2013 AEC-NRC Bilateral Technical Meeting

Overview of Recent Regulatory Activities in Taiwan

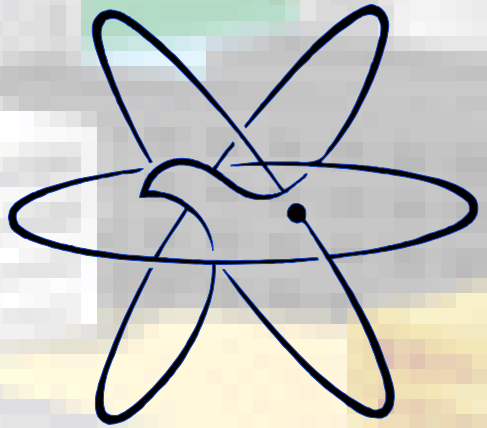
Department of Nuclear Regulation
Atomic Energy Council, Taiwan

July 10, 2013

Contents

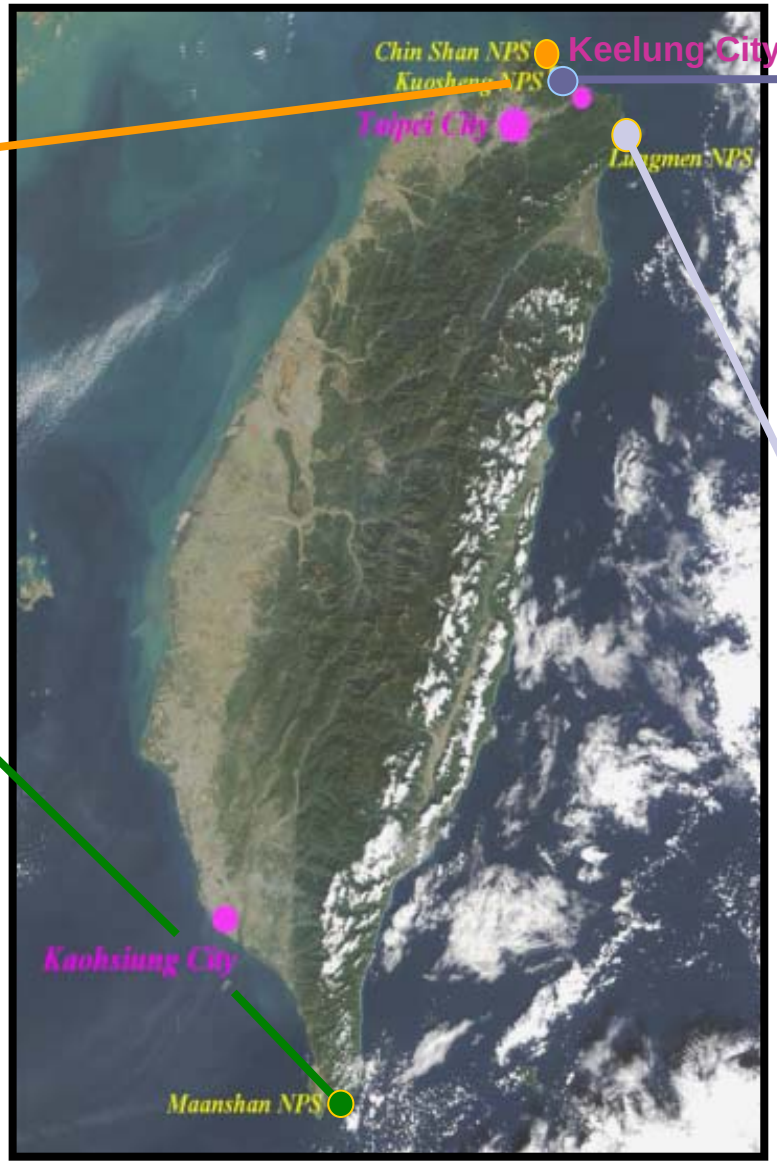
- Operating Nuclear Power Plants Performance Record
- Recent Nuclear Regulatory Activities
- Concluding Remarks

