Amendment to the National Report of May 2013

Issued by AEC: 2013/08/26

0 Introduction and process of safety re-assessment

0.1 Nuclear oversight in Taiwan

AEC, the Atomic Energy Council, is the regulatory body in Taiwan for the regulation of nuclear energy. AEC, which oversights Taiwan's nuclear facilities, is a second tier agency under the Executive Yuan (Office of the Prime Minister). These nuclear facilities include the nuclear power plants, the interim storage facilities for spent nuclear fuels and the nuclear research facilities of the INER, NTHU in Taiwan. The scope of AEC's oversight extends from the planning, construction, operation and decommissioning of the facilities to the final disposal of radioactive wastes and spent nuclear fuels. The authority's responsibility also includes radiation protection for staff and the general public, as well as security and safeguards. In addition, AEC oversees the transport of radioactive substances from and to the nuclear facilities, and the site selection regarding geological disposal of low-level radioactive waste. Licensing procedures for new nuclear power plants were in place in Taiwan before the events at Fukushima; AEC was involved in these procedures, and it compiled safety evaluation reports for this purpose.

0.2 Considerations by AEC

On March 11, 2011, the Great East Japan earthquake and the ensuing tsunami led to severe accidents with core meltdown in three nuclear units at the Fukushima Daiichi Nuclear Power Plant (NPP) site in Japan. On April 12, 2011, these events were classified by the Japanese authorities as INES 7 ("major accident").

As a direct consequence, AEC thoroughly reviewed the lessons learned from Fukushima accident and proposed the "Programs for Safety Re-assessment" which was approved by Executive Yuan on April 19, 2011 and issued administrative orders to Taiwan Power Company (TPC), the operator of Taiwan's nuclear power plants, in which immediate measures and additional re-assessments were required. In the wake of Fukushima accident, AEC has requested TPC to re-evaluate its capability to cope with extreme natural disasters, including earthquakes, tsunamis, extreme rainfalls and mudslides resulted from the related hazards, and take possible countermeasures. AEC

has completed its assessment and verification of TPC's reports, and is committed to continuing its efforts in inter-ministerial coordination and communication with domestic organizations and stakeholders. The re-assessment program comprises of two parts: 1) nuclear safety assurance, and 2) radiation protection, emergency response and preparedness, which were implemented in two stages: near-term (by June 2011) and mid-term (by December 2011) assessments. The report (in Chinese) on the first-stage and second-stage assessments, approved by the Executive Yuan in October 2011 and August 2012 respectively, is available on AEC's website. The final report covers the near-term and mid-term assessment results for both stages. The report provides a comprehensive background on external hazards, and how to protect against them, as well as an overview of the enhancement measures to nuclear safety and security for the accidents in light of the Fukushima Daiichi accident. Lessons learned from the Fukushima accident as well as relevant information available internationally were used as reference during preparation of this report.

The direct cause of the nuclear accident at Fukushima, an earthquake with magnitude 9.0 resulting in an over 14 meters high tsunami, is far beyond the design basis tsunami analyzed by utility and approved by regulator. Although there have been huge tsunamis attacking the east coast of northern area in the main island of Japan, design basis tsunami at the Fukushima Daiichi site appears to only have been made to protect against a 5.7 meters high surge above sea level based on numerical simulation only. The nuclear power plants of TPC, both operating and new build, should follow the lessons learned to re-visit the design basis. In addition, AEC's regulation on design basis analysis requires TPC to demonstrate that adequate protection is in place for an extremely rare natural event, developed based on simulation from the historical record. AEC then requires TPC to show that there are significant "cliff-edge" or enough safety margins based on the specification of EU stress tests. While the investigation of the detailed accident scenarios in Japan is still left to be clarified, there is sufficient information to develop initial lessons learned for AEC. Based on our preliminary conclusions and first-stage requirements, AEC refers the actions recommended by USNRC to be taken without delay and the best international practices considered in the nuclear community by taking the nuclear regulatory cases into account to the second-stage report. Although there are some emerging lessons, these are proposed as requirements for further work.

After reviewing the TPC's near-term action submittals required by AEC, two

issues related to the current licensing basis (CLB) of the nuclear power plants were found: the elevation measurement did not comply with FSAR in Chinshan plant, and the design for tsunami protection was not adequate at the ECW pump room in Kuosheng. These issues were later confirmed resolved upon site inspection in June 2011. While the assessment of post-Fukushima evaluation reveals neither immediate nuclear safety concern nor threat to the public health and safety, AEC requested that TPC focus on strengthening its re-evaluation on design basis against earthquakes, tsunamis and heavy rainfalls, and enhancing its capability to mitigate a prolonged station blackout (SBO) for further improvement. Many areas of improvement have been identified in the issues of nuclear safety assurance. The key areas include the enhancement of capability to mitigate a prolonged station blackout, protection against tsunami hazards, spent fuel pool cooling, hydrogen detection and explosion prevention, severe accident management, protection against seismic hazards, critical infrastructure, and safety culture.

