IMPLICATIONS OF THE FUKUSHIMA ACCIDENT FOR NPP DESIGN SAFETY IN FINLAND

IAEA Technical Meeting on
EVALUATION OF NUCLEAR POWER PLANT DESIGN SAFETY IN THE AFTERMATH OF THE FUKUSHIMA DAIICHI ACCIDENT

26 - 29 August 2013
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Outline

Actions taken in Finland following the Fukushima accident
– National safety review
– European Stress Tests

Safety enhancements
– Loviisa 1&2
– Olkiluoto 1&2
– Olkiluoto 3

Updates to legislation and regulatory guides
Actions taken in Finland following the Fukushima accident – Two parallel activities

National safety review of the operating plants, the plant under construction, new plants, sites
– The formal process for plant safety improvements
– Started a week after the accident
– Ended at the end of 2011 as a separate activity
– Plant enhancements continue as normal safety improvement activities

European Stress Tests
– Started at the beginning of June 2011
– Peer review in 2012

Results of the national review were utilised in the National Stress Test Report
EU Stress Test peer review recommendations taken into account in the final STUK decisions
Legal basis

Finnish Nuclear Energy Act (990/1987)

– **Section 7 a – Guiding principles**

  The safety of nuclear energy use shall be maintained at as high a level as practically possible. For the further development of safety, measures shall be implemented that can be considered justified considering operating experience and safety research and advances in science and technology.

Government Decree on the Safety of Nuclear Power Plants (733/2008)

– **Section 24, Operational experience feedback and safety research**

  Nuclear power plant operational experience feedback shall be collected and safety research results monitored, and both assessed for the purpose of enhancing safety. Safety-significant operational events shall be investigated for the purpose of identifying the root causes as well as defining and implementing the corrective measures. Improvements in technical safety, resulting from safety research, shall be taken into account to the extent justified on the basis of the principles laid down in section 7 a of the Nuclear Energy Act.
National safety review

No such hazards or deficiencies that would require immediate actions were found.

Detailed requests for plant safety assessments were sent to licensees.

The utilities were asked to evaluate plant behaviour in accidents concerning multiple units

All important external events should be evaluated (not only earthquake & flooding)
Lovisa NPP

Two 500 MW VVER units. Operation started 1977 (LO1) and 1980 (LO2)

Operating licence to 2027 (LO1) and 2030 (LO2)

Ice condenser containments

Four redundant (in some respects two redundant) safety systems

Low power, large water inventory → plenty of time in most accidents

Plant modifications in 90’s to cope with severe accidents
Enhancement plan for Loviisa 1&2 (VVER-440)
Based on the request to Fortum (Loviisa 1 and 2) in August 2011

Earthquakes:
- Seismic fragilities of pool structures (capacity of the structures on and beyond current DBE level combined with possible boiling of pool water) re-analyzed with results showing very low probability of leakage
- Also seismic fragility of fire water systems has been re-analyzed

Flooding:
- Enhancing local protection of important areas vs. general plant protection (plan due Dec 2013)

Loss of safety functions:
- Air-cooled cooling towers as an alternative ultimate heat sink for decay heat removal (implementation in 2014)
- Further improvements on the diesel driven auxiliary emergency feed water pumps (finalised early 2013)
Enhancement plan for Loviisa 1&2 (cont’d):

Fuel pools:
– Instrumentation to monitor the water level and temperature
– Additional water injection capabilities by mobile pumps

Severe accident management (plant modifications already in 90’s):
– To take in consideration in the emergency instructions a case where an accident is considering both units and all fuel pools. (due Jun 2013)
→ No need for updates of the SAM strategy

Emergency preparedness arrangements:
– Plan for ensuring and restoring access routes at and to the site. (due Jun 2013, training due Dec 2103)
Olkiluoto units 1 and 2

Two 840 MW BWRs. Operation started 1979, 1982

Operating licence to 2018

Four redundant safety systems

Good physical separation

Plant modifications in 90’s to cope with severe accidents
Enhancement plan for Olkiluoto 1&2 (BWRs)
Based on the request to TVO in October 2011

Earthquakes:
- Seismic fragilities of pool structures of fuel storages in reactor buildings re-analyzed with results showing very low risk
- Seismic capacity evaluation of fire water system has resulted in decision to reinforce specific structures

Flooding (probability of exceeding the DBF is very low)
- Some improvements along with other modifications

Loss of safety functions:
- An independent way of pumping water to the reactor pressure vessel is being considered through the fire fighting water system and/or with a steam turbine driven pump. (planning ongoing)
  → An independent way to supply water to the reactor, and it would be available irrespective of the operation of the present backup power systems.
- Modifications to cool the auxiliary feed water system pumps independently from the sea water systems are planned (recirculation of water through the demineralised water tank acting as the heat sink). (implementation 2014)
Enhancement plan for Olkiluoto 1&2 (cont’d):

Fuel pools in the reactor building and in the spent fuel interim storage:
- Implementation of external junctions (possibility to use fire-fighting vehicles)
- Improving measurement to monitor the water level and temperature

Severe accident management:
- Reactor building top-venting to exhaust steam and possibly hydrogen. (in 2013)
- Improving capabilities of managing multi-unit accidents.
→ No need for updates of the SAM strategy

Emergency preparedness arrangements:
- Plan for ensuring and restoring access routes at and to the site.
  (plans due Dec 2012, training due Dec 2013)
Olkiluoto 3 – EPR under construction

In national safety review, no such design deficiencies have been identified regarding provisions against natural hazards and disturbances in power supply that would lead to significant changes in the plant design.
Possible enhancements in Olkiluoto 3 (EPR under constr.)
Based on the request to TVO in October 2011

The following items have been investigated:

- Evaluation of the robustness of EDG building doors against flooding indicate no threat to loss of EDGs due to flooding (leak tight up to over 10 m of water)
- The licensee has evaluated 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 refuelling outages have been under consideration.
- 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.

→ No need for major changes
   (in general, OL3 is well protected against external events)
Summary of the safety enhancements

No major modifications required due to the Fukushima accident
- Low seismicity in Finland
- Moderate and slow sea level changes
- Natural events (excl. seismic for existing plants) taken into account in the design (especially Olkiluoto 3)

Further improvements
- Protection against extremely high sea level in (Loviisa 1&2)
- Reducing the heat removal dependency of sea water systems (Loviisa 1&2 and Olkiluoto 1&2)
- Reducing the reactor cooling dependency of AC power (Olkiluoto 1&2)
- Improving fuel pool cooling capabilities (water injection, monitoring)
- Emergency preparedness in case of multi-unit events
Updates to the national requirements

Government Decrees to include taking into account
– multi-unit accidents at the same site (emergency preparedness)
– off-site centre to support on-site actions (emergency preparedness)
– extended autonomy of the plant to ensure the safety functions (safety)

More specific requirements in YVL Guides on DEC situations:
– 72 h autonomy without material support from off-site facilities
– additional arrangement for decay heat removal independently of the on-site AC grid
– managing the situations during extreme weather conditions required already; storms, earthquakes, flooding, extreme temperatures, etc. (extreme conditions further studied in the national research programme)
Thank you