Operating Nuclear Power Plants Performance Record



Chinshan NPS

GE BWR-4 1840 MWt × 2
Commercial Dec-1978 Unit1
Jul-1979 Unit2



Kuosheng NPS

GE BWR-6 2943 MWt × 2
Commercial Dec-1981 Unit1
Mar-1983 Unit2

Maanshan NPS

Westinghouse PWR
2822 MWt × 2
Commercial Jul-1984 Unit1
May-1985 Unit2

Lungmen NPS

GE ABWR
approximately 3926 MWt × 2
Under Construction

Locations and Design Features of NPPs in Taiwan

Operating Nuclear Power Plants Performance Record

Real-Time Nuclear Power Plant Operational Status

2013/07/04 07:58:03

Plant & Units	Chinshan		Kuosheng		Maanshan	
	Unit 1	Unit 2	Unit 1	Unit 2	Unit 1	Unit 2
Reactor Status	Operating	Operating	Operating	Operating	Operating	Operating
Reactor Power (%)	89	100	100	100	100	100
Generator Output (MWe)	551	644	998	1005	971	968

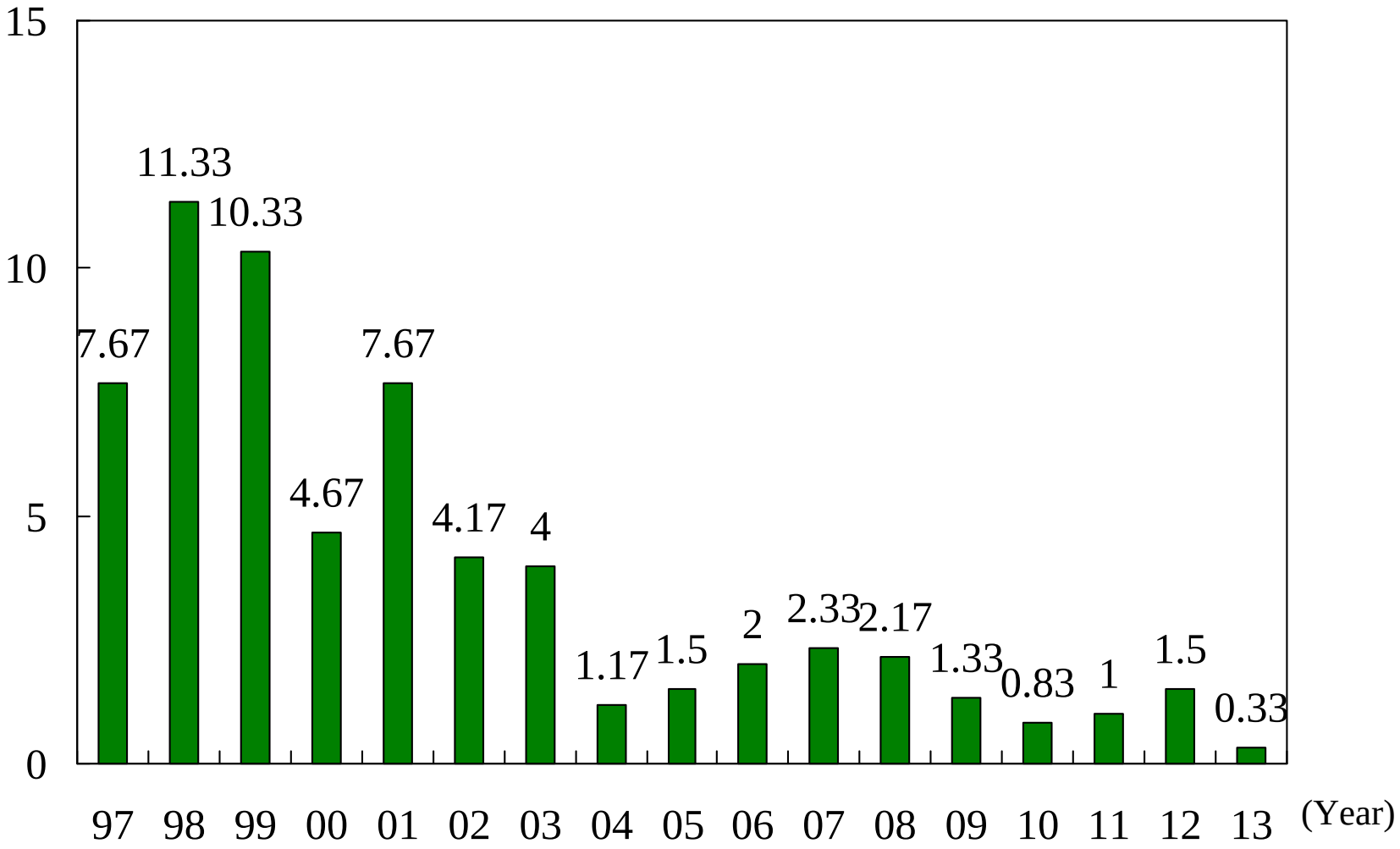
Reactor Status Display :
[Green] : Operating, [White] : Refueling Outage, shutdown, [Gray] : Computer Maintenance, Computer down, Communication Fault, and Connected to Simulator for drill.

