2014 AEC-NRC Bilateral Technical Meeting

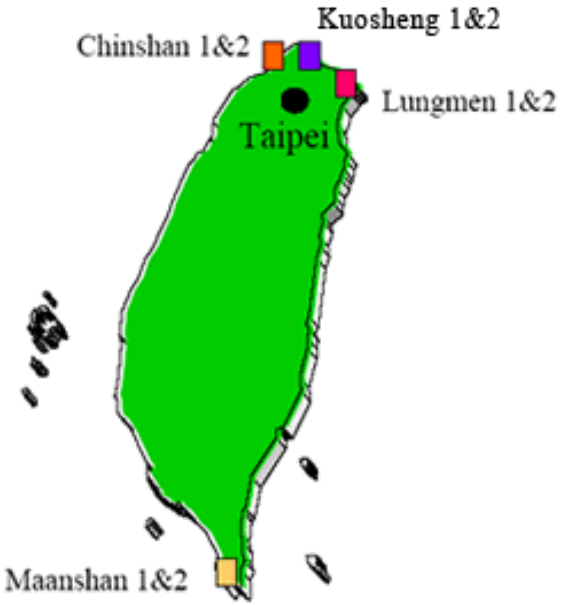
Recent Regulatory Activities in Taiwan

Department of Nuclear Regulation

Atomic Energy Council, R.O.C

July 1, 2014

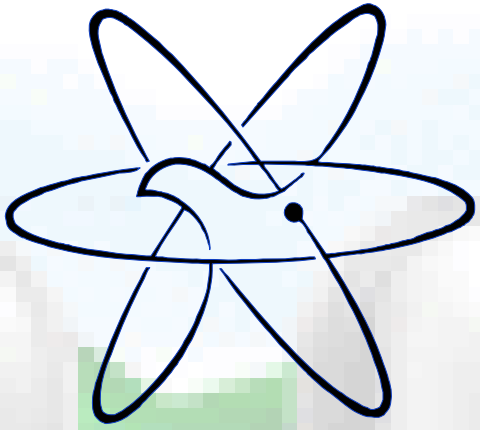
Nuclear Power Plants in Taiwan



Plant	Capacity/Type	Operating License
Chinshan	1804 MWt/unit GE BWR4 X 2	Unit 1:1978.12.06 Unit 2:1979.07.16
Kuosheng	2943 MWt/unit GE BWR6 X2	Unit 1:1981.12.28 Unit 2:1983.03.15
Maanshan	2822 MWt/unit WH PWR X2	Unit 1:1984.07.27 Unit 2:1985.05.18
Lungmen	3926 MWt/unit GE ABWR X2	Under Construction

