CNS Second Extraordinary Meeting

National Report

FINLAND

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Executive summary

General

Finland on 20 September 1994 signed the Convention on Nuclear Safety, which was adopted on 17 June 1994 at the Vienna Diplomatic Conference. The Convention was ratified on 5 January 1996, and it came into force in Finland on 24 October 1996. This report is the Finnish National Report for the Extraordinary Meeting of the Convention of Nuclear Safety in August 2012.

There are two nuclear power plants operating in Finland: the Loviisa and Olkiluoto plants. The Loviisa plant comprises two VVER units (Soviet type pressurised water reactors) operated by Fortum Power and Heat Oy and the Olkiluoto plant two BWR units (boiling water reactors) operated by Teollisuuden Voima Oyj (TVO). In addition, a new nuclear power plant unit is being constructed by TVO at the Olkiluoto site (EPR type pressuried water reactor). At both sites there are interim storages for spent fuel as well as final repositories for intermediate and low level radioactive waste. Furthermore, a Triga Mark II research reactor is operated in Espoo by the Technical Research Centre of Finland.

Following the accident at the Fukushima Dai-ichi NPP on 11 March 2011 (TEPCO Fukushima Dai-ichi accident), safety assessments in Finland were initiated after Radiation and Nuclear Safety Authority (STUK) received a letter from the Ministry of Employment and the Economy (MEE) on 15 March 2011. The Ministry asked STUK to carry out a study on how the Finnish NPPs have prepared against loss of electric power supply and extreme natural phenomena in order to ensure nuclear safety. STUK submitted the study report to MEE on 16 May 2011. Although immediate actions we not considered necessary, STUK required the licensees to carry out additional assessments and present action plans for safety improvements. Assessments were conducted and reported by the Finnish licensees to STUK on 15 December 2011. STUK is reviewing the results of national assessments, and is aiming to take a position on the suggested safety improvements and additional analyses by the end of June 2012.

Finland also participated in the EU Stress Tests and submitted the national report to European Commission at the end of 2011. An EU level peer review on the report was completed by April 2012. The results of the EU peer review will be taken into account in the national decisions.

Actions, responses and new developments in Finland, which have been initiated, finished or were influenced by the TEPCO Fukushima Dai-ichi accident, are discussed in this report in six topical areas. Finland's Stress Test Report which was submitted to the European Commission is given as an attachment to this report. The Attachment contains further information on the assessment and its results that support the information provided in this report.

Based on the results of assessments conducted in Finland to date, it is concluded that no such hazards or deficiencies have been found as would require immediate actions at the Finnish NPPs. As presented in this report, areas where safety can be further enhanced have been identified and there are plans on how to address these areas.

External events - earthquakes

Finland is situated in a low-seismicity area. There are no seismically active fault lines and zones in Finland. No earthquake disasters in the area of Finland are mentioned in written history. Requirements concerning seismic design were introduced into the Finnish nuclear safety regulations the first time in 1988. Because of that, and due to the low seismicity of southern Finland, earthquakes were not considered in the original design of the operating NPPs in Finland. Earthquakes are taken into account in the design of new plants.

The seismic safety assessment of the currently operating NPPs is mostly based on seismic PSA studies. First studies were completed in 1992 for Loviisa NPP and in 1997 for Olkiluoto NPP. In these studies certain structures were identified that were strengthened to withstand seismic loads. The seismic risk estimated in the latest PSA updates (Loviisa 2010, Olkiluoto 2008) is considered low.

As a result of the studies made after the TEPCO Fukushima Dai-ichi accident, further studies will be conducted to confirm the adequate robustness of certain vital structures such as the spent fuel pool structures and fire water systems. These studies are ongoing.

External events - flooding

Both Finnish NPPs are located on the coast of the Baltic Sea. Seawater level variations in the Baltic Sea are moderate. Due to geological conditions and the shallow water, strong tsunami-type phenomena are not considered possible in the Baltic Sea.

The Finnish regulations do not include explicit quantitative requirements on the flood level for consideration in the design of NPPs. The design values shall be based on site-specific assessments conducted or contracted by the licensee and reviewed by STUK in co-operation with the appropriate expert organizations, especially the Finnish Meteorological Institute.

Based on the previous evaluations and studies made after the TEPCO Fukushima Dai-ichi accident, exceeding of the critical seawater level at Olkiluoto site is very unlikely. The Loviisa site is more vulnerable to high seawater level especially if either of the plant units is in cold shutdown and the seawater system has been opened for maintenance. The licensee of Loviisa NPP is considering either local protection for certain safety significant buildings, or flood banks. STUK is reviewing the different actions proposed by the licensee.

External events – extreme weather

The original design of the operating NPPs in Finland did not take into account all possible aspects of weather phenomena or their possible combinations. Weather phenomena and other extreme external conditions including the combinations of phenomena relevant at the plant site have been comprehensively analyzed at the operating NPPs by a weather PSA, which is part of the overall PSA. The results of the weather PSA studies and operational experiences regarding the impact of extreme weather phenomena on plant

operation have been taken into account in the design of preventive measures, technical modifications and plant procedures included.

As a result of the studies made after the TEPCO Fukushima Dai-ichi accident, some further changes will be made at the operating NPPs, as discussed in this report and in the Attachment.

Design

The systems needed for residual heat removal from the reactor, containment and fuel pools require external power (e.g electricity) at both Finnish NPPs. At both sites, the ultimate heat sink is the sea. Depending on the design features of the plant, the time margins to withstand station blackout and loss of ultimate heat sink vary. A reliable supply of electrical power to the systems providing for basic safety functions at the Finnish NPPs is ensured by the Defence-in-Depth concept. As a result of multiple and diversified electrical power sources at different levels, the probability of loss of all electrical supply systems is considered very low at the Finnish NPPs.

However, as a result of the studies made after the TEPCO Fukushima Dai-ichi accident, further changes are expected to be implemented at both NPPs. Main changes are aimed at decreasing the dependency on plant's normal electricity supply systems as well as on the sea water cooled systems for residual heat removal from the reactor, containment and spent fuel pools.

Severe accidents

A comprehensive severe accident management (SAM) strategy has been developed and implemented at the Olkiluoto 1 and 2 as well as Loviisa 1 and 2 plant units. Development of the strategies started after the accident in Chernobyl in 1986, and the latest measures were in place in 2003. These strategies are based on ensuring containment integrity, which is required in the existing national regulations. STUK has reviewed these strategies and has made inspections in all stages of implementation. Provisions for severe accident management were included in the original design of Olkiluoto 3.

As a result of the studies made after the TEPCO Fukushima Dai-ichi accident, no major changes at the plants are considered necessary. However, licensees are expected to consider all plant stages in the SAM procedures as well as any implications on them possibly arising from simultaneous multi unit accidents.

National organizations

The main stakeholders in Finland having a role or responsibilities with regard to nuclear and radiation safety are Parliament, the Government, the Ministry of Employment and the Economy, the Ministry of Social Affairs and Health, the Ministry of the Interior, regional Rescue Authorities, licensees operating nuclear facilities and licensees using radiation, the Radiation and Nuclear Safety Authority (STUK), the Technical Research Centre of Finland (VTT), and the Universities.

Roles and responsibilities of the main stakeholders are defined in the Finnish legislation. According to the Nuclear Energy Act, a licensee is responsible for safety. STUK is responsible for the regulatory oversight of the safety of the use of radiation and nuclear energy. The rights and responsibilities of STUK are provided for in the Radiation Act and the Nuclear Energy Act.

As a result of the studies made after the TEPCO Fukushima Dai-ichi accident, no major changes are considered necessary in this area so far. However, based on the experience from the follow-up and assessment of the TEPCO Fukushima Dai-ichi accident in March 2011, prompt and flexible means to engage TSO resources and tools also in accident situations to support regulatory recommendations will be explored.

Emergency Preparedness and Response and Post-Accident Management (Off-Site)

The requirements for off-site plans and activities in a radiation emergency are provided for in the Decree of the Ministry of the Interior issued in 2011. Off-site emergency plans are prepared by regional authorities. In addition to actual emergency rescue planning, the authorities are also required to be prepared for long-term actions following an accident involving radioactive releases. Legislation and plans define clearly the roles and responsibilities of stakeholders having a role in an emergency. Emergency exercises are conducted annually between the licensee and STUK. Every third year all authorities are training together.

For post accident management, STUK has prepared so called VAL guides. These guides contain the intervention strategy in Finland (for various types of emergencies, protective measures and intervention levels in the early and intermediate phases of a nuclear or radiological emergency). The VAL guides are put into force by the Ministry of the Interior.

As a result of the studies made after the TEPCO Fukushima Dai-ichi accident, no major changes are identified in this area so far. However, there is a need to ensure accessibility to the site in case of extreme weather conditions, a sufficient amount of radiation protection equipment and radiation monitoring capabilities for rescue services and communication capabilities. In addition, there is a need to ensure that the resources of rescue authorities can be reasonably coordinated between radiological and other emergencies, should they happen simultaneously. The coordination of activities and sharing of resources between different regional rescue authorities also needs to be enhanced. Discussions between STUK, licensees and rescue authorities are ongoing.

International co-operation

Finland has signed the international conventions and treaties aiming at a safe and peaceful use of nuclear energy, and is commited to transparency and enhancing nuclear safety internationally through international co-operation and implementation of the IAEA Action Plan.

Finland is a party to the Convention on Early Notification of a Nuclear Accident and the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency. Finland has bilateral agreements with neighbouring countries to ensure the possibility

of sharing information and experiences on nuclear safety. This ensures good contacts and information exchange also during emergencies.

Finland participates actively in the work of international organisations such as the IAEA, the OECD/NEA and the EC. Finland has actively contributed to the work on the IAEA Safety Standards since the standards are seen as a very important tool to harmonise and improve nuclear safety globally. The IAEA standards are also utilised in Finland when renewing national safety regulations. In addition, Finland supports strongly the use of the IAEA peer review services. The IAEA peer reviews have been hosted in Finland and Finnish experts often participating in peer reviews abroad. Finland also participates actively in European level harmonisation.

Utilization of operating experience feedback is seen as a very important tool to improve safety worldwide. Finland believes that the international operating experience process should be improved to ensure that lessons are learned from operating experience and measures are taken to avoid recurrence of significant events.

INTRODUCTION

A severe accident took place in Japan at Fukushima Dai-ichi nuclear power plant on the 11th of March in 2011 (TEPCO Fukushima Dai-ichi accident). Several investigations and studies have been initiated since, to study whether the same kind of accident could take place in other nuclear power plants (NPP), as well.

Safety assessments in Finland were initiated after Radiation and Nuclear Safety Authority (STUK) received a letter from the Ministry of Employment and the Economy (MEE) on 15 March 2011. The Ministry asked STUK to carry out a study on how the Finnish NPPs have prepared against loss of electric power supply and extreme natural phenomena in order to ensure nuclear safety. STUK submitted the study report to MEE on 16 May 2011. Although immediate actions we not considered necessary, STUK required the licensees to carry out additional assessments and present action plans for safety improvements. Assessments were conducted and reported by the Finnish licensees to STUK on 15 December 2011. STUK is reviewing the results of national assessments, and is aiming to take a position on the suggested safety improvements and additional analyses by the end of June 2012.

Finland also participated in the EU Stress Tests and submitted the national report to European Commission at the end of 2011. An EU level peer review on the report was completed by April 2012. The results of the EU peer review will be taken into account in the national decisions.

The experiences from the TEPCO Fukushima Dai-ichi accident are taken into consideration in the ongoing renewal of the legislation and Finnish Regulatory Guides (YVL Guides).

Finland signed on 20 September 1994 the Convention on Nuclear Safety which was adopted on 17 June 1994 in the Vienna Diplomatic Conference. The Convention was ratified on 5 January 1996, and it came into force in Finland on 24 October 1996. This report is the Finnish National Report for the Extraordinary Meeting of the Convention of Nuclear Safety in August 2012, and introduces national actions in Finland initiated after March 2011 as a result of TEPCO Fukushima Dai-ichi accident.

1. EXTERNAL EVENTS

1.1 General considerations of external events in Finnish NPPs

In general, external natural hazards are to be taken into account when selecting the NPP site in Finland, as well as in assessing the safety of NPPs. For new plants, there are specific requirements for protection against earthquakes, and these requirements are also applied when renewing or replacing systems and components at existing plants. For other external hazards, site-specific design requirements are defined according to the local conditions.

