November 2023

THE REPUBLIC OF CHINA NATIONAL REPORT FOR THE CONVENTION ON NUCLEAR SAFETY

NUCLEAR SAFETY COMMISSION

TAIWAN, REPUBLIC OF CHINA

EXECUTIVE SUMMARY

The Republic of China (hereafter referred to as ROC or Taiwan) has not yet signed the Convention on Nuclear Safety (hereafter referred to as the CNS or the Convention) of the International Atomic Energy Agency (IAEA) as adopted on June 17, 1994. However, the safety of the civil applications of the nuclear energy is always considered as the top priority in Taiwan. As long as an international activity is helpful to the promotion of this nation's nuclear safety, Taiwan is willing to participate in it and fulfill the relevant obligations. Thus, despite being a non-contracting party of the CNS, Taiwan is willing to act as a contracting party to meet all the requirements addressed in the applicable articles established by the Convention. The information collection and relevant description are basically updated till 2022. This report is prepared for peer review as agreed upon in the 2017 Bilateral Technical Meeting between the USA and the ROC. It evaluates the implementation of the safety requirements of the Convention by the nuclear power plants (NPPs) in Taiwan and demonstrates how Taiwan fulfills the obligations addressed in Chapter 2 (including Article 4 and Articles 6 to 19) of the Convention.

In Taiwan, there are currently a total of three land-based civil NPPs, namely Chinshan, Kuosheng, and Maanshan NPPs. According to the sequence of their corresponding project starting dates, Chinshan, Kuosheng and Maanshan NPPs are also called the First, Second and Third NPPs, respectively. Among them, the operating licenses of the units of Chinshan NPP and Kuosheng NPP are expired. The decommission permits of Chinshan NPP were issued on July 16, 2019. Both units of Maanshan NPP are operating. The operating licenses of both units of Maanshan NPP will be expired in July 2024 and May 2025, respectively. Considering that the construction permit of Lungmen NPP was expired on December 31, 2020, and the referendum of activating the Lungmen NPP didn't pass in 2021, this report mainly focuses its description on Chinshan, Kuosheng and Maanshan NPPs.

The Chinshan Nuclear Power Plant consists of two Type 4 boiling water reactors (BWR-4) with Mark I containment, while the Kuosheng Nuclear Power Plant features BWR-6 reactors with Mark III containment. As for the Maanshan Nuclear Power Plant, both of its units utilize a 3-loop pressurized water reactor (PWR) housed within a steel-lined, pre-stressed, post-tensioned large dry reinforced concrete containment. All three NPPs are owned by the Taiwan Power Company (hereafter referred to as TPC or Taipower), which can be viewed as a state-owned utility.

The regulatory body for all nuclear and radiation-related affairs in Taiwan is the Atomic Energy Council (hereafter referred to as the AEC. The AEC was restructured into the Nuclear Safety Commission on September 27, 2023), which is currently at the third-tier ministry level in the governmental organization and reports directly to the Executive Yuan (EY) (i.e. the Cabinet) or the Premier.

In this report, the specific improvements made in the regulatory requirements and activities of the regulatory body (AEC) as well as in the nuclear power operational safety of the license holder (TPC) are described. A number of fundamental nuclear laws and acts have been legislated and promulgated in early 2000s. AEC continued to establish and amend nuclear enforcement rules, regulations, and guidelines in 2020-2022, which would strengthen regulatory regulation in Taiwan.

A compact reactor oversight process (ROP), similar to the ROP adopted by the United

States Nuclear Regulatory Commission (USNRC), has been established and implemented as a part of actions for the AEC's Information Transparency Policy. The purpose of this compact ROP system is to establish a system for inspecting and assessing the plant performance to ensure the safe operation of the plant, and for an easily understood indicator of the safety status of an operating NPP to the public.

The inspection of the NPP during construction, operation, and decommissioning stage by the regulatory body is strictly implemented by inspections and documents or report reviews. Various kinds of inspections are being performed including, for example, the resident inspection, periodic inspection, refueling outage inspection, expert team inspection, unannounced inspection, and other inspections when needed.

In the beginning of commercial operation, the NPPs in Taiwan adopted the customer technical specifications (CTS) (for Chinshan NPP) or standard technical specifications (STS) (for Kuosheng and Maanshan NPPs). Later, on Feb. 26, 2002, the Chinshan NPP converted its CTS into the improved technical specifications (ITS). Because of the fruitful implementation of ITS in Chinshan, the STSs for both Maanshan and Kuosheng NPPs were also converted into ITS in September 2004 and January 2008, respectively. In 2018, the unit 1 of Chinshan NPP started decommissioning activities and adopted an interim technical specification, i.e. Pre-Defueled Technical Specification (PDTS).

In order to strengthen the robustness of a nuclear unit against an accident of loss of power sources, the power supply systems design of the NPPs in Taiwan is based on the defense-in-depth concept. Every nuclear power unit has several lines of defense in preventing the occurrence of loss of power.

Besides, to provide the public's information on radiation and nuclear power, the AEC directly communicates with the public through its facebook and thus shares the fundamental knowledge about nuclear safety and radiation protection. AEC also visit and have dialogue with local groups to collect information from broader aspects.

In case a nuclear accident should occur, the ROC's nuclear emergency response organizations, among which the National Nuclear Emergency Response Center (NNERC) is the leading agency, will immediately react to take the responsibility to protect the public and to mitigate the effects to the public. An on-site nuclear emergency response drill is required for each NPP to be conducted every year. Pursuant to Paragraph 15.1 of the Nuclear Emergency Response Act, the central Competent Authority shall select one emergency planning zone (EPZ) to conduct exercises every year based on the approved Emergency Response Basic Plan. Through the experiences obtained from these drills and exercises, the contingency plans for the emergency response and emergency preparedness (EP) are in place and will be continually updated and improved.

After the Japanese Fukushima Daiichi NPP accident in March 2011, a national "Programs for Safety Re-assessment" for all NPPs in Taiwan was immediately initiated in April 2011. Furthermore, a nuclear stress test (ST) program based on the European Union (EU) "stress tests" specifications was conducted for each NPP in August 2011, in order to well utilize the EU stress tests experiences. A final national report for the Safety Re-assessment Program, entitled "Comprehensive Safety Reassessment Report for NPPs in Taiwan in Response to the Lessons Learned from Fukushima Daiichi Accident" (written in Chinese), was published by AEC in August 2012, while the formal "Taiwan Stress Test National Report for Nuclear Power Plants" by AEC was issued on May 28, 2013. International peer reviews of the ST National Report as well as the licensee's ST reports by the Nuclear Energy Agency of the Organization for Economic Cooperation and Development (OECD/NEA) and the European Nuclear Safety Regulators Group of the European Commission (EC/ENSREG) expert teams, respectively, were also conducted. Based on results of these safety re-assessment and stress tests, a variety of lesson-learned requirements and orders to strengthen the nuclear safety of NPPs in Taiwan were issued by AEC to TPC. The TPC may propose alternatives subject to AEC approval.

Current abnormal operating procedures (AOPs) and emergency operating procedures (EOP) are symptom-based. They are suitable for handling internal events. When there is a large-scale severe compound external event, like the Fukushima accident, of which the effects are on the entire plant site, an urgent response will be required and thus the symptom-based procedures may not be appropriate. Therefore, after the Fukushima Daiichi nuclear accident, each NPP of the TPC has developed an alternate rescue strategy, the ultimate response guidelines (URG), with respect to the plant specific features, which was renamed as specific major incident guidelines (SMI). In April 2018, AEC issued the Safety Evaluation Report and approved the implementation of the SMI with some action items for further enhancements, including the implementation of NTTF 4.2 with FLEX and the implementation of NTTF 8 with SMI.

In response to the Fukushima Daiichi accident in 2011, the Taiwan government issued a new nuclear energy policy on November 3, 2011 that no life extension of the operating NPPs will be granted and the nuclear power will be gradually reduced.

On the other hand, with an intention to make the government structure smaller, an "Amendments to the Law Governing Organization of the Executive Yuan" was passed by the Legislative Yuan (LY) (i.e., the Congress) of Taiwan in January 2010, reducing the legal number of second-tier ministries from 37 to 29. Accordingly, a Government Reform Program for the Executive Yuan (EY) started in January 2012. In the governmental structure proposed by this reform program, the authority of nuclear regulation is no longer a 2nd tier ministry member of the Cabinet (Executive Yuan), but a 3rd-tier independent organization called the "Nuclear Safety Commission." In addition, the "Institute of Nuclear Energy Research (INER)," the primary research and development (R&D) organization to technically support the AEC in carrying out the nuclear regulation affairs, is proposed to be transformed into a non-departmental public bodies, "National Research Institute of Atomic Energy Science," but still remains its affiliation to the new nuclear regulatory body. A draft of "Nuclear Safety Commission Organization Act" has been approved by the Executive Yuan (EY) in 2022 and then approved by Legislative Yuan in May 2023.

In conclusion, Taiwan has demonstrated its fulfillment of the Principles of the Vienna Declaration on Nuclear Safety (VDNS), consideration of challenges identified during the 6th review meeting under the CNS, and implementation of lessons learned from the Fukushima Daiichi accident through the activities of the AEC and its licensee, the TPC, in all aspects of the domestic NPPs. Detailed information can be found in the following Articles of this report.

Note: During the compilation period of this report (January 2022 to July 2023), the nuclear safety regulation authority was the "Atomic Energy Council of the Executive Yuan" (hereinafter referred to as

the "AEC"), so the name of the "AEC" is still retained in the content of this report. On September 27, 2023, the AEC was restructured into the Nuclear Safety Commission, so this report is issued as the Nuclear Safety Commission.

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INTRODUCTION

A. General

The Republic of China (hereafter referred to as the ROC or Taiwan) is not a Contracting Party of the Convention on Nuclear Safety (hereafter referred to as the CNS or the Convention) of the International Atomic Energy Agency (IAEA). However, nuclear application safety in Taiwan is always considered a top priority. Therefore, Taiwan will be willing to participate in any international activity that promotes nuclear safety in order to fulfill its pertinent obligations. This National Report of the ROC submitted to the CNS illustrates how the obligations under the terms of the CNS are in compliance with this nation.

The indigenous energy sources are perennially insufficient in Taiwan. In 2021, the total primary energy supply was about $143,970.4 \times 10^3$ kilo-liter oil equivalent (KLOE), a decrease of 3.33% compared to that of 2018. Of this supply, 97.73% of the total energy supply was imported. The indigenous energy supply contributed only 2.27% to the total amount of supply, an increase of 13.12% compared to that of 2018. When categorized into different energy sources, nuclear power constituted about 5.59% of the total amount. Fossil fuel contributed 92.28% in total. Within fossil fuel, coal accounted for 30.78%, oil for 43.39% and natural gas for 18.11%. As for renewable energy, hydropower constituted about 0.23%, energy produced from biomass and waste for 1.17%, while the combined contribution of wind and solar power was about 0.74%. Since 2001, coal is no longer mined domestically and the supply of it has been totally dependent on imports. On the other hand, the reserves of crude oil and natural gas are very limited in Taiwan.

The outline of the nuclear power utilization in Taiwan is as follows, both units of the Maanshan nuclear power plant (NPP) are currently in operation. Both units of the Chinshan NPP are in the process of being decommissioned. The operating licenses of the two units of the Kuosheng NPP expired in 2021 and 2023, respectively. Each of these three NPPs has two identical units. All of the NPPs in Taiwan are owned and operated by the Taiwan Power Company, which is a state-owned utility with 96.93% of its stock held by the ROC government and 3.07% by private sectors.

As shown in Table 6.2, the expiration date of the Chinshan NPP Unit 1&2 operating license is December 5, 2018 and July 15, 2019, while the Kuosheng NPP Unit 1&2 operating license expiration date is December 27, 2021 and March 14, 2023, respectively. According to the Nuclear Reactor Facilities Regulation Act, the reactor license renewal applications of an NPP must be submitted to the regulatory authority between 5 and 15 years before the operating license (OL) expiration date. The TPC submitted the license renewal application of the Chinshan NPP to the AEC in July 2009. The review of this application was the first of its kind in Taiwan and was expected to take 24 to 26 months to complete. During the reviewing period, the TPC requested the AEC to postpone the review due to the Japan Nuclear Accident at Fukushima Dai-ichi that struck in March 2011 and the implementation of the stretch power uprate program of the Chinshan NPP in 2012 (Subsection 6.1.2). The review started again in August 2014 and was expected to take another 2 years to complete. However, because of the Fukushima Dai-ichi nuclear disaster, the energy policy of Taiwan has been altered since May, 2016. The new policy stated that all the NPPs in Taiwan must be decommissioned on schedule provided that the power supply was sufficient, reasonable electricity prices could be maintained, and carbon emission reduction plan could be met. Consequently, the TPC withdrew its application for the license renewal of the Chinshan NPP on July 7, 2016.

