Analysis of the National Action Plans of France, Germany, and the UK to Reflect the Post-Fukushima Lessons Learned and Stress Test Peer Review

Sang-Kyu Ahn*, Sang-Won Kim, Young Gill Yune, Hyung-Joon Ahn,
Won Joon Chang, Seung-Ho Cho
Korea Institute of Nuclear Safety, 62 Gwahak-ro, Yuseong, Daejeon, Korea, 305-338
**Corresponding author:* k052ask@kins.re.kr

1. Introduction [1]

In the joint statement of 26th April 2012 concluding the stress tests conducted in Europe further to the Fukushima accident, the European Nuclear Safety Regulators (ENSREG) and the European Commission emphasized the need to implement an overall action plan to ensure that the stress tests would result in follow-up measures and that these measures would be carried out in a consistent manner. This need was confirmed in the conclusions of the European Council meeting of 28th and 29th June 2012.

In its overall action plan of 25th July 2012, the ENSREG plans for the drafting and publication of national action plans by each country's nuclear safety regulator. These documents shall present the state of progress in the implementation of:

- the decisions taken at national level further to the Fukushima accident;
- the recommendations from the review results of the European stress tests;
- the recommendations resulting from the extraordinary meeting of Contracting Parties to the Convention on Nuclear Safety (CNS) in August 2012.

In this study, each country's national action plan was introduced and analyzed.

2. French National Action Plan [1]

2.1 Process to establish the plan

The Prime Minister tasked the ASN (French Nuclear Safety Authority) with carrying out a study of the safety of the civilian nuclear facilities in the light of the Fukushima Daiichi accident. The French study covers all nuclear installations, including research and fuel management facilities, and subcontractors.

On 26th June 2012, the ASN adopted 32 resolutions consisting of some thirty complementary requirements.

2.2 French Complementary Requirements

The followings are complementary requirements:

ECS - 1: Defining the structures and components of the "hardened safety core", including the emergency management premises.
Defining the requirements applicable to the hardened safety core.
Hardened safety core based on diversified structures and components.
ECS - 4: End of the Blayais experience feedback (REX) work
ECS - 5: Conformity of the volumetric protection
ECS - 6: Reinforcement of protection against flooding, above the current safety baseline
ECS - 7: Measures to cope with site isolation in the event of flooding (Cruas, Tricastin)
ECS - 8: Conformity of seismic instrumentation with RFS1.3.b
ECS - 9: Reinforcement of the seismic interaction approach
ECS - 10: Reinforcement of team preparation in the event of an earthquake
ECS - 11: Robustness of the Fessenheim and Tricastin embankments
ECS - 12: Verification of the seismic design basis of the fire-fighting system
ECS - 13: Study of the implementation of automatic shutdown in the event of an earthquake
ECS - 14.I: Integration of industrial risks in extreme situations
ECS - 14.II: Coordination with neighboring industrial operators in the event of an emergency
ECS - 15: Heat sink design review
ECS - 16.I: Emergency water make-up system
ECS - 16.II: Emergency water make-up in the reactor coolant system, for shutdown states
ECS - 17: Reinforcement of the facilities to manage long lasting situations of total loss of heat sink or total loss of electrical power supplies
ECS - 18.I: Reinforcement of battery autonomy
ECS - 18.II: Ultimate backup diesel generator sets
ECS - 18.III: Installation of provisional emergency generator sets
ECS - 19: Redundancy of instrumentation for detecting reactor vessel melt-through and hydrogen in containment
ECS - 20: Reinforcement of pool condition instrumentation
ECS - 21: Additional measures to prevent or mitigate the consequences of a fuel transport package falling in the fuel building Studies of the consequences of a package falling in the fuel building
ECS - 22: Reinforcement of the measures to prevent accidental rapid draining of the pools
ECS - 23: Placing a fuel assembly in safe position during handling
ECS - 24: Thermo-hydraulic development of a pool accident
ECS - 25: Reinforcement of the provisions for managing a transfer tube leak
ECS - 27.I: Study of the feasibility of installing a geotechnical containment or a system with the same effect
ECS - 27.II: Updating of the hydrogeological sheets
ECS - 28: EPR - Reinforcement of the provisions for managing the pressure in the containment
ECS - 29: Reinforcement of the U5 venting-filtration system ("sand-bed filter")
ECS - 30: Designing the emergency premises to withstand earthquakes and flooding
ECS - 31: Modifications to ensure facility management further to releases
ECS - 32: Multiple plant unit emergency organization
ECS - 34: Updating of agreements with hospitals
ECS – 35: I and II: Feasibility of emergency management actions in extreme situations
ECS – 35: III and IV: Accident management training
ECS - 36: FARN (Nuclear rapid intervention force)

3. German National Action Plan [2]

3.1 Process to establish the plan

After the reactor accidents in the Japanese Fukushima Dai-ichi nuclear power plants (NPPs), the Reactor Safety Commission (RSK) was asked by the Federal Government in the middle of March 2011 to carry out a safety review of the operating nuclear power plants for testing their robustness. Also, the GRS, a technical support organization of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU), made recommendations for possible improvement in robustness. Thereafter, German National Action Plan was established on the basis of the recommendations by the RSK and the GRS, review results of the EU stress test, and the recommendations of the extraordinary meeting of the Contracting Parties to the Convention on Nuclear Safety (CNS) in August 2012.