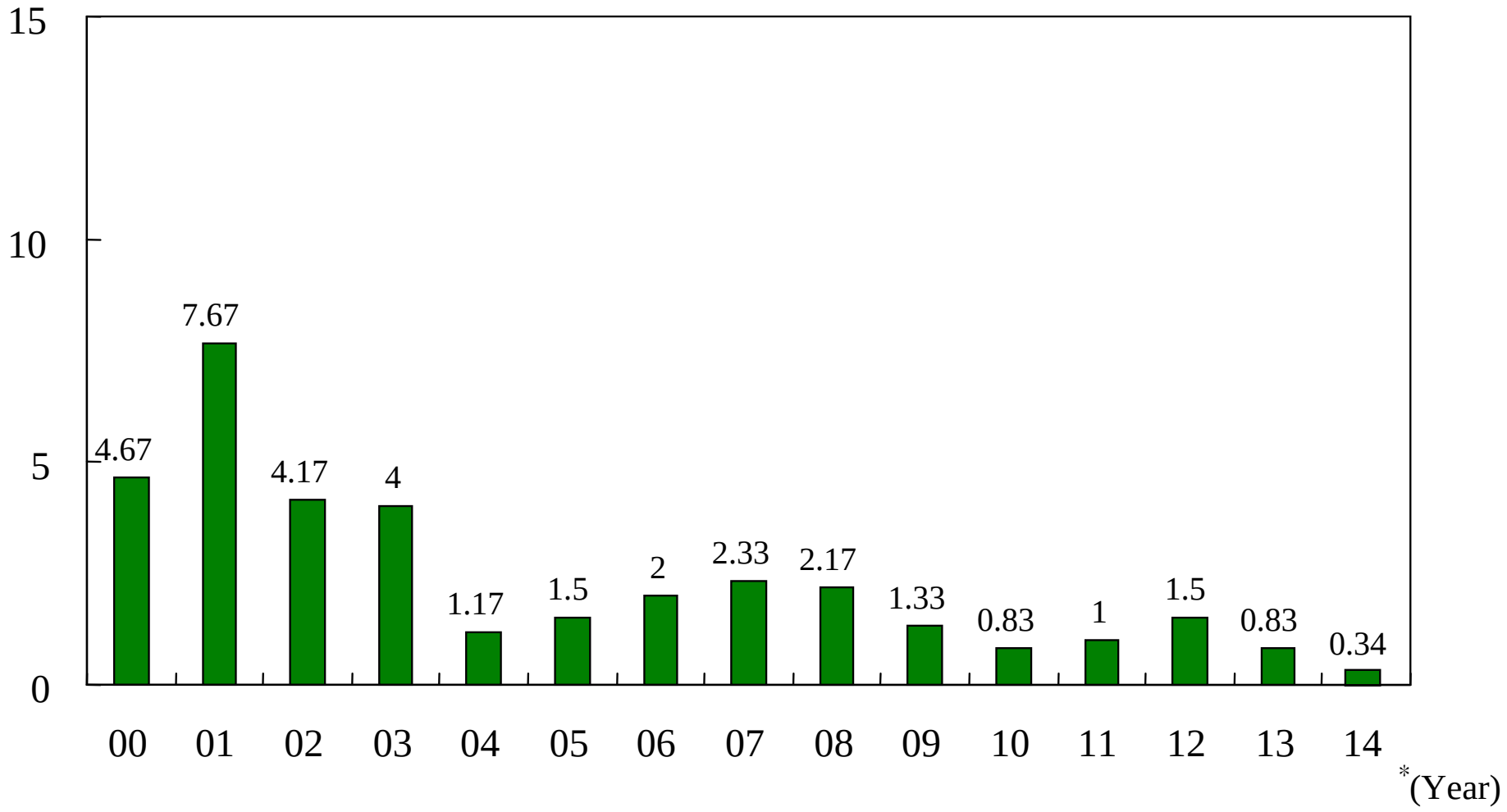
Contents

- **Generic**
  - Operating NPP Performance Record
  - Stretch Power Uprate Review
  - Safety Re-evaluation and Enhancement Project for Seismic Resistance
  - Post-Fukushima Safety Reassessment and Followup
- **Chinshan NPP**
  - Status of License Renewal
  - Issue of Spent Fuel Pool
- **Kousheng NPP**
  - Degradation and Failure of RPV Support Skirt Anchor Bolts
- **Maanshan NPP**
  - Containment Recirculation Sump Modification
- **Lungmen NPP**
  - Status of Lungmen NPP Construction



- Operating NPP Performance Record
- Stretch Power Uprate Review
- Safety Re-evaluation and Enhancement Project for Seismic Resistance
- Post-Fukushima Safety Reassessment and Followup