The Taiwan Power Company (TPC) is a state-owned utility. It used to be the only utility in Taiwan and provided all the electricity needed in this country. However, due to the national policy of privatizing electricity sectors, private power companies or so-called independent power producers (IPPs) came into existence after June 1999. The TPC's power plants used to generate 100% of the total power supply until 1998. After the introduction of IPPs, the TPC's electricity generation contribution decreased to about 76% of the total power supply in 2021.

As of December 2021, the overall domestic installed electricity capacity reached 51.155 GWe as shown in Table I-1, including the electricity capacity provided by the units owned by the TPC and the independent power producers (IPPs). The installed electricity capacity provided by the TPC was 34.321 GWe, accounting for 67.1% of the total capacity. The private power plants contributed the rest 32.9%, approximately 16.834 GWe to the grid. The outline of the installed electricity capacity provided by the TPC is as follows, fossil fuel contributed 26.341 GWe or 51.5% to the total installed electricity capacity; nuclear power 2.887 GWe or 5.6%; renewable energy sources such as hydro-power (pumped storage hydropower excluded), wind power and solar power 2.490 GWe or 4.9%; and pumped storage hydro-power accounted for 2.602 GWe or 5.1%.

In 2021, the total amount of electricity generated in Taiwan reached 248.8 billion kWh. Of this amount, 189.1 billion kWh or 76.0% of the total amount, was generated by the TPC. The nuclear power plants generated about 26.8 billion kWh worth of electricity, accounting for 10.8% of the total generation. Regarding the utilization of renewable energy in 2021, it contributed about 1.6% to the total amount of electricity generation or 3.9 billion kWh (IPP excluded). The electricity generated from pumped storage hydropower accounted for about 1.3%. Table I-2 shows the total amount of electricity generated in Taiwan in 2021 along with the data of 2019 for comparison. This table is updated every three years concurrent with the publishing of the latest CNS report.

Table I-1 Installed Power Capacity in Taiwan in 2022

Type of Energy Source	2022 Installed Capacity (MWe)	2022 Percentage (%)	2019 Percentage (%)
TPC:			
Oil	1,592	3.0	5.4
Coal	11,600	21.6	24.5
LNG	13,149	24.5	25.7
Pumped Storage Hydro	2,602	4.8	5.4
Renewable	2,507	4.7	4.7
Nuclear	2,887	5.4	8.1
(TPC Subtotal)	34,337	(63.9)	(73.5)
IPP (including renewal):	19,399	36.1	26.5

Total	53,736	100.0	100

Source: 2021 Sustainability Report, Taiwan Power Company.

All of the NPPs in Taiwan are owned and operated by the TPC. It is the TPC’s duty to maintain the stability and the safety of all of its nuclear power plants. The NPPs still in operation have had an excellent performance record in recent years. The weighted annual capacity factor of all of the nuclear units still in operation was 82.06% in 2021 mostly due to the Chinshan NPP’s permanent cessation of its operation.

The Atomic Energy Council (AEC) is the governing authority for all atomic energy-related affairs. It was established in 1955 at the ministerial level as a Cabinet member under the Executive Yuan, which is the highest administrative authority in this country. There are three affiliated organizations under the AEC, namely the Institute of Nuclear Energy Research (INER), the Fuel Cycle and Materials Administration (FCMA), and the Radiation Monitoring Center (RMC). INER is the sole nuclear R&D institute in this country. The major nuclear R&D areas of INER in recent years have included the evaluation of level 2 probabilistic risk assessments (PRA) of the operating NPPs, source term evaluation, seismic risk re-assessment of an NPP, high efficient solidification technology (HEST) study for the low level waste (LLW), nuclear facility decommissioning and radioactive waste management, radiobiological medicine R&D, the establishment of the accreditation platform for the nuclear grade industrial technologies, etc. (More information about INER’s R&D programs can be found in Subsection 6.3.8.) FCMA has two major responsibilities: firstly, the safety regulation of the treatment, transportation and final disposal of the radioactive wastes including both LLW and the spent nuclear fuels (SNF); and secondly, the safety regulation of the import, export, storage, and transfer of the nuclear materials as well as nuclear fuels. The major responsibility of the RMC is the monitoring of natural and man-made ionizing radiation in the environment, including the radioactivity content in the civilian-consumed foods and commodities.

Table I-2 Electricity Generation in Taiwan in 2022

Type of Energy Source	2022 electricity generation (billion kWh)	2022 Percentage (%)	2019 Percentage (%)
TPC:			
Oil	3.5	1.4	1.9
Coal	67.9	27.1	29.0
LNG	84.6	33.7	29.6
Pumped Storage Hydro	3.1	1.2	1.4
Renewable	6.3	2.5	2.4
Nuclear	22.9	9.1	13.4
(TPC Subtotal)	188.3	(75.1)	(77.6)
IPP (including renewal) :	62.5	24.9	22.4

Total	250.7	100.0	100

Source: Taiwan Power Company website, information disclosure.

Following the Fukushima Daiichi accident in Japan, a national "Programs for Safety Re-assessment" was launched and later the stress tests (ST) for each NPP based on the EU "stress tests" specifications were performed. International peer reviews of the ST National Report as well as the licensee's ST reports by the Nuclear Energy Agency of the Organization for Economic Cooperation and Development (OECD/NEA) and the European Nuclear Safety Regulators Group of the European Commission (EC/ENSREG) expert teams, respectively, were also undertaken. In response to a complex nuclear disaster like the Fukushima Daiichi nuclear accident, the robustness of NPPs with respect to the power supply systems and other aspects has thus significantly increased.

This ROC National Report for the CNS of 2023 is a comprehensive document and there is no need to refer to the earlier reports in advance. In the following Article 6, the nuclear power plants (NPPs) in Taiwan are presented with their design features, power uprates, power unit performance, power supply sources, etc. Also included in Article 6 are the re-assessment of nuclear safety, the stress tests for all Taiwanese NPPs and a variety of regulatory requirements and orders issued by the regulatory body to the licensee with the aim to strengthen the robustness of the NPP following the Fukushima accident. The regulation and operation measures for COVID-2019 pandemic since 2019 are also addressed in Article 6.

Article 7 provides an overview of the legislative and regulatory framework in the ROC. The Atomic Energy Act is the fundamental law that provides the legislative and regulatory framework for the utilization of nuclear energy in the ROC. In addition to the Atomic Energy Act, there are six basic laws, six subsidiary enforcement rules and the related regulations.

Article 8 outlines the mission and the structure of the regulatory body. The AEC, in the implementation of regulatory tasks and R&D works, adheres to the following principles: safety first, reasonable control, and convenience to the people. The AEC consists of 15 council members in addition to the Chairman (Minister) and 2 deputy Chairmen (deputy Ministers), four technical departments and four administrative units within the Headquarters. In addition, there are nine advisory committees on nuclear policy and safety (among them, seven advisory committees are regularly operating). Moreover, under the AEC's supervision, there are three affiliated organizations.

In Article 9, the main subjects are the mechanism for the license holder to fulfill its prime responsibility for safety and the mechanism for the regulatory body to ensure that the license holder will meet its prime responsibility for safety.

Article 10 provides the overview of the arrangements and requirements to prioritize safety, the voluntary activities and good practices related to safety, and the enhanced transparency of nuclear safety information to ensure that "Safety" has always been the foremost priority in the country.

Article 11 discusses the financial requirements of the licensee including the financing of safety improvements, financial provisions for decommissioning and radioactive waste management, financial protection program for liability claims arising from nuclear accidents as well as the manpower resources of the licensee.

Article 12 presents the overview of human factors and organizational issues for the safety of NPPs, the human factors in the design of NPPs and subsequent modifications, the methods to prevent, detect, and correct human errors, the managerial and organizational issues, and the role of the regulatory body and facility operator.

Article 13 describes the quality assurance (QA) policy, the requirements and programs which are applied for the NPPs in stages of design, procurement, manufacturing, construction, and operation and maintenance.

Article 14 depicts the comprehensive and systematic safety assessments throughout the plant life, the verification of plant safety by analysis, surveillance, testing and inspection, and the lessons learned from the accidents at Fukushima to ensure the prevention of disaster resulting from combined accidents at the TPC's NPPs.

Article 15 mentions about the purpose of the Ionizing Radiation Protection Act (IRPA) which is to properly manage radioactive material, equipment capable of producing ionizing radiation, and radiation practices, so as to prevent the radiation workers and the public from the detriment of radiation. In this article, the principle of "As Low As Reasonable Achievable" (ALARA) is emphasized for reduction of occupational radiation exposure and protection of radiation exposure for members of the public.

Article 16 focuses on the emergency preparedness (EP), for either on-site or off-site of any nuclear reactor facility. Based on "The Nuclear Emergency Response Act", the response mechanisms have been established. The emergency response organizations include (1) National Nuclear Emergency Response Center, (2) Radiation Monitoring and Dose Assessment Center, (3) Regional Nuclear Emergency Response Center and (4) Nuclear Emergency Support Center. After Fukushima accident in 2011, the emergency planning zones (EPZ) for the three NPPs were all enlarged from 5 to a new 8 kilo-meters from the center of the nuclear power station.

Article 17 outlines the evaluation of site-related factors affecting the safety of an NPP, and the assessment of the safety impact on individuals, society, and environment.

Article 18 discusses the protection (defense in depth) of NPPs against the release of radioactive material, the application of proven technologies to ensure the safety of NPPs, and the Fukushima lessons learned to re-visit the design basis to confirm the capability of NPPs in response to both the design basis accident (DBA) and the beyond design basis accident (BDBA).

Finally, activities related to the operation of NPPs in Taiwan are comprehensively evaluated in Article 19 which includes the development of the specific major incident guidelines (SMI) procedure by the TPC to prevent the reactor core from melting in the beyond design basis conditions.

On February 18, 2015, the contracting parties to the CNS issued the Vienna Declaration on Nuclear Safety in INFCIRC 872. The declaration does not establish new requirements but reaffirms the contracting parties' commitment to the implementation of the CNS principles and objectives to prevent accidents and mitigate radiological consequences.

Though not a member of the Convention, the ROC is willing to adhere to the Vienna Declaration on Nuclear Safety and the implementation of the prevention and mitigation of accidental radiological consequences, as discussed in Articles 6, 14, 17, 18, and 19.

It is worth noting that the operational experience feedback (OEF) for lessons learned from the Fukushima accident are discussed in several subsections such as, Subsections 14.3, 16.3 and 18.4.

To foster a sound safety culture and to ensure that a high level of nuclear safety will continue to be maintained by both the AEC and the TPC, the review process of the Convention on Nuclear Safety is a good practice for Taiwan to examine the performance of its domestic NPPs and to share experiences with other contracting parties. It is of great importance to the international community to ensure that the use of nuclear energy is safe, well regulated, and environmentally sound, as stated in the preamble of the Convention. In conclusion, Taiwan fulfills all the obligations of the Convention on Nuclear Safety of the IAEA.

B. Lessons Learned from the Fukushima Daiichi Accident

Following the Fukushima Daiichi accident, a number of technical and administrative measures have been implemented to enhance the plant robustness under natural or man-made external events at Taiwan's NPPs. These measures were mainly identified during the implementation of Programs for Safety Reassessments and Stress Tests for NPPs in Taiwan. Examples of these safety enhancement measures include the upgrading of the AC and DC power supply sources capacity, the safety enhancements against seismic/tsunami hazards, the issuance of new regulatory orders, and the development of the specific major incident guidelines (SMI). For more information, please see Subsections 14.3, 16.3 and 18.4.

C. Adoption of Findings from Peer Review Missions

The regulatory authority (AEC) and the licensee (TPC) have adopted the findings and recommendations from international peer reviews such as those from the OECD/NEA and EC/ENSREG peer review teams on the NPP stress tests. For more information, please see Subsections 14.3.1, 14.3.2, 14.3, and 18.4.

D. Challenges Identified by the Special Rapporteur at the 6th Review Meeting

At the 6th review meeting of the CNS (24 March – 4 April 2014), five challenges were posed by the special rapporteur, Mr. Petteri Tiippana (Finland), on Fukushima for the consideration of the contracting parties in their next national reports under the CNS:

Challenge 1: How to minimize gaps between Contracting Parties' safety improvements?

Challenge 2: How to achieve harmonized emergency plans and response measures?

Challenge 3: How to make better use of operating and regulatory experience, and international peer review services?

Challenge 4: How to improve regulators' independence, safety culture, transparency and openness?

Challenge 5: How to engage all countries to commit and participate in international cooperation?