Reactor Power and Generator Output Display :
[Green] : Reactor Power within 100%, [White] : Reactor Power between 101%~102%, [Yellow] : Reactor Power above 102%

Display is changing automatically every 5 seconds; decimals will round off for the numbers.

http://gamma.aec.gov.tw/spds/plantdata_e.asp

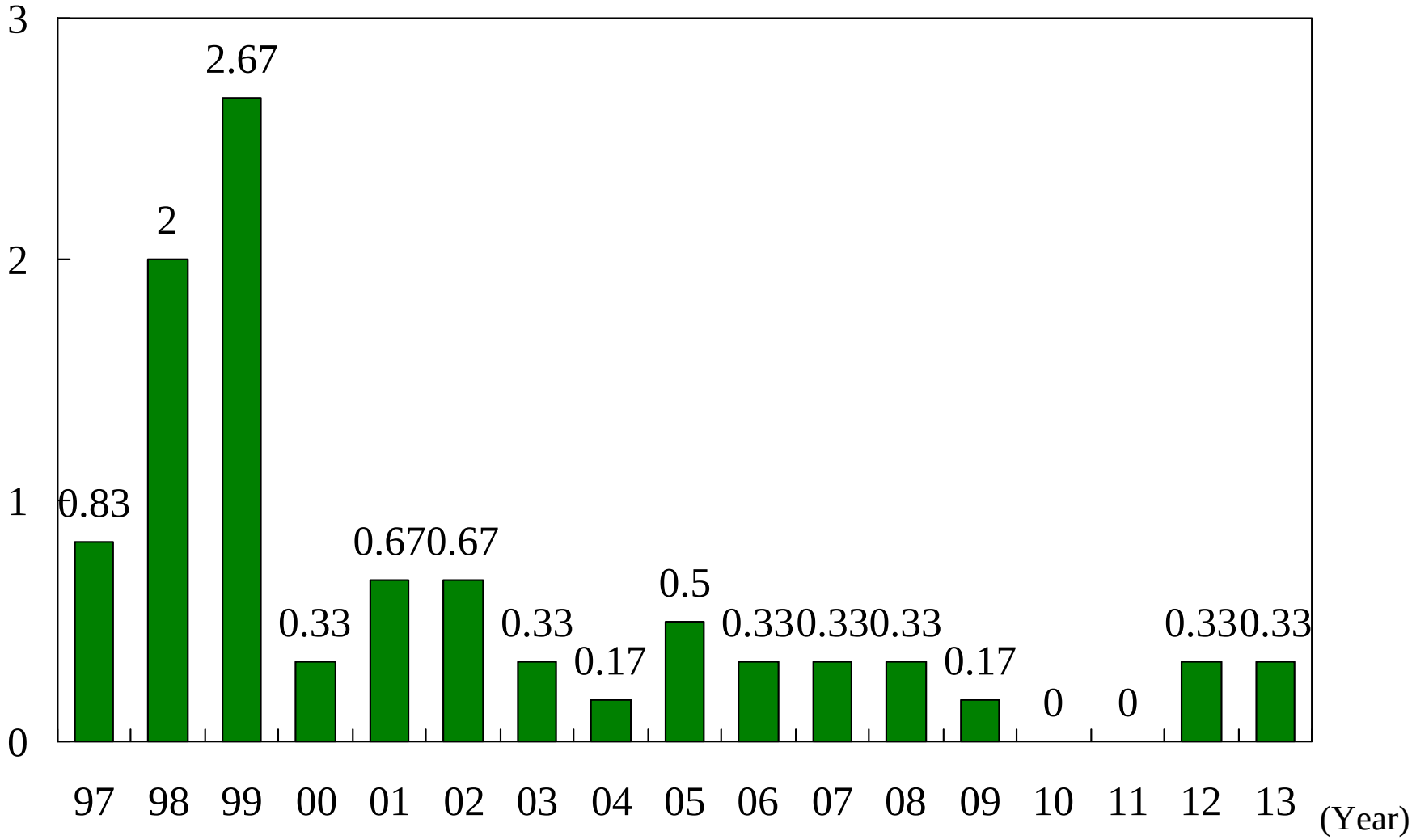
Operating Nuclear Power Plants Performance Record