The Government Decree on the Safety of Nuclear Power Plants (733/2008) states about siting of a plant that *the safety impact of local conditions, as well as the security and emergency preparedness arrangements, shall be considered when selecting the site of a nuclear power plant. The site shall be such that the impediments and threats posed by the facility to its environment remain extremely minor and heat removal from the plant to the environment can be reliably implemented.*

Furthermore, the Decree includes provisions for protection against external hazards: *The design of a nuclear power plant shall take account of external events that may challenge safety functions. Systems, structures and components are to be designed, located and protected so that the impacts of external events on plant safety remain minor. External events to be accounted for include at least exceptional weather conditions, seismic events and other factors resulting from the environment or human activity. Design must also take account of illegal activities undertaken to damage the plant, and a large airliner crash.*

The specific requirements for further safety assessment, as well as licensees' suggestions to manage external events are given in Section 1.2 below. A more detailed evaluation of the situation in Finland conserning external events is given in the National Stress Test Report given as an attachment to to this report.

Earthquakes

Finland is situated in the north-western part of Europe and belongs to the Baltic shield. Due to the intraplate location Finland is in low seismicity area. There are no seismically active fault lines and zones in Finland. No earthquake disasters in the area of Finland are mentioned in the written history.

Operating units in Loviisa and Olkiluoto sites are located in the lowest seismic hazard zone of Finland. These units were not originally designed against earthquakes. However, in accordance with STUK's Guide YVL 2.8 seismic PSAs with extensive structural analyses of critical structures and components have been conducted for the operating units, and plant modifications have been carried out to improve seismic safety. Current Finnish seismic requirements stated in Guide YVL 2.6 are in accordance with IAEA NS-G-3.3 requirement 5.3 with footnote 1. NPP site specific peak ground acceleration (PGA) criteria is set so that, in the current geological circumstances, stronger earthquakes are anticipated not more often than once in a hundred thousand years (10^{-5}/a) on median confidence level, which is stated in guide YVL 2.6.

Further on since 1988 design basis earthquake (DBE) for safe shutdown has been set 0.10 g in horizontal directions and 2/3 of 0.10 g in vertical direction concerning new units and SSCs at Loviisa and Olkiluoto sites. This is according to minimum level suggested by IAEA NS-G-1.6 and IAEA NS-G-3.3.

As required in YVL 2.8, licensees in Finland have continuous full scope PSA based process to evaluate and develop the nuclear safety at NPPs. Latest seismic PSA has been done 2008 for Olkiluoto NPP and 2010 for Loviisa NPP. Seismic PSAs are updated in accordance to periodic safety reviews (PSR).

Based on the results of the PSA, seismic risk is low in Finnish NPPs. Unit specific seismic CDF for Loviisa units is a fraction of 0.3% of total CDF, for Olkiluoto operating units 1 & 2 about 1% of total CDF, and for Olkiluoto 3 under construction (EPR) it is estimated to be around 1% of total CDF.

The Finnish research program on nuclear power plant safety (SAFIR) is supporting the safety development in Finland. At the end of 2010, STUK initiated in SAFIR a project for seismic safety research in order to update Finnish state of the art knowhow, assess seismic safety design margins cumulating from seismic hazard analyses to final qualification as well as enforcing the corresponding education in Finland.

Flooding

Seawater level variations in the Baltic Sea are moderate. Due to geological conditions and the shallow water strong tsunami type phenomena are not considered possible in the Baltic Sea.

At Loviisa the observed maximum seawater level is +1.77 m above the mean sea level (N60 reference system). The design basis of the Loviisa NPP is about +3 m during power operation and about +2.1 m during refueling shutdown. Based of extreme value distribution fitting, the annual probability of exceeding the level +3 m is about $4 \cdot 10^{-7}$. The refueling shutdowns are scheduled for summer and early autumn when the sweater level variations are small. The design basis of the Loviisa NPP is considered sufficient in the short term. Although the estimated annual probability of exceeding the design value is very small, the consequences of flooding of the basement of the Loviisa NPP would be severe, as all cooling systems might be lost. Therefore, to ensure safe operation in the long term, the possibilities for decreasing the risk of seawater flooding have to be examined.

At Olkiluoto region the observed maximum seawater level is about +1 m in the N60 system (about +1.23 m above the current mean sea level). The design basis of all Olkiluoto NPP units is +3.5 m (N60). Based of extreme value distribution fitting, the annual probability of exceeding the level +3.5 m is less than $1 \cdot 10^{-9}$. The design basis of the Olkiluoto NPP units is considered sufficient. The design basis of the spent nuclear fuel interim storage (SPF storage) is only +1.2 m. The value corresponds to general building requirements, and according to the current view cannot be considered sufficient for a nuclear facility. However, it has been estimated that in practice the SPF storage can withstand seawater levels up to +3.5 m, but additional investigations are required.

In the vicinity of the Finnish NPPs, there are no major rivers or dams which would pose a flooding risk to the plants.

Extreme weather

The original design of the operating NPPs in Finland did not take into account all possible aspects of weather phenomena or their possible combinations. Weather phenomena and other extreme external conditions including the combinations of phenomena relevant at the plant site have been comprehensively analyzed at the operating NPPs by a weather PSA, which is part of the overall PSA. The results of the weather PSA studies and operational experiences regarding the impact of extreme weather phenomena on plant operation have been taken into account in the design of preventive measures, technical modifications and plant procedures included.

1.2 Activities performed by the operators

1.2.a Actions taken or planned to address the topic

Based on studies responding to the letter from MEE after the TEPCO Fukushima Dai-ichi accident STUK set the following requirements to licensees.

Loviisa NPP

1. *An action plan with a schedule for ensuring fuel pool structures which have not been originally designed against seismic loads and further verification of fire protection after design basis earthquake. Corresponding pool structures are reload batching pools for reactors and spent fuel pools at the site.*

   In its response the licensee presented that it has made an agreement on analyses for reload batching pools for reactors and spent fuel pools in order to update fragility assessments against earthquakes. Corresponding PGA levels are 0.1 g, 0.2 g, 0.3 g and 0.4 g according to seismic PSA. The cracking of reinforced concrete and leak tightness of pool liners will be assessed against earthquake and loads caused by boiling water. Increase of boiling point because of overpressure in reactor building will be also taken into account. Analyses are estimated to be ready 30.4.2012.

   Firewater pumping in Loviisa site can be driven both by electric motors and diesel motors. In the case of SBO it is possible to get all the required firewater from diesel motor driven firewater pumps. Diesel motor driven firewater pumping facility can also provide cooling water to support heat removal during SBO. The licensee is currently concentrating seismic assessment on diesel engine driven firewater pumping station. Further seismic assessment of the firewater supply system is under consideration.

2. *An action plan with a schedule for improving preparedness for high seawater level at Loviisa NPP. Well-founded design values concerning high seawater level and a clarification of implementation of the defense in depth principle were also required.*

   In its response the licensee presented the effects of seawater flooding including the effects of exceeding the design basis and the effects of seawater pipe breaks.

The risk estimates are based on hazard curves for high seawater levels, which were updated in 2008 by the Finnish Meteorological Institute (FMI) using the best available data and expertise.

The flooding risk at Loviisa is small but not insignificant in comparison to the total risk. As the uncertainties with extreme natural phenomena are large, the licensee considers additional improvements to reduce the flooding risk. The alternatives include local flooding protection of critical safety equipment and protection of the site area with a levee. The licensee plans to carry out the necessary studies in 2012 and make decisions in 2013.

3. *A clarification on impacts of beyond design basis extreme cold and warm weather on plant safety systems including their auxiliary and support systems.*

   The licensee presented a clarification of the impacts of exceptional extreme warm and cold weather on safety systems and their support and auxiliary systems.

   On the basis of registered long-term temperature observations adjusted to relevant frequency distributions the licensee has estimated the risks and consequences of beyond design basis parameters i.e. extreme cold and high air temperature, high sea water temperature, and the combination of high air and sea water temperature on plant systems. In particular, loss of off-site power and availability of diesel generators in extreme cold temperature have been studied. Additionally, consequences of the combination of cold weather and strong wind on plant structures and safety related systems and equipment were considered.

   Based on the analysis the licensee considers the plant robustness and current protection against risks originated from exceptional high or cold temperatures of air and seawater are adequate and no acute measures are foreseen. In SAFIR programme, however, the licensee participates in the EXWE project, which focuses to effects of long-term changes in climate on plant design bases.

4. *In addition, STUK required the licensee to further analyse consequences of tornados and downbursts (missiles and pressure loads) on plant structures and systems.*

   In its response the licensee refers to its previous studies from 2006 and PSA results on the consequences of missiles and pressure loads due to tornados and downbursts, as they are considered as a part of the weather PSA studies. Based on the studies the overall risk due to these phenomena is low, , as strong tornados are very rare in Finland.

Olkiluoto NPP:

1. *An action plan with a schedule for ensuring fuel pool structures which have not been originally designed against seismic loads and further verification of fire protection after design basis earthquake.*

   In its response the licensee presented that it is going to update the reactor building fuel pools' fragility assessments fragility assessments against earthquakes during 2012. The spent fuel intermediate storage pools are designed to withstand seismic events.

   Firewater pumping in Olkiluoto site can be driven both by electric motors and diesel motors. In the case of SBO it is possible to get all the required firewater from diesel motor driven firewater pumps. Diesel motor driven firewater pumping facility can also provide cooling water to support heat removal during SBO. Seismic capacity of diesel driven pumps at firewater building is high; estimate for High Confidence of Low Probability of Failure (HCLPF) is 0.74 g. The licensee is updating corresponding seismic assessment on firewater pumping and firewater supply system at the plant.

2. *A more detailed clarification on the effects of exceptionally high seawater level on the cooling systems of the spent fuel interim storage and their electric power supply.*

   In its response the licensee presented a more detailed clarification on the effects of exceptionally high seawater level on the cooling systems of the spent fuel interim storage and their electric power supply. The critical seawater level for losing the cooling of the spent fuel pools is +2.5 m. According to the licensee, mobile pumps can remove the excess water from the building at seawater levels from +1.2 m to +2.5 m.

3. *A clarification on impacts of beyond design basis exceptional extreme cold and warm weather on plant safety systems.*

   In its response to STUK the licensee has presented the measures already implemented against extreme low and high air temperature conditions on plant structures and systems and the reassessment of the consequences of exceptional high and low air temperature. Based on the reassessment the licensee considers the plant robustness and current protection against risks originated from exceptional high or cold temperatures of air adequate and no acute measures are foreseen. In SAFIR programme, however, the licensee participates in the EXWE project, which focuses to effects of long-term changes in climate on plant design bases.

4. *In addition, STUK required the licensee to further analyse consequences of tornados and downbursts (missiles and pressure loads) on plant structures and systems.*

   Tornados and downbursts are considered as a part of the weather PSA studies, but deterministic investigations on extreme conditions have not been carried out. The licensee has started further investigations on the high wind speed effects on the reactor, control room and auxiliary buildings. For OL3 under construction, analyses done as part of the licensing process show that tornadoes up to the class EF3 (maximum wind speed 74 m/s) do not endanger safe shutdown.

1.2.b Schedules and milestones to complete the planned activities

See previous section.

1.2.c Results of these activities, including proposals for further actions

Preliminary results from the seismic hazards concerning the strength of the fuel pools show that they are not susceptible to earthquakes at levels currently considered as design basis in Finland.

Further results are not available yet.

1.3 Activities performed by the regulator

1.3.a Actions taken or planned to address the topic

Finland has ongoing research projects on extreme weather phenomena, extreme seawater level variations and seismic issues in the national nuclear safety research programme SAFIR2014. Planning and implementation of the programme is managed and overseen by STUK. As a result of the TEPCO Fukushima Dai-ichi accident, a reassessment was made how the accident should be taken into account, and the research projects mentioned here were somewhat redirected.

Related to stress tests and SAFIR2014 research STUK is considering sensitivity analyses for site specific hazard studies and reassessment of seismic fragilities of SSCs important to safe shutdown. Also update of assessment and possible qualification of the safety systems is under consideration.

STUK is currently renewing its regulatory guides (YVL guides) and requirements for more detailed SSE related monitoring and shut down requirements are under consideration. If specific safe shut down requirements are set, corresponding qualification for the monitoring systems and equipment would also be required.

1.3.b Schedules and milestones to complete the planned activities

STUK plans to complete the evaluation of the licensees' answers and suggestions to the specific requirements by the end of June 2012.

Regulatory guides that set requirements related to the topic 1 (for externals hazards, design of nuclear power plants and safety classification) are expected to be finalized by the end of 2012

1.3.c Conclusions of the outcome of the operators' activities

Not available yet.