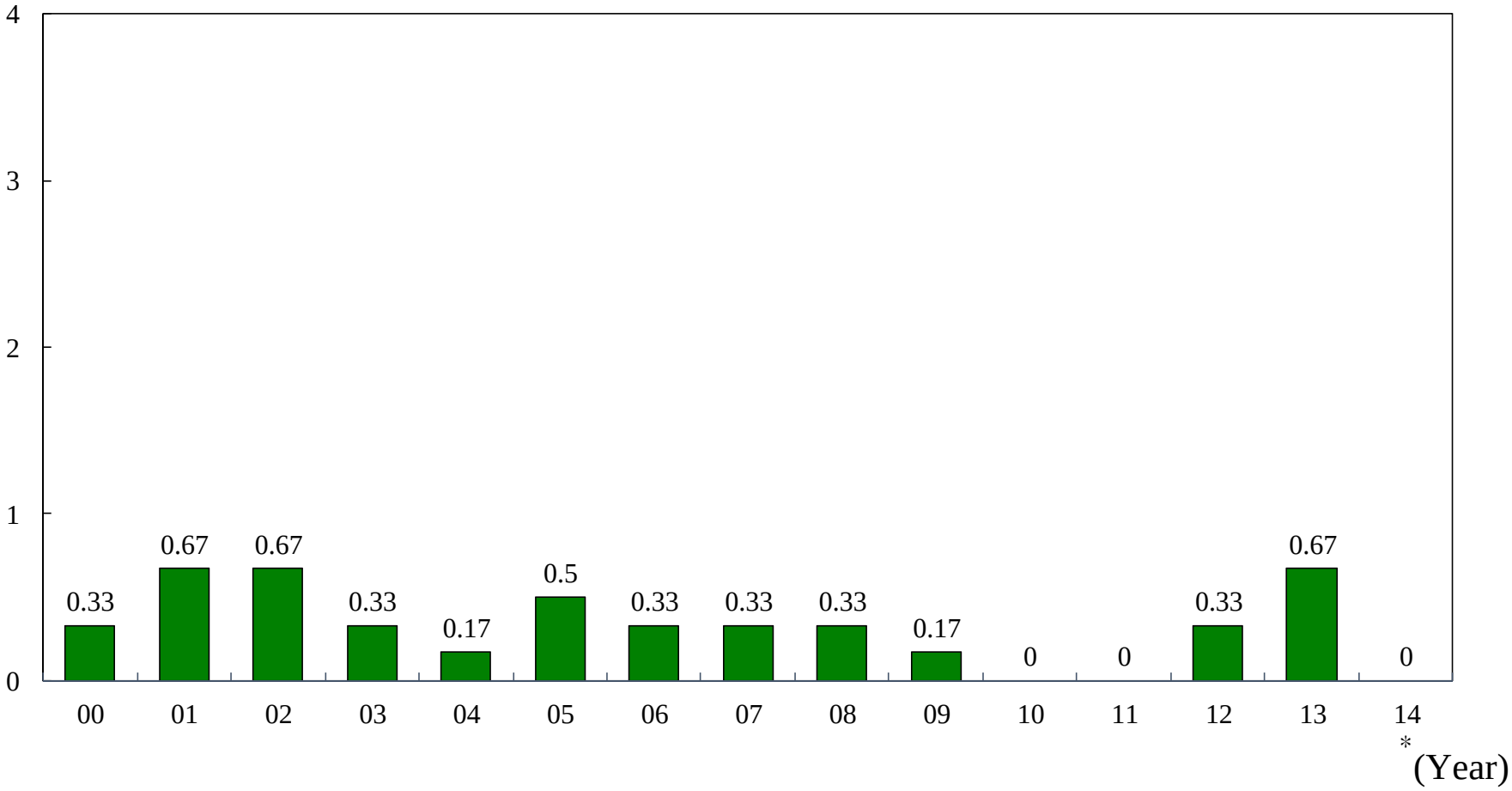
Operating Nuclear Power Plants Performance Record



Average Number of RERs per Unit

(*: Data up to the end of June 2014)

