中华人民共和国环境保护部
Ministry of Environmental Protection of the People's Republic of China

Safety Enhancement of Nuclear Power Plant in China after Fukushima

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Contents

Overview

- After the Fukushima nuclear accident, the NNSA took safety enhancement actions, which was composed of the major three phases as follows:
  - **Phase 1：** Comprehensive safety examination on nuclear power plants.
  - **Phase 2：** Conduct External events and SBO safety margin evaluation.
  - **Phase 3：** Formulating new safety requirements for newly built nuclear power plants based on the conclusions of examination， evaluation and experience feedback from Fukushima nuclear accident.

Nuclear safety regulatory actions in China (phase 1)

1 Comprehensive safety examination on NPPs

- The NNSA conducted comprehensive safety examination on nuclear power plants in operation and under construction in China from March to December, 2011.
- To find out potential safety weaknesses according to laws, regulations, and experience feedback from Fukushima accident.

Conclusions

- The design, construction and operation of NPPs satisfy requirements of Chinese safety regulations.
- The NPPs are fully capable to deal with DBA, and have basic capability to prevent and mitigate severe accidents.
- Potential improvments to enhance capability of NPPs against external events, SBO etc.
- Improvements can be divided into short-term and medium-term actions.

Implementation issues:

Misunderstanding and disunity on improvement measures among the NPPS.

NNSA developed “Generic Technical Guidelines on Post-Fukushima Improvement Actions”.

2 Generic technical guidelines on post-Fukushima improvement actions

- To provide guidance for the NPPs to carry out post-Fukushima improvement measures.
- To standardize the common improvements.
- To reach technical integrity during the implementation.
- To coordinate the depth and width of safety improvement strategies.
- To define definite improvement acceptance criteria.

- Technical guidelines on following common improvement items were put forward :

Capability against flood.

Backup water-injection and related equipments.

Mobile power supply.

Monitoring of spent fuel pool.

Hydrogen monitoring and controlling systems.

Habitability and functions of emergency control center .

Radiation Environmental Monitoring and Emergency.

Dealing with External Natural Disasters.

- The generic technical guideline specified some conditions and requirements in implementing the improvements, mainly including:

1. In making water-proof seal and blocking, the blocked water level shall be evaluated under scenario in which design basis flood level superposed with a precipitation once in 1000 years, to ensure that one residual heat removal safety train is available before the mobile makeup water unit is connected.
2. The capacity design for mobile makeup water units is based on connection 6 hours after reactor shutdown, and two units will be provided at multi-reactor site.
3. Two mobile power sources shall be provided, with one of them sized to drive the LP safety injection pump or auxiliary feedwater pump.

4. Mobile makeup water units and mobile power sources shall be stored at a place over 5m above the design basis flood level, and away from safety buildings by over 100m, and the storing structures shall be checked as per SL2.
5. Necessary level and temperature monitoring shall be added for spent fuel water pool.
6. Amount of hydrogen in the containment shall be evaluated as reaction of 100% active zone cladding zirconium with water.
7. Structures of emergency control center shall be checked as per SL2. The inhabitability in case of a severe accident shall be evaluated on the basis of 100mSv, and so on.

water-proof seal

seal of hole

Water-proof door

mobile diesel generator

Diesel pump

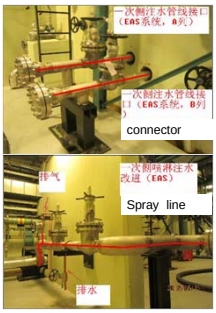
Mobile emergency power improved （380V）

connection box and quick plug

Mobile DG connect exercise

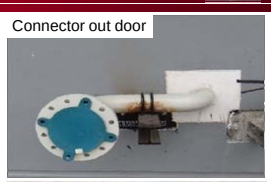
Primary side feed water

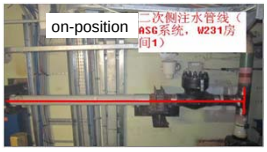
PTR



secondary side feed water

Connector out door



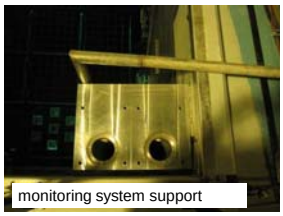


Secondary side（ in door）

Out door

exercise

Spent fuel pool temperature, liquid level monitoring and improvement



Exercises on Implementing Relevant Revised Procedures

- The “Generic technical guidelines” were prepared by incorporating the actual conditions of nuclear power plants in China, taking into overall account the preliminary experience feedback from Fukushima nuclear accident as far as possible.
- The “Generic Technical guidelines” will be amended and improved step by step, while more progress being made and more knowledge being acquired through domestic and international research and studies on the Fukushima accident.