In response to Challenge 1, Taiwan has joined international organizations such as WANO and participated in various international cooperation programs such as CSARP, CAMP, CPD, and CODAP. For several decades, a bilateral conference between Taiwan and Japan nuclear communities as well as the TECRO-AIT Joint Standing Committee meeting on civil nuclear cooperation have been held annually, which are beneficial to both sides. For more information, please see Subsection 6.3.5.

To harmonize emergency plans and response measures for Challenge 2, each NPP in Taiwan conducts a nuclear emergency drill every year, while the central Competent Authority selects one EPZ to conduct exercises at least once every three years. For more information, please see Subsection 16.1.2.

Regarding Challenge 3, the operational experience feedback (OEF) programs conducted in Taiwan are beneficial to the safety improvement of the NPPs through the periodic safety review (PSR), which is called the 10-year integrated safety assessment (ISA) in this nation. For more information, please see Subsections 6.2.2, 10.4.1 and 19.8.

With respect to Challenge 4, the AEC has implemented a reactor oversight process (ROP) system and published the performance indicators and inspection indicators of the Operating NPPs in Taiwan on its website in order to improve the regulator's transparency and openness. Additionally, all regulations and more and more information about the AEC activities are also available on the AEC's website. On the other hand, the TPC also presents information about the company in six aspects, including the information on management, power generation, demand & supply of electricity, customers, environment, and construction engineering, to the public through the TPC's web site. Furthermore, an advanced safety culture program has been developed by TPC since June 2011 to foster a high level of nuclear safety to ensure the health and safety of the general public. This advanced Safety-Culture program includes 4 major areas: management effectiveness, contractor management, risk management and personnel performance. For more information, please see Subsections 6.2.1, 8.5 and 10.2.

Similar to Challenge 1, Challenge 5 has been addressed by joining international organizations and participating international cooperation programs. For more information, please see Subsection 6.3.5.

E. Principles of the Vienna Declaration on Nuclear Safety

The 2015 Vienna Declaration on Nuclear Safety (VDNS) stipulates three principles for implementing the objective of the CNS as follows:

1. New nuclear power plants are to be designed, sited, and constructed, consistent with the objective of preventing accidents in the commissioning and operation and, should an accident occur, mitigating possible releases of radionuclides causing long-term off site contamination and avoiding early radioactive releases or radioactive releases large enough to require long-term protective measures and

actions.

2. Comprehensive and systematic safety assessments are to be carried out periodically and regularly for existing installations throughout their lifetime in order to identify safety improvements that are oriented to meet the above objective. Reasonably practicable or achievable safety improvements are to be implemented in a timely manner.

3. National requirements and regulations for addressing this objective throughout the lifetime of nuclear power plants are to take into account the relevant IAEA Safety Standards and, as appropriate, other good practices as identified among others in the Review Meetings of the CNS.

These three principles of the VDNS are all satisfied in Taiwan. The implementation of Principle 1 is addressed in more detail in Subsections 6.2.3, 10.3.1 and 19.1 (although the new NPP being constructed was put into mothballs). Principle 2 was adopted and implemented through the performance of the 10-year integrated safety assessment (ISA) program and addressed in more detail in Subsections 6.2.2 and 14.1.2. On the other hand, Principle 3 was strengthened through the execution of "Programs for Safety Reassessments and Stress Tests for NPPs" in Taiwan, which resulted in the issuance of new regulatory orders and the licensee's safety enhancement measures accordingly. For more information, please see Subsections 10.4 and 14.3.

The AEC granted a permit to TPC to decommission the Chinshan Nuclear Power Plant on July 12, 2019 and the permit took effect on July 16, 2019. The overall planned work items will be completed in 25 years. During this period, the decommissioning activities at the Chinshan NPP will be subject to comprehensive regulatory scrutiny. The AEC has already established the necessary regulatory system to oversee TPC to complete the decommissioning plan as scheduled and as required, in compliance with regulatory requirements in radiation protection, nuclear materials and radioactive waste management, environmental protection.

F. Changes to the 2020 ROC's National Report

For the convenience of the readers, Table I-3 summarizes the types of changes made to the 2020 ROC's National Report.

Table I-3 List of Changes to the 2020 ROC's National Report

Report Sections		Changes
EXECUTIVE SUMMARY		
INTRODUCTION		
A.	General	Updated to discuss current status and activities conducted in the last 3 years
B.	Lessons Learned from the Fukushima Daiichi Accident	Editorial changes only
C.	Adoption of Findings from Peer Review Missions	Editorial changes only

Report Sections		Changes
D.	Challenges Identified by the Special Rapporteur at the 6th Review Meeting	No change
E.	Principles of the Vienna Declaration on Nuclear Safety	No change
F.	Changes to the 2020 ROC’s National Report	New section
ARTICLE 6. EXISTING NUCLEAR INSTALLATIONS		
6.1	Nuclear Power Plants in Taiwan	Updated to discuss current status and activities conducted in the last 3 years
6.1.1	Plant Site, Ground Elevation and Tsunami Runup	Updated to discuss current status and activities conducted in the last 3 years
6.1.2	Nuclear Power Unit Characteristics, SSCs Shared and Power Uprates	Rename as Nuclear Power Unit Characteristics Updated to discuss current status and activities conducted in the last 3 years
6.1.3	Performance of the Operating NPPs	Editorial changes
6.1.4	Power Supply Sources of the NPPs	Updated to discuss current status and activities conducted in the last 3 years
6.1.4.1	Offsite Power	Editorial changes Merged into Section 6.1.4
6.1.4.2	Onsite Backup Power ─ Water-Cooled EDGs	Editorial changes Merged into Section 6.1.4
6.1.4.3	Emergency Backup Power ─ Air-Cooled Swing EDG and Gas turbines	Editorial changes Merged into Section 6.1.4
6.1.4.4	DC Power and Mobile Diesel Generators	Editorial changes Merged into Section 6.1.4
6.1.4.5	Enhancement of Power Supply Systems after Fukushima	Editorial changes Merged into Section 6.1.4
6.1.5	Status of Nuclear Installations in Taiwan	Updated to discuss current status and activities conducted in the last 3 years
6.2	Major Safety Assessments	Editorial changes only
6.2.1	Licensee’s Nuclear Safety Culture Program	Renamed as Licensee’s Nuclear Safety Culture Program and Reporting Requirements Editorial changes
6.2.2	Reporting Requirements	Merged into Section 6.2.1

Report Sections		Changes
6.2.3	Regulatory Reviews, Inspections and Assessments	Moved to Section 6.2.2 Updated to discuss current status and activities conducted in the last 3 years
6.2.3.1	Application and Approval for the Construction, Initial Fuel Loading or Operating License	Deleted
6.2.3.2	Regulatory Inspections	Deleted
6.2.3.3	Reactor Oversight Process	Deleted
6.2.3.4	Integrated Safety Assessment (Periodic Safety Review)	Deleted
6.2.3.5	Regulatory Measures for Decommissioning of NPPs	Deleted
6.2.3.6	Nuclear Safety Reassessments after Fukushima Accident	Deleted
6.2.3.7	International Peer Reviews	Moved to Section 6.2.4 Editorial changes
6.3	Programs and Measures for Safety Upgrading	No change
6.3.1	Regulatory Requirements for Changes and Modifications	No change
6.3.2	Automatic Seismic Trip System	No change
6.3.3	Update of Final Safety Analysis Report	Updated to discuss current status and activities conducted in the last 3 years
6.3.4	Update of Technical Specifications	Updated to discuss current status and activities conducted in the last 3 years
6.3.5	International Cooperation	Editorial changes only
6.3.5.1	General	Deleted
6.3.5.2	Seismic Study	Deleted
6.3.6	Probabilistic Risk Assessment (PRA) and Risk-Informed Application	No change
6.3.7	Corrective Action Program	No change
6.3.8	Governance, Oversight, Support, and Perform	Deleted
6.3.9	Research and Development Programs in Nuclear Safety	Moved to Section 6.3.8
6.3.9	Response measures to COVID-19	New section
6.4	Enhancement Actions after Lessons Learned from Fukushima	Deleted
6.4.1	Programs for Safety Reassessments and Stress Tests for NPPs in Taiwan	Deleted

Report Sections		Changes
6.4.2	Regulatory Requirements for Safety Enhancement	Deleted
6.4.3	Licensee's Enhancement Measures	Deleted
6.4.3.1	General	Deleted
6.4.3.2	Electrical Power Supply Enhancement	Deleted
6.4.3.3	Cooling Water Supply and Ultimate Heat Sink Enhancement	Deleted
6.4.3.4	Seismic and Tsunami Flooding Safety Enhancement	Deleted
6.4.3.5	Development of Ultimate Response Guidelines (URG)	Deleted
ARTICLE 7. LEGISLATIVE AND REGULATORY FRAMEWORK		
7.1	Legislative and Regulatory Framework in the ROC	No change
7.2	Nuclear Regulatory Laws, Regulations and Requirements	No change
7.2.1	Basic Laws	Editorial changes only
7.2.2	Enforcement Rules	No change
7.2.3	Regulations	Updated to discuss current status and activities conducted in the last 3 years
7.3	Enforcement	No change
7.4	Amendment of Regulations	Updated to discuss current status and activities conducted in the last 3 years
7.4.1	Regulations Related to the Nuclear Reactor Facilities Regulation Act	No change
7.4.2	Regulations Related to the Ionizing Radiation Protection Act	No change
7.4.3	Regulations Related to the Nuclear Emergency Response Act	Updated to discuss current status and activities conducted in the last 3 years
7.4.4	Regulations Related to the Nuclear Materials and Radioactive Waste Management Act	No change
ARTICLE 8. REGULATORY BODY		
8.1	Nuclear Regulatory Body	Renamed as Structure of the Regulatory Body
8.1.1	Mandate	Renamed as Atomic Energy Council
8.1.2	Authority and Responsibilities	Merged into Section 8.1.1

Report Sections		Changes
8.1.3	Structure of the Regulatory Body	Renamed as Affiliated Agencies
8.1.3.1	Atomic Energy Council	Deleted
8.1.3.2	Offices of the Atomic Energy Council	Deleted
8.1.3.3	Affiliated Agencies	Deleted
8.1.3.4	Advisory Committees	Deleted
8.1.4	Financial and Human Resources of the Nuclear Regulatory Body	Renamed as Advisory Committees
8.1.4.1	Financial Resources	Deleted
8.1.4.2	Fees Collected from the Licensees	Deleted
8.1.4.3	Nuclear Emergency Response Fund	Deleted
8.1.4.4	Human Resources	Deleted
8.1.5	Position of the AEC in the Government	Deleted
8.1.5.1	Executive Yuan	Deleted
8.1.5.2	Local Counties	Deleted
8.1.5.3	Legislative Yuan	Deleted
8.2	Separation of Functions of the Regulatory Body from Those of Bodies Promoting Nuclear Energy	Renamed as Financial and Human Resources of the Nuclear Regulatory Body
8.2.1	Financial Resources	New section
8.2.2	Fees Collected from the Licensees	New section
8.2.3	Nuclear Emergency Response Fund	New section
8.2.4	Human Resources	New section
8.3	Position of the AEC in the Government	New section
8.3.1	Executive Yuan	New section
8.3.2	Local Counties	New section
8.3.3	Legislative Yuan	New section
8.4	Separation of Functions of the Regulatory Body from Those of Bodies Promoting Nuclear Energy	New section
8.5	Measures to Enhance Transparency of Nuclear Safety Information	New section
ARTICLE 9. RESPONSIBILITY OF THE LICENSE HOLDER		
9.1	Prime Responsibility of the License Holder for the Safety of Nuclear Installations	Updated to discuss current status and activities conducted in the last 3 years

Report Sections		Changes
9.1.1	Organization of the Taiwan Power Company and Mechanism for the License Holder to Discharge Its Prime Responsibility for Safety	Updated to discuss current status and activities conducted in the last 3 years
9.1.2	Mechanism for the License Holder to Maintain Open and Transparent Communication with the Public	No change
9.1.3	Mechanism for the License Holder to Ensure Having Appropriate Resources (Technical, Human, Financial) for On-Site Accident Management and Consequence Mitigation	No change
9.2	Mechanism for the Regulatory Body to Ensure that the License Holder Will Meet Its Prime Responsibility for Safety	No change
9.3	Prime Responsibility of the License Holder for the Decommissioning of Nuclear Installations	No change
ARTICLE 10. PRIORITY TO SAFETY		
10.1	Overview of the Arrangements and Requirements to Prioritize Safety	No change
10.1.1	Safety Policy	No change
10.1.2	Commitment to Safety	Renamed as Commitment to Nuclear Safety
10.1.3	Safety Culture	Renamed as Licensee Nuclear Safety Culture and moved to Section 10.2 Editorial changes
10.1.3.1	Safety Culture Implementation Plan	Moved to Section 10.2.1
10.1.3.2	Safety Culture Reinforcement Plan	Moved to Section 10.2.2
10.1.3.3	Safety Culture Advanced Plan	Moved to Section 10.2.3
10.1.4	Regulatory Control	Renamed as Nuclear Safety Regulatory Action of the Regulatory Authority and moved to Section 10.3
10.1.4.1	Licensing	Moved to Section 10.3.1
10.1.4.2	Inspections and Enforcement	Moved to Section 10.3.2
10.1.4.3	Reactor Oversight Process	Moved to Section 10.3.3
10.1.5	Independent Safety Assessment	Renamed as Independent Safety Assessment and Voluntary Activities and moved to Section 10.4