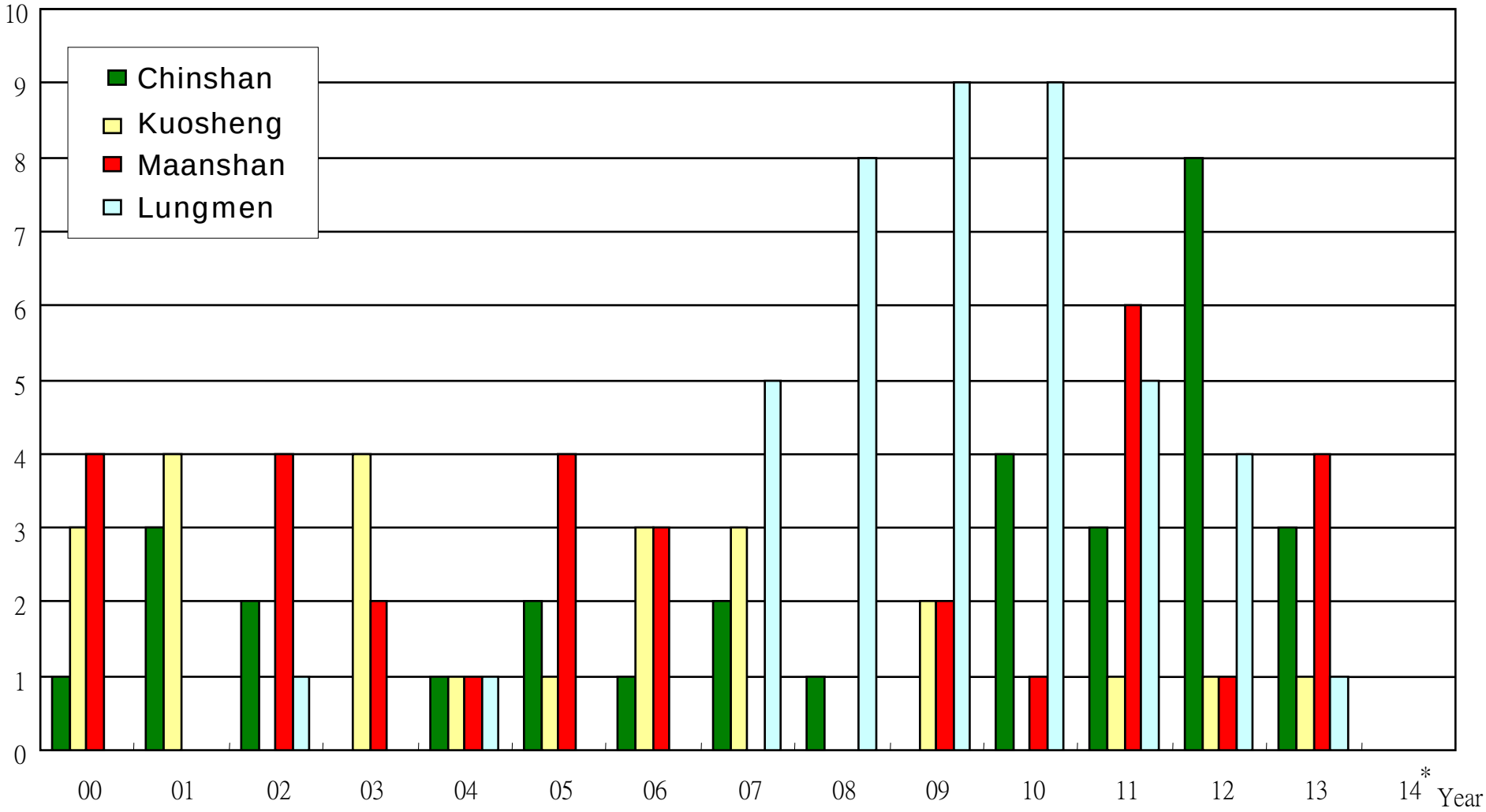
Operating Nuclear Power Plants Performance Record



Average Number of Automatic Scram per Unit

(*: Data up to the end of June 2014)

Operating Nuclear Power Plants Performance Record



Number of Violations of Each Plant

(*: Data up to the end of June 2014)

Stretch Power Uprate Review of NPPs (1/2)

- TPC has launched **SPU 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.