Average Number of RERs per Unit

(Data up to the end of June 2013)

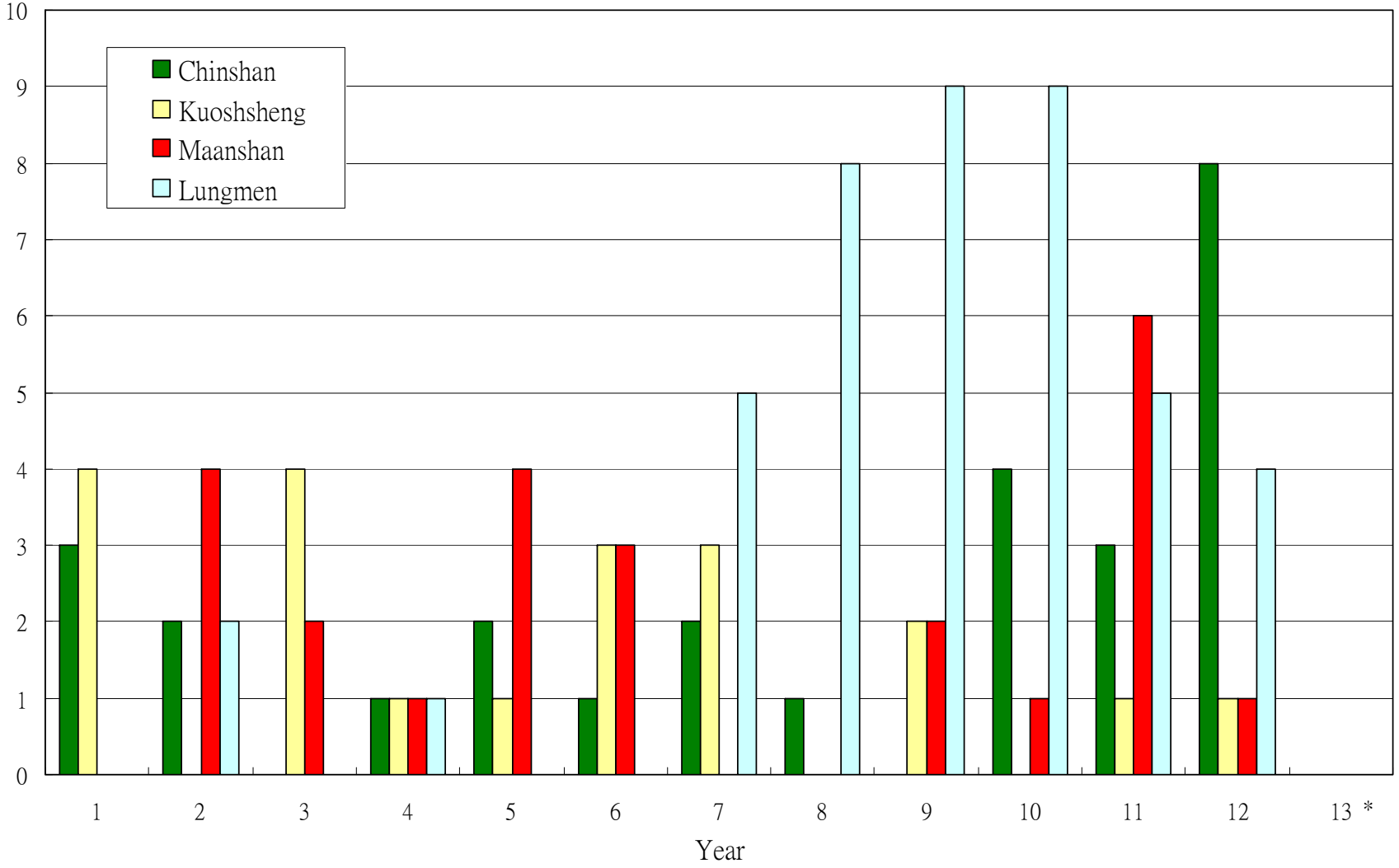
Operating Nuclear Power Plants Performance Record