Report Sections		Changes
10.1.5.1	INPO and WANO Safety Review	Renamed as WANO Safety Review Moved to Section 10.4.1 Editorial changes
10.1.5.2	Independent Review on Stress Test Reports	Deleted
10.2	Voluntary Activities and Good Practices Related to Safety	Moved to Section 10.4.2
10.3	Measures to Enhance Transparency of Nuclear Safety Information	Moved to Section 8.5
ARTICLE 11. FINANCIAL AND HUMAN RESOURCES		
11.1	Financial Resources	No change
11.1.1	Financial Requirements	No change
11.1.2	Financial Resources of the Licensee	Renamed as Financial Resources Requirements of the Construction Licensee Editorial changes
11.1.3	Financing of Safety Improvements	Deleted
11.1.4	Financial Provisions for Decommissioning and Radioactive Waste Management	Moved to Section 11.1.3 Editorial changes Updated to discuss current status and activities conducted in the last 3 years
11.1.5	Financial Protection Program for Liability Claims Arising from Nuclear Accidents	No change
11.2	Human Resources	No change
11.2.1	Requirements for Personnel Qualification, Training and Retraining	Updated to discuss current status and activities conducted in the last 3 years
11.2.1.1	Training Requirements for Regulatory Staff	Merged into Section 11.2.1
11.2.1.1.1	Nuclear power plants inspectors	Merged into Section 11.2.1
11.2.1.1.2	Nuclear security and emergency response inspectors	Merged into Section 11.2.1
11.2.1.1.3	Radioactive materials management inspector	Merged into Section 11.2.1
11.2.1.1.4	Nuclear power plants decommissioning inspectors	Merged into Section 11.2.1
11.2.1.2	Regulatory Requirements for Reactor Operators	Merged into Section 11.2.1
11.2.1.2.1	Requirements for the Number of ROs On-Duty	Merged into Section 11.2.1

Report Sections		Changes
11.2.1.2.2	Qualification Requirements for the ROs	Merged into Section 11.2.1
11.2.1.3	Regulatory Requirements for Radiation Protection Personnel	Merged into Section 11.2.1
11.2.1.4	Regulatory Requirements for Radioactive Waste Operators	Merged into Section 11.2.1
11.2.1.5	Licensee's Training and Retraining Programs for Its Employees	Merged into Section 11.2.1
11.2.1.5.1	Reactor Operators Training	Deleted
11.2.1.5.2	Licensed Reactor Operators Retraining Program	Deleted
11.2.1.5.3	Re-qualification of Licensed Reactor Operators	Deleted
11.2.1.5.4	Training for Non-Licensed Plant Technical Staff	Deleted
11.2.1.5.5	Training for TPC's General Employees and Contractors' Personnel	Deleted
11.2.1.5.6	Plant Simulator Training Center	Deleted
11.2.1.5.7	The Taipower Institute of Training	Deleted
11.2.2	Human Resources of the Licensee	Editorial changes Updated to discuss current status and activities conducted in the last 3 years
11.2.2.1	Manpower of the Taiwan Power Company	Merged into Section 11.2.2
11.2.2.2	Supports from Contractors in Emergency	Merged into Section 11.2.2
11.2.2.3	On-site and Off-site Manpower Supports for Severe Accident Management	Deleted
11.2.3	Other Human Resources	No change
ARTICLE 12. HUMAN FACTOR		
12.1	Overview of Human Factors and Organizational Issues for the Safety of NPPs	No change
12.2	Human Factors in the Design of NPPs and Subsequent Modifications	No change
12.3	Methods to Prevent, Detect, and Correct Human Errors	No change
12.4	Managerial and Organizational Issues	No change
12.5	Role of the Regulatory Body and the Facility Operator	No change
12.5.1	Role of the Regulatory Body	No change
12.5.2	Role of the Facility Operator	No change
12.6	Fukushima Lessons Learned	Deleted

Report Sections		Changes
12.6.1	Strengthening Nuclear Safety Organization and Culture	Deleted
12.6.2	Routine Training in Response to Emergency Situations	Deleted
ARTICLE 13.	QUALITY ASSURANCE	
13.1	Quality Assurance Programs	No change
13.2	Implementation and Assessment of Quality Assurance Programs	Editorial changes only
ARTICLE 14.	ASSESSMENT AND VERIFICATION OF SAFETY	
14.1	Ensuring Safety Assessment throughout Plant Life	No change
14.1.1	Safety Assessment before Operation Stage	Editorial changes only
14.1.2	Safety Assessment at Operation Stage	Editorial changes only
14.1.3	Design Changes	No change
14.1.4	Decommissioning Plan of Nuclear Power Plants	Editorial changes Updated to discuss current status and activities conducted in the last 3 years
14.2	Verification by Analysis, Surveillance, Testing and Inspection	Editorial changes only
14.2.1	Nuclear Power Plant Inspection	Merged into Section 14.2
14.2.2	Reload Safety Analysis	Merged into Section 14.2
14.2.3	Preventive Maintenance	Merged into Section 14.2
14.2.4	Other Safety Analysis at Operation Stage	Merged into Section 14.2
14.2.5	Pre-Decommissioning Stage	Deleted
14.3	Fukushima Lessons Learned	No change
14.3.1	Comprehensive Safety Assessment of Nuclear Power Generation	No change
14.3.2	Stress Tests and Independent Peer Review	Editorial changes only
14.3.3	Issuance of Regulatory Orders	Editorial changes only
14.3.4	Status of Implementation	Editorial changes Updated to discuss current status and activities conducted in the last 3 years
ARTICLE 15.	RADIATION PROTECTION	
15.1	Regulatory Framework and Protection of Radiation Workers	No change
15.1.1	Laws, Enforcement Rules, and Regulations for Radiation Protection	No change

Report Sections		Changes
15.1.2	ALARA for Occupational Exposure	Editorial changes and tables deleted
15.1.2.1	Implementation of ALARA in the Design and Construction of Nuclear Power Plants	Merged into Section 15.1.2
15.1.2.2	Criteria for Radiation Exposure Control	Merged into Section 15.1.2
15.1.2.3	Management of Radiation Work	Merged into Section 15.1.2
15.1.2.4	Reduction of Occupational Radiation Exposure	Merged into Section 15.1.2
15.1.2.5	Personnel Dosimetry Service and Its Verification	Merged into Section 15.1.2
15.1.2.6	Radiation Protection Training	Merged into Section 15.1.2
15.1.3	Activities to Enhance the Regulatory Control	Editorial changes
15.1.3.1	Safety Standards for Protection against Ionizing Radiation	Merged into Section 15.1.3
15.1.3.2	Utilization of Radiation Protection Control System	Merged into Section 15.1.3
15.2	Protection of Radiation Exposure for Members of the Public	No change
15.2.1	Dose Constraints on Radioactive Effluents	No change
15.2.2	Assessment of Radiation Doses to the Population around NPPs	Editorial changes and tables deleted
15.2.3	Environmental Radiation Monitoring by the Licensee	Editorial changes
15.2.4	Environmental Radiation Monitoring Network by the AEC	Editorial changes and figures updated
15.3	Fukushima Lessons Learned	Deleted
15.3.1	Radiological Protection Guideline Following a Nuclear Accident	Deleted
15.3.2	Review the Rescue and Support Capability	Deleted
15.3.3	Establishment of Dose Reconstruction Capabilities for the Public and Rescuers	Deleted
15.3.4	Enhancing the Analysis Capability of Environmental Radiation Detection Laboratories	Deleted
15.3.5	Radiation Safety Measures Taken by AEC to Reduce the Impact of Fukushima Accident to the People in Taiwan	Deleted
ARTICLE 16. EMERGENCY PREPAREDNESS		
16.1	On-site and Off-site Emergency Preparedness	No change

Report Sections		Changes
16.1.1	Laws, Regulations and Requirements	No change
16.1.1.1	Emergency Response Organizations and Their Missions	Moved to Section 16.1.2
16.1.1.2	Emergency Response Organizations of the Licensee and Their Missions	Moved to Section 16.1.3
16.1.1.3	Categorizations of Nuclear Accidents	Moved to Section 16.1.4
16.1.1.4	Emergency Planning Zone (EPZ)	Moved to Section 16.1.5
16.1.2	Planning and Training	Moved to Section 16.1.6
16.1.2.1	Nuclear Accident Emergency Response Basic Plan and Nuclear Emergency Public Protection Plan	Merged into Section 16.1.6
16.1.2.2	Emergency Response Plan of the Nuclear Reactor Facility Licensee	Merged into Section 16.1.6
16.1.2.3	Training and Routine Equipment Testing	Merged into Section 16.1.6
16.1.3	Nuclear Safety Duty Center	Merged into Section 16.1.7
16.2	Notification and Protection of the Public	No change
16.2.1	Implementation of Emergency Preparedness	No change
16.2.2	Exercise	No change
16.2.3	Recovery Measures	No change
16.2.4	Compensation for Nuclear Damage	No change
16.3	International Framework and Relationship with Neighboring Countries	Deleted
16.4	Fukushima Lessons Learned	Moved to Section 16.3
16.4.1	Emergency Response Mechanism of Complex Disaster	Moved to Section 16.3.1 Editorial changes
16.4.2	Emergency Response and Preparedness	Moved to Section 16.3.2
16.4.3	Marine and Airborne Radiation Monitoring	Moved to Section 16.3.3
16.4.4	Review of Radiation Detection Plan	Moved to Section 16.3.4
16.4.5	Precautionary Evacuation and Nuclear Disaster Response Measures	Moved to Section 16.3.5
ARTICLE 17. SITING		
17.1	Evaluation of Site-related Factors	Updated to discuss current status and activities conducted in the last 3 years
17.1.1	Nearby Industrial and Military Facilities and Transportation	No change
17.1.2	Meteorology	No change
17.1.3	Hydrology	No change

Report Sections		Changes
17.1.4	Geology and Seismology	Updated to discuss current status and activities conducted in the last 3 years
17.2	Experience of Site Selection from the Lungmen Nuclear Project	Updated to discuss current status and activities conducted in the last 3 years
17.2.1	Evaluation of Safety Impact on Individuals, Society, and the Environment	Updated to discuss current status and activities conducted in the last 3 years
17.2.2	Regulatory Requirements for Environmental Impact Assessment	Updated to discuss current status and activities conducted in the last 3 years
17.3	Evaluation of Radiological Consequences	Deleted
17.4	Reevaluation of Site-Related Factors after Fukushima Daiichi Accident	Deleted
ARTICLE 18. DESIGN AND CONSTRUCTION		
18.1	Protection against the Release of Radioactive Materials	No change
18.1.1	Licensing Process and Regulatory Requirements	No change
18.1.2	Implementation of Defense-in-Depth Concept	No change
18.1.3	Prevention and Mitigation of Accidents	No change
18.2	Application of Proven Technologies	No change
18.3	Consideration of Human Factors and Man-Machine Interface	No change
18.4	Fukushima Lessons Learned	Editorial changes Updated to discuss current status and activities conducted in the last 3 years
ARTICLE 19. OPERATION		
19.1	Initial Authorization to Operate a Nuclear Installation	No change
19.2	Operational Limits and Conditions	No change
19.3	Operation, Maintenance, Inspection, and Testing Conducted in Accordance with Approved Procedures	Editorial changes only

Report Sections		Changes
19.4	Procedures for Responding to Anticipated Operational Occurrences (AOO) and Accidents and the Ultimate Response Guidelines (URG)	Renamed as Procedures for Responding to Anticipated Operational Occurrences (AOO) and Specific Major Accident Strategy Guidelines (SMI) Editorial changes
19.4.1	Emergency Operating Procedures (EOPs)	No change
19.4.2	Ultimate Response Guidelines (URG)	Renamed as Specific Major Accident Strategy Guidelines (SMI) Editorial changes
19.5	Engineering and Technical Support	No change
19.6	Reporting of Incidents Significant to Safety	No change
19.6.1	Regulatory Requirements for Reporting Incidents	Editorial changes only
19.6.2	Restart of a Nuclear Power Unit after Scram	Editorial changes only
19.6.3	Evaluation of the Abnormal Occurrence and Equipment Malfunctions of the Nuclear Power Plant	Updated to discuss current status and activities conducted in the last 3 years
19.7	Penalty for Violations of Regulatory Requirements	Updated to discuss current status and activities conducted in the last 3 years
19.7.1	Violations by the Nuclear Facilities	Updated to discuss current status and activities conducted in the last 3 years
19.7.2	Violations by the Reactor Operators	Updated to discuss current status and activities conducted in the last 3 years
19.8	Operating Experience Feedback	Editorial changes only
19.8.1	Regulatory Information Study and International Operating Experience Collections	No change
19.8.2	Establishment of a System for the Feedback of Operating and Maintenance Experiences	No change
19.8.3	Lessons Learned from Domestic and International Operating Experiences and or Incidents	Editorial changes only
19.8.4	Lessons Learned from Emergency Drills Exercise	Deleted