AEC required TPC to immediately implement and complete the nuclear regulatory orders issued in the second-stage report for safety improvement. TPC may submit alternative subjected to AEC approval to provide the equivalent function. To keep up with the pace of international countermeasures after Fukushima, AEC is actively involved in such activities as to have the national reports prepared in accordance with EU Stress Test specifications reviewed by international counterparts, and to have examined rigorously the 10-year periodic safety review of nuclear power plants.

The following Table 0-1 shows the investigations and measures set in motion in the Taiwan's nuclear power plants, and the timeline for their implementation.

On the basis of the reviews conducted to date, the TPC and AEC have derived a number of improvement measures that are detailed in the following Chapters of this report.

Table 0-1: Investigations and measures for the Taiwan's NPPs

Date	Milestones of safety re-assessment and EU stress test
2011/03/11	Fukushima Daiichi accident
2011/04/19	"Programs for Safety Re-assessment" approved by Executive Yuan
2011/05/30	Preliminary Assessment Report for Nuclear Safety, it has included the "Stress tests" specifications proposed by the WENRA Task Force on April 21, 2011 (in Chinese)

2011/10/07	"The near-term Overall Safety Assessment Report for NPPs in Taiwan in response to the lessons learned from Fukushima Daiichi accident" approved by Executive Yuan (in Chinese) The draft report in July, 2011 has included the "EU Stress tests specifications" issued by ENSREG on May 25, 2011
2011/11~ 2012/1	AEC has conducted five regulatory meetings on stress test progress with TPC
2012/02	Draft version of Comprehensive Safety Reassessment report for NPPs in Taiwan in response to the lessons learned from Fukushima Daiichi accident (in Chinese)
2012/03	Stress test Utility reports for three operating NPPs submitted by TPC (in Chinese)
2012/04	Stress test Utility report for new build NPP submitted by TPC (in Chinese)
2012/08	"Comprehensive Safety Reassessment report for NPPs in Taiwan in response to the lessons learned from Fukushima Daiichi accident" approved by Executive Yuan (in Chinese)
2012/09	Draft National report for three operating NPPs (in English) Draft National report for new build NPP (in English)
2012/11/05	AEC issued the regulatory orders (a total of 90 regulatory cases for three operating NPPs and one new build NPP) based on the safety re-assessment and EU stress test
2013/01	Final version of National report for three operating NPPs (in English)
2013/02	To provide the final National report for three operating NPPs to the independent peer review team organized by OECD/NEA
2013/03/04~20 2013/03/15	OECD/NEA independent peer review Joint press conference with OECD/NEA peer review team
2013/04/23	Final report of OECD/NEA independent peer review
2013/05/31	Revised National report for three operating NPPs and new build NPP and four Utilities reports sent to the ENSREG review team (in English)
2013/06/06	AEC issued the regulatory orders (a total of 17 regulatory cases for three operating NPPs and one new build NPP) based on the recommendations and technical observations of OECD/NEA independent peer review

Above and beyond the quoted orders and on the basis of internationally available information, AEC has carried out a safety re-assessment of Taiwan's NPPs after the Fukushima accident and has published the results in four reports. These reports provide detailed descriptions of the findings and observations of the response of Taiwan's NPPs in response to the Lessons Learned and specific checkpoints that can be derived from these findings and orders. These checkpoints will be closely monitored in the coming years by AEC oversight activities. The fourth, national report based on the EU stress test specifications provides evaluation of the cliff edge

and response to the Fukushima accident for Taiwan's NPPs.

