Peer Review Results of Taiwan's Stress Test National Report

Department of Nuclear Regulation
Atomic Energy Council, Taiwan
July, 2013

Outlines

- Post-Fukushima Safety Re-Evaluation in Taiwan
- Stress Test Evaluation in Taiwan
- Independent Peer Review
- Concluding Remarks

Post-Fukushima Safety Re-Evaluation in Taiwan (1/4)

- By reference to measures recommended by various major nuclear authorities or international organizations, such as NRC, NEI, WENRA (later ENSREG), WANO and NISA, AEC required TPC to verify the capability of NPPs in response to both the DBA and beyond DBA
- Two-Stage Approach
  - Near-Term Evaluation (by June, 2011)
  - Mid-Term Evaluation (by December, 2011)

UNITED STATES NUCLEAR REGULATORY COMMISSION

NEI NUCLEAR ENERGY INSTITUTE

ENSREG European Nuclear Safety Regulators Group

WANO

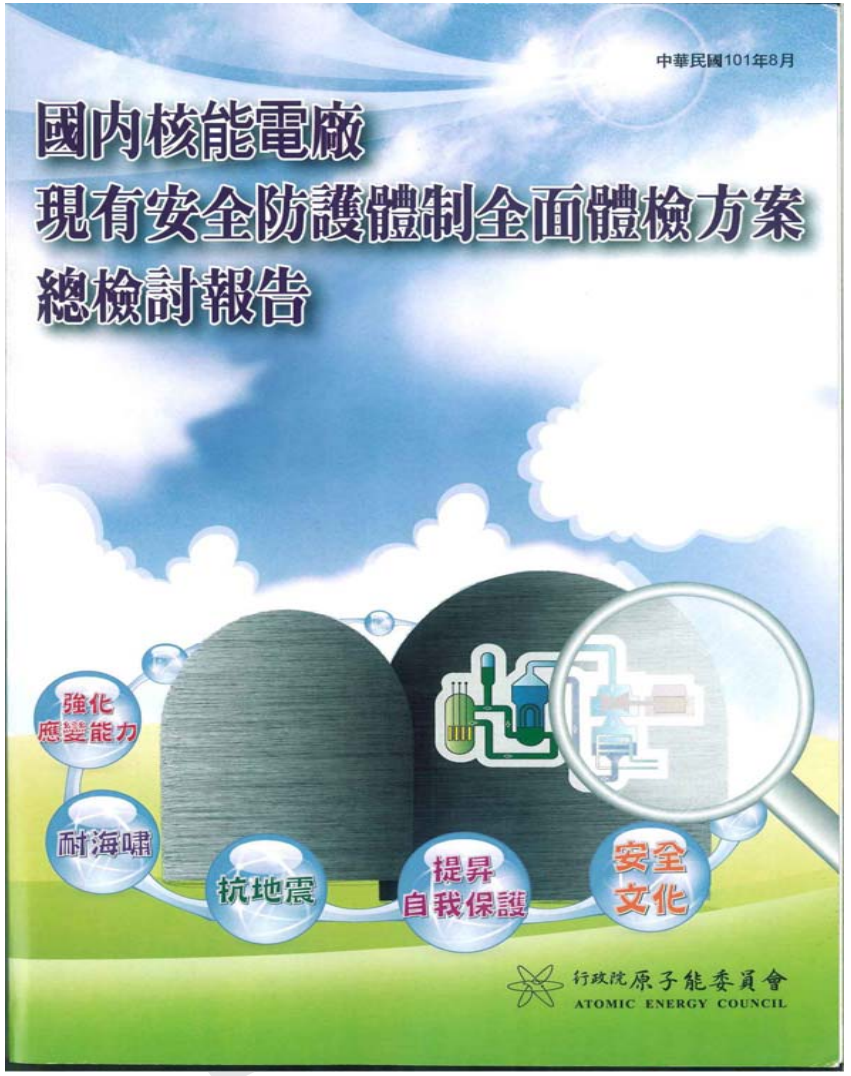
IAEA International Atomic Energy Agency
Atoms For Peace

Post-Fukushima Safety Re-Evaluation in Taiwan (2/4)