Report Sections		Changes
19.9	Radioactive Waste Management	Updated to discuss current status and activities conducted in the last 3 years
19.9.1	Low Level Waste Management	Updated to discuss current status and activities conducted in the last 3 years
19.9.1.1	Low Level Waste Treatment and Storage	Merged into Section 19.1.1
19.9.1.2	Low Level Waste Final Disposal	Merged into Section 19.1.1
19.9.2	Spent Nuclear Fuel Management	Editorial changes only
19.9.2.1	Onsite Dry Storage of Spent Nuclear Fuel	Merged into Section 19.1.2
19.9.2.2	Final Disposal of Spent Nuclear Fuel	Merged into Section 19.1.1
19.10	Transparency of Nuclear Information	Deleted
APPENDIX A ACRONYMS		
APPENDIX B CONTRIBUTORS TO THE ROC'S NATIONAL REPORT		
ANNEX 1 REGULATORY REQUIREMENTS ORDERS IN THE AFTERMATH OF FUKUSHIMA DAIICHI NUCLEAR ACCIDENT		
A.	Regulatory Orders Issued on November 5, 2012	No change
B.	Regulatory Orders Issued on June 6, 2013	No change
C.	Regulatory Orders Issued on March 6, 2014	Editorial changes only

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ARTICLE 6. EXISTING NUCLEAR INSTALLATIONS

Each Contracting Party shall take the appropriate steps to ensure that the safety of nuclear installations existing at the time the Convention enters into force for that Contracting Party is reviewed as soon as possible. When necessary in the context of this Convention, the Contracting Party shall ensure that all reasonably practicable improvements are made as a matter of urgency to upgrade the safety of the nuclear installation. If such upgrading cannot be achieved, plans should be implemented to shut down the nuclear installation as soon as practically possible. The timing of the shut-down may take into account the whole energy context and possible alternatives as well as the social, environmental and economic impact.

6.1 Nuclear Power Plants in Taiwan

Taiwan has three land-based civil nuclear power plants (NPPs), named “First NPP,” “Second NPP,” and “Third NPP;” or “Chinshan (CS),” “Kuosheng (KS),” and “Maanshan (MS)” based on the place names. Each NPP has two identical nuclear power units. The Unit 1 of Chinshan NPP was shut down on December 10, 2014 during the refueling outage stage at the end of Cycle 27 (EOC 27). During the refueling stage, a water rod connecting bolt of the C1F029 fuel bundle failed. Unit 1 remained in a shutdown state until its license expired on December 5, 2018. A transmission tower in Unit 2 of Chinshan NPP that connected the main transformer to the switchyard collapsed on June 2, 2017, causing the main turbine generator of Unit 2 to trip and scram the reactor. Unit 2 halted until its license expired on July 15, 2019. Currently, both units of Chinshan NPP are in the decommissioning stage. In addition, the licenses of Unit 1 and Unit 2 of Kuosheng NPP expired on December 27, 2021 and March 14, 2023, respectively, and both units entered the decommissioning stage. The two units of Maanshan NPP are still in operation.

As of December 2022, the total installed capacity of nuclear power was 2,887 MWe from the operating NPPs, representing about 5.4 % of the total installed capacity in Taiwan’s power system which reached about 53,736 MWe. In 2022, the electricity generated from the nuclear power was about 22.9 billion kWh, which contributed about 9.1% to the total domestic supply of electricity.

6.1.1 Plant Site, Ground Elevation and Tsunami Runup

Chinshan and Kuosheng NPPs are located on the northern coast of Taiwan as shown in Figure 6.1. The distance between Chinshan and Kuosheng NPPs is about 12 kilometers (km), with Chinshan being northwest of Kuosheng.

The Kuosheng NPP (KSNPP) is located on the northern coast of Taiwan and faces the East China Sea. The ground elevation of the Kuosheng NPP is about 12 meters above MSL and the plant is about 500 m from the shore. According to the evaluation result of the KSNPP’s FSAR, the potential maximum tsunami run-up height was 7.78 meters. Taking into account tides and geographical landscape, the potential maximum tsunami run-up height would be 10.28 meters, which is lower than the plant ground elevation of 12 meters. Figure 6.2 shows the elevations of major facilities in the Kuosheng NPP.

The Maanshan NPP (MSNPP) is located at the southern tip of Taiwan. It is about 300 meters from the shore. The plant site elevation is about 15 meters above MSL. The maximum astronomical tidal level in Nan Wan Bay is 4.03 m CDL (Critical Datum Line). Assuming a tsunami with 5m high waves triggered by a magnitude 8.0 (Mw) earthquake, the height of the tsunami waves reaching the coast of Maanshan will be approximately 11 m. The tsunami run-up height near the plant will consequently be approximately 8 m. Taking into account a 4.03 m spring tide rise and an additional 0.5 m safety margin, the potential maximum tsunami run-up level at the plant will be 12.53 m, which is the design basis (DB) tsunami height. Compared to the ground elevation of the main building area (15 m above MSL), the plant will have enough safety margin against tsunami. Figure 6.3 shows the elevations of major facilities at the Maanshan NPP.

To summarize, Table 6.1 lists the plant ground elevations and the potential maximum tsunami run-up heights of the NPPs in operation in Taiwan.