Average Number of Scram per Unit

(Data up to the end of June 2013)

Number of Violations for Each Plant



Number of Violation for Each Plant（* : Data up to the end of June 2013）

Recent Nuclear Regulatory Activities

Recent Nuclear Regulatory Activities

- Stretch Power Uprate Review of NPPs
- Transient Analysis Methodology Licensing Applications
- Containment Recirculation Sump Modification of Maanshan NPP
- Safety Re-evaluation and Enhancement Project for Seismic Resistance
- Degradation and Failure of RPV Support Skirt Anchor Bolts at Kuosheng NPP
- Lungmen ABWR Construction
- Post-Fukushima Safety Re-assessment
- Stress Test (OECD/NEA and ENSREG peer review)

Stretch Power Uprate Review of NPPs (1/2)

- Taipower has launched Stretch Power Uprate project for its Chinshan & Kuosheng NPPs after 1.66~1.70% OLTP MUR power uprate in 2007~2009 .
- Safety Analysis covers 3% OLTP uprate. For implementation, 2 Step power uprate is conducted.
  - 1st step : 2% OLTP uprate,
  - 2nd step :1% OLTP additive uprate if SDVM is installed per EPRI BWRVIP-182A due to main steam line acoustic effect on steam dryer issue.
- No major changes or modification to equipment.

* SDVM : Steam Dryer Vibration Monitoring

* OLTP : Original Licensed Thermal Power(CS:1775 MWt; KS:2894 MWt)

Stretch Power Uprate Review of NPPs (2/2)

- A review task force team of experts and AEC staff was established to conduct comprehensive technical review after acceptance review.

Plant	% UPRATE	△MWt	DATE SUBMITTED	DATE APPORVED	DATE UPRATE
ChinShan	2% OLPT (1st step only)	36	2010.12.20	2012.11.15	2012.11.23(U1) 2012.11.29(U2)
KouSheng		58	2012.11.29	2014.05.30 (tentative)	----------

Transient Analysis Methodology Licensing Applications(1/2)

- Transient Analysis has mainly been performed for TPC by the fuel vendors.
- In order to develop TPC's own safety analysis capability, TPC submits a series of topical reports of TITRAM (TPC/INER Transient Analysis Methods) for licensing review.
- Four main topics are included:
  - System Thermal Hydraulics
  - Core Thermal Hydraulics
  - Thermal Hydraulics Transients
  - Special Transients

Transient Analysis Methodology Licensing Applications(2/2)

- Totally 42 reports, 29 have been approved (2006-2013), and 7 are under review.
- Part of these reports have been implemented in the MUR applications. Some are prepared for supporting the SPU projects.
- Technical Specification Change, Relief for Safety System setpoints may be the future application.

Containment Recirculation Sump Modification of Maanshan NPP(1/3)

- Since the issuance of NRC Generic Letter 2004-02, AEC has requested Taipower Company to evaluate the potential impact of debris blockage on emergency recirculation sump during design basis accidents and take necessary measures to address this issue.
- Taipower proposed a Maanshan NPP's sump strainer improvement plan with two-phase scope.
  - Phase I: Perform walkdown activities and provide strainer technical specification for Phase II project.
  - Phase II: Select vendor/manufacturer for strainer design, testing, manufacturing, and installation.

Containment Recirculation Sump Modification of Maanshan NPP(2/3)

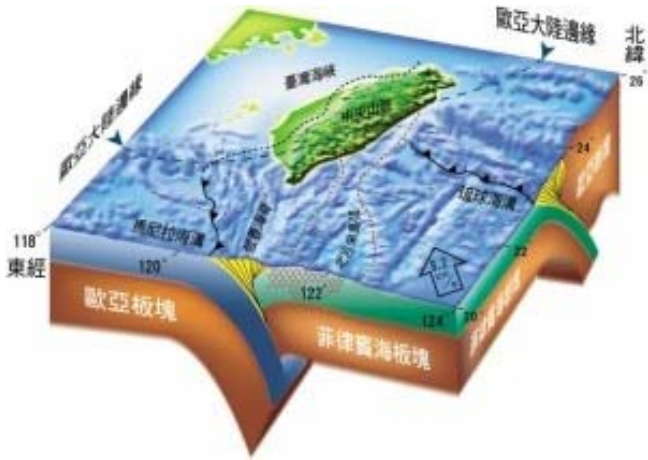
- North Anna Event in September 2010 impacted the original schedule, Maanshan NPP had to re-check documents and perform additional walkdown to make sure the insulation material inside the containment conformed to the licensing basis.
- Maanshan NPP found more insulation types than expected, ex: Encapsulated, Tempmat, Microtherm, Foamglass type insulations. With these new data input, Maanshan NPP updated the Debris Generation Analysis Report.