- **May 31, 2011:** AEC issued "Preliminary Assessment Report of Nuclear Safety" and held a public meeting
- **October, 2011:** AEC issued "The Near-Term Overall Safety Assessment Report for Nuclear Power Plants in Taiwan in Response to the Lessons Learned from Fukushima Daiichi Accident"

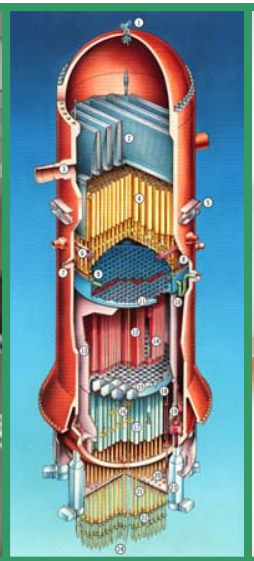
Post-Fukushima Safety Re-Evaluation in Taiwan (3/4)

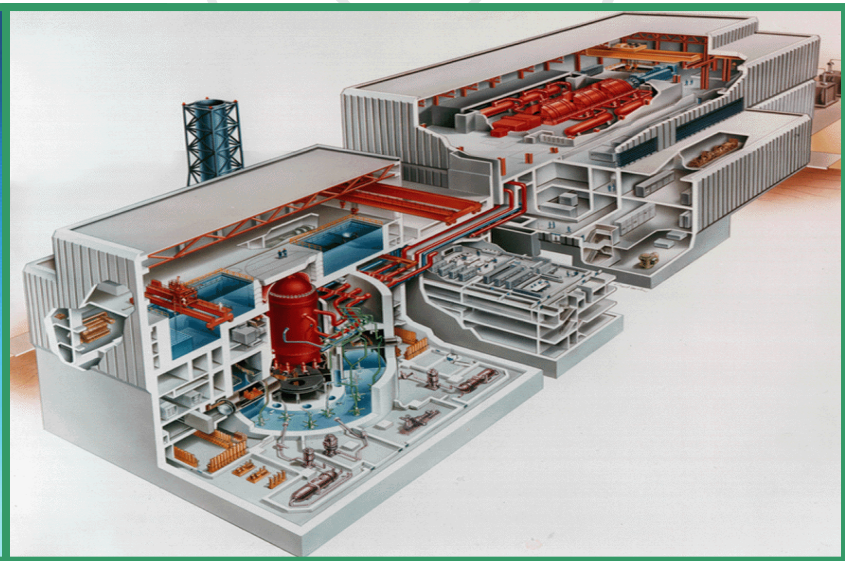
- **August, 2012 : AEC issued "The Overall Safety Assessment Report for Nuclear Power Plants in Taiwan in Response to the Lessons Learned from Fukushima Daiichi Accident" final version and the draft regulatory orders**
- ***November, 2012 : the final regulatory orders were issued by AEC***



Post-Fukushima Safety Re-Evaluation in Taiwan (4/4)

- **Evaluation for Lungmen Plant**
  - **No immediate threat, since no nuclear fuels in the reactor**
  - **Complete the required actions similar to operating NPPs before the initial fuel loading**
  - **Two Gas-Turbine Generators should be installed in Lungmen**