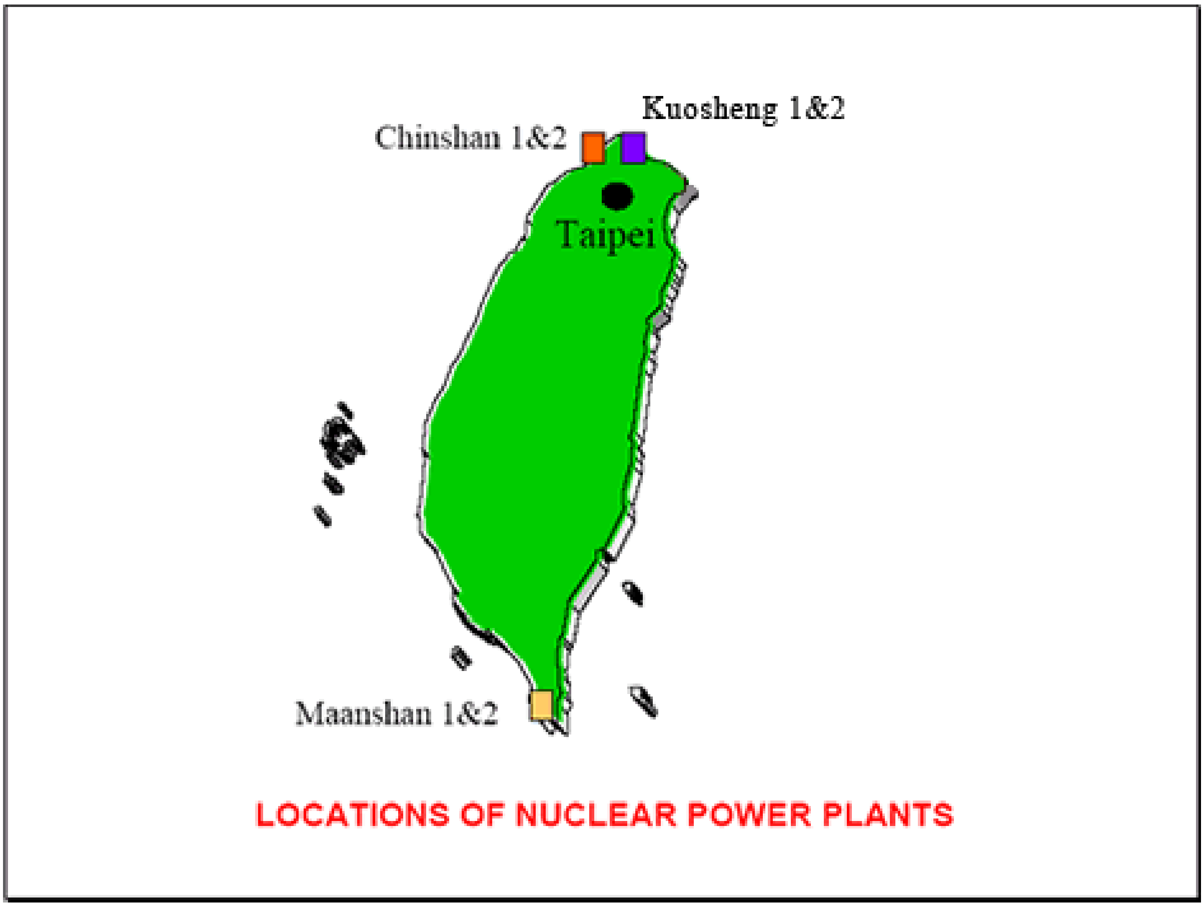


Figure 6.1 Site Locations of the NPPs in Taiwan

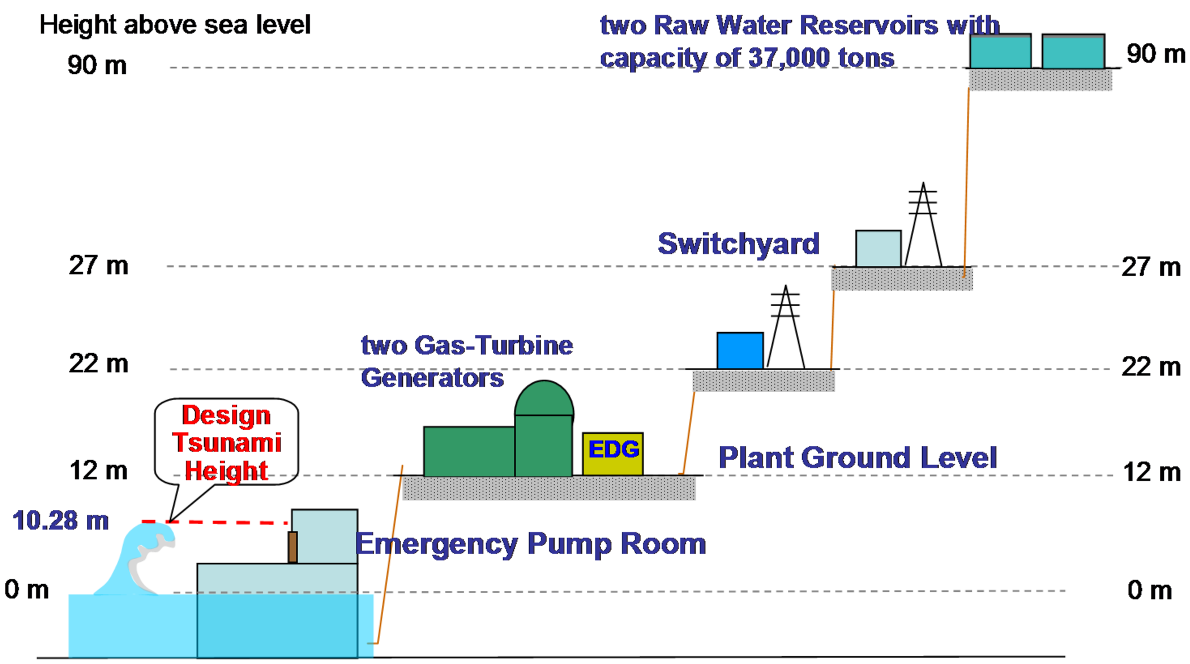


Figure 6.2 Elevations of Major Facilities in Kuosheng NPP

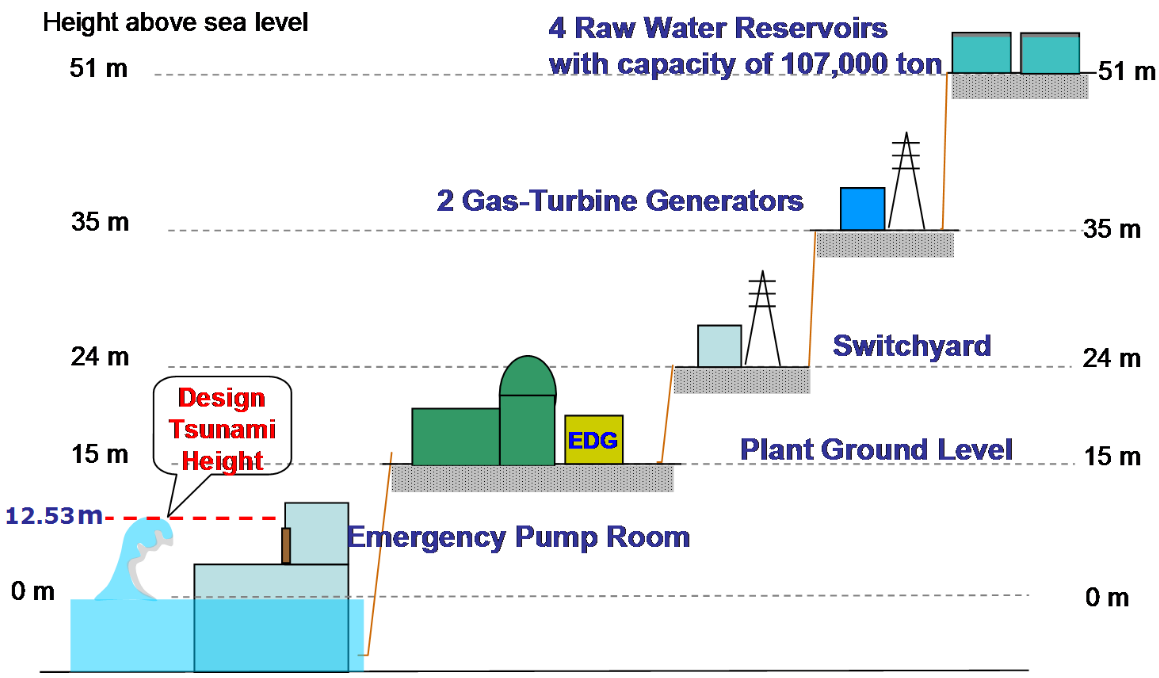


Figure 6.3 Elevations of Major Facilities in Maanshan NPP

Table 6.1 Summary of Design Basis Tsunami Heights and Plant Ground Elevations of Operating NPPs in Taiwan

Plant Name	Maanshan
Potential maximum tsunami run-up height (by FSAR)	12.53 m
Plant ground elevation	15.0 m

6.1.2 Nuclear Power Unit Characteristics

Among the NPPs in Taiwan, the Kuosheng NPP consists of two units with their reactors being of the type of BWR-6 and with Mark III containment. On the other hand, the Maanshan NPP's two units are equipped with 3-loop pressurized water reactor (PWR) with steel-lined pre-stressed post-tensioned large dry reinforced concrete containment.

The nuclear steam supply systems (NSSS) of the two BWRs of Kuosheng NPP were all designed and manufactured by the General Electric Company (GE). The vendor of all the main turbine generators (TG) for Kuosheng NPP was the Westinghouse Electric Corporation (W). On the other hand, the NSSS of the two PWRs of the Maanshan NPP were supplied by W, with GE manufacturing the main TG sets. The first nuclear power unit installed in this country was the Chinshan Unit 1, which achieved initial criticality on October 16, 1977 and started its commercial operation on December 6, 1978. Units 1 and 2 of the Kuosheng NPP achieved initial criticality on February 1, 1981 and March 26, 1982, respectively, and started their commercial operation on December 28, 1981 and March 15, 1983, respectively. As for the Maanshan NPP, Units 1 and 2 achieved initial criticality on March 30, 1984 and February 1, 1985, respectively, and started their commercial operation on July 27, 1984 and May 18, 1985, respectively.

The storage capacity of the spent fuel pool of the Kuosheng Plant is insufficient and the construction of the dry storage facility is delayed due to the run-off wastewater reduction permit required by the local government (the New Taipei City). Therefore, Taiwan Power Company transfered 8 fuel storage racks of Lungmen Plant to the Kuosheng Plant. The racks were installed in the cask loading pools of the two units of the Kuosheng Plant after the application of design change request was approved by the AEC. This would increase the capacity of 440 spent fuels in each unit. This application had undergone a two-stage review, procedural and substantial, in accordance with the Review Specification. The procedural review focused on the completeness of the analysis report submitted for review. The procedural review was completed on September 20, 2016 after the TPC provided the explanation and revision of the report. A substantial review team, which consisted of scholars and experts along with the AEC colleagues of the relevant agencies, was formed to review this case thoroughly from various safety aspects to ensure compliance with regulations. Ten review meetings had been held since September 21, 2016 and 187 review questions were addressed and solved. Finally, the review team confirmed that the TPC had provided appropriate assessments and explanations on various safety items and related operations, and the safety requirements were met. This application for the rack installation was approved by the AEC on April 6, 2017. Spent fuel storage in the cask loading pools of both Kuosheng Units was approved on May 19, 2017 and January 11, 2019, respectively. The cask loading pool will be recovered to the original installation for spent fuel cask loading when the dry storage facility is completed.

A brief summary of the design data of all the existing NPPs in Taiwan is presented in Table 6.2.

Table 6.2 Basic Data of the Nuclear Power Units in Taiwan

	Chinshan		Kuosheng		Maanshan	
	Unit 1	Unit 2	Unit 1	Unit 2	Unit 1	Unit 2
Construction License Issued Date	Dec. 15, 1971	Dec. 4, 1972	Aug. 19, 1975	Aug. 19, 1975	Apr. 1, 1978	Apr. 1, 1978
Commercial Operation Date	Dec. 6, 1978	July 16, 1979	Dec. 28, 1981	Mar. 15, 1983	July 27, 1984	May 18, 1985
Expiration Date	Dec. 5, 2018	July 15, 2019	Dec. 27, 2021	Mar. 14, 2023	July 27, 2024	May 17, 2025
Status (2023.6.30)	Decommissioning Period		Decommissioning Period		Operation	
Reactor Type (Vendor)	BWR-4 (GE)		BWR-6 (GE)		3-loop PWR (W)	
Rated Thermal Power	1,840 MWt		3,001 MWt		2,822 MWt	
Installed Electrical Power capacity	636 MWe		985 MWe		951 MWe	
TG Vendor	W		W		GE	
A/E	Ebasco		Bechtel		Bechtel	
Containment	Mark I		Mark III		Large, Dry Post-Tensioned Reinforced Concrete	
DBE: SSE OBE	0.3 g (PGA) 0.15 g (PGA)		0.4 g (PGA) 0.2 g (PGA)		0.4 g (PGA) 0.2 g (PGA)	

Note. TG ─ turbine generator; A/E ─ architect/engineer;
DBE ─ design basis earthquake; SSE ─ safe shutdown earthquake;
OBE ─ operating basis earthquake; PGA ─ peak ground acceleration.

6.1.3 Performance of the Operating NPPs

The World Association of Nuclear Operators (WANO) uses performance indicators (PI) to support the exchange of operating experience information by collecting, trending and disseminating nuclear plant performance data. These WANO PI items are the main areas that the operating NPPs aim to improve their performance. WANO PIs also appear in the colored-light control scheme of the AEC ROP, such as: Unplanned Total Scrams per 7,000 hours critical (US7), Collective Radiation Exposure, Safety System Performance Indicator (SSPI) and Liquid Radioactive Waste Management. Through the effective management of TPC and the rigorous regulation from AEC, the operating NPPs achieved outstanding performance. Figure 6.4 and 6.5 show the trends of the average annual numbers of the reportable event reports (RER) per unit and the automatic scrams per unit, respectively.

The majority of the low level waste (LLW) (or low level radioactive waste, LLRW) produced by volume in Taiwan originates from the operating NPPs. By applying the high efficiency solidification technology (HEST) developed by the Institute of Nuclear Energy Research (INER) and the plant staff's efforts, the annual generation of the solidified LLW from these NPPs significantly dropped from a peak of nearly 12,000 drums (200 liters each) in 1983 to less than 200 drums per year so far, as illustrated in Figure 6.6.

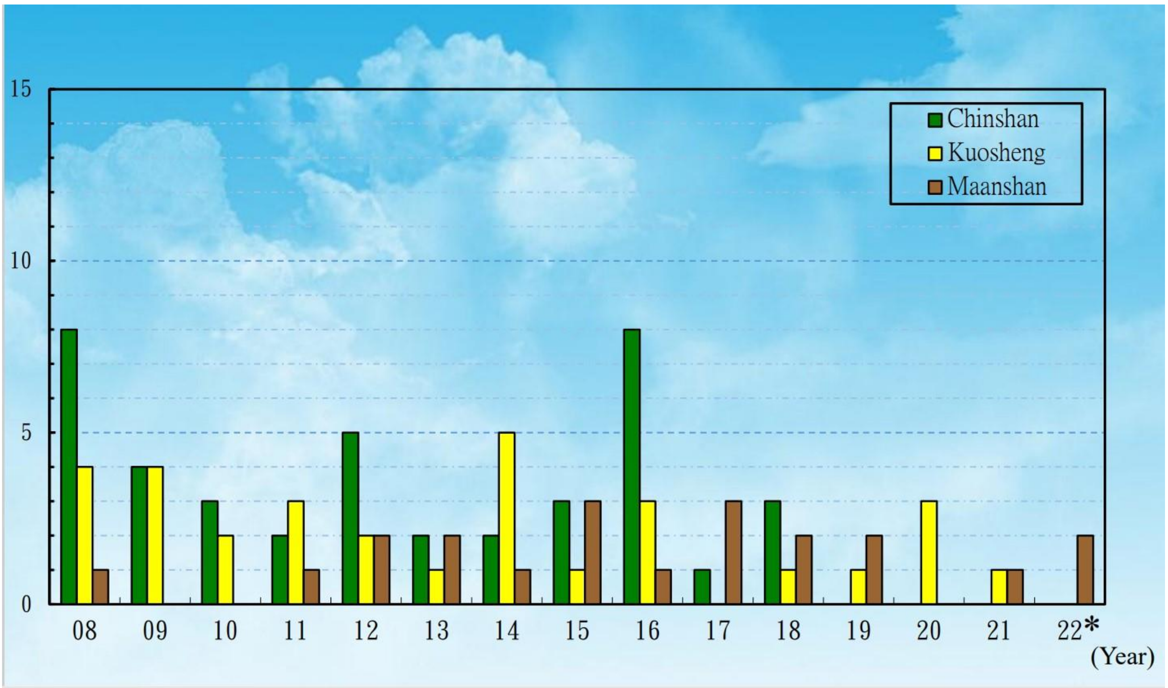


Figure 6.4 Average Annual Number of RERs per Unit for the Operating NPPs in Taiwan (Data up to the end of 2022)