* OLTP: Original Licensed Thermal Power (CS: 1,775 MWt; KS: 2,894 MWt)

* SDVM: Steam Dryer Vibration Monitoring

Stretch Power Uprate Review of NPPs (2/2)

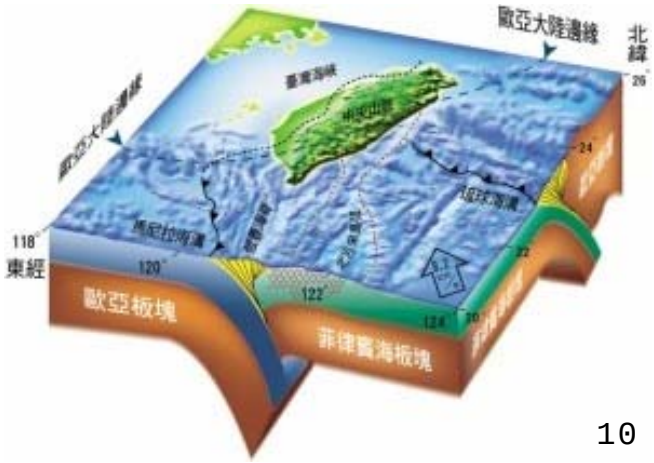
Status of Power Uprate

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		25(*)	2012.11.29	2014.01.17	2014.01.23(U1) 2014.01.21(U2)

- The power of Kuosheng were just raised to ~102.56% OLTP due to constraint on main turbine control valves characteristic curve. It is found that there is discrepancy between analysis and actual condition.
- Kuosheng has discussed with vendor and plans to shift the transition point on control valves characteristic curve to allow more % opening of control valves.

Safety Re-evaluation and Enhancement Project for Seismic Resistance (1/4)

- **Background**
  - **Hengchun Earthquake (M_L=7.0)** induced two major shakes to Maanshan NPP on December 26, 2006
  - **New active fault identified**
    - Sanchiao Fault in northern Taiwan near Chinshan and Kuosheng NPPs (2007)
    - Hengchun Fault in 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 (2/4)

- **Scope of Project**
  - **Geologic survey on land and marine region**
    - Geologic characteristics of active fault
  - **Seismic hazard re-analysis**
    - Design earthquake re-evaluation
    - Site effect analysis of NPP
  - **Re-evaluation of seismic safety margin**
  - **Reinforcement of seismic resistance**

Safety Re-evaluation and Enhancement Project for Seismic Resistance (3/4)

- **Current Status of Project**
  - **Geologic survey on land and marine region**
    - **AEC has submited SER for survey report on Sanchiao Fault with 74km and Hengchun Fault with 41 km in October 2013.**
    - Extended survey on the marine region of Sanchiao Fault requested by AEC will complete in **October** 2014.
    - Further investigation on geologic parameter and seismic activity is under planning.
  - **Seismic hazard re-analysis**
    - The result of PSHA & DSHA (assume Sanchiao Fault 114km included) is under review by AEC
    - PSHA requires further SSHAC Level 3 or 4 process.
    - DSHA is adopted at present .

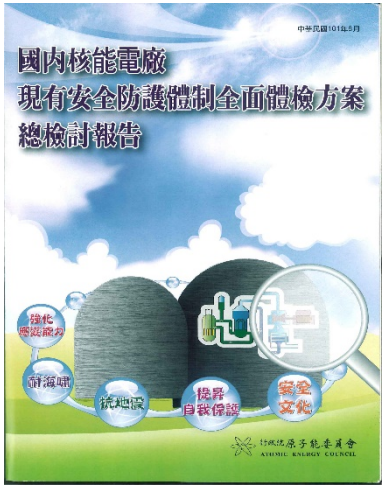
Safety Re-evaluation and Enhancement Project for Seismic Resistance (4/4)

- **Current Status of Project (cont.)**
  - **Re-evaluation of seismic resistance margin (SMA) and Reinforcement**
    - Based on EPRI-SMA(NP-6041) method and NUREG-1407
    - Being under review by AEC.
    - **Reinforcement of seismic resistance on SSCs has been conducted in March~June, 2014.**
  - **Re-evaluation of seismic hazard per NTTF 2.1 is ongoing and SPRA would be completed in June 2015.**