0.3 Details of AEC review after Fukushima accident

0.3.1 Safety Re-assessment

After Fukushima accident, AEC proposed the "Programs for Safety Re-assessment" approved by Executive Yuan on April 19, 2011 and issued administrative orders to operator of the Taiwan's nuclear power plants, in which immediate measures and additional re-assessments were required. The re-assessment program comprises two parts: (1) nuclear safety, and (2) radiation protection and emergency response and preparedness. The outcome provides a comprehensive background on external hazards, and how to protect against them, as well as an overview of the enhancement measures to nuclear safety and security for the accidents in light of the Fukushima Daiichi accident. Lessons learned from the Fukushima accident as well as relevant information available internationally were used as references in the safety re-assessment. There are 11 technical areas in the nuclear safety part, it includes (1) Re-examine the Capability for Loss of All AC Power (SBO), (2)Re-evaluate Flooding and Tsunami Protection, (3)Ensure Integrity and Cooling of Spent Fuel Pool, (4)Assess Heat Removal and Ultimate Heat Sink, (5)EOP Re-examination and Re-training, (6)Buildup the Ultimate Response Guidelines (URG), (7)Support between Different Units, (8)Considerations for Compound Accidents, (9)Mitigation beyond DBA, (10)Preparedness and Backup Equipment and (11)Manpower, Organization, Safety Culture. All of the sub-items of each technical areas examined by the operator of nuclear power plants are submitted to AEC.

Following the AEC requirements, TPC's nuclear power plants submitted several progress reports based on the "Programs for Safety Re-assessment" from 2011 to 2012. These reports contain information about the work progress, the methodology applied, the tools utilized and the interim results. AEC reviewed these reports and concluded that the information is in compliance with the AEC regulations. The methods used to re-assess the plants were presented by the operators in an easily comprehensible form. With respect to earthquakes and flooding, the TPC's staff was able to refer to the latest studies, such as the plant-specific seismic probabilistic safety analyses, or the proof of protection against flooding submitted in 2011, 2012. From AEC's viewpoint, the procedures outlined by TPC in their progress reports differed in their level of detail, but were basically in accordance with AEC's expectations. AEC

inspectors performed several special task force inspections to confirm the adequacy of progress reports submitted by TPC.

After reviewing the TPC's near-term action submittals required by the AEC, two issues related to the current licensing basis of the nuclear power plants were found: (1) the re-measurement of site elevation showed not compliant with FSAR in the Chinshan plant, and (2) the design for tsunami protection was not adequate at the Emergency Circulating Water pump room in the Kuosheng plant. These issues were later confirmed resolved upon site inspection in June 2012. While the assessment of post-Fukushima evaluation reveals neither immediate nuclear safety concern nor threat to the public health and safety, the AEC requested the TPC to continue strengthening its ability against earthquakes, tsunamis and heavy rainfalls, and enhancing its capability to mitigate a prolonged station blackout (SBO), i.e., loss of all AC power, for further improvement. AEC issued the regulatory orders requiring TPC to enhance the safety of nuclear power plants on November 5, 2012.

0.3.2 EU Stress Test

The AEC then required the TPC to identify the "cliff-edge" effects based on EU stress tests specifications. AEC's order dated June 28, 2011 requested TPC to perform the stress test following the EU stress test specifications based on the safety enhancement requirement of comparable plants at EU. The scope of the stress test of Taiwan's NPP to be carried out is in accordance with the ENSREG stress test specifications. The final reports submitted by TPC on January 3, 2012 were further detailed on the basis of the review insights gained as a result of the orders issued by AEC. In connection with the EU stress test the following aspects must be examined: the robustness of nuclear power plants in case of events beyond the design basis due to earthquakes, external flooding and extreme weather conditions, as well as loss of the power supply and of the heat sink. For this purpose, the first step is to set out the hazard assumptions and design bases for the nuclear power plants and to evaluate their adequacy. As a second step, the protective measures initiated and the safety margins in relation to the design, together with any cliff-edge effects, must be identified and evaluated. Finally, any relevant improvement measures must be derived from this information.

AEC requested both the European Union (EU) and Nuclear Energy Agency (NEA) of the Organization for Economic Cooperation and Development (OECD)

identifying experts that could conduct an independent peer review of Taiwan's National Stress Test Report that was performed in light of the accident at the Fukushima Daiichi NPP. NEA's independent peer review team reviewed the National stress tests Report for the three operating nuclear power plants. The independent peer review team from NEA had the opportunity to hear presentation by and discuss with AEC's and TPC's staff, as well as paid a site visit to Kuosheng NPP, between March 4 and 15, 2013. The preliminary findings were discussed with representatives from AEC and TPC at a meeting on March 15, 2013, and the preliminary findings were presented to the public in a press conference on the same day. The final report of NEA peer review has been provided to AEC on April 23, 2013. AEC has reviewed the NEA final peer review report and issued the new regulatory orders to TPC on June 6, 2013. However, AEC would like to emphasis that the peer review including the plant under construction, two site visits, new completed and planned enhancement measures and new findings from geological survey will be performed by the EU efforts.