Nuclear Safety Regulatory Actions of China after Fukushima Nuclear Accident

National Nuclear Safety Administration

April, 2013
Presentation Outline

1. Overall
2. NNSA Actions after Fukushima
3. Recent Works
After the Fukushima nuclear accident, the NNSA took corresponding response actions, mainly including three phases.

- **Phase 1**: Comprehensive safety examination on nuclear power plants, Draw up Nuclear Safety Plan.
- **Phase 2**: Conduct External events safety margin evaluation
- **Phase 3**: Recent Works, Studying new safety requirements for newly built nuclear power plants based on the conclusion of examination, evaluation and experience feedback from Fukushima nuclear accident.

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Overall
The NNSA conducted comprehensive safety examination on nuclear power plants in operation and under construction in China during March to December, 2011.

To find out potential safety weaknesses according to laws, rules, standards currently in force and Last IAEA documents.
Conclusion

- The design, construction and operation of NPPs satisfy requirements of Chinese safety regulations, and reach the safety level in IAEA new requirements.
- The NPPs have fully ability to prevent DBA, and have basic ability to prevent and mitigate severe accidents and risk is under control.
Put forth management requirements on post-Fukushima improvement actions, to enhance the safety level of the NPPs farther, including short-term and medium-term improvements.

Prevention of external events, Prevention and mitigation for severe accident, Emergency management

- **Implement problems**: Misunderstanding, disunity
- Compiled “General technical requirements on post-Fukushima improvement actions”
General technical requirements 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 coordinating the depth and broadness of safety improvement strategies
- To set definite improvement acceptance criteria
It put forth technical requirements on eight common improvement items, namely:

- Requirements against Flood protection Capability
- Requirements of Emergency Water-Injection and Related Equipment
- Requirements for mobile power supply
- Requirements for monitoring of spent fuel pool
- Requirements for modification of hydrogen monitoring and controlling systems
- Requirements for habitability and functions of emergency control center
- Requirements Improvement on Radiation Environmental Monitoring and Emergency
- Requirements in Dealing with External Natural Disasters
The general technical requirements specified some conditions and requirements in implement the improvements, mainly including:

1. In making water-proof seal and blocking, the blocked water level shall be evaluated under scenario in which design base 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 that can prevent a flood over 5m above the design base flood, and away from safety system by over 100m, and the structures shall be one degree higher than civil buildings, and 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 one degree higher than civil buildings, and be checked as per SL2. The inhabitability in case of a serious accident shall be evaluated on the basis of 100mSv, and so on.
The “General technical requirements” were prepared by incorporating the actual conditions of nuclear power plants in China, taking into overall account the preliminary experience feedback after Fukushima nuclear accident as far as possible.

The “General Technical Requirements” 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 II)

- NNSA required operating nuclear power plants in Mar. 2012 to perform further evaluation of safety margins for beyond design basis external events, to optimize and implement the improvement actions proposed in comprehensive safety inspections.
The external 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 external events, effectiveness of defense and consequences mitigation measures, and weak links and steep edge effect possibly existing in nuclear power plants.
In anti-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 flood 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 set.
NNSA entrusted the Nuclear Energy Industry Association to organize a peer review of the preliminary evaluation reports. The conclusion of peer review is:

- All operating nuclear power plants in China mainland can meet the anti-seismic requirements of 1.5 times the DBE or over;
- 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 plant have adopted fairly complete countermeasures against losing AC supplement, and batteries have the capacity to supply power for 8 hours after the blackout.
Nuclear safety regulatory actions presently under way in China

(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 need 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 system, 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) Studying safety requirements for newly built nuclear power plants

- Presently in China, 15 units are in operation and 30 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.
The nuclear safety planning set the safety goal for newly built nuclear power plants in China for a period in the future, the important ones are:

- “during the Twelfth Five-year Plan period (before 2015), the newly built nuclear power units shall have fairly complete provisions to prevent and mitigate severe accidents, the core destruction frequency (CDF) per reactor-year shall be lower than 10-5 and the large scale radioactive substance release frequency (LRF) per reactor-year shall be lower than 10-6.”
- “For nuclear power units built in Thirteenth Five-year Plan period (after 2015), efforts shall be made to actually eliminate the possibility of large scale radioactive substance release in design”.

Important requirements set in the nuclear power safety planning include “adopting the highest nuclear safety requirements in the world”, “newly built nuclear power units must comply with the third generation safety standards”
Presently, the NNSA is conducting research on strengthening the safety goal of nuclear power plants, and conducting 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!

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