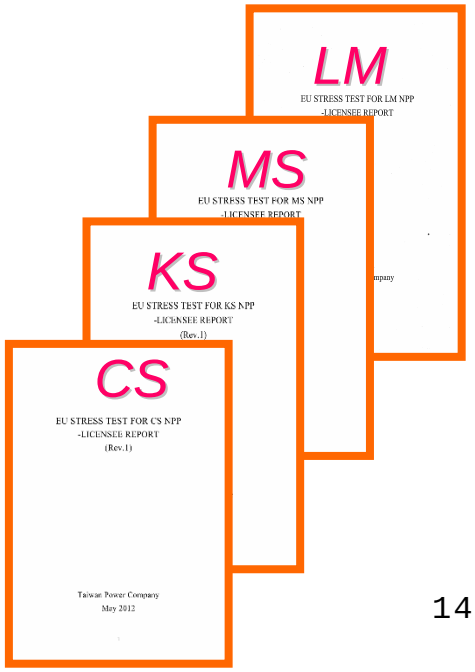
Inspection on reinforcement of EDG fuel oil storage tank in CS NPP

Inspection on 480V MCC in MS NPP

Post-Fukushima Safety Reassessment and Followup (1/5)



- After Japan's Fukushima Daiichi Accident, AEC required TPC to **re-evaluate** each site's capability to cope with extreme natural disasters
- 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
- **Peer Review** by International Experts organized by
  - OECD/NEA: March 2013
  - ENSREG: September 2013



Post-Fukushima Safety Reassessment and Followup (2/5)

- **Post-Fukushima Safety Reassessment**
  - Adopted NRC NTTF Tier 1 Recommendations
  - Follow-up the Tier 2 & 3 Recommendations
  - Special countermeasures for issues related to the Seismic, Tsunami, and SBO, by referring to international good practices(e.g. IAEA, NISA, EU)
  - Extend the SBO coping time to at least 24 hours
  - Watertight of seismic qualified 5th gas-cooled

Post-Fukushima Safety Reassessment and Followup (3/5)

- **OECD/NEA peer review**
  - To perform fault displacement hazard analysis
  - To deploy a local seismic network
  - 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

Post-Fukushima Safety Reassessment and Followup (4/5)

- **EC/ENSREG peer review**
  - site-specific basis assessment for mud flows and mass movements
  - post-seismic inspection for SSC with a low seismic classification
  - To develop strategies to minimize the quantities of contaminated water produced under accident conditions and to evaluate possible options to create closed cooling circuits
  - To improve the availability of RPV depressurization for BWRs

Post-Fukushima Safety Reassessment and Followup (5/5)

- **EC/ENSREG peer review (cont.)**
  - The additional hardened alternative to the Main Control Room and improvement the habitability in the local shutdown panel areas under accident conditions
  - the training of SAMGs are appropriate for multi-unit events
  - As roads/bridges represent weak points to access sites, infrastructure improvements could be considered together with ensuring availability of heavy road-clearing equipment

Chinshan NPP

Status of License Renewal

Issue of Spent Fuel Pool

Status of License Renewal (1/4)

- **Operating License Expiration for three NPPs**

Plant \ Unit	Unit 1	Unit 2	Submission Deadline for License Renewal
Chinshan	DEC 05, 2018	JUL 15, 2019	DEC 05, 2013
Kuosheng	DEC 27, 2021	MAR 14, 2023	DEC 27, 2016
Maanshan	JUL 26, 2024	MAY 17, 2025	JUL 26, 2019

License Renewal Regulations (2/4)

- **Nuclear Reactor Facilities Regulation Act** (*Article 6*)

  When there is a need to continue operation after the license is expired, an application for renewing the license thereof shall be filed by the licensee.

- **Regulations on Applications for Operating License of Nuclear Reactor Facilities** (*Article 16*)

  - *Submission deadline*: 5~15 years prior to the expiration of the existing license.
  - *Contents of application*
    - ✓ Integrated Plant Assessment (IPA)
    - ✓ Time-Limited Aging Analysis (TLAA)
    - ✓ Updated Final Safety Analysis Report (UFSAR)

License Renewal Application (3/4)

- The important reference: U.S. NRC regulation **10 CFR 54**, “Requirements for Renewal of Operating Licenses for Nuclear Power Plants”.
- In **2009**, AEC received the application from TPC for renewing the operating license of its Chinshan NPP.
  - This application filed for the service life renewal for Units 1 and 2 from **40 years to 60 years**.
  - TPC must demonstrate that it has identified and can manage the effects of aging and it can continue to maintain an acceptable level of safety throughout the period of extended operation.
  - AEC intends to complete License Renewal reviews within **24 months** upon receipt of the Chinshan application files.