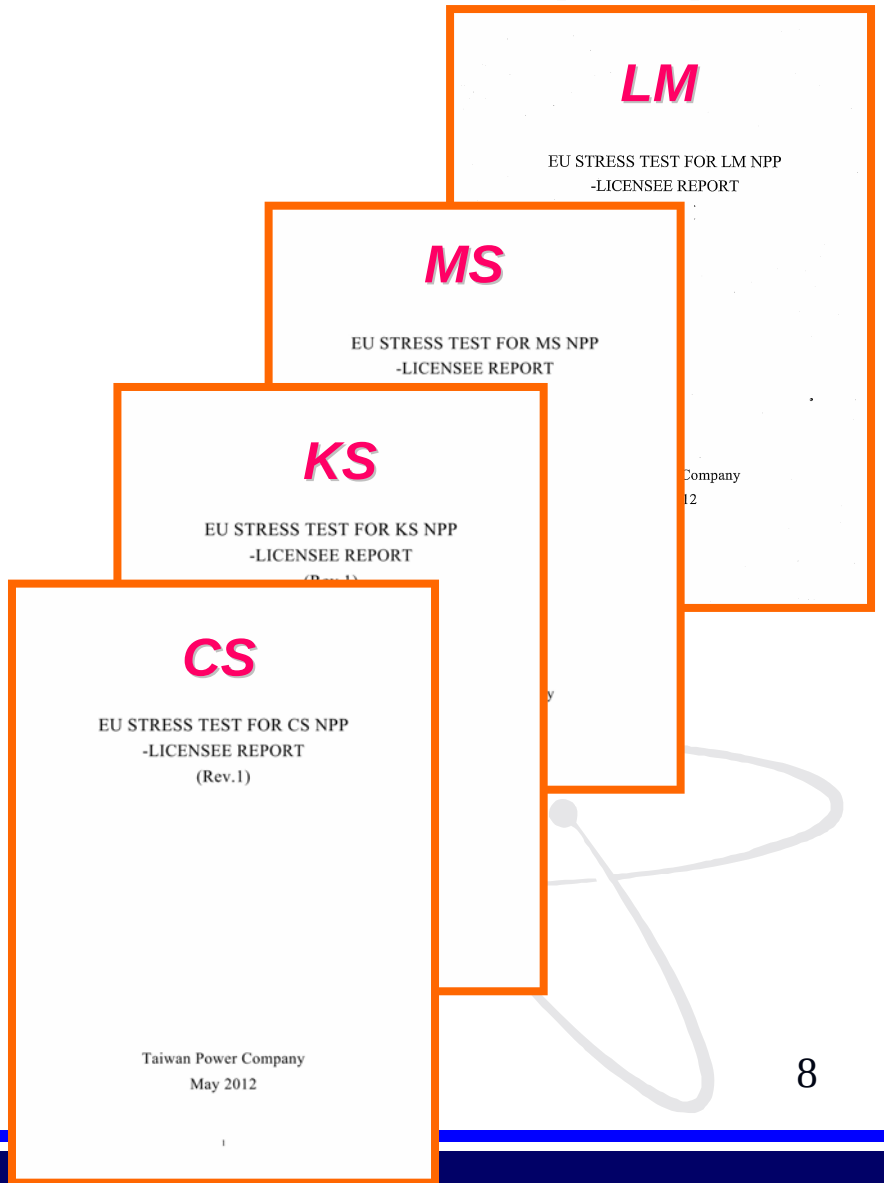


Stress Test Evaluation in Taiwan (1/10)

- According to EU Stress Test Specification, Implementing Stress Test to confirm defense-in-depth and safety margins and identify Cliff-edge Effect and effectiveness of countermeasures
- Initiating events
  - Earthquake
  - Flooding
- Consequence of loss of safety functions from any initiating event conceivable at the plant site
  - Loss of electric power, including station blackout (SBO)
  - Loss of the ultimate heat sink (UHS)
  - Combination of both

Stress Test Evaluation in Taiwan (2/10)

- **Compliance with the EU specifications**
  - Utilities Final Report for operating NPPs: March, 2012
  - Utilities Final Report for NPP under construction :April, 2012
  - Draft National Report : June, 2012
  - Final National Report : January, 2013



Stress Test Evaluation in Taiwan (3/10)

- **Compilation of Recommendations and Suggestions from the Review of the European Stress Tests - July 26, 2012**
- **European Level Recommendations**

2.1. European guidance on assessment of natural hazards and margins	**AEC Requirement**
2.2. Periodic Safety Review	**AEC Requirement**
2.3. Containment integrity	**AEC Requirement**
2.4. Prevention of accidents resulting from natural hazards and limiting their consequences	**AEC Requirement**

Stress Test Evaluation in Taiwan (4/10)