Containment Recirculation Sump Modification of Maanshan NPP(3/3)

- Phase I of the plan is completed. Phase II is recently started with Candu Energy of Canada that won the contract of designing and manufacturing Maanshan's sump strainer in April 2013.
- The schedule to install the modified strainers is in EOC 21 for unit 2 in 2014, and EOC 22 for unit 1 in 2015.
- Thin bed test, full debris load/vortex test, bypass test, and bench-top test will be conducted to facilitate strainer manufacturing.
- In-vessel downstream effects solution is not included in this stage and Maanshan NPP is planning to solve it in the future by adopting Option 2 (Mitigative Measures and Alternative Methods Approach) of SECY-12-0093.

Safety Re-evaluation and Enhancement Project for Seismic Resistance (1/2)

- **Background**
  - **Hengchun Earthquake (M_L=7.0) induced two major shocks to Maanshan NPP on Dec. 26, 2006**
  - **New active fault identified**
    - Sanchiao Fault (fault length 34 km or longer) of Northern Taiwan near Chinshan and Kuosheng NPPs (2007)
    - Hengchun Fault (fault length 16 km or longer) of Southern Taiwan near Maanshan NPP (2009)
  - **Experience from KK (2007) and Hamaoka (2009) NPPs in Japan**
- **The project was initiated in 2009**



Safety Re-evaluation and Enhancement Project for Seismic Resistance (2/2)

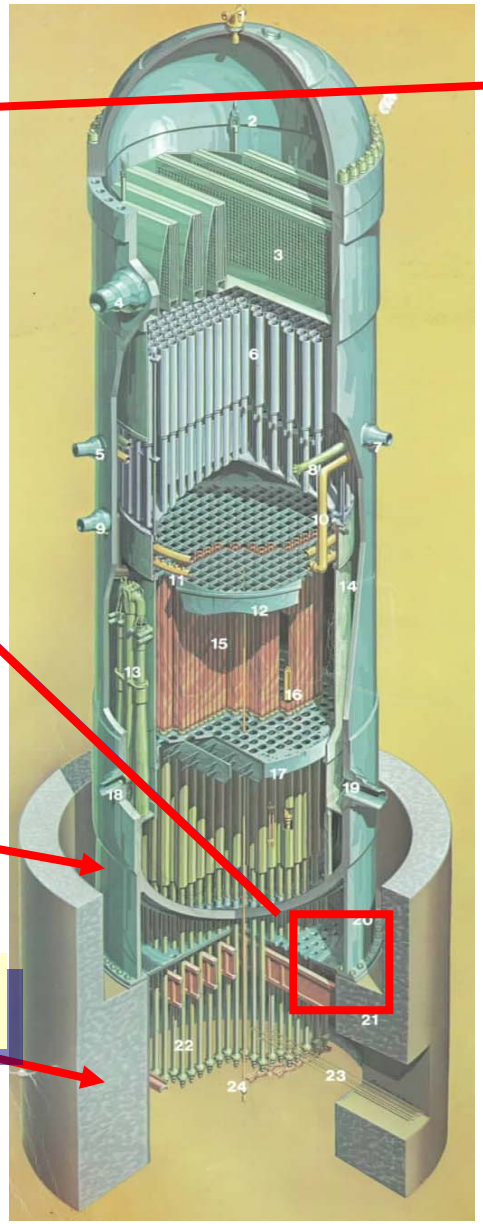
- **Current Status of Project**
  - **Geologic survey on land and marine region**
    - Under current results, total length of Sanchiao Fault and Hengchun Fault is 74km and 41 km respectively
    - The result of investigation is under review by AEC
    - Extended survey on the marine region is requested by AEC based on the fact that Sanchiao Fault may have longer length in marine region
  - **Seismic hazard re-analysis**
    - The result of investigation is under review by AEC
  - **Re-evaluation of seismic resistance margin (tentative date: Dec. 2013)**
  - **Reinforcement of seismic resistance on SSCs based on evaluation results (tentative date: 2016~2018)**