2. DESIGN ISSUES

2.1 Overview of the performed analyses

A detailed evaluation of the situation in Finland conserning external events is given in the National Stress Test Report given as an attachment to this report.

The specific requirements for further safety assessment, as well as licensees' suggestions to manage these are given in Section 2.2 below.

2.2 Activities performed by the operators

2.2.a Actions taken or planned to address the topic

Based on studies responding to the letter from MEE after the TEPCO Fukushima Dai-ichi accident STUK set the following requirements to licensees.

Loviisa NPP:

1. *A plan to secure heat removal from the fuel to the ultimate heat sink (sea, atmosphere) in exceptional external threat situations.*

   The licensee considers a plant modification to ensure the decay heat removal in case of loss of seawater by implementing a secondary heat sink. The modification consists of two air-cooled cooling units per plant unit, one removing decay heat from the reactor and the other one ensures the decay heat removal from in-containment spent fuel pool and from the spent fuel storage pools. The cooling unit is connected to the intermediate cooling circuit, and it backs up the seawater cooled heat exchangers.

   In case of loss of ultimate heat sink, the licensee is investigating possibilities to operate the air-cooled cooling units and the boron injection pumps with an air-cooled diesel-generator. The modifications in consideration would create a possibility to closed-loop operation also in case of combined station blackout and loss of ultimate heat sink.

2. *A plan and schedule to secure alternative means of decay heat removal from fuel storage pools located in the reactor building.*

   The licensee has evaluated that water injection into the pool and boiling of the pool water is planned to be be used as an alternative means to remove decay heat from the in-containment pools. Based on more detailed analyses to be done, the water source will be defined.

3. *A plan and schedule to secure alternative means of reactor cooling in case of loss of existing systems.*

   This item is partly covered by the answer to requirements 1 above, and 8 and 9 below. In addition, the licensee has evaluated the measures needed to secure the availability of the auxiliary emergency feed water system in the case of loss of electrical power, water supply for the diesel driven auxiliary emergency feed water pumps,

and electricity supply for instrumentation needed in accidents. Some modifications may be needed, and testing of the arrangement is planned.

4. *An investigation of possibilities to secure decay heat removal from fuel storage pools (outside containment).*

   As explained above, the new air-cooled cooling units would remove the decay heat from all spent fuel storages (cf. the answer to requirement 1). In addition, water injection could be provided through mobile water injection systems in order to recover the boil-off of water from the pools.

5. *A plan and schedule to increase fuel reserve for emergency power at the site*

   There is enough diesel fuel in the EDG tanks for at least 72 h of operation, and with realistic loads in case of accident, the duration is evaluated twice that long.

   At present the Emergency Diesel Generators (EDGs) at Loviisa NPP use bio-free-diesel fuel, which is available only in limited scope. An investigation of replacing bio-free-diesel with widely available biodiesel is being done by the licensee and the diesel engine manufacturer.

   Secondly, the licensee started to investigate for a container to transfer diesel fuel at site. The purpose of this container is to make fuel transfer easier and faster. The container was acquired late 2011, and the procedures for its operation are under preparation.

   In addition, the licensee has started an investigation to build a fuel tank, from which it is possible to deliver fuel to the diesel generators' day tanks. This is a longer term task.

6. *A plan and schedule to secure DC power for long time needs.*

   The DC batteries depletion times are considered rather short in some cases. The duration of DC power supply is considered to be enhanced at least to such levels, that the severe accident management (SAM) diesel generators can be started up and connected to supply recharging of the batteries.

   The SAM diesel generator startup batteries are designed for 6 startups, and the control batteries of these diesel generators dimensioned equally as they are used as a backup for the startup batteries. Without recharcing, the control batteries provide electricity for more than 100 hours.

   There is an ongoing automation renewal project at Loviisa NPP, and the discharging time of the batteries supplying plant automation will come substantially longer as a result of the renewal.

   The licensee will give more detailed answers to STUK during the second quarter of 2012 about the most critical UPS battery loads.

In addition, the licensee will install two new separate underground cables from the new diesel power plant to the 6.3 kV diesel busbar, which will furthermore ensure and enhance battery charging possibilities.

7. *An investigation of the availability and operability of safety systems and their components in accidents of long duration.*

   The licensee has evaluated that further improvements on securing the long-term operability of the safety systems and equipment are not necessary. The risk studies carried out during the plant operation have shown the possibilities for significant safety improvements, and these have been made. The requirement is considered to be covered with the PSA studies continuously updated in Finland.

8. *An investigation of needs and possibilities to use mobile power supply and mobile pumps in accidents.*

   The licensee has studied the possibilities to utilize mobile power supply and mobile pumps to support safety functions in case the normal systems for the accident management at the plant are inoperable. Based on the studies the mobile devices are designed and can be used for the following targets:

   - to manage subcriticality by boron supply and the supply of seal water for reactor coolant pumps,
   - to ensure the secondary circuits mass balance,
   - to ensure water supply to auxiliary emergency feed water systems
   - to ensure the accident instrumentation,
   - to ensure electrical power supply to primary circuit SAM depressurization valves
   - to ensure heat transfer from the containment by ensuring water supply to containment external spray system
   - to transfer decay heat from spent fuel storage pools
   - to power control rooms lighting and communication at site

   The licensee has not yet made an investment decision for mobile power supply and mobile pumps. Implementation is planned to be made in 2012 and 2013.

9. *A plan and schedule to secure the availability of demineralised water, as well as raw water, at the site in an accident of long duration.*

   The licensee has evaluated different sources of demineralised water and concluded that there are adequate reservoirs of demineralised water at the plant site. There is enough water to supply decay heat removal for more than ten days, and thus increasing the capacity is not considered necessary. Ensuring water transfer between different tanks in considered more essential. STUK is reviewing this evaluation.

Olkiluoto NPP:

1. *A plan and schedule to secure decay heat removal from OL1 and OL2 reactors in case of total loss of AC power sources.*

   Currently the systems needed for providing cooling of the core are all electrically driven at Olkiluoto 1 and 2. Due to the short time margin before the reactor core damage in the case of a total loss of electricity, although considered as a very unlikely situation, nn independent way of pumping water to the reactor pressure vessel is being planned by the licensee. The arrangement could be based on the fire fighting water system but additional booster pumps would be needed. The design basis of the new equipment has not been decided, but the need to consider extreme external conditions will be considered. STUK will review the design basis and detailed design of the system.

2. *A plan and schedule to secure operation of the OL1 and OL2 auxiliary feed water system for accidents involving loss of seawater as ultimate heat sink.*

   The current residual heat removal chain of the Olkiluoto 1 and 2 is dependent on the sea water cooling. Licensee is planning plant modifications to decrease the dependence on the sea water cooling. As a first step, a modification in the auxiliary feed water system will be planned to enable cooling of the components by demineralised water in addition to sea water based cooling chain. By this modification system can remain operational for a significant period of time even during the loss of the primary ultimate heat sink (sea water). The licensee is also investigating possibilities to use atmosphere as a diverse heat sink for the residual heat removal, but this is a longer term task.

3. *A plan and schedule to secure decay heat removal from the fuel storage pools located in the OL1/OL2 reactor building in case of loss of existing systems.*

   The licensee has evaluated that water injection into the pool and boiling of the pool water could be used as an alternative means to remove decay heat from the in-containment pools. Feed of water to the fuel storage pools will be possible from the plant fire-fighting water system or an external fire-fighting vehicle. Some modifications are planned to ensure water injection with fixed systems.

4. *A plan and schedule to ensure reactor heat removal from OL3 reactor in case of loss of existing systems.*

   Olkiluoto 3 (OL3) is currently under construction and operating license application is expected to be submitted to the Ministry by the end of 2012. Evaluation of the compliance of the detailed design of the plant with Finnish safety requirements is therefore still ongoing.

   At present the licensee has not seen any immediate needs to implement modifications to OL3 plant. With regard to flooding, licensee has evaluated further the robustness of EDG building doors against flooding. The results indicate that the doors and the openings of the building can withstand several meters of water without a

threat to loss of EDGs. With regard to seismicity, OL3 has been designed to be able to withstand 0,1 PGA seismic event.

However, the licensee has assessed possibilities to implement external feed water connections to the Steam Generator (SG) secondary side, connections to external AC power supply and external make-up water injection into the RCS during refueling outages in order to have independent (from plant systems) means to fulfill residual heat removal function in case plant's normal systems are lost.. STUK is currently evaluating licensee's suggestions.

5. *An investigation of possibilities to secure heat removal from the fuel pools in the fuel building of OL3 and heat removal into the ultimate heat sink in case of exceptional external events.*

   For the decay heat removal from the fuel pools in the fuel building of OL3 the possibility to use fire water systems and boiling of the pool water has been evaluated. Additional mobile pumps to provide water injection into the fire water system are to be acquired before the start of operation of OL3. The needed external connection points, as well as temperature and level measurements are already included in the design of the fuel building systems.

6. *An investigation of alternative methods to supply coolant to the fuel storage pools (including a potential need for new instrumentation).*

   Interim spent fuel storage is common to OL1 and 2, and the storage is currently being enlarged and modified to be able to store the spent fuel from OL3 reactor. External junctions to the spent fuel storage pool water system will be added during the extension project. Feed of water to the fuel storage pools will be possible from fire-fighting vehicle via those junctions. Additional measurements to monitor the water level in the pools are to be implemented.

7. *An investigation of the need, and a plan and schedule if seen necessary, to secure fuel reserve for emergency power.*

   There is enough diesel fuel for more than one week of operation of EDGs at Olkiluoto NPP site, if fuel transfer between different tanks is considered. According to the licensee's evaluation there is no need for any upgrade in securing fuel reserve. The procedures for securing the reserve of lubricating oil are under investigation by the licensee.

8. *A plan and schedule to secure DC power for long time needs.*

   The discharge times of DC batteries at OL1 and 2 are well above 10 h, in some cases tens of hours. At OL3 there are separate 2 h and 12 h battery backed power supply systems. Thus, the licensee evaluates that there is no need for upgrading the battery capacity. However, the mobile power supplies (aggregates) for charging batteries are under investigation by the licensee (see also req. 10 below).

9. *An investigation of the availability and operability of safety systems and their components in accidents of long duration.*

   The licensee has evaluated the availability of the systems and their components using PSA methodology with regard to redundancy, diversity, and design safety margins. The operability of the various systems is also covered by the other requirements. The requirement is considered to be covered with the PSA studies continuously updated in Finland.

   Already for several years, the licensee has been preparing the possible renewal of all the eight emergency diesel generators (OL1 and OL2). Several plans, surveys and studies have been prepared for this project and the licensee is at present considering it but so far no investment decision for the EDG renewal has been made. The proposed renewal plan includes several safety improvements. First of all, the new EDGs would be equipped with two diverse component cooling systems. The primary EDG cooling would be provided by the sea water based cooling system, similar to present EDGs units, but an alternative, automatically activated air based cooling system would be added to cope with the loss of sea water situations. This would provide extra protection against external hazards, internal hazards such as fires, as well as component failures.

   Also, one extra EDG, a so-called 9th EDG, would be set up. This EDG would be located in a new, separate diesel building and, if needed, it could be connected to supply electric power to either OL1 or OL2. The 9th EDG could also be placed above ground level to im-prove protection against external flooding.

10. *An investigation of needs and possibilities to use mobile power supply and mobile pumps in accidents.*

    Investigation of needs and targets for mobile power supply has been started in autumn 2011 and is ongoing. Enhancing charging of batteries has been found feasible to improve the availability of DC power.

    After the investigation the licensee will perform pre-planning and this will completed in 2012. After that the licensee will make decision about the scope and schedule of the modifications. It is expected that installation will begin in 2013.

11. *An investigation of possibilities to secure the availability of demineralised water at the site in an accident of long duration.*

    At both OL1 and OL2, the amount of demineralised water available for feeding the reactor is at least 900 m^3, which is enough for cooling the core for about 1.5 days.

    The water inventories of the emergency feed water storage tanks and demineralised water tanks of OL3 are designed for 72 h regarding plant operation at full power at the initiation of an event.

    The raw water basin, which is situated next to the plant site in Korvensuo, contains above 130,000 m^3 of raw water. Due to the higher elevation of the basin surface in relation to the plant site grade level, a gravity driven water flow from the basin to the

water treatment plant at the site can be used to replenish the fire water reservoirs from where the water can be pumped to the plant with diesel driven fire water pumps. The gravity driven flow has been verified to reach at least 50 kg/s with the normal basin level.