3.2 National Recommendations and Suggestions

Recommendations and suggestions provided in the National Action Plan are as follows:

N-1 To ensure a stable subcritical state of the plant and the safe removal of residual heat for at least 10 hours, in the event of a station blackout. To ensure the power supply required for this (e.g. batteries) as well as the power supply of the accident overview measuring systems and the necessary lighting.
N-2 To establish accident management measures by which, with an additional emergency power generator, the three-phase supply can be reestablished within 10 hours, in the event of a station blackout,
N-3 A service water supply, independent regarding its power supply and the required auxiliary systems.
N-4 A pump designed against beyond-design-basis events, which commensurate with its task is mobile and independent of the power supply of the plant, as emergency measure.
N-5 For PWR plants, there should be a possibility of a reactor pressure vessel injection with borated water that is independent of the active emergency cooling system, taking account of the existing safety-related design.
N-6 Filtered containment venting
N-7 To prevent hydrogen accumulation, inside the containment building (e.g. catalytic re-combiners, whose functionality in cases of a station-blackout lasting is to be longer than 10 hours.).
N-8 Permanent systems for fuel pool cooling, as an emergency measure.
N-9 Remote shutdown station
N-10 Alternative location for the emergency response staff, and communication means of for communication to the remote shutdown station and to the control room have to be available in case of emergency.
N-11 Auxiliary equipment has to be available e.g. to provide access to buildings after external events.
N-12 Measures to review and, where required, improve the reliability of the ultimate heat sink with regard to blockage of the cooling water intake.
N-13 To ensure the vital safety functions in case of beyond design basis external or internal hazards.
N-14 Further specification of recommendation N-13 on earthquakes
N-15 Further specification of recommendation N-13 on flooding
N-16 Further specification of recommendation N-13 on flooding of the annulus
N-17 Further specification of recommendation N-13 on load drop
N-18 To clarify whether the safety objectives of the accident management measures can also be achieved during or after natural external design basis hazards.
N-19 To demonstrate that the supply of three-phase alternating current required for the vital safety functions is ensured even if there is no grid connection available for up to a week.
N-20 Review of the accident management concept with regard to injection possibilities for the cooling of fuel assemblies and for ensuring sub-criticality.
N-21 Performance of the filtered containment venting.
Effectiveness of installations to reduce hydrogen in the containment.
N-22 Consideration of wet storage of fuel assemblies in the accident management concept.
N-23 Implementation of the Severe Accident Management Guidelines (SAMG) in the short term.

4. British National Action Plan [2]

4.1 Process to establish the plan

The British National Action Plan has been developed from a number of UK ONR (Office for Nuclear Regulation) reports produced in response to Fukushima accident. These reports are as follows:

- Interim report (May 2011) and final report (Sept. 2011) by HM chief inspector to UK Govt.
- UK National stress test report (Dec. 2011)
- Implementation Report on progress in implementing lessons learned (Oct. 2012)

4.2 Implementation of ENSREG Compilation of Recommendations

Activities in the ENSREG compilation are categorized by 3 topics (natural hazards, loss of safety systems, and severe accident management) as follows:

1) Natural hazards
- Hazard frequency ; secondary effects of earthquakes
- Protected volume approach ; early warning notifications
- Seismic monitoring; qualified walk-downs
- Flooding margin assessments; external hazard margins

2) Loss of safety systems
- Alternate cooling and heat sink; AC & DC power supplies
- Operational and preparatory actions; instrumentation and monitoring
- Shutdown improvements; reactor coolant pump seals
- Ventilation; main and emergency control rooms
- Spent fuel pool; separation and independence
- Flow path and access availability; mobile devices
- Bunkered/hardened systems; multiple accidents
- Equipment inspection and training programs; further studies to address uncertainties
- The integrity of the SFP and its liner in the event of boiling or external impact.
- The functionality of control equipment during the SBO to ensure that cooling using natural circulation would not be interrupted in a SBO.
- The performance of additional studies to assess operation in the event of widespread damage.

3) Severe accident management
- WENRA reference levels; SAM hardware provisions
- Review of SAM provisions following severe external events
- Enhancement of severe accident management guidelines (SAMG)
- SAMG validation; SAM exercises; SAM training
- Extension of SAMGs to all plant states
- Improved communications; presence of hydrogen in unexpected places
- Large volumes of contaminated water; radiation protection
- On-site emergency center; support to local operators
- Level 2 probabilistic safety assessments (PSAs); severe accident studies

5. Conclusions

From the results of the above analysis, it was recognized that enhancement of “Defense in Depth” principle and maintaining of essential safety functions, such as reactor core and spent fuel pool cooling, during and after a station blackout or any predictable severe external and internal conditions are the most important in nuclear safety.

It is expected that the detail analysis results [4, 5] of each national plan will be helpful to enhance the safety of domestic operating nuclear power plants.

REFERENCES

[1] National Action Plan of the French Nuclear Safety Authority, ASN, December 2012
[2] German Action Plan for the implementation of measures after Fukushima Dai-ichi reactor accident, December 2012
[3] UK ONR ENSERG Related ‘National Action Plan’, Office for Nuclear Regulation, An agency of HSE, December 2012
[4] KINS/RR-1025, Analysis of the French Regulatory Technical Requirements for the Prevention and Mitigation of Severe Accidents in Nuclear Facilities, KINS, April 2013
[5] KINS/RR-1040, Analysis of German and British National Action Plans for the Prevention and Mitigation of Severe Accidents in Nuclear Power Plants, KINS, July 2013