Degradation and Failure of RPV Support Skirt Anchor Bolts at Kuosheng NPP (1/2)

- **Background**
  - **One broken bolt had been found at Kuosheng Unit 2 in Oct. 2011 during scheduled inspection per ISI program**
  - **Three broken bolts and another four bolts with crack indication were found at Kuosheng Unit 1 in March 2012**
- **Root Cause Analysis**
  - **Stress corrosion cracking (SCC) was identified as the root cause of crack initiation.**
    - Sensitive material, concentrated stress or high residual stress due to early improper installation tool and corrosive environment during construction contributed to the conditions for SCC occurrance.
  - **For the bolts with larger initial cracks, the cracks were further propagated due to fatigue and then fatigue cracks grew progressively until failure.**
  - **For the cracks which the stress intensity factor (△K) were below the threshold (△Kth) will not grow.**

Skirt

Inner Bolts (60)



Skirt

Pedestal

Outer Bolts(60)

ASTM A-540 Gr. B23
Class 1 ,
φ : 3 inch (7.6 cm)
L : 26 inch (66 cm)

Degradation and Failure of RPV Support Skirt Anchor Bolts at Kuosheng NPP (2/2)

- **Corrective Actions**
  - For unit 1, 7 damaged bolts have been replaced with new ones
  - For unit 2, anchor function of one damaged bolt has been replaced by special designed Engineered Anchoring System (EAS)
  - Preload checks for the remaining bolts have been executed to ensure they are still maintained in designed condition (pretension 560kips, 510kips+10% margin)
  - UT examination has been performed on all bolts to verify the structural integrity and will be conducted during each following refueling outage thereafter

Lungmen ABWR Construction (1/2)

- Currently Lungmen Project are working on the 18 construction improvement action items to fix the identified problems, including those of RCCV liner, surface mounting plate, cable tray seismic enhancement, and fire protection
- For unit 1, pre-operational tests of 126 systems should be performed before initial fuel loading
- All systems are completely installed and are under system MMI, alarm, logic and pre-operational tests
- The overall progress of Unit 1 pre-op test reaches 78% in late May, 2013, according to TPC's data

Lungmen ABWR Construction (2/2)

- **For verifying system function integrity and reliability, TPC will perform pre-op re-test for systems finishing pre-op test and approved, except ones that can't re-build the test conditions**
  - TPC calls senior engineers from other 3 NPPs, with GEH TAs, to form the Reinforced Safety Evaluation Task Force, to perform turn-over package review, walkdown, and pre-op re-test
- **The results of Post-Fukushima Safety Evaluation requires Lungmen to perform seismic and tsunami simulations, add two gas turbine generators, sea wall, and spent fuel pool instrumentation, … etc.**
- **AEC required TPC to complete 75 tasks, including the approval of System Function Test Reports, before applying the fuel loading permit**

Post-Fukushima Safety Re-assessment

- After Japan's Fukushima Daiichi Accident, Atomic Energy Council (AEC) required Licensee (TPC) to re-evaluate each site's capability to cope with extreme natural disasters, including earthquake, tsunami, and flooding
- The re-assessment comprises three parts : Nuclear Safety (focus of this presentation), Radiation Protection, Emergency Response and Preparedness
- August, 2012 : The Overall Safety Assessment Report for Nuclear Power Plants in Taiwan in Response to the Lessons Learned from Fukushima Daiichi Accident" final version
- November, 2012 : the final regulatory orders were issued by AEC

Post-Fukushima Safety Re-assessment(cont.)

- **Areas for re-evaluation (TPC) and review (AEC)**
  - Re-examine the Capability for Loss of All AC Power (SBO)
  - Re-evaluate Flooding and Tsunami Protection
  - Ensure Integrity and Cooling of Spent Fuel Pool
  - Assess Heat Removal and Ultimate Heat Sink
  - EOP Re-examination and Re-training
  - Buildup the Ultimate Response Guidelines (URG)
  - Support between Different Units
  - Considerations for Compound Accidents
  - Mitigation beyond DBA
  - Preparedness and Backup Equipment
  - Manpower, Organization, Safety Culture

Regulatory Orders (1/4)