2.2.b Schedules and milestones to complete the planned activities

Loviisa NPP:

The conceptual design plan for the air-cooled cooling towers providing an alternative ultimate heat sink will be ready in summer 2012. The cooling towers would be realised 2013 - 2015 (requirements 1, 2, 3 and 4).

The modifications to secure the availability of the auxiliary emergency feed water system will be realised during 2012 and 2013, with the exception of improving the instrumentation by 2015. (req. 3)

Related to the ensuring adequate reserve fuel for the EDGs, the licensee has already acquired a container to transfer diesel fuel at site.

During the second quarter of 2012 the licensee will give a more detailed answer to STUK about the most critical UPS battery loads.

Investment decision for mobile power supply and mobile pumps will be made in 2012 after related assessments on the need and purpose of mobile devices have been completed.

The two separate dedicated cable connections from the new diesel plant to the 6 kV safety switchgears will be completed in 2012–2013.

Olkiluoto NPP:

The conceptual design plans for plant modifications concerning

- the independent way of pumping water to the reactor pressure vessel using the fire-fighting water system (req. 1),
- implementing an additional way of component cooling of the auxiliary feed water system, independent of sea water cooling (req. 2), and
- using water injection and boiling as an alternative means to remove decay heat from the fuel storage pools located in the OL1/OL2 reactor building (req. 3)

will be completed by June 2012. The actual plant modifications are planned to take place during refueling outages of 2013 and 2014.

The external junctions to the interim spent fuel storage pool (outside the reactor buildings) water system will be added during the extension project of spent fuel storage between January 2012 and May 2013.

Investigation of needs and targets for mobile power supply has been started in autumn 2011 and is expected to be completed by the end of 2012. Procurement of the devices and needed modifications are expected to begin in 2013.

2.2.c Results of these activities, including proposals for further actions

Loviisa NPP:

The plant modifications concerning water injection to spent fuel pools (reqs. 3 and 4) will require further analysis before starting the detailed design work. The more detailed analysis will be performed in 2012 and 2013.

The licensee's analysis and investigations regarding the availability and operability of safety systems and their components (req. 7), and the availability of demineralised water (req. 8) resulted in the conclusion that no plant modifications were needed.

The licensee has a long time task to build a new tank of fuel at site, from which it is possible to deliver fuel to diesel generators' day tanks.

Olkiluoto NPP:

The Licensees analysis and investigations regarding the availability and operability of safety systems and their components (req. 9), and the availability of demineralised water (req. 11) resulted in the conclusion that no plant modifications were needed.

At present the licensee (TVO) is planning no modifications to OL3 plant under construction. However, possibilities to implement external feed water connections to the SG secondary side, connections to external AC power supply and external make-up water injection into the RCS during refueling outages have been under consideration.

2.3 Activities performed by the regulator

2.3.a Actions taken or planned to address the topic

The experiences from the TEPCO Fukushima Dai-ichi accident will also be taken into consideration in the ongoing renewal of the legislation and Finnish Regulatory Guides called YVL Guides. A plan has been prepared which indicates the different issues to be considered and the corresponding affected Guides. A new Guide dealing with the design of NPPs is currently in the final draft stage and has been sent out for external comments. The draft already incorporates lessons from the TEPCO Fukushima Dai-ichi accident by requiring protected autonomous systems that enable the decay heat removal from the reactor and the containment and arrangements to ensure sufficient cooling of the fuel in fuel storages for 8 hours without material replenishment or need to charge batteries. Decay heat removal shall be possible for 72 hours without any external help outside the plant.

The YVL Guides are applied as such in the design, construction and operation of the new NPPs (Fennovoima 1, Olkiluoto 4). A separate decision will be made concerning their application at the operating units (Loviisa 1 and 2, Olkiluoto 1 and 2) and also the unit under construction (Olkiluoto 3)

STUK is currently evaluating licensees' responses based on the national safety assessments and the suggestions to improve safety of the plant. STUK is also evaluating the detailed design of OL3 in order to confirm the fulfillment of Finnish requirements.

Furthermore, lessons from the TEPCO Fukushima Dai-ichi accident will be addressed in the National Research Programme on Nuclear Power Plant Safety 2011 – 2014.

2.3.b Schedules and milestones to complete the planned activities

STUK plans to complete the evaluation of the licensees' responses and suggestions to improve safety by the end of June 2012.

The end of 2012 is the target for completing the new regulatory guides (YVL Guides).

2.3.c Conclusions of the outcome of the operators' activities

Not available yet.

3. SEVERE ACCIDENT MANAGEMENT

3.1 Severe accident management in the Finnish NPPs

A comprehensive severe accident management (SAM) strategy has been developed and implemented both at Olkiluoto 1&2 and Loviisa 1&2 plant units. Development of the strategies started after the accident in Chernobyl in 1986, and the latest measures were in place in 2003. These strategies are based on ensuring the containment integrity which is required in the existing national regulations. STUK has reviewed these strategies and has made inspections in all stages of implementation.

Severe accidents have been considered in the original design of Olkiluoto 3. STUK has reviewed the overall SAM strategy and the approach has been accepted. No changes to this approach are expected based on current knowledge from the TEPCO Fukushima Dai-ichi accident.

A detailed evaluation of the situation in Finland conserning external events is given in the National Stress Test Report given as an attachment to this report.

The specific requirements for further safety assessment, as well as licensees' suggestions to manage these are given in Section 3.2 below.

3.2 Activities performed by the operators

3.2.a Actions taken or planned to address the topic

Based on studies responding to the letter from MEE after the TEPCO Fukushima Dai-ichi accident STUK set the following requirements to licensees.

Loviisa NPP:

1. *Licensee shall investigate needs and possibilities to use mobile power supply and mobile pumps in accidents.*

   Licensee is investigating possibilities to implement additional injection points for mobile pumps to provide more flexibility to the water supply of the containment external spray. These connections could provide capability to inject enough water for both units with one pump. The different possibilities will be analysed in more detail in 2012.

2. *Licensee shall make a review of the applicability of procedures and availability of personnel in case of accident in multiple units.*

   The licensee takes into consideration in the emergency instructions a case where an accident is considering both units and all fuel pools. The instructions will be evaluated in 2012, and improved where necessary. Some additions to number of people responsible for specific duties within the emergency organisation are planned.

   The licensee also aims at ensuring sufficient communication systems by supplying electricity to them from electrical systems available in severe accidents.

3. *Licensee shall investigate the need to secure containment heat removal without the sea water systems (the present method).*

   Further modifications are not seen necessary by the licensee, as there is already the possibility to inject water from external sources by mobile pumps (fire trucks) as a back-up for the fixed pumps.

The approach for spent fuel pools severe accident management is to "practically eliminate" the possibility of fuel damage. This approach can be considered acceptable, and to support this, STUK set the following requirements to the licensee.

4. *Licensee has to provide a plan and schedule to secure alternative means of decay heat removal from in-containment fuel pools.*

5. *Licensee has to investigate possibilities to secure decay heat removal from the spent fuel storage pools*

   To respond both requirements 4 and 5 above, the following approach is being considered. As an alternative ultimate heat sink, the possibility to install independent air-cooled cooling units with no connections to seawater systems or emergency diesel generators. The cooling units would take care of decay heat removal of reactors and fuel pools of both reactors and of spent fuel storage pools. Preliminary design on the solution is ongoing, and the basic design is estimated to be ready until summer 2012.

   Furthermore, licensee will improve EOPs and SAM Guidelines to support heat removal from spent fuel pools by pool boiling and supplying additional water to the pools. Licensee is also studying the seismic resistance of the fuels pools as well as the influence of pool water boiling to the pool structures.

   These are addressed also in Topic 2.

<u>Olkiluoto NPP:</u>

1. *STUK required the licensee to investigate the needs and possibilities to use mobile power supply and mobile pumps in accidents.*

   To secure recharging of DC batteries, the licensee is investigating the possibilities for fixed connection points for recharging of the safety important batteries using transportable power generators. The possible acquisition and use of transportable power generators for other supporting tasks, e.g. to recharge the batteries of the weather measurement instrumentation, is also under investigation.

   The licensee has initiated an investigation to secure electrical power by mobile aggregates. Investigation includes also renewal of the present mobile SAM diesel generators. Pre-planning of the arrangements is going to be ready in 2012 and possible installation is estimated to be carried out in 2013.

   External junctions to the spent fuel storage pool water system will be added during the extension project of spent fuel storage. Feed of water to the fuel storage pools will be possible from fire-fighting vehicle via those junctions.

2. *STUK required the licensee to review the applicability of procedures and availability of personnel in case of accident in multiple units.*

   Licensee has assessed possibilities to manage accidents affecting simultaneously multiple units at the site. This includes applicability of the procedures and required resources for accident management. Procedures and operating staff are unit specific, and therefore no significant issues have been identified. However, support resources needed for e.g. accident management, maintenance, rescue services at the site need to be reconsidered.

   In order to have additional communication facilities/systems, the licensee has decided to obtain satellite telephones to the emergency centres.

The approach for spent fuel pools severe accident management is to "practically eliminate" the possibility of fuel damage. This approach can be considered acceptable, and to support this, STUK set the following requirements to the licensee.

3. *The licensee has to provide a plan and schedule to secure decay heat removal from fuel storage pools located in the reactor building in case of loss of existing systems, and to investigate alternative methods to supply coolant to fuel storage pools (including potential need for new instrumentation).*

   To support monitoring of the water level in the spent fuel pools, there is a plan to equip all the fuel pools with a level measurement system with a measurement range from the normal water level down to the top of the fuel assemblies.

   Since the approach is to keep the spent fuel adequately submerged all the time, no other measures have been planned for enhancement of the capability to restrict radioactive releases from the fuel pools. Possibilities for adding makeup water from the fire fighting system to the pools from safe locations will be provided. The pool water level indications will also be routed to those locations.

4. *Regarding Olkiluoto 3 (OL3 under construction), STUK has requested the licensee to investigate possibilities to secure decay heat removal from fuel storage pools in the fuel building of OL3.*

   For the decay heat removal from the fuel pools in the fuel building of OL3 the possibility to use fire water systems and boiling of the pool water has been evaluated. Additional mobile pumps to provide water injection into the fire water system are to be acquired before the start of operation of OL3. The needed external connection points, as well as temperature and level measurements are included in the design of the fuel building systems.

3.2.b Schedules and milestones to complete the planned activities

See previous section.

3.2.c Results of these activities, including proposals for further actions

Not available yet.

3.3 Activities performed by the regulator

3.3.a Actions taken or planned to address the topic

Based on the current knowledge from the TEPCO Fukushima Dai-ichi accident, no specific changes to the regulatory guides are foreseen related to the severe accident management systems, as these are required already. To be able to manage the situation on-site in case of multi-unit severe accidents is to be included in the national legislation on Emergency Preparedness (EP) and in more detail in the EP specific regulatory guides (YVL Guides).

STUK is still evaluating the design of OL3, but the overall SAM strategy and approach has been accepted. No such hazards or deficiencies that would require changes to this approach have been found, and based on studies responding to the letter from MEE after the TEPCO Fukushima Dai-ichi accident STUK has not set any further requirements on the SAM approach of OL3. However, evaluation of the seismic robustness of severe acciden management systems is under consideration.

The final organisational issues for OL3 are not provided yet. The accident situation in more than one unit of the Olkiluoto site will have to be taken into account when considering the acceptability of the final plans.

3.3.b Schedules and milestones to complete the planned activities

STUK plans to complete the evaluation of the licensees' responses and suggestions to improve safety by the end of June 2012.

The end of 2012 is the target for completing the new regulatory guides (YVL Guides).

3.3.c Conclusions of the operators' activities

Not available yet.

4. NATIONAL ORGANIZATIONS

4.1 The general Finnish infrastructure

The Finnish Constitution is the cornerstone of all legislation and exercise of public power. It contains provisions on state organization, checks and balances between the top government branches and fundamental civil rights. The new Constitution of Finland entered into force on 1 March 2000. According to the constitution Finland is a sovereign republic. The constitution stipulates, how and by whom the acts and decrees as well as delegation of legislative powers can be issued.

The Ministry of the Employment and the Economy is responsible for the legislation in the nuclear energy field and the Ministry of Social Affairs and Health for the use of radiation (acts and decrees). Based on the Nuclear Energy Act and Radiation Act STUK has been authorized to issue the detailed safety requirements (YVL Guides and ST Guides). STUK's duties have been manifested in the Act and Decree on STUK as well as in the radiation and nuclear legislation.