License Renewal Application (4/4)

- TPC had twice requested AEC delaying the reviews on its license renewal application until its SPU project was completed and its post-Fukushima safety measures were implemented.
- In **2013**, TPC formally requested the AEC to **reactivate** the review of license renewal application for Chinshan NPP.
- It is necessary for TPC to revise the license renewal application based on the current plant configuration before the AEC can resume technical reviews.
- **AEC estimates the technical review will be resumed this July and be completed in two years.**

Issue of Spent Fuel Pool in Chinshan NPP (1/2)

- The unit 1 & 2 have 1410 & 1620 cells in the beginning of construction. There was expanded into **2470 cells for the first re-racking in 1987**; The latest re-racking was expanded into **3083 cells in 2000**.

	First re-racking (in 1987)	latest re-racking (in 2000)
Type	Free standing	Free standing
Poison	Boral (0.013g/cm2)	Boral (0.018g/cm2)
Patch	6.536 in	6.276 in
Cell Diameter	6.3615 in	6.09 in
Critical Design	Keff < 0.95	Keff < 0.95
Storage Capacity	2470 cells + 34 sipping can + 31 control rod	3083 cells + 2 sipping can + 80 control rod

Issue of Spent Fuel Pool in Chinshan NPP (2/2)

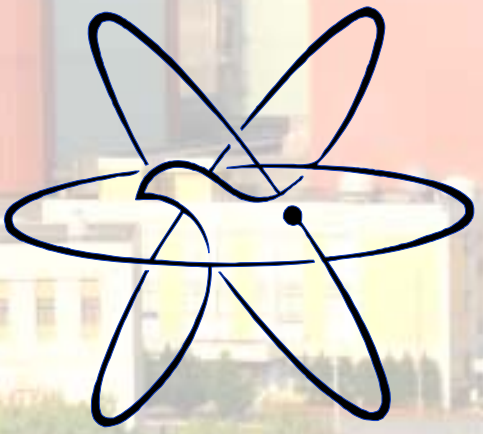
Current Status of the Spent Fuel Pool in Chinshan NPP

	Unit 1	Unit 2
Storage Capacity	3083 cells	3083 cells
Cycle	27 (102/7~103/12)	27 (103/6~104/11)
Occupied	2982 cells	2972 cells
Vacant (include SBG & DBG)	101 cells	111 cells

- If the Chinshan Dry Storage Project doesn't implemented on time, unit 1 of Chinshan NPP will be shutdown in 2016 due to the full of SFP.

Kousheng NPP

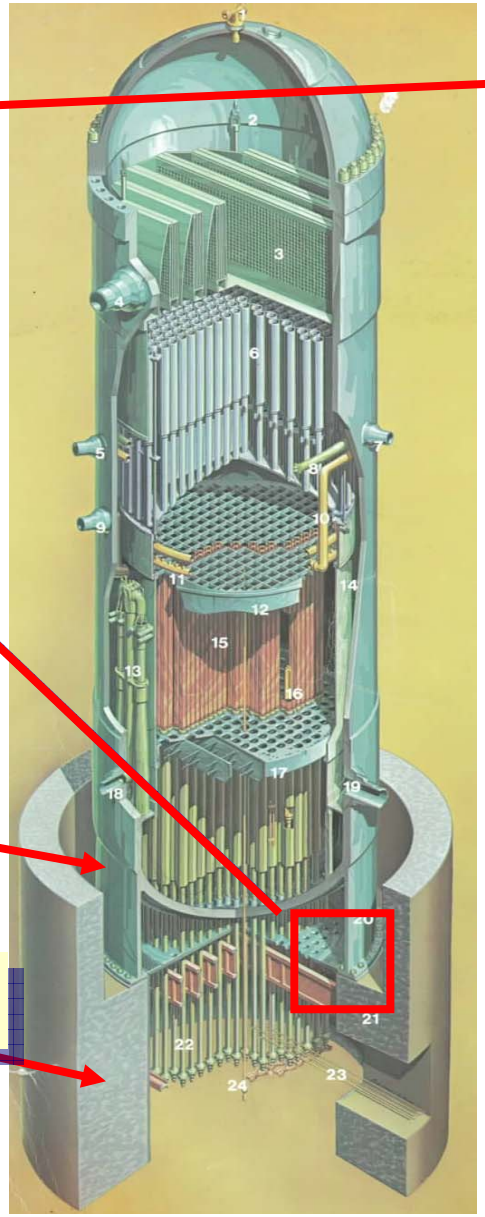
Degradation and Failure of RPV Support Skirt Anchor Bolts