3.1 Topic I items (natural hazards) to be considered	
3.1.1 Hazard Frequency	AEC Requirement
3.1.2 Secondary Effects of Earthquakes	Future Plan
3.1.3 Protected Volume Approach	AEC Requirement
3.1.4 Early Warning Notifications	AEC Requirement
3.1.5 Seismic Monitoring	AEC Requirement
3.1.6 Qualified Walkdowns	AEC Requirement
3.1.7 Flooding Margin Assessments	AEC Requirement
3.1.8 External Hazard Margins	AEC Requirement

Stress Test Evaluation in Taiwan (5/10)

3.2 Topic 2 items (loss of safety systems) to be considered	
3.2.1 Alternate Cooling and Heat Sink	AEC Requirement
3.2.2 AC Power Supplies	AEC Requirement
3.2.3 DC Power Supplies	AEC Requirement
3.2.4 Operational and Preparatory Actions	AEC Requirement
3.2.5 Instrumentation and Monitoring	AEC Requirement
3.2.6 Shutdown Improvements	Under Evaluation
3.2.7 Reactor Coolant Pump Seals	AEC Requirement
3.2.8 Ventilation	AEC Requirement
3.2.9 Main and Emergency Control Rooms	Future Plan
3.2.10 Spent Fuel Pool	AEC Requirement
3.2.11 Separation and Independence	AEC Requirement
3.2.12 Flow Path and Access Availability	Under Evaluation
3.2.13 Mobile Devices	AEC Requirement
3.2.14 Bunkered/Hardened Systems	Future Plan
3.2.15 Multiple Accidents	AEC Requirement
3.2.16 Equipment Inspection and Training Programs	AEC Requirement
3.2.17 Further Studies to Address Uncertainties	Under Evaluation

Stress Test Evaluation in Taiwan (6/10)

3.3 Topic 3 items (severe accident management) to consider	
3.3.1 WENRA Reference Levels •Hydrogen mitigation in the containment •Hydrogen monitoring system •Reliable depressurization of the reactor coolant system •Containment overpressure protection •Molten corium stabilization	 AEC Requirement AEC Requirement AEC Requirement AEC Requirement Under Evaluation
3.3.2 SAM Hardware Provisions	Under Evaluation
3.3.3 Review of SAM Provisions Following Severe External Events	Under Evaluation
3.3.4 Enhancement of SAMG	AEC Requirement
3.3.5 SAMG Validation	AEC Requirement
3.3.6 SAM Exercises	AEC Requirement
3.3.7 SAM Training	AEC Requirement
3.3.8 Extension of SAMGs to All Plant States	Under Evaluation
3.3.9 Improved Communications	AEC Requirement
3.3.10 Presence of Hydrogen in Unexpected Places	AEC Requirement
3.3.11 Large Volumes of Contaminated Water	Future Plan
3.3.12 Radiation Protection	AEC Requirement
3.3.13 On Site Emergency Center	AEC Requirement
3.3.14 Support to Local Operators	AEC Requirement
3.3.15 Level 2 Probabilistic Safety Assessments (PSAs)	Under Evaluation
3.3.16 Severe Accident Studies	Under Evaluation

Stress Test Evaluation in Taiwan (7/10)

Initiating Event : Earthquake

Plant	Design Basis	Cliff-edge as original design
CS	0.3g	1.05g (core support structure)
KS	0.4g	0.77g (RCIC DC Switchgear)
MS	0.4g	1.48g (DC Bus Switchgear)
LM	0.4g	2.0g (RBCW)

*All values are peak ground acceleration values

Stress Test Evaluation in Taiwan (8/10)

Initiating Event : Tsunami

Plant	Design Basis	Cliff-edge as original design	Cliff-edge with countermeasure
CS	10.7 run up(m)	11.2 m (RCIC)	16.7 m (TPC is now planning to build tsunami wall with height of 10.7+ 6 m)
KS	10.3 run up(m)	12.3 m (RCIC)	16.3 m (TPC is now planning to build tsunami wall with height of 10.3+6 m)
MS	12.0 run up(m)	15 m (DC Bus)	18.0 m (TPC is now planning to build tsunami wall with height of 12+6 m)
LM	8.5 run up(m)	12 m (RCIC…)	14.5 m (TPC is now planning to build tsunami wall with height of 8.5+6 m)