Nuclear safety regulatory actions in China (phase 2)

- NNSA required operating nuclear power plants in Mar. 2012 to perform further evaluation of safety margins for beyond design basis external events and SBO, to optimize and implement the improvement actions proposed in comprehensive safety examination.

- The events selected in the evaluation included earthquake (initial event), flood (initial event) and station blackout (subsequently followed by failure of safety systems).
- The evaluation covered the accident response of nuclear power plant in extreme events, effectiveness of defense and consequences mitigation measures, and weakness and cliff edge effect possibly existing in nuclear power plants.

- **In seismic margin,** the EPRI SMA approach was adopted, all systems and components for mitigating accident were identified, and then the successful route to bring the nuclear power plant to safe and steady shutdown was selected on this basis.
- **In flooding safety margin,** the most probable flooding route was identified from component, system and building data, with the assumption that the systems gradually fail with the continual rising of flood level, until core melting.
- **In station black out (SBO),** the time in which the unit can be maintained under control was evaluated in the accidental condition that the main unit parameters are monitored and unit status is controlled only with power from batteries without restoring the offsite power source and emergency diesel generator sets.

- NNSA entrusted the Nuclear Energy Industry Association to organize a peer review of the preliminary evaluation reports, conclusions of peer review are:
  - all operating nuclear power plants in China mainland can pose the seismic margin of 1.5 times the DBE or above;
  - they have the safety margin to cope with BDF flood. for the 300MW unit in Qinshan Nuclear Power Plant on a wet site, improvement actions are under way, and it will have the safety margin against BDF after their completion;
  - all power plants have adopted fairly complete counter measures against losing AC supplement, and batteries have the capacity to supply power for 8 hours after the station block-out.


Rebuilding of dam in Qinshan NPP

Nuclear safety regulatory actions presently under way in China (phase 3)

(I) Supervising the post-Fukushima improvement actions, to implement improvement requirements according to schedule

- Short-term: finished
- Medium and long-term: In progress
- Under construction: Before FFL

(II) Further deepening the studies on experience and lessons of Fukushima nuclear accident

- We know that the research of experience and lessons of Fukushima nuclear accident will be a long process.
- The improvement measures is based on the preliminary experience feedback of the Fukushima accident, whether appropriate still needs further research to verify .
- NNSA has organized a special team to study the experience and lessons of Fukushima nuclear accident.

(III) Carrying out international cooperation to jointly learn experience and lessons

- Nuclear safety is not limited by national boundaries, learning lessons and experience for Fukushima nuclear accident is a common job and task of the nuclear safety field in the world.
- NNSA have conducted in-depth exchanges with international peers to learn and take experience from different countries.

(Ⅳ) Further perfect nuclear safety code, upgrade of safety standards

- After Fukushima nuclear accident, NNSA proposed strengthening nuclear safety code, upgrade of safety standards, especially on external events, severe accidents, emergency preparedness and response.

(Ⅴ) Strengthening nuclear safety culture development

- Fukushima nuclear accident demonstrated importance of safety culture.
- NNSA establish safety culture assessment standard.

(Ⅵ) formulating safety requirements for newly built nuclear power plants

- Presently in China, 22 units are in operation and 26 units are under construction.
- After Fukushima nuclear accident, China suspended the review and approval of construction of new nuclear power plants.
- In October of 2012, the State Council approved restarting the nuclear power construction in China.

- Higher safety requirements were put forth for new nuclear power plants, mainly in two documents, one is the "*Twelfth Five-year Plan and 2020 long-term goal for nuclear safety and radioactive pollution prevention and control"* (the nuclear safety planning) developed and prepared by the NNSA， and the other is the *"Nuclear power safety planning"* (nuclear power safety planning) developed and prepared by the National Energy Administration.

- Presently, the NNSA is conducting research on strengthening the safety goal of nuclear power plants, and carrying out further comparison and analysis of nuclear power units of different reactor types with advanced standards.
- The research work is now still in progress, the NNSA has prepared the draft of *"Safety requirements for newly built nuclear power plants during 'Twelfth Five-year Plan' period" (Safety requirements),* to ask for comments extensively in the nuclear industry.

Thank you !