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

- **Background**
  - One broken bolt had been found at Unit 2 in October 2011
  - Three broken bolts and another four bolts with crack indication were found at Unit 1 in March 2012
- **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
  - UT examination has been performed on all bolts to verify the structural integrity and will be conducted during each following refueling outage thereafter.
  - **UT on all bolts of Unit 1 during refueling outage in December 2013 did not show any abnormal indication.**

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



Outer Bolts (60)

Inner Bolts (60)

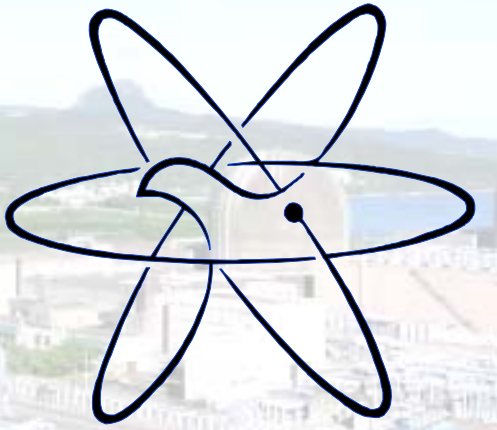
Skirt

Pedestal

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

Maanshan NPP

Containment Recirculation Sump Modification



Containment Recirculation Sump Modification of Maanshan NPP (1/2)

- Since the issuance of NRC **Generic Letter 2004-02**, AEC has requested TPC to evaluate the potential impact of debris blockage on emergency recirculation sump during design basis accidents and take necessary measures to address this issue.
- TPC proposed a Maanshan NPP's sump strainer improvement plan with two phases.
  - 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 (2/2)

- Phase I of the plan has completed. For Phase II, Candu Energy of Canada that won the contract of designing and manufacturing Maanshan's sump strainer in April 2013.
- **Unit 2 installed the modified strainers during EOC-21 in April 2014**. The schedule for unit 1 is by EOC-22 next year(2015).
- Thin bed test, full debris load/vortex test, bypass test, and bench-top test have been conducted in Canada 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.

Lungmen NPP

Status of Lungmen NPP Construction

Issue of Lungmen ABWR Construction (1/2)

- For Lungmen Unit 1, the construction of all systems is nearly completed, and the pre-operational tests of 126 important systems are on the verge of completion
- The Unit 1 System Function Test Reports are submitting to AEC for review
- Recent important pre-op tests:
  - **EDG/SDG Testing**
  - **SIT and ILRT**
  - **LOOP/LOCA Testing**
  - **Integrated Cold Functional Testing**

SIT concrete crack mapping check

Issue of Lungmen ABWR Construction (2/2)

- For Unit 2, the construction progress seems to have relatively come to a halt
- Post-Fukushima Safety Evaluation
  - perform seismic and tsunami simulations, add two gas turbine generators, sea wall, and spent fuel pool instrumentation, … etc.
- Due to Taiwan's hostile sociopolitical atmosphere against the operation of NPPs, TPC has **been forced to defer of the whole Lungmen plant upon completion of Unit 1's pre-op tests**
- **AEC refers USNRC GL 87-15 to develop deferred nuclear power plant regulation guideline**

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

The rock landscape of Yehliu Geopark is one of most famous wonders in the world