Stress Test Evaluation in Taiwan (9/10)

Initiating Event : Station black out

Plant	Design Basis	Cliff-edge as original design	Countermeasure for Cliff-edge
CS	8 hours	DC power: 24 hours (isolate non-vital DC load) Coping time: 8 hours	• upgrade the capacity of DC power to 24 hour without load shedding for the first 8 hour • Evaluation: extending coping time to 24 hours • Autonomy of 72 hours With portable D/G
KS	8 hours	DC power: 24 hours (isolate non-vital DC load) Coping time: 8 hours	Same as CS
MS	8 hours	DC power: 8 hours (isolate non-vital DC load) Coping time: 8 hours	Same as CS
LM	8 hours	DC power: 8 hours (isolate non-vital DC load) Coping time: 8 hours	Same as CS

Stress Test Evaluation in Taiwan (10/10)

Initiating Event : Loss of ultimate heat sink

Plant	Cliff-edge as original design	Countermeasure for Cliff-edge
CS	40 hours (CST storage capacity)	With fresh water from reservoir(There is no limitation for water supplying from creek or sea)
KS	24 hours (CST storage capacity)	With fresh water from reservoir(There is no limitation for water supplying from creek or sea)
MS	40 hours (CST storage capacity)	With fresh water from reservoir(There is no limitation for water supplying from creek or sea)
LM	21 hours (CST storage capacity)	With fresh water from reservoir(There is no limitation for water supplying from creek or sea)

OECD/NEA and ENSREG peer review

ENSREG peer review	OECD/NEA independent peer review
September~October 2013	March 2013
expert team with nine members： Team leader (1), Rapporteur (1), topic 1 (2), topic 2 (3), topic 3(2) topic 1: initiating events topic 2: loss of safety functions topic 3: severe accident management	expert team with seven members： Team coordinator (1), five (5) experts for technical areas including seismic, flooding, other extreme hazards, loss of safety functions, and severe accident management, and AEC Liaison (1)
10 working-days Site visit: PWR, ABWR	10 working-days Site visit: BWR-6 with Mark III cont.
Press release	Press conference
NGO workshop	NA

Background on Independent Peer Review

- AEC requests support from international community for independent peer review
  - European Union (EU)
  - Organisation for Economic Cooperation and Development / Nuclear Energy Agency (OECD/NEA)
- NEA agrees to support AEC with the identification of independent experts for review
- Team start independent peer review on 4 March 2013

Independent Peer Review Methodology

- **Based on English versions of 4 reports**
  - National Report
  - Chinshan NPS Stress Test Report
  - Kuosheng NPS Stress Test Report
  - Maanshan NPS Stress Test Report
- **In-depth technical discussions held with AEC and TPC (Headquarters and Kuosheng) staff**
- **Site visit to Kuosheng NPS**
- **Focused on both process for implementing the stress test and the technical basis supporting the analyses conducted as part of the stress test**
- **Identified recommendations to improve stress test and other technical observations**

Major Findings of NEA Peer Review

- To perform fault displacement hazard analysis
- To deploy a local seismic network near NPPs
- To provide an interface between post-earthquake and post-tsunami operating procedures
- To systematically assess the combinations of events in the areas of flooding and extreme natural events
- To check the probable maximum precipitation with regional topographical maps

Note: Other findings are already included in the AEC's regulatory orders

Conclusions of NEA Peer Review

- **Overall the Independent Peer Review Team found that the Stress Test implemented in Taiwan was consistent with the process according to the ENSREG Criteria used in the EU**
- **Enhancements that have been identified are consistent with those identified in other countries**
- **Implementation of the enhancements identified by AEC and TPC is seen as a strength**
- **Completion of ongoing technical evaluations in the seismic and flooding areas using updated methodologies and assumptions could identify other issues that TPC and AEC may need to address**

Concluding Remarks

- All Findings of NEA Peer Review, include nine strengths, one recommendation and eight technical observations in the assessment for five technical areas, are all included in the AEC's regulatory orders
- In September, ENSREG expert team will conduct peer review of the National Report of EU Stress Test for the operating and under-construction nuclear power plants in Taiwan


Thank you