Oy submitted to the Finnish Centre for Radiation and Nuclear Safety an application for the construction of a repository for low and intermediate level reactor waste. On 29 September 1988, the Finnish Centre for Radiation and Nuclear Safety approved the application and the attached Preliminary Safety Analysis Report for the facility. Imatran Voima Oy postponed the facility's construction, however, as there was plenty of intermediate storage space available for use at the Loviisa nuclear power plant and waste management methods were still being developed. Low and intermediate level reactor waste includes i.a. ion-exchange resins, evaporation and solidifcation wastes of process waters, and maintenance waste.

Under the transition provisions of the Nuclear Energy Act which entered into force in 1988, the Finnish Centre for Radiation and Nuclear Safety's approval for the construction of the facility was in force until 28 February 1993. Thereafter, a construction permit should have been applied from the Council of State, in accordance with the Nuclear Energy Act.

An amendment in the town plan concerning the repository took legal effect in the beginning of February 1993, whereafter the building board of the town of Loviisa granted a construction permit for the facility. On 22 February 1993, the Finnish Centre for Radiation and Nuclear Safety approved for the facility a quality assurance programme, an excavation work description and a research programme for the construction period. On 26 February 1993, Imatran Voima Oy commenced excavation of the repository which is due for completion in 1996.

The layout plan of the repository is given in Fig 7. The actual waste rooms, which comprise a hall for solidified waste and four ends of tunnels for the placement of maintenance waste, will be excavated in bedrock, at 100 meters' depth. The total excavation volume is about 100 000 m^3. The layout plan will be reviewed later i.a. on the basis of bedrock investigations which will be conducted during the construction of the transport tunnel.

6.2 Regulations

The Nuclear Energy Decree has been amended and supplemented (26 March 1993). Licencing was extended i.a. so that the export controls of the Nuclear Energy Act also apply to so called dual-use items, equipment and materials plus related information for which the Ministry for Trade and Industry grants export licences. Apart from peaceful uses, dual-use items can have military applications as well.

English-language translations of the below YVL Guides of the Finnish Centre for Radiation and Nuclear Safety have been published: Regulatory control of nuclear facility valves and their actuators (Guide YVL 5.3), Control of nuclear fuel and other nuclear materials required in the operation of nuclear

power plants (Guide YVL 6.1) and Limitation of public exposure in the environment of and limitation of radioactive releases from nuclear power plants (Guide YVL 7.1).

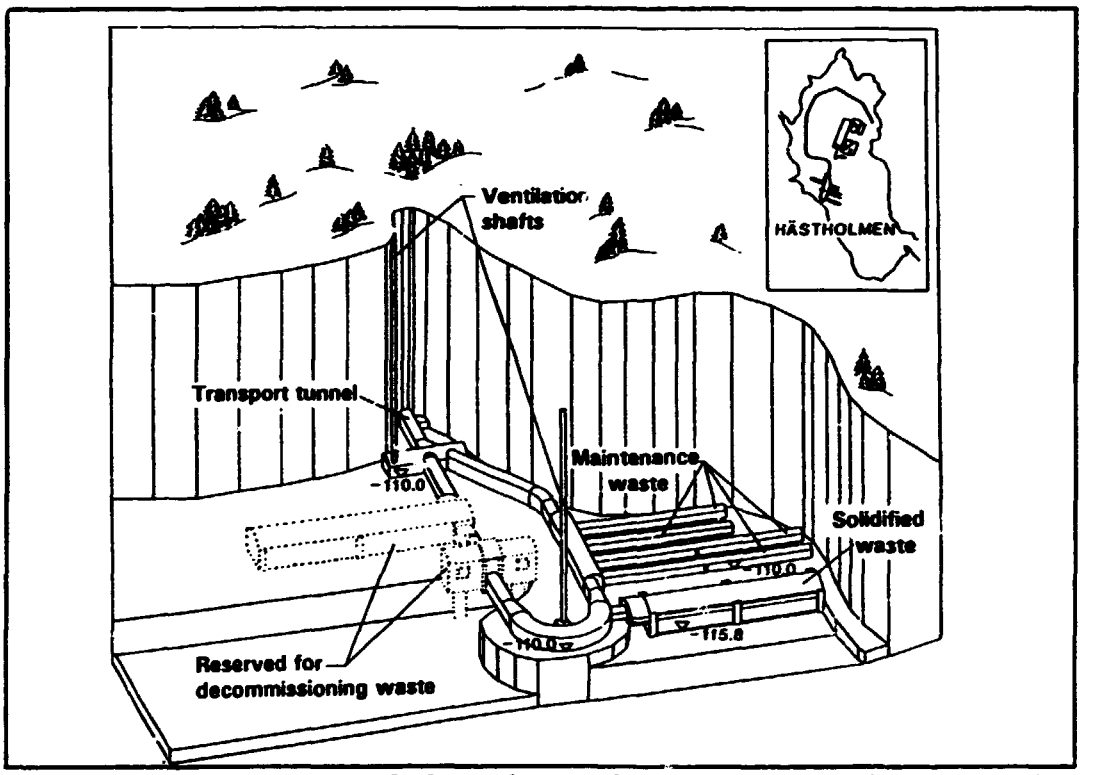

Fig 7. A diagram of a repository for low and intermediate level waste from the Loviisa nuclear power plant; the facility is being constructed on the island of Hästholmen.

APPENDIX 1

REGULATORY CONTROL OF NUCLEAR FACILITIES

The regulatory control performed by the Finnish Centre for Radiation and Nuclear Safety encompasses the following areas (the granting of the licenses mentioned in parentheses is recommended when the control activities have been completed and no reason for withholding the license has arisen):

Construction Phase

- Preliminary plans of the nuclear facility
- Location and environmental effects of the plant
- Arrangements for nuclear fuel and nuclear waste management
  (Decision in principle)

- Preliminary safety analysis report on the planned structure and operation of the plant as well as the preliminary safety analyses
- Safety classification of components and structures
- Quality assurance plan
- Plans concerning nuclear fuel and nuclear waste management
- Physical protection and emergency preparedness
  (Construction permit)

- 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
- Composition 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)

Operating Phase

- Start-up testing at various power levels
- Maintenance, inspections and testing of components and structures
- Operation of systems and the whole plant
- Operation and competence of the operating organisation
- Exceptional events
- Repairs and modifications
- Refuelling
- Nuclear fuel management and safeguards
- Nuclear waste management
- Radiation protection and safety of the environment
- Physical protection and emergency preparedness
- Observance of quality assurance programme

APPENDIX 2

PLANT DATA

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
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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