4.2 National infrastructure and framework for safety

The main stakeholders in Finland having role or responsibilities with regard to nuclear and radiation safety are

- the Parliament and the Government,
- the Ministry of Employment and the Economy, the Ministry of Social Affairs, the Ministry of the Interior,
- licensees operating nuclear facilities and licensees using radiation,
- Radiation and Nuclear Safety Authority (STUK),
- Rescue Authorities,
- Technical Research Centre of Finland (VTT), and
- universities.

There are no plant vendors, or major heavy component suppliers for nuclear industry in Finland.

The policies and strategies for nuclear and radiation safety are mainly expressed trough legislation. The current nuclear energy legislation in Finland is based on the Nuclear Energy Act originally from 1987. The Act has been amended several times during the years it has been in force: most changes are minor and originate from changes to other Finnish legislation. Nuclear energy legislation was updated and reformed in 2008 to correspond to current level of safety requirements and the new Finnish Constitution. Together with a supporting Nuclear Energy Decree originally from 1988, the scope of this legislation covers e.g.

- the construction and operation of nuclear facilities; nuclear facilities refer to facilities for producing nuclear energy, including research reactors, facilities for extensive disposal of nuclear wastes, and facilities used for extensive fabrication, production, use, handling or storage of nuclear materials or nuclear wastes

– the possession, fabrication, production, transfer, handling, use, storage, transport, export and import of nuclear materials and nuclear wastes as well as the export and import of ores and ore concentrates containing uranium or thorium.

The licensing process for a nuclear facility includes the following phases: decision-in-principle, construction license and operating license. The Decision-in-principle is done and licenses for the construction and operation are granted by the Government. The related administrative preparation work is carried out by the Ministry of Employment and the Economy. In addition to safety, many other essential issues related to the use of nuclear energy are considered, and therefore the licensing decisions are made in Finland at the governmental level.

The current radiation protection legislation is based on the Radiation Act and Decree, both of which are from 1991 and take into account the ICRP Publication 60. Section 2, General principles, and Chapter 9, Radiation work, of the Act are applied to the use of nuclear energy. According to the Act the use of radiation is not generally allowed without a license granted by STUK.

Based on the Nuclear Energy Act, the Government issued in 2008 the following regulations:

– Government Decree on the Safety of NPPs (733/2008)
– Government Decree on the Security in the Use of Nuclear Energy (734/2008)
– Government Decree on Emergency Response Arrangements at NPPs (735/2008)
– Government Decree on the Safety of Disposal of Nuclear Waste (736/2008).

The legislation provides the regulatory control system for the use of radiation and nuclear energy. According to the Radiation and Nuclear Energy Acts, STUK is responsible for the regulatory oversight of the safety of the use of radiation and nuclear energy. The rights and responsibilities of STUK are provided in the Radiation and Nuclear Energy Acts. Safety review and assessment as well as inspection activities are covered by the regulatory oversight.

The duties of the authorities having responsibilities for safety are given by law. These duties include e.g. rulemaking, licensing and oversight of activities. Typical areas of safety calling for coordination are environmental issues, security arrangements as well as emergency preparedness.

Considering nuclear facility emergencies, in addition to the on-site emergency plans established by the licensees, off-site emergency plans required by the rescue legislation are prepared by regional authorities. The requirements for off-site plans and activities in a radiation emergency are provided in the Decree of the Ministry of Interior. In the case of nuclear and radiological accidents, STUK is an expert body to support the Ministry of Interior and other ministries as well as other government agencies in the emergency response. For that purpose STUK receives notifications from the licensees and initiates its emergency response according to procedures and starts to monitor, follow and evaluate the course of the accident as well as radiological consequences of the accident. Based on the expert support and recommendations from STUK, the rescue authorities make decisions and implement actions to protect the people in the affected areas. In the case of an accident, the role and responsibility of the licensee is to make any decision needed and

implement actions needed to ensure safety of the people, environment and the plant. The arrangements are tested in off-site emergency exercises conducted at routine intervals.

The technical services for research of nuclear safety during normal operation and in the case of a radiological emergency are mainly provided by the Technical Research Centre of Finland (VTT) and to some extent also by Finnish universities. STUK and licensees in Finland order safety related research from VTT to support normal operation as well as to support knowledge on the behaviour of the plant in accident conditions. Based on the experience of the TEPCO Fukushima Dai-ichi accident follow-up in March 2011, STUK will explore possibilities to engage VTT support promptly and flexibly also in accident situations.

With regards to radiation safety as well as radiological environmental monitoring, a contracted laboratory collects and analyses about 300 samples (air, fallout, sediment, indicator organisms, milk, etc.) per year from the environment of each NPP. STUK has approved in 2007 the use of the dosimetry service of the Loviisa nuclear power plant and the Olkiluoto nuclear power plant until 2011. As appropriate, the approval also covers the agreement between the operator and the outsourced services provided by private company, responsible for routine dosimetry at the Olkiluoto NPP. STUK controls the dose monitoring services by inspections and annual tests of dosimeters.

4.3 The regulatory body and its independence

The current Act on STUK was given in 1983 and the Decree in 1997. The duties of STUK are described in the legislation. STUK is an independent governmental organization for the regulatory control of the use of radiation and nuclear energy. STUK is administratively under the Ministry of Social Affairs and Health. It is emphasized that the regulatory control of the safe use of radiation and nuclear energy is independently carried out by STUK. No Ministry can take for its decision-making a matter that has been defined by law to be on the responsibility of STUK. STUK has no responsibilities or duties which would be in conflict with regulatory control. The responsibilities and rights of STUK, as regards the regulation of the use of radiation and nuclear energy, are provided in the Radiation and Nuclear Energy Acts.

An Advisory Commission on Nuclear Safety has been established in 1998 by a Decree. This Commission gives advice to STUK on important safety issues and regulations. The Commission also gives its statements on licence applications. The Commission has now two international committees, one for reactor safety and one for waste safety issues. The members of the Advisory Commission on Nuclear Safety are nominated by the Government.

To assist STUK's work in nuclear security, an Advisory Committee on Nuclear Security was established in 2009. The members of the committee come from the various Finnish authorities, and the nuclear licencees also have their representatives. The duties of the committee include the assessment of the threats in the nuclear field as well as consultation to STUK in important security issues. The committee also aims to follow and promote both the international and internal co-operation in the field of nuclear security.

4.4 Responsibility for safety

The responsibility for the safety rests with the licensee as prescribed in the Radiation and Nuclear Energy Acts. Accordingly, it is the licensee's obligation to assure safe use of radiation and nuclear energy. Furthermore, it shall be the licensee's obligation to assure such physical protection and emergency planning and other arrangements, necessary to ensure limitation of nuclear damage, which do not rest with the authorities. It is the responsibility of the regulatory body to verify that the licensees fulfil the regulations.

As part of its verification activities, STUK emphasizes the licensee's commitment to the strong safety culture. The obvious elements of licensee's actions to meet these responsibilities are strict adherence of regulations, prompt, timely and open actions towards the regulator in unusual situations, active role in continuous development of the safety based on improvements of technology and science as well as effective exploitation of experience feedback.

4.5 Competence for safety

The competence of the licensees as well as the vendor and main sub contractors is one of the key review areas in the licensing processes for the use of radiation and nuclear energy. During the lifetime of the facilities the competence remains a key subject to the regulatory control by STUK. STUK is currently updating the legislation and regulatory guides and is going to set goals and requirements on the resources needed to be available for the licensee during normal operation as well as during emergencies.

The Nuclear Energy Act was amended in 2003 to ensure funding for a long term nuclear safety and nuclear waste management research in Finland. Money is collected annually from the license holders to a special fund. The research projects are selected so that they support and develop the competences in nuclear safety and to create preparedness for the regulator to be able to respond on emerging and urgent safety issues. These national safety research programmes are called SAFIR and KYT. They have an important role in the competence building of all essential organizations involved in nuclear energy. In 2011, research needs originating from the TEPCO Fukushima Dai-ichi accident were studied, and an appendix addressing the topics for further research (e.g. spent fuel pool accidents) was added to the research programme.

There are two universities in Finland that currently educate nuclear specific experts to the organizations in the field. In addition to education given by the universities, Finnish organizations have organized a national a basic professional training course on nuclear safety. The first 6-week course commenced in September 2003 and the 9th basic professional training course commenced in autumn 2011. Due to planned expansion of the use of nuclear energy, a study has been conducted in Finland to explore the need of experts and education of experts in Finland to meet the needs from the organizations in the field. The study was finished in March 2012.

Training and competence for licensees using radiation sources is provided by several universities and other training organizations. Radiation safety training programs of these organizations are approved by STUK at five years intervals.

5. EMERGENCY PREPAREDNESS AND RESPONSE AND POST-ACCIDENT MANAGEMENT (OFF-SITE)

5.1 Nuclear power plant off-site emergency preparedness and response in Finland

The Finnish concept of off-site nuclear emergency response has been developed since 1976, when the first public authorities' off-site emergency plan was prepared. The development has been a continuous process since then.

The primary safety principle in Finland is that of remote nuclear power plant (NPP) siting, meaning also restrictions on land use within about 5 km radius from the nuclear power plant. In off-site emergency planning another planning zone is applied for an area within a radius of about 20 km. A detailed off-site emergency response plan is required in this area including rapid alerting and evacuation possibility of the population if necessary. For the areas outside 20 km radius, the requirements imposed by a potential nuclear accident have to be taken into account in the general emergency preparedness planning. Thus the nuclear and radiation accident preparedness covers the whole country in Finland.

The nuclear power plants in Finland are located on coastal sites. The population density in the vicinity of the sites is low. For each of the sites, the number of permanent residents living within 5 km from the plant is below 100. The maximum number of seasonal inhabitants of recreational homes in this region is about 1000. Within the 20 km radius from both existing NPP sites a town with 20 to 40 thousand inhabitants is situated.

STUK has issued regulatory guides concerning also radiation protection and on-site emergency preparedness as well as on radiological and meteorological monitoring of nuclear power plant accident sites.

5.2 Nuclear off-site emergency planning, basis

Nuclear power plants are regarded as establishments requiring a special off-site emergency response plan to be drawn up by the rescue authority. The plan is to be prepared by the regional rescue service authority as a separate document.

In addition to actual emergency rescue planning, the authorities are also required to be prepared for long-term actions following a nuclear accident. These include radiation level measurements and surveys, health control of the population and measures to control agricultural production.

The Ministry of the Interior has issued the Ministry of the Interior Decree (774/2011) on the requirements for External emergency plans for sites posing particular hazard and the Ministry of the Interior Degree (774/2011) on information to the public in emergency situations with danger of radiation.

A specific Government Decree on NPP emergency preparedness (735/2008) exists. The authority, STUK has issued the guide YVL Guide concerning NPP emergency plans.

5.3 National off-site emergency preparedness organization

In every emergency situation there must be one authority in charge of leading operations. In Finland, this responsibility generally lies with the regional rescue service or-

ganizations. Maritime rescue operations are managed by the Coast Guard which is part of Border Guard organization. Police forces have operative responsibilities on certain part of the security and emergency action.

The country is divided into 22 regional administrative rescue service regions.

The officer in charge of rescue operations comes from the rescue service region where NPP or radiological emergency began. The command of rescue operations rests with rescue authorities. The rescue authorities of the Ministry of the Interior have the right to issue orders concerning rescue operations and decide on the officer in charge of rescue operations and his or her area of operation.

On the national level, STUK acts as the nuclear safety authority and as the emergency advisory support organization. A response organization of STUK will be formed upon receiving the authorities' alert from a NPP. STUK's response team is to advise the emergency rescue organizations about protective measures that require the assessment of the environmental consequences. STUK provides recommendations of protective measures to authorities on local, regional and governmental level. Furthermore, STUK provides advice to the public, and private sector for trade and commerce.

Department of Nuclear Reactor Regulation of STUK sets up a situation assessment group to monitor the progress of the accident and the safety status of the NPP. It also sends an expert site team to the NPP, which follows the emergency actions at the plant and reports independently to the STUK's situation assessment group. For the assessment of the safety status of the NPP, a real time computerized data system for main safety parameters from NPPs is in use at Emergency Response Centre of STUK.

Department of Research and Environmental Surveillance of STUK sets up a consequence assessment group for evaluating the possible radiological effects of radioactive releases from the NPP during an accident. Finnish Meteorological Institute supports this group by supplying the weather information and calculating the weather forecasts needed for evaluation of the spreading of the releases in the environment.