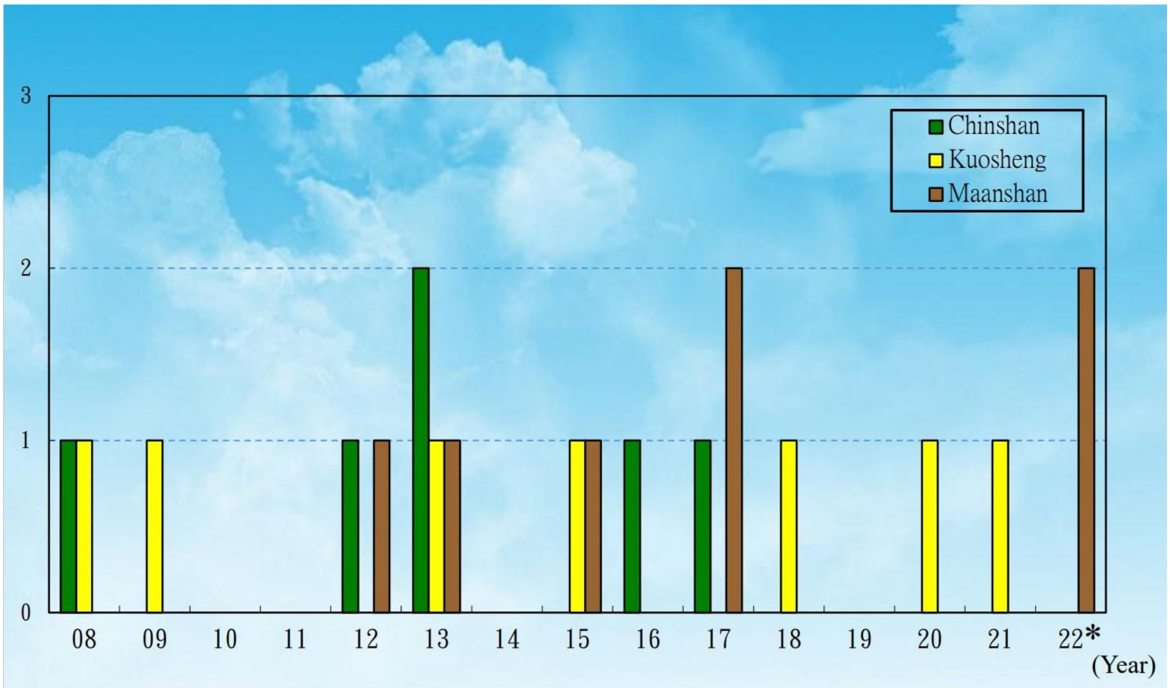
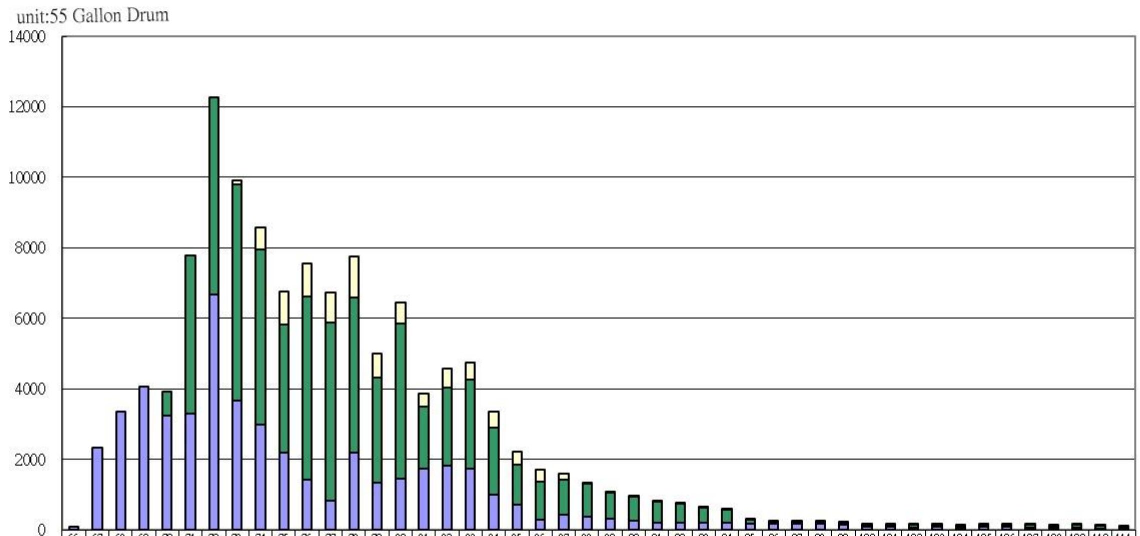


Figure 6.5 Average Annual Number of Scrams per Unit for the Operating NPPs in Taiwan (Data up to the end 2022)



	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88
Chinshan								138	607	935	919	842	1147	686	586	381	529	500	449	388	356	176	34
Kuosheng					673	4494	5576	6107	4982	3625	5204	5054	4405	2983	4391	1757	2214	2525	1904	1114	1070	983	938
Chinshan	83	2345	3365	4069	3258	3293	6682	3680	2984	2191	1425	838	2194	1349	1463	1736	1833	1731	1010	729	292	444	374

	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111
Chinshan	24	18	17	27	18	19	30	17	12	22	18	15	30	35	35	42	32	41	40	32	35	40	34
Kuosheng	741	685	582	538	446	387	107	62	61	59	68	57	58	66	51	58	58	57	74	62	72	68	61
Chinshan	316	260	219	200	200	195	190	180	180	170	148	90	90	80	90	63	85	85	75	54	65	51	40

Figure 6.6 Annual Number of Drums of Solidified LLW Generated from the NPPs in Taiwan (up to the year 2022)

6.1.4 Power Supply Sources of the NPPs

The power distribution systems of nuclear power plants in Taiwan are classified into two categories: safety-related and non-safety-related. Non-safety-related power systems provide various auxiliary load power needed for the operation of a nuclear power unit, while safety-related power systems provide power to the reactor protection system (RPS) and emergency core cooling systems (ECCS) to ensure safe shutdown of the reactor and cooling of the core. Safety-related power systems therefore must meet the requirement of the seismic category I and electrical class 1E.

When a nuclear power plant is in normal operation, the power needed can be supplied by the output of the plant itself via its auxiliary transformers. The off-site power supply system of each nuclear power plant is connected to two independent external power grids (345kV and 69kV or 161kV grids), each of which is outfitted with several transmission lines:

- KSNPP: Four 345 kV transmission lines and two 69 kV transmission lines
- MSNPP: Four 345 kV transmission lines and two 161 kV transmission lines

Each NPP has diverse emergency power sources that provide backup electric power, including emergency AC and DC power, in the event of an emergency.

Emergency AC Power Source – Water-cooled EDG System

Each reactor unit of the two NPPs in operation in Taiwan has redundant and safety-related, seismic category I qualified, water-cooled 4.16 kV EDGs that provide the onsite backup power. These EDGs are designed to automatically start-up and reach rated speed and voltage in seconds, and then their power output circuit breakers will close automatically to provide power to the essential bus in case of design basis events. For example, the water-cooled EDGs will automatically start and provide power to the RPS and Emergency Cooling Systems in the event of a loss of off-site power (LOOP) accident. Each unit of the Kuosheng and Maanshan NPPs has 2 redundant water-cooled EDGs, with Kuosheng having one extra water-cooled EDG that is used only to provide emergency power to the high pressure core spray system.

Emergency AC Power Source – Gas-cooled EDG System

Each NPP in Taiwan has one additional swing 4.16 kV EDG that is safety-related, air-cooled, and seismic category I qualified in design. Furthermore, each of the operating NPPs has another two redundant non-safety grade, non-seismically qualified, and air-cooled gas turbine generators (GTG) with black-start capability. This air-cooled swing-EDG can take over the function of the onsite backup water-cooled EDGs in supplying power to the essential safety systems in an emergency, by manually aligning to provide the emergency AC power to either one of the two units on the site. After the Fukushima accident, the related plant operating procedures were modified to make the swing EDG able to provide power for one bus of both units simultaneously under load control if required. These air-cooled EDGs could be the alternative power sources to back up the water-cooled EDGs in case of a SBO accident.

Alternative Emergency AC Power Source

Following the Fukushima Daiichi accident, each NPP has access to a variety of additional and large-scale (4.16 kV/1500 kW) mobile diesel generator (MDG) power trucks and medium-scale (480 V/500 kW or 480 V/200 kW) MDGs, which can alternatively supply the essential power in an emergency.

Emergency DC Power Source

The capacity of the battery system of each NPP unit is originally designed to be capable of providing direct current (DC) power supply for at least 8 hours in the event of loss of all AC power. After the Fukushima Daiichi accident, the pertinent plant operating procedures have been amended to ensure that the DC battery duration can last for at least 24 hours in an emergency.

In case of station blackout (SBO), the BWR-type Kuosheng NPPs can maintain sufficient reactor water level and appropriate pressure by operating the reactor core isolation cooling (RCIC) system to provide feedwater to the reactor pressure vessel (RPV) and by actuating the safety relief valves (SRVs) on the main steam lines to relieve the steam pressure. Similarly, the PWR-type Maanshan NPP can cope with SBO by injecting feedwater into the secondary side (or shell side) of the steam generators (SG) by the turbine-driven auxiliary feedwater pump and by actuating the power-operated relief valves (PORVs) on the main steam lines to relieve the steam pressure. During this period of time, it is expected that the station's normal onsite backup power supply (i.e., water-cooled EDGs) and/or the alternative backup power supplies including the air-cooled swing EDG and GTGs as well as the mobile power supplies can be set up.

To summarize, based on the defense-in-depth concept, the power supply systems of the NPPs in Taiwan have several lines of defense as follows:

- An offsite power system with two independent loops,
- Multiple water-cooled, safety-related, seismically qualified EDGs for onsite backup power,
- One air-cooled, safety-related, seismically qualified swing EDG for diverse emergency backup power,
- Two air-cooled, non-safety grade, non-seismically qualified GTG sets with black start capability for diverse emergency backup power,
- Batteries, and
- Large scale (4.16 kV/1500 kW) MDG power vehicles and medium scale (480 V/500 kW or 480 V/200 kW) MDGs for power supply to critical systems and battery recharging systems in emergency.

6.1.5 Status of Nuclear Installations in Taiwan

The operating licenses of the two units of the Chinshan NPP expired on December 5, 2018 and July 15, 2019, respectively. The operating licenses of the two units of the Kuosheng NPP expired on December 27, 2021 and March 14, 2023, respectively. Currently, these units have entered the decommissioning period. The operating licenses of the two units of the Maanshan NPP will expire on July 27, 2024 and May 17, 2025, respectively. Both units of Maanshan NPP are still in operation, and will be permanently shutdown after the operating licenses expire in accordance with the energy policy of "nuclear-free homeland" of the Government.

6.2 Major Safety Assessments

6.2.1 Licensee's Nuclear Safety Culture Program and Reporting Requirements

Based on the IAEA (1991) Report: "Safety Series No.75-INSAG-4", the TPC developed its own nuclear safety culture (SC) by emphasizing the idea of "safety first, quality top priority" and asking all its employees as well as related organizations to cultivate the right ideas and proper attitude toward nuclear safety.

The licensee of an NPP is required to submit the following reports to the AEC within the specified periods:

- Operation report — quarterly and annually,
- Radiation safety and environment monitoring reports — quarterly and annually,
- Nuclear event notification — reporting by phone within one hour after knowing an accident occurred and submitting a written report within 30 days,
- Radioactive waste production reports — monthly and annually,
- Performance indicators report resulting from the reactor oversight process — quarterly,
- Radioactive effluent release report — quarterly and annually,
- Reports on in-service inspections and tests as well as containment leakage rate test — within 90 days after each refueling outage, and
- Reports of the dose evaluation for the residents who live in the vicinity of the NPP — every 5 years,
- Implementation Reports for Chinshan and Kuosheng decommissioning — annually.

6.2.2 Regulatory Reviews, Inspections and Assessments

The inspection of the NPPs in operation is one of the most important tasks of the AEC with regard to its nuclear safety enhancement regulatory program. Regulatory inspections of an NPP during its operating period include the resident inspections, regular inspections, refueling outage inspections, expert team inspections, special team inspections and the unannounced inspections. Although both units of the Chinshan NPP and both units of the Kuosheng NPP have entered their decommissioning periods, the regulatory inspections will continue to be carried out because the spent fuel remain in their cores.

The AEC resident inspectors are assigned for each NPP perform their daily oversight and regulatory tasks on site. Occasionally, an unannounced inspection, normally at the late night hours, is performed to enhance the alertness of the plant operators. At the end of each operation cycle, when a nuclear power unit is scheduled to be shut down for refueling, inspection, maintenance, and modification of the structures, systems, and components (SSCs) to ensure a stable operation in the next cycle, it is essential for the AEC to conduct refueling outage inspections to examine the quality of all these activities carried out by the licensee and its contractors. The AEC has established stringent requirements to audit the implementation quality of these outage activities on site in order to ensure the operational safety and stability of the nuclear power unit. In addition to these regular inspections, some expert team inspections based on pre-selected topics are conducted as well. Moreover, there will also be a special team inspection whenever needed.

The "Enhanced Check for the Application of Criticality" is an on-site verification of the contents of the documents submitted by the TPC, in accordance with Article 9 of the "Regulations on the Re-start of Nuclear Reactor Facilities after Shutdown".

In line with the AEC's policy of transparency of nuclear safety information and referring to the "reactor oversight process (ROP)" of the USNRC, the AEC established a ROP system. This system consisted of two major parts: performance indicators and inspection indicators. The former reflected the performance of various safety systems of nuclear power plants, which were collected by the power plant once a quarter, and the results began to be published online from the end of 2004; The latter followed the inspection plan formulated by the AEC. During the regular on-site and taskforce inspections, the inspectors conducted on-site inspections to verify the performance indicators' statistical results and safety performance and posted the inspection findings on the website. The AEC completed this part in 2005.

The primary purpose of the AEC's ROP system is to display the performance of nuclear power plants on safety-related systems and equipment in a simple and transparent way. The system uses green, white, yellow, and red lights to indicate the level of safety concerns for each plant. Green lights indicate no safety concerns; white lights indicate minor safety concerns; yellow lights indicate moderate safety concerns; red lights indicate significant safety concerns. The AEC will also adjust the regulatory measures of each nuclear power plant based on the "colors." The system can also encourage nuclear power plants to strengthen self-management, improve the operational safety of nuclear power units, and make the most effective utilization of regulatory resources to ensure public safety.

The AEC updates the results of ROP on the official website every quarter. In addition, for NPPs entering decommissioning stage, the ROP system will be continuously carried out before the reactor is defueled. But the performance indicators and inspection program are modified to those applicable to non-defueled situations. For example, the unplanned scrams, power changes, steam-driven coolant injection system (e.g. HPCI, RCIC) availability are removed from performance indicators.