- AEC required TPC to adopt the conclusions of USNRC NTTF Report Tier 1 Recommendations
  - 2.1 Seismic and flood hazard reevaluations
  - 2.3 Seismic and flood walkdowns
  - 4.1 Station blackout (SBO) regulatory actions
  - 4.2 Equipment covered under 10 CFR 50.54(hh)(2) (implementation of B.5.b)
  - 5.1 Reliable hardened vents for Mark I and Mark II containments (Filtration, different types of CTMT design)
  - 7.1 SFP instrumentation
  - 8 Strengthening and integration of EOPs, SAMGs, and EDMGs (& URGs)
  - 9.3 Emergency preparedness regulatory actions (staffing and communications)

Regulatory Orders (2/4)

- Follow-up the Tier 2 & Tier 3 Recommendations by USNRC
- Follow-up the ENSREG's Action Plans from EU stress tests
- Special Countermeasures for issues related to the Seismic, Tsunami, and SBO, by referring to international good practices
  - To conduct survey on the newly found faults near NPPs 3 years ago
  - Install additional seismic instrumentation for monitoring and system identification
  - Re-evaluate the hazard by state-of-the-art methodology and incorporate the new findings
  - Simulate the mechanism of seismic and tsunami hazards and the resulting risks
  - Enhance the watertightness of Buildings (or build seawall, or tidal barrier) to the level 6 meters above current licensing bases
  - Enhance the structure of non-seismic qualified TSC
  - Build the seismic isolation TSC building

Enhance the structure of non-seismic TSC

Regulatory Orders (3/4)

- **Additional Considerations for SBO Rule**
  - It includes snowfall, hurricane, tornado, and storm resulting the LOOP in RG 1.155 but not seismic, tsunami, salt fog and landslides damage
  - Specific natural events with high hazard
  - Capability to recover offsite power in 2 hours
  - Initiating event frequency of LOOP
  - North-south elongated island surrounded by the sea with isolated grid, no backup
- **Countermeasures for SBO**
  - Enhance emergency DC power supply
    - to secure a storage capacity of at least 8 hours with the storage capacity of the batteries of one system without isolating the load/ and at least 24 hours after the unnecessary loads are isolated
  - Extend the SBO coping time to at least 24 hours
  - Installation of seismic qualified 6th gas-cooled EDG
  - Installation the alternate UHS
- **Install Passive Autocatalytic Recombiners (PAR) to prevent hydrogen explosions**

Regulatory Orders (4/4)

- Perform the Volcanic PRA of NPPs and study the impacts from ash dispersion
- Enhance the water-tight capabilities for the fire doors of essential electrical equipment rooms
- Enhance the seismic resistance for the fire brigade buildings to cope with BDBE
- Improve the seismic resistance of raw water reservoir and consider to install the impermeable liner
- Improve the reliability of offsite power supplies
- RCP seal LOCA issue of PWR plant
- TPC may submit alternative plans to provide the equivalent function to comply with the requirements of regulatory orders subject to AEC approval

OECD/NEA and ENSREG peer review (1/3)

- In order to strengthen our regulatory competence, AEC seeks recommendations from the internationally renowned nuclear organization on the expert team with required knowledge, experience and technical capability that may provide assistance to the AEC in conducting a peer review of the National Report of EU Stress Test for the operating and new build nuclear power plants in Taiwan
- Both OECD/NEA and ENSREG accepted the requested.

Results of OECD/NEA peer review (2/3)

- **Met the criteria established by the AEC that were based on the specification endorsed by the European Union as developed by ENSREG**
- **The enhancements that have been implemented or are in the process of being implemented at the operating reactors in response to the stress test evaluations were found to be a strength by the team**
- **Nine strengths, one recommendation and eight technical observations in the assessment for five technical areas**
- **The stress test recommendation is to consider systematically assessing the combinations of events in the areas of flooding and extreme natural events**
- **The linkage of Independent peer review report as follows**
  - http://www.aec.gov.tw/webpage/npp- check/files/index_01_9_1-01.pdf

OECD/NEA and ENSREG peer review (3/3)

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

Concluding Remarks

- The overall safety performance of nuclear power plants in Taiwan is continuously maintained at a high level of standards
- The goal of regulating NPPs is to assure the safety and protection of public health and environment. Hence, enhancements on capability to maintain the stable/reliable of NPPs is crucial.
- Continue our effort to be more effective, efficient, consistent, open and transparent in regulatory activities


Thank you