5.4 Interface between off-site and on-site plans

Coordination of the off-site and on-site emergency response plans is ascertained in several ways. The off-site plan is approved by the regional rescue authority after submitting it for consideration to the Regional State Administrative Agency and also to the nuclear regulatory authority, STUK.

There are several sectors where off-site and on-site plans are interdependent.

The site emergency head of the licensee's organization must notify the authorities via Emergency Response Centre when an alert or emergency is declared. The off-site emergency response organization shall, in turn, inform the site organization and STUK of initiated and ongoing protective actions in the nearby areas.

It is also the responsibility of the licensee to make on-line and patrol radiation measurements in the vicinity of the plant, and to determine and indicate the local meteorological dispersion conditions should a release occur. This shall also include the capability

to collect and analyse the activity of air samples. An efficient two-way exchange of measurement results is necessary, since the bulk of the radiation measurements are carried out by STUK and the rescue authority.

The emergency rescue organization also has other associated experts and liaison persons who can be called to the command centre of rescue services when needed.

5.5 Protective measures in emergencies

In Finland, the emphasis on the measures contemplated for the protection of the public has shifted somewhat over the years. Earlier, restricted evacuation was seen as a principal course of action and sheltering was considered mainly as a precaution while today sheltering inside the houses and iodine prophylaxis are the main planned actions. The vicinity up to about 5 km starting from the direction of the spreading in case of a reactor core melt should be evacuated before a release may occur.

The iodine tablets have been distributed beforehand to the population living within about 5 km radius of the plant and this measure is recognized as an efficient counter-measure especially for the children. The decision to advice tablets to be used by the members of the public in an emergency is to be made by the health authorities on the recommendation of STUK. It is implemented then by rescue service actions.

5.6 Information to the public

A special “notice for households” is regularly prepared and updated by the regional rescue authority and the licensee at each NPP site, and distributed to every house owner or tenant within about 5 km radius. It is also published in the regional internet-pages. It contains information about the warning signals, what action to take, where to assemble in case a notice of evacuation is given.

In an accident situation the principal information medium to the public is FM radio, TV and internet. The first outdoor warning to the public close the NPP is given by general warning signal via sirens or loudspeakers. By arrangement with broadcasting companies, urgent RDS-notifications can be transmitted promptly over the FM-radio and TV.

5.7 Training of personnel, emergency drills

The off-site emergency plan must also include a training program. The training shall comprise co-operation between authorities as well as training in the special tasks of each authority in a nuclear power plant accident.

The position of the authorities is that an off-site emergency exercise, involving all the authorities concerned, must be held before the licensee is given an operating license and then regularly at least every third year.

5.8 Co-operation between the NPP and authorities

Permanent coordination groups (SVPP) have been established for both Loviisa and Olkiluoto NPPs in order to ensure coordinated and consistent emergency plans, to improve and develop emergency planning and arrangements and to share lessons learnt from the exercises, regulations and other information. Also extensive emergency pre-

paredness training is coordinated by these groups. Members of these groups are the regional rescue service and police authorities, STUK and the licensee (NPP).

5.9 Monitoring of the radiation situation 24/7

STUK monitors constantly the radiation situation throughout the country. The aim is to identify potential radiation hazards quickly and to take efficient measures to protect the population against the harmful health effects of radiation. In addition to STUK, the Ministry of the Interior, the Finnish Meteorological Institute, and the Finnish Defence Forces and their organizations participate in radiation monitoring.

The dose rate of external radiation is measured by a monitoring network maintained by STUK and local rescue authorities. The network comprises almost 300 automatic stations. Measurement data is stored in a national data system, where it is available for several authorities in real time. The radiation readings of these continuously operating stations are displayed to the public on the website of STUK.

Additionally real-time airborne spectrometric measuring stations are situated e.g. at a distance of 20-30 km from the NPPs.

5.10 Intervention levels

STUK has prepared so called VAL Guides, which contain the intervention strategy in Finland. VAL Guides contain protective measures and intervention levels in early and intermediate phases of a nuclear or radiological emergency, for various types of emergencies (such as fallout from nuclear detonation, severe accident in a NPP, malicious acts, contamination due to radioactive substances etc.). VAL Guides contain reference levels of exposure during the first year and factors, other than radiation, affecting choice of protective measures and protective measures to be considered during nuclear or radiological emergencies and transition to recovery.

VAL Guides contain criteria when protective measures are needed and when those can be lifted or modified. Criteria are given for each countermeasure as a projected dose and as an operational intervention level. They also include triggers such as plant condition, or emergency action levels such as duration of a protective measure. VAL Guides include principles for reducing exposure of various parts of society (e.g. actions concerning population, exercising own profession in a contaminated area, decontamination, handling of waste containing radioactive substances etc).

In the preparation of the VAL Guides, STUK requested comments from stakeholders (e.g. authorities from governmental, regional and local level, nuclear operators as well as organizations from the private sector). In addition, the draft guides have been tested during various kinds of emergency exercises (NPP accident, malicious acts). In the VAL Guides, the new IRCP concept has been fully implemented in addition to international guidance available.

VAL Guides are to be put into force by the Ministry of the Interior.

5.11 External risks, including extreme weather conditions

In Finland, main natural external threats of NPPs and the society at the same time are e.g. extreme low and high temperatures in extended periods, storms in different seasons of the year (incl. snow storms) and elevated sea water levels. Examples of other external threats are e.g. oil transport accident at the Baltic Sea, collapse of the electrical grid or data network.

The risks of these situations are regularly evaluated both for NPPs and for all important functions of the society. Often there is a possibility to enhance the regional preparedness based on the predicted circumstances.

Finnish authorities have a Natural Disaster Warning System (LUOVA), which is coordinated and run by the Finnish Meteorological Institute. It secures information gathering and transfer to competent safety authorities about regional storms, tornados, significant snowfall, significant lightning, rural and urban flooding, and sea level rise. Also European phenomena like nearby forest fire, wide and sudden snow storms, storms etc are monitored, and followed. Global seismic and tsunami events are reported without delay. This guarantees in advance warning and continuous situation assessment for the authorities and the population potentially concerned.

After the TEPCO Fukushima Dai-ichi accident, evaluations to enhance the off-site actions were initiated between STUK, licensees and regional rescue services. Ensuring accessibility of the NPP site was considered an essential part to support accident management on-site. Thus clearance of the roads leading to the site e.g. after extreme storms is under evaluation, and further enforcements to support this is being considered. Furthermore, sufficient amount of radiation protection equipment and radiation monitoring capabilities for rescue services is being checked and supplemented, if necessary.

Future development of NPP off-site emergency planning should seriously consider all aspects of coordinated resource allocation when there might be serious limitations of communication and transport as well as a simultaneous situation requiring urgent health and property saving actions and NPP emergency actions to protect the population in the same region. Also the construction of NPPs on the new sites where there is no NPP today sets new challenges to the authorities.

6. INTERNATIONAL CO-OPERATION

6.1 The conventions before the TEPCO Fukushima Dai-ichi accident

Finland has signed the international conventions and treaties aiming on safe and peaceful use of nuclear energy. These conventions are related to radiation and nuclear safety of the use of nuclear energy, nuclear waste management, environmental impact assessment of the nuclear facilities, emergency preparedness and liability in case of an accident. The treaties are related to the non-proliferation of the nuclear materials. Detailed information on the compliance of the requirements of these conventions and treaties can be found from the related reports available on the STUK web site.

Finland signed on 20 September 1994 the Convention on Nuclear Safety which was adopted on 17 June 1994 in the Vienna Diplomatic Conference. The Convention was ratified on 5 January 1996, and it came into force in Finland on 24 October 1996. In 2010 Finland published the Finnish National Report for the Fifth Review Meeting in April 2011. Corresponding reports have previously been submitted in 1999, 2002, 2004 and 2007. In the report it was concluded that Finland has implemented the obligations of the Convention and also the objectives of the Convention are complied with. Safety improvements have been annually implemented at the Loviisa and Olkiluoto plants since their commissioning. Regulatory guidance have been further developed and the work is still going on taking into account safety research and advances in science and technology as well as the operating and construction experiences. There exists no urgent need for additional improvements to upgrade the safety of these plants in the context of the Convention. (CNS 5th report 2010, TEM OTR report 2/2012).

The Finnish National Report, in accordance with the provisions of the Article 32 of the Joint Convention, to the 4th Review Meeting of the Contracting Parties in May 2012, was published in 2011. The aim of the report is to present the recent developments of waste management in Finland, to describe waste management facilities and practices in Finland and, for discussion and review among contracting parties, to describe how the obligations under the Convention are fulfilled in Finland.

Finland is a party to the Convention on Environmental Impact Assessment in a Transboundary Context, done in Espoo in 1991. The Convention is applied for Finnish nuclear facility projects by providing a full participation to all neighbouring countries, which announce the willingness to participate in the environmental impact assessment procedure in question. In Finland, the EIA is conducted at an early stage of a NPP project, prior to the final selection of the plant site or design, based on the power range of the plant and on general information on the available designs.

In 2007, initiatives for building additional nuclear power reactors in Finland were announced. Environmental Impact Assessment (EIA) procedures were carried out for the possible Olkiluoto 4, Loviisa 3 and Fennovoima units in 2007–2009. The Finnish Ministry of the Environment requested comments from altogether nine countries near the Baltic See. Several comments from e.g. Estonia, Sweden and Germany were given and considered by the Finnish authorities. Additionally, the Austrian Government as a party of the Espoo convention sent their statement on each EIA and requested for consultation in Finland. Thus, subsequent meetings were arranged in 2008–2009 at the Finnish Ministry of the Environment where a Finnish delegation of experts from the utility con-

cerned, STUK and the Ministry of Employment and the Economy gave detailed explanations to the questions provided.

Finland is a party to the Convention on Early Notification of a Nuclear Accident and the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency, done in Vienna in 1986. Being a member of the European Union, the Council Decision (87/600/EURATOM) on Community arrangements for the early exchange of information in the event of a radiological emergency applies in Finland, too. In addition, Finland has respective bilateral agreements with Denmark, Germany, Norway, Russia, Sweden and Ukraine. Accordingly, arrangements have been agreed to directly inform the competent authorities of these countries in the case of an accident.

The financial provisions to cover the possible damages to third parties caused by a nuclear accident have been arranged in Finland according to the Paris and Brussels Conventions. Related to the revision of the Paris and Brussels Conventions in 2004, Finland has decided to enact unlimited licensee's liability by law. The revised law will also have some other modifications, such as extending the claiming period up to 30 years for victims of nuclear accidents. These changes are still in 2012 pending on the international ratification of the Paris and Brussels Conventions, although some preparations have been made to update the national legislation.

The regulatory control of nuclear materials (i.e. nuclear safeguards) is a prerequisite for the peaceful use of nuclear energy in Finland. Safeguards are required for Finland to comply with international agreements on nuclear non-proliferation – mainly the Non-Proliferation Treaty (NPT). The Nuclear Materials Section of the Finnish Radiation and Nuclear Safety Authority (STUK) exercises this regulatory control.

The Comprehensive Nuclear-Test-Ban Treaty (CTBT) is one of the elements of the global nuclear non-proliferation effort. STUK has two roles in relation to the CTBT: STUK operates the Finnish National Data Centre (FiNDC) and one of the radionuclide laboratories designated in the CTBT. The main task of the FiNDC is to inspect data received from the International Monitoring System and to inform the national authorities, the Ministry for Foreign Affairs, about any indications of a nuclear weapons test. The FiNDC falls under the non-proliferation process in STUK's organisation, together with the regulatory control of nuclear materials.

After the TEPCO Fukushima Dai-ichi accident Finland signed among 130 other countries in the General Conference in September 2011 the IAEA Action Plan covering all the relevant aspects relating to nuclear safety, emergency preparedness and response, and radiation protection of people and the environment, as well as the relevant international legal framework. This Action Plan consists of 12 actions aimed at strengthening the global nuclear safety framework. The summary of the activities related to the action plan is presented in the conclusions of this review of the international co-operation.

6.2 Mechanisms for communicating with neighbouring countries and the international community

Finland has bilateral agreements with neighbouring countries and also with some other countries having a nuclear program. As an example in 2010, STUK continued bilateral co-operation in the form of meetings and conferences with the nuclear safety regulatory

authorities of Sweden, Russia, France and the USA, among others. More detailed information on the meeting and conferences can be found from "Regulatory oversight of nuclear safety in Finland", Annual report 2010 and 2011 (in Finnish).

The bilateral agreements include provisions to exchange information on the design and operation of nuclear facilities as well as on regulatory frameworks and approaches. In the European Union a specific statement is also prepared for each new nuclear power plant unit in a member state before authorisation of the operation (Euratom Treaty, Article 37). This is based on a General Data report submitted by the member state and on its examination in a plenary meeting of Group of Experts. For Olkiluoto unit 3 this process was conducted in 2010. Based on the legislation on land use planning, statements from neighbouring countries must be requested for the land use plans of a nuclear power plant. In practice the regional plan drafts for Fennovoima's two northern sites were submitted to all Baltic Sea countries and Norway (8 altogether).

In the field of emergency preparedness Finland has bilateral and international agreements on change of information. The exchange of experts and information during the emergency exercises is a routine practice. As an example in 2010 in addition to the domestic nuclear emergency exercises held annually on each nuclear power plant site, STUK has taken part in international emergency exercises. STUK has also participated as a co-player in emergency exercises arranged by the Swedish and Russian nuclear power plants and authorities. Neighbouring countries have been actively invited to take part in the Finnish exercises.

As a result of the TEPCO Fukushima Dai-ichi accident there has been no need to for any new agreement to mechanism of communication. However there has been a need to enhance the exchange of information during the event and coordination of the protective measures recommended by the regulatory body. This topic is discussed more in the section of co-operation in framework of international working groups.

6.3 Co-operation with international organizations

In Finland international co-operation and transparency belong to the cornerstones of the development of the national safety policy and regulations as well as operation of the nuclear facilities. All of the involved organizations ministries, the regulatory body, the utilities and research organizations take actively part into international co-operation at relevant forums, e.g. IAEA, EU, OECD/NEA, WANO, ENISS, and EUR.

STUK takes actively part in preparation of IAEA safety standards. Finland is represented in all of the safety standard committees, the safety standard commission, the International Nuclear Safety Group (INSAG) and SAGSI, dealing with nuclear material safeguards. Finnish expert regularly participates in the IAEA IRRS missions and technical working groups. The Finnish utilities have participated in the work for European Utility Requirements (EUR). VTT participates in the co-operation between the European Technical Safety Organisations (ETSON) and as part of this co-operation ETSON has contributed to the activities of the TSO-Forum established in the framework of IAEA nuclear safety co-operation in 2011.

Finland participated in the activities of the EU member states' nuclear safety regulators' co-operation group (ENSREG, European Nuclear Safety Regulators Group) and in two of

its subgroups (nuclear safety and nuclear waste management). The co-operation group participates in the preparation of directives pertaining to nuclear safety and coordinates the implementation of directives in the member states.

The Finnish regulatory body, STUK took an active part in the planning and steering of the European coordination centre for nuclear power plants' operational experience feedback network (EU Clearinghouse on NPP OEF). The coordination centre works in conjunction with the European Commission's Institute for Energy, Joint Research Centre (IE-JRC) located in Petten, the Netherlands. One STUK employee works as a detached national expert at the IE-JRC in Petten.

The nuclear safety research is one of the cornerstones for the use of nuclear energy. The volume of the nuclear safety research was 73.5 million euros in 2010 in Finland. The nuclear waste research accounted for 68% of the total, nuclear power plant safety research for 20%, fusion research for 7%, and other research – also including reactor safety research on the new generation or GenIV reactors – for 5%. Finland participates in international research activities on a relatively broad front. International co-operation enables the use of shared research facilities and effective building of the nuclear safety know-how. Regarding Finnish participation in international research activity within the field of nuclear power plant safety, the volume and significance of OECD/NEA and EU Euratom projects is by far the greatest. The essential results of the Finnish publicly funded nuclear safety research programme SAFIR2014 and waste management programme KYT2014 are available on the web sites of the programmes. More information on the research can found from section research can be found in the "Report of the Committee for Nuclear Energy Competence in Finland" published in 2012. (Publications of the Ministry of Employment and the Economy, Energy and the Climate, 14).

The Finnish research organizations take actively part in the radiation and nuclear safety research funded by the European Union.

The Nuclear Energy Agency of the OECD (NEA) coordinates international co-operation in the field of safety research in particular. The organisation also provides an opportunity for co-operation between regulatory authorities. Finland is represented in all main committees of the organisation dealing with radiation and nuclear safety issues. Finland's representatives also participated actively in the activities of working groups under the standing committees.

The Finnish utilities take actively part in WANO activities. The activities include sharing of operating experience information, WANO peer reviews, technical support, performance indicators, etc. In 2011 WANO announced a programme for further enhancing the nuclear safety and WANO's peer review services in the area of design, severe accidents as well as emergency preparedness. Furthermore, in 2011 WANO released three significant operating experience reports on nuclear safety and implementation of the lessons learned from the TEPCO Fukushima Dai-ichi accident. The utilities have provided their response to WANO.

The utilities have co-operation also with similar plants including seminars, staff exchances, following outage arrangements, co-operation in spare parts arrangements and in technical issues.

After the TEPCO Fukushima Dai-ichi accident the IAEA held the ministerial conference in June 2011 and launched the Action Plan which was approved in September 2011. Finland has taken actively part in the activities such as review of the IAEA safety requirements and developing the changes due to the lessons learned and participated in conferences on the exchange of information related to the accident and the remediation of the environment. Finnish experts have participated in the IAEA and NEA missions to Japan

Finland has participated to the OECD/NEA activities to share information on the lessons learned and actions taken due to the TEPCO Fukushima Dai-ichi accident and to explore possibilities and areas where international co-operation would benefit member countries.

Finland agreed with the European Commission on the participation to the European Stress Test in which the robustness of the European nuclear power plant designs against external threats especially seismicity, flooding and extreme weather conditions is reviewed. The conditions challenging mitigation of the consequences of the accidents are considered. The review plan consists of national activities and the peer review of the findings as well as the verification of the assessments. Finland has been actively working with the review at each phase from defining the requirements through drawing the conclusions. The results of the European Stress Test were published in April 2012.

6.4 Co-operation in the frame of international working groups

Finland is an active player in several international working groups such as WENRA, MDEP, VVER forum, NERS, ETSON and ENIS. Each of these working groups aim at enhancing nuclear safety and their have made initiatives in respect to lessons learned from the TEPCO Fukushima Dai-ichi accident in March 2011.

STUK participated in the WENRA (Western European Regulators' Association) working groups on nuclear safety, inspection activities, nuclear waste and decommissioning. The groups developed common safety reference levels on the basis of the IAEA standards and discussed regulatory practices in different countries. The leading nuclear safety authorities who comprise the WENRA group have set as their original objective that the requirements for nuclear safety are brought into compliance with these reference levels in the WENRA member states by the end of 2010. The WENRA member countries are close to achieving the objective, but in some countries the updating of the authorities' requirements is taking slightly longer than anticipated. At STUK, the WENRA reference levels will be taken into account in the revision of the YVL Guide revision. The target is to publish the new YVL Guides by the end of 2012. The target schedule for the requirements for nuclear waste storage is the end of 2012; for the requirements for decommissioning, the end of 2013; and for the harmonisation of the requirements for final disposal of nuclear waste, the end of 2015. In 2010, the nuclear safety group also drew up general safety principles for new reactors. The position paper presenting the safety goals were developed in 2011.

The Multinational Design Evaluation Programme (MDEP) was originally established on the initiative of the United States nuclear safety authority (Nuclear Regulatory Commission, NRC) with the objective of improving co-operation in the field of the assessment of new nuclear power plants and to develop convergent regulatory practices. Nuclear

safety authorities from 10 countries participate in the programme: the USA, South Africa, Japan, Canada, China, Korea, France, Finland, the United Kingdom and Russia. Participants in the programme include only countries with new nuclear power plants at some stage of assessment by the regulatory authorities. Some other countries have also expressed their interest in joining the programme, and criteria for the membership of new countries were adopted at the end of 2010. The programme has contracted the OECD Nuclear Energy Agency to function as its secretariat. In addition to meeting arrangements, the secretariat takes care of the library where all the documents are gathered.

The MDEP's work is organised in Design-Specific and Issue-Specific working groups. Currently there are two Design-Specific working groups: the EPR working group and the AP 1000 working group. Finland participates in the EPR working group only. The other countries in the EPR group include France, the USA, the United Kingdom, Canada and China. The Finnish representative is the chairperson of the EPR working group. The EPR group's work was originally a continuation of co-operation between the Finnish and French authorities concerning safety assessment of EPR power plants.

The plenary meeting of WENRA in March 2012 decided to update the reference levels for the nuclear power reactors and assess the implementation of the reference levels. In the same meeting WENRA agreed on the establishment of two new working groups under Reactor Harmonization Working Group chaired by Finland. These two new groups would establish reference levels for the extreme weather conditions and define the information needed to share in between the regulatory bodies in the case of an accident. The lessons learned from other international activities would be integrated to the work.

The lessons learned from the TEPCO Fukushima Dai-ichi accident have an impact to the new reactor project worldwide. MDEP has discussed the implications of the accident in the meetings of the Steering Technical Committee as well as in the EPR and AP1000 design specific working groups. The goal of the work is to find harmonised design solutions to address concerns raised by the accident such as independent means to supply water to steam generators and to the core, safety of fuel pools, flooding protection etc.

Within the co-operation between the European Technical Safety organisations, the report on the research needs due to the TEPCO Fukushima Dai-ichi accident has been published. VTT has contributed to the preparation of this report.

Utilities TVO and Fortum are participating the ENISS steering committee and working groups activities. The mission of ENISS is to bring together decision-makers, operators and specialists from the nuclear industry with regulators on European level in order to identify and possibly agree upon the scope and substance of harmonized safety standards. The first task of ENISS is to establish a common industry position with regards to the safety reference levels that WENRA has proposed. By engaging in constructive debate with WENRA and playing a dynamic role in the process, ENISS also defends the industry's interests in a proactive way. Another task of ENISS is to strengthen the industry influence in the revision work of the IAEA Safety Standards.

6.5 Hosting international peer reviews

The transparency and international co-operation are one of the corner stones in the Finnish nuclear safety policy. Finland regularly hosts international peer review and also offers its' expert for the review in other countries. The latest reviews are the following:

- IAEA carried out an OSART safety review in Loviisa in March 2007, with a follow-up review in July 2008.
- WANO peer review to Loviisa was per-formed in March 2010.
- WANO peer reviews have been carried out at the Olkiluoto nuclear power plant during the year 2006. A follow- up for the last WANO peer review was carried out in August 2009.
- IAEA's International Physical Protection Advisory Service (IPPAS) mission was carried out in Finland in 2009. The follow up mission was hosted in April 2012.
- In 2009 STUK organized a Peer Review of STUK's waste management related activities. All EU member states were invited and representatives from 11 countries participated in the peer review.
- In 2011 STUK hosted a peer review of the emergency preparedness with the OECD NEA countries.
- STUK participated in the work carried out by the working group of European authorities (European Pilot Study on Demonstrating the Safety of Geological Disposal), which resulted in a recommendation for safety case content for final disposal at different stages of final disposal. The recommendations were published in 2011.
- Finland had IRRT mission in 2001 and the follow-up mission in 2003. At the moment Finland is preparing the IRRS mission to the regulatory body in October 2012.
- IAEA has agreed to carry out a pre-OSART (Operational Safety Review Team) mission to Olkiluoto 3 NPP in late 2011 or 2012 depending on the project schedule with regard to fuel load.

Finland continues the hosting and participation to the international peer reviews. As a result of the TEPCO Fukushima Dai-ichi accident there is no need for changes in this activity in Finland.

6.6 Sharing international operating experience

Finland promotes learning from the operating experience by several means. The evaluation of foreign operational occurrences and incidents is based on the reports of the IRS Reporting System (IAEA/NEA) and on the reports of other national regulatory bodies. IRS reports are also evaluated by the licensees. Reports for the IRS System on safety-significant occurrences at Finnish nuclear power plants are written by STUK.

STUK has also participated in co-operation between international organisations such as the IAEA, the OECD/NEA and the EU, which exchange information on safety issues and operating events. Other forums that STUK uses to obtain information are WENRA, the VVER Forum and the NERS Forum as well as some bilateral agreements. A special exchange of information between Rostechnadzor and STUK on the operation of the Kola and Leningrad nuclear power plants and of Finnish nuclear power plants is also ongoing activity.

At the Loviisa NPP, VVER reactor operating experience is collected, screened and evaluated by a dedicated operating experience feedback group composed of engineers from the plant operation organisation and from Technical Support. The main information to be handled comes from WANO (World Association of Nuclear Operators) Moscow Centre which links all the VVER reactor operators. Additional reports are received from the IAEA, OECD/NEA and NRC (U.S. Nuclear Regulatory Commission). The activities of the operation experience feedback group are not limited only to VVER reactors. The plant managers of VVER-440 reactors run a so-called VVER Club with periodic meetings. The plant operation problems, modernisation, back-fitting, plant life management and safety questions are handled and experiences are exchanged in these meetings and in further individual contacts.

TVO which operates Olkiluoto 1 and 2 has also an operating experience feedback group. This onsite group gives recommendations to the line organisation that makes decisions on eventual corrective actions. The industry operating experience from similar reactor types is followed by several means. The main sources of information are ERFATOM (the owners group for Nordic BWR operators), KSU (Swedish nuclear training centre), WANO and the Swedish Forsmark NPP. Information is also coming directly from several sources (IAEA and OECD/NEA, IRS), Loviisa power plant (e.g. operating experience meetings and reports), vendors (Westinghouse Atom, Alstom Power Sweden AB), component manufacturers, the WANO Network, BWROG (BWR Owners Group) and BWR Forum (FANP).

At the time of writing this report no need is foreseen for any new forum for the exchange of operating experience. However there is need to improve the effectiveness of the lessons learned process globally.

6.7 Utilization of IAEA safety standards

According to the Finnish nuclear safety policy the Finnish nuclear legislation and regulations aim at high safety level at the Finnish nuclear facilities. The legislation and the regulations are kept up to date and all the stakeholders are determined to practices typical to high reliability organizations. The IAEA safety standards are used as a reference when developing the Finnish requirements.

Summary Table

Activity	Activities by the Operator			Activities by the Regulator		
	(Item 2.a) Activity - Taken - Ongoing - Planned	(Item 2.b) Schedule Or Mile-stones for Planned Activities	(Item 2.c) Results Available - Yes - No	(Item 3.a) Activity - Taken - Ongoing - Planned	(Item 3.b) Schedule Or Mile-stones for Planned Activities	(Item 3.c) Conclusion Available - Yes - No
Topic 1 – External Events						
Updating the seismic fragility analyses of the spent fuel pools	Taken	30.4.2012	Yes	Ongoing	30.6.2012	No
Loviisa NPP: improving prepared-ness for high seawater level	Ongoing	2014	No	Ongoing	30.6.2012	No
Olkiluoto NPP: clarification on the effects of exceptionally high seawater level on the cooling systems of the spent fuel interim storage	Taken	N/A	Yes	Ongoing	30.6.2012	No
Analysis of conse-quences of beyond design basis low and high temperature	Taken	15.12.2011	Yes	Ongoing	30.6.2012	No
Loviisa: Analysis of conse-quences of tornados and downbursts on plant structures and systems	Taken	15.12.2011	Yes	Ongoing	30.6.2012	No
Olkiluoto: Analysis of conse-quences of tornados and downbursts on plant structures and systems	Planned		No	Ongoing	30.6.2012	No
Including new issues in the national research programme	N/A	N/A	N/A	Taken	2012-2014	No
Implementing the new requirements to regula-tory guides	N/A	N/A	N/A	Ongoing	2012	No

Activity	Activities by the Operator			Activities by the Regulator		
	(Item 2.a) Activity - Taken - Ongoing - Planned	(Item 2.b) Schedule Or Mile-stones for Planned Activities	(Item 2.c) Results Available - Yes - No	(Item 3.a) Activity - Taken - Ongoing - Planned	(Item 3.b) Schedule Or Mile-stones for Planned Activities	(Item 3.c) Conclusion Available - Yes - No
Topic 2 – Design Issues						
Loviisa NPP						
Implementation of an alternative ultimate heat sink	Ongoing	2014	No	Ongoing	30.6.2012	No
Securing the availability of the auxiliary emergency feed water system	Ongoing	2012-2013	No	Ongoing	30.6.2012	No
Acquiring a container to transfer diesel fuel at site	Taken	2011	Yes	Ongoing	30.6.2012	No
Enhancing the battery power sources	Planned	2014	No	Ongoing	30.6.2012	No
Acquiring mobile power supply and mobile pumps	Planned	2012/2013	No	Ongoing	30.6.2012	No
Connecting the additional diesel power engine to the plant switchgears by a dedicated cable	Planned	2012-2013	No	Ongoing	30.6.2012	No
Modifications of water injection into the spent fuel pools	Planned	–	No	Ongoing	30.6.2012	No
Evaluation of demineralised water reservoirs	Taken	–	Yes	Ongoing	30.6.2012	No
Acquiring a new diesel fuel tank at site	Planned	–	No	Ongoing	30.6.2012	No

Activity	Activities by the Operator			Activities by the Regulator		
	(Item 2.a) Activity - Taken - Ongoing - Planned	(Item 2.b) Schedule Or Mile-stones for Planned Activities	(Item 2.c) Results Available - Yes - No	(Item 3.a) Activity - Taken - Ongoing - Planned	(Item 3.b) Schedule Or Mile-stones for Planned Activities	(Item 3.c) Conclusion Available - Yes - No
Topic 2 – Design Issues						
Olkiluoto NPP						
Conceptual design of independent way of pumping water into the RPV	Ongoing	June 2012	No	Ongoing	30.6.2012	No
Conceptual design of implementing an additional way of component cooling of the auxiliary feed water system (independent of sea water cooling)	Ongoing	June 2012	No	Ongoing	30.6.2012	No
Conceptual design of using water injection and boiling as an alternative means for fuel pool cooling	Ongoing	June 2012	No	Ongoing	30.6.2012	No
Implementing external junctions to the spent fuel storage pool water system	Planned	May 2013	No	Ongoing	30.6.2012	No
Implementation of mobile power supply	Ongoing	2013	No	Ongoing	30.6.2012	No
Evaluation of demineralised water reservoirs	Taken	–	Yes	Ongoing	30.6.2012	No
Evaluating modifications required for independent decay heat removal system for Olkiluoto 3	Ongoing	–	No	Ongoing	30.6.2012	No

Activity	Activities by the Operator			Activities by the Regulator		
	(Item 2.a) Activity - Taken - Ongoing - Planned	(Item 2.b) Schedule Or Mile-stones for Planned Activities	(Item 2.c) Results Available - Yes - No	(Item 3.a) Activity - Taken - Ongoing - Planned	(Item 3.b) Schedule Or Mile-stones for Planned Activities	(Item 3.c) Conclusion Available - Yes - No
Topic 2 – Design Issues						
General issues						
Including new issues in the national research programme	N/A	N/A	N/A	Taken	2012-2014	No
Implementing the new requirements to regula-tory guides	N/A	N/A	N/A	Ongoing	2012	No

Activity	Activities by the Operator			Activities by the Regulator		
	(Item 2.a) Activity - Taken - Ongoing - Planned	(Item 2.b) Schedule Or Mile-stones for Planned Activities	(Item 2.c) Results Available - Yes - No	(Item 3.a) Activity - Taken - Ongoing - Planned	(Item 3.b) Schedule Or Mile-stones for Planned Activities	(Item 3.c) Conclusion Available - Yes - No
Topic 3 – Severe Accident Management						
Capability of dealing with multi-unit severe accidents	Ongoing	–	No	Ongoing	June 2012	No
Ensuring the water injection into the spent fuel pools and monitor-ing the conditions of the pool	Ongoing	–	No	Ongoing	June 2012	No

Activity	Activities by the Operator			Activities by the Regulator		
	(Item 2.a) Activity - Taken - Ongoing - Planned	(Item 2.b) Schedule Or Mile-stones for Planned Activities	(Item 2.c) Results Available - Yes - No	(Item 3.a) Activity - Taken - Ongoing - Planned	(Item 3.b) Schedule Or Mile-stones for Planned Activities	(Item 3.c) Conclusion Available - Yes - No
Topic 4 – National Organizations						
Preparations to achieve rapid support from TSOs to the authority	N/A	N/A	N/A	Ongoing	–	No

Activity	Activities by the Operator			Activities by the Regulator		
	(Item 2.a) Activity - Taken - Ongoing - Planned	(Item 2.b) Schedule Or Mile-stones for Planned Activities	(Item 2.c) Results Available - Yes - No	(Item 3.a) Activity - Taken - Ongoing - Planned	(Item 3.b) Schedule Or Mile-stones for Planned Activities	(Item 3.c) Conclusion Available - Yes - No
Topic 5 – Emergency Preparedness and Response and Post-Accident Management (Off-Site)						
Provision to ensure accessibility of NPP sites in extreme weather conditions	Planned	–	No	Ongoing	–	No
Ensuring sufficient amount of radiation protection equipment and radiation monitor-ing device for rescue services	Ongoing	–	No	Ongoing	–	No

Activity	Activities by the Operator			Activities by the Regulator		
	(Item 2.a) Activity - Taken - Ongoing - Planned	(Item 2.b) Schedule Or Mile-stones for Planned Activities	(Item 2.c) Results Available - Yes - No	(Item 3.a) Activity - Taken - Ongoing - Planned	(Item 3.b) Schedule Or Mile-stones for Planned Activities	(Item 3.c) Conclusion Available - Yes - No
Topic 6 – International Co-operation						
WANO SOER 2011-2	Taken	2011	Yes	N/A	N/A	N/A
WANO SOER 2011-3	Taken	2011	Yes	N/A	N/A	N/A
WANO SOER 2011-4	Taken	2012	Yes	N/A	N/A	N/A
Participation in the IAEA-ISSC work	N/A	N/A	N/A	Ongoing	According to the work of the IAEA-ISSC	
Participation in the WENRA RHWG work	N/A	N/A	N/A	Ongoing	According to the WENRA RHWG	
Participation in the CNRA and CNRA STG on Fukushima	N/A	N/A	N/A	Ongoing	According to the CNRA and STG	
Participation in the MDEP STC and EPR design specific working group	N/A	N/A	N/A	Ongoing	According to the MDEP STC and EPRWG	
Participation in EU Stress Tests	Taken	N/A	Yes	Taken	June 2012	Yes

Overall conclusions

The actions initiated in Finland right after the TEPCO Fukushima Dai-ichi accident on 11 March 2011 resulted in the national safety reviews of Finnish NPPs, which concentrated on the findings from the accident. In those evaluations no hazards or deficiencies requiring immediate actions at the operating Finnish nuclear power plants were identified. Also, in the European stress tests no needs for immediate actions have come up.

Continuous improvement of safety is an important principle which has been implemented effectively during the operation of the existing NPP units in Finland. Although a license for operation of a NPP has once been granted, there is an explicit requirement to follow the national and international experiences, technological development and research related to nuclear safety issues, and to apply new knowledge for safety improvements.

Following the principle of continuous improvement, the licensees have long term programmes for plant ageing management, for modernisation of the plants, and for improving safety. Strategies and actions needed to cope with severe accidents have been implemented at the operating Finnish NPPs. Also in accordance with this principle, some actions will be implemented based on the stress tests, both at the operating NPP units and at Olkiluoto 3, to further enhance the safety of the units. These actions focus on the prevention of severe accidents in case of harsh environmental conditions and in case of loss of any of the three basic safety functions: reactivity control, decay heat removal, or containment of radioactive materials.

The experiences from the TEPCO Fukushima Dai-ichi accident will also be taken into consideration in the ongoing renewal of the Finnish legislation, and Regulatory Guides called YVL Guides. A plan has been prepared which indicates the different issues to be considered and the corresponding affected Guides. A new Guide dealing with the design of NPPs is in the final draft stage and has been sent out for external comments. The draft already incorporates lessons from the accident by requiring autonomous systems that enable the decay heat removal from the reactor and the containment and arrangements to ensure sufficient cooling of the fuel in fuel storages. Decay heat removal shall be possible for 72 hours without power supply from the plant's AC power distribution systems.

The YVL Guides need to be taken into account in the design of new NPPs as such (Fennovoima 1, Olkiluoto 4). A separate decision will be made concerning their application at the operating units (Loviisa 1 and 2, Olkiluoto 1 and 2) and also the unit under construction (Olkiluoto 3).

Furthermore, lessons from the TEPCO Fukushima Dai-ichi accident will be addressed in the National Research Programme on Nuclear Power Plant Safety 2011 – 2014. The research activities are carried out in close international co-operation.

Finland is devoted to transparency and enhancing nuclear safety internationally through international co-operation and activities support the implementation of the IAEA Action Plan. IAEA Safety Standards are seen as important global reference for different types of activities. The protection of the people and the environmental as well as the future generations is the prime objective of the regulatory work in Finland.