Similar to the international practice of requiring NPPs to conduct Periodic Safety Review (PSR), the licensee is required by the Regulations to conduct an integrated safety assessment (ISA) of the NPP every ten years and submit an integrated safety assessment report (ISAR) to the AEC for review, six months before the corresponding ten-year operation date is due. The contents of the ISAR are required to include at least the following areas:

- Review and assessment of the plant operation safety, the radiation safety, and the radio-active waste management over the past 10 year's operation history,
- Review and assessment of the committed betterment or reinforcement items,
- Based on the above two items, summarize the matters needing attention and

commit to improve matters and timetable in the next ten years; and

- Other items requested by the Regulatory Body as needed.

The purpose of the AEC's 10-year ISA (or PSR) requirement is to request the license holder to perform a re-assessment in accordance with the present state of art knowledge, analytical methods, and equipment (e.g. new seismic methodology and digital seismometer), and to identify potential aging problems. Some examples of important improvements resulting from the 10-year PSR are as follows:

- Each TPC's operating NPP unit has installed an automatic seismic trip system (ASTS) in order to strengthen the ability to safely shut down the reactor in case of a strong earthquake and thus enhance the public confidence in the operation of NPPs. The ASTS is designed to trip the reactor automatically under an earthquake stronger than OBE. To comply with the existing control logic of the reactor protection system (RPS) of each unit, there are 3 or 4 groups of independent channels of seismic sensors in the ASTS.

- Most cables within the drywell of the Chinshan NPP suffering from high temperature have been replaced after 1994 by DCR-785S1 of improving the high temperature of drywell from about 80℃ to about 46℃ in average. The cables of motor operated valves (MOV) in the upper area of the drywell in Kuosheng NPP have been replaced by cables able to endure higher temperature.

- Each TPC's NPP site has now two offsite power sources (either "345 kV and 69 kV" or "345 kV and 161 kV") for startup. Originally there was only one 345 kV startup transformer in each site. Due to the aging failure incident in Chinshan NPP in 2007, the TPC decided to add one more backup startup transformer in each site.

Following the Fukushima Daiichi accident, the AEC required that the 10-year ISARs or PSR reports of the operating NPPs should additionally include a dedicated chapter to discuss "lessons learned from the Fukushima Daiichi nuclear accident."

6.2.3 Regulatory Measures for Decommissioning of NPPs

The operating licenses of Chinshan Nuclear Power Plant Unit 1 and Unit 2 expired on December 5, 2018 and July 15, 2019, respectively. The licenses of the two units of Kuosheng Nuclear Power Plant also expired on December 27, 2021, and March 14, 2023, respectively. Currently, these four units have entered the decommissioning period. The decommissioning of nuclear power plants is an important issue in Taiwan. In view of this topic, the AEC has already established a regulatory system to supervise TPC to complete the decommissioning plan as scheduled and with adequate quality control, and to participate actively in the international meeting to connect the professional technology and knowledge with the world. Besides, the relevant information is published on the AEC official website to carry out information disclosure for promoting public participation.

In Taiwan, the Regulatory laws on the Decommissioning of Nuclear Power Plants comprise the "Nuclear Reactor Facilities Regulation Act", "Ionizing Radiation Protection Act", "The Nuclear Materials and Radioactive Waste Management Act", and the related regulations for environmental protection of the Environmental Impact

Assessment Act. In addition, the personnel safety in the dismantling and the decontamination of waste soils in decommissioning must be well handled in accordance with other relevant laws and regulations. Moreover, the Decommissioning Plan of NPPs must include the environmental impact assessment report, which is submitted to the authority for review to confirm the impact on environment and ecological conservation complies with the provisions of the related Acts.

According to the regulatory requirement on reviewing the decommissioning plan, a one-month procedural review will first initiate to confirm that the integrity of the documents submitted in the application meets the requirements. After the confirmation of procedural review is made, the substantial review will start. In this review stage, appropriate assessments have been conducted and all responses have to be clear and satisfactory to confirm the safety issues involved in decommissioning. A project review panel with external experts and relevant technical staff members in the authority was organized to review the decommissioning plan proposed by TPC. The overall substantial review is planned to take about three rounds with a duration of about 18 months. After completion, the results will be made and notified to TPC. The authority must verify the feasibility of the decommissioning plan and the approval of environmental impact assessment for the EPA review. Only then the Decommissioning Permit can be issued according to the regulation. As for the Chinshan Decommissioning Plan, the AEC issued a permit to TPC to decommission the Chinshan Nuclear Power Plant on July 12, 2019 (effective on July 16, 2019), and the overall planned work items will be executed over a 25-year period.

The TPC submitted the application of the Decommissioning Permit for Kuosheng NPP on December 27, 2018 and the procedural review was completed on January 21, 2019. Meanwhile, three substantial review meetings were held on April 10, 2019, September 17, 2019, and February 13, 2020, respectively. The review process was temporarily delayed by the Coronavirus pandemic (Covid-19) and was completed in October, 2020. The decommissioning environmental impact assessment was reviewed by the EPA and the review process concluded on August 10, 2022. Subsequently, the decommissioning environmental impact assessment was approved on January 7, 2023.

On July 26, 2021, the TPC applied for the decommissioning permit of the Maanshan NPP and submitted the decommissioning plan to the AEC for review. On November 15, 2021, April 12, 2022, and September 13, 2022, the first, second, and third substantive review meetings were held for the evaluation of the decommissioning plan. The joint summary meeting of the review of the decommissioning plan of the Maanshan NPP was held on February 14, 2023. The review comments of this case have been agreed upon and answered; the AEC has completed the review of the decommissioning plan of the Maanshan NPP on April 24, 2023.

The following are the decommissioning activities of Chinshan NPP:

- The dismantling plan of the on-site transmission tower between the main transformer and the switchyard

  The decommissioning permit for Chinshan NPP took effect on July 16, 2019. On July 23, 2019, the TPC submitted the dismantling plan for the on-site transmission tower between the main transformer and the switchyard. The AEC completed the review on November 13, 2019. The TPC started the on-site dismantling operation on November 20, 2019, and completed the operation on March 4, 2020.

- The dismantling plan of the equipment and building of gas turbine and the equipment of the first pumping station

On February 24, 2020, the TPC submitted the dismantling plan for the equipment and building of gas turbine and the equipment of the first pumping station of Chinshan NPP. A task force assigned from the AEC approved the submission on October 5, 2020. The TPC finalized the removal operation of ground objects for the second phase of the dry storage prospective area by the end of May 2022. The objects included the gas turbine equipment and building, the first pumping station, and the 69kV-related power towers. Subsequent preparations for the transfer of storage land will continue.

- The dismantling plan for the main turbine of Unit 2, the main generator of Unit 1 and Unit 2 and their auxiliary equipment, main/auxiliary transformers, and condensate pump.

Since May 2022, the Chinshan NPP of TPC has not yet started to dismantle. At present, even though “The dismantling plan of the main turbine of Unit 2 of the Chinshan NPP, and the main generator and its auxiliary equipment, main/auxiliary transformers, condensate pump of Unit 1 and Unit 2 of the Chinshan NPP” has been approved, the TPC has not yet completed the bidding process and the on-site preparations for the dismantling plan. As a result, there was no dismantling progress in 2022.

- Three dismantling plans for the nitrogen storage tank, hydrogen water chemistry(HWC) system, main turbine of Unit 1 and other BOP equipment of Unit 1 and Unit 2 submitted in 2022 were to be reviewed after background radiation characteristics survey.

6.2.4 International Peer Reviews

Various international expert groups have reviewed the operation of the NPPs in Taiwan on a regular basis. For example, the World Association of Nuclear Operators-Tokyo Center (WANO-TC) conducts a peer review of each nuclear power plant every four years. The reports of these reviews are extremely valuable. However, according to the agreement with WANO-TC, these reports are not allowed to be released to any third party. However, none of the expert groups has ever found any problem that was deemed serious enough to require even a temporary mandatory shutdown of any of the reactors in Taiwan.

As an example, on July 14, 2022, the WANO-TC organized a team of 15 experts who spent a total of 15 days visiting the Maanshan NPP to conduct a peer review on all eleven areas, including (1) the organization and administration, (2) operation, (3) maintenance, (4) engineering sup-port, (5) radiation protection, (6) operating experience, (7) chemistry, (8) fire protection, (9) emergency preparedness, (10) training and qualification, and (11) lessons learned from WANO Significant Operating Experience Report (SOER). The evaluation results and recommendations from these reviews were quite beneficial to the TPC.

6.3 Programs and Measures for Safety Upgrading

6.3.1 Regulatory Requirements for Changes and Modifications

Similar to that in 10 CFR 50.59, any design change or equipment modification in an NPP in Taiwan during the operating period must be approved by the regulatory body in advance before its implementation if it involves any of the following significant safety concerns:

- Change of the technical specifications,
- Resulting in more than a minimal increase in the frequency of occurrence or the consequence of an accident previously evaluated in the FSAR,
- Resulting in more than a minimal increase in either occurrence of a malfunction or the malfunction consequence of the structure, system and component (SSC) important to safety which was previously evaluated in the FSAR,
- Creating a possibility for either an accident of a different type or a malfunction of an SSC important to safety with a different result than previously evaluated in the FSAR,
- Change of the design basis limit for a fission product barrier as described in the FSAR,
- Change of the evaluation method used in establishing the design basis and safety analyses as described in the FSAR, and
- Others as required by the regulatory body.

6.3.2 Automatic Seismic Trip System

On January 17, 1995, a major earthquake with a moment magnitude of 6.9 (a Japan Meteorological Agency magnitude of 7.3) struck the Osaka-Kobe area of Japan and resulted in severe casualties and destruction. In response to the consequence of this Great Hanshin earthquake (also known as the Kobe earthquake, Osaka-Kobe earthquake or Hyogoken Nanbu earthquake) and as a neighboring nation, the AEC asked TPC on January 28, 1995 , to study the feasibility of adopting a regulation requiring an automatic reactor scram on a strong earth-quake for the operating nuclear units. On September 21, 1999 at 01:47 a.m., a devastating major earthquake(also called the Gi-Gi earthquake, Chi-Chi earthquake or 921 earthquake) with a Ritcher magnitude of 7.3 badly damaged the central areas of Taiwan. Almost immediately after this Great 921 earthquake, in order to protect the reactor from seismic damage, the AEC formally sent a request to the TPC on November 4, 1999 requiring the installation of equipment that will automatically trip the reactor on a signal of strong earthquake for all operating NPPs. The set-point of the signal to trigger the ASTS on strong earthquake is set at the design value of the operating basis earthquake (OBE) which is normally set at a value equal to half of the safe shutdown earthquake (SSE). Therefore, a protection of the nuclear power reactor from large earthquake by the ASTS was formally on-line for all operating NPPs since the end of November 2007.

6.3.3 Update of Final Safety Analysis Report

For a newly commercialized operating NPP, the first update of its final safety analysis report (FSAR) must be completed within two years after the operating license is granted. If one FSAR is shared by multiple units, the reference date will be set from the date when the last operating license is granted. The follow-up FSAR updates must be completed within six months after each fuel reload. If one FSAR is shared by multiple units, the reference date will be set from the date when the last fuel reload is completed.

Any change or modification of the FSAR mentioned above that involves the contents related to the essential safety concerns listed in Subsection 6.3.1 must be approved by the AEC.

When the operating licenses of Chinshan NPP and Kuosheng NPP expire and enter the decommissioning period, the TPC must still temporarily store the nuclear fuels in the reactor vessel before completing the installation of the dry storage facilities and making them ready for use. According to the requirements of the essential regulatory items in the review of the decommissioning plan, the TPC submitted the corresponding safety analysis report for the early transition stage before removing all the spent fuels from the reactor vessel. For Chinshan NPP, the TPC proposed the revision of the “Pre-Defuel Safety Analysis Report in Decommissioning Period of Chinshan Plant” on December 1, 2017, and submitted it to the AEC for review, which approved the document on November 30, 2018. As for Kuosheng NPP, the TPC submitted the revision of the “Pre-Defuel Safety Analysis Report in Decommissioning Period of Kuosheng Plant” to the AEC for review on December 8, 2020. After review, the AEC approved the document on September 29, 2021.

6.3.4 Update of Technical Specifications

According to the Nuclear Reactor Facilities Regulation Act and its Enforcement Rules, during the operating period of a nuclear reactor facility, any design modification or equipment change that involves the modifications or revision of the technical specifications (TS) requires the prior approval by the regulatory authority before implementing the modification or change.

Ever since its installation, each of the commercial operating NPPs in Taiwan has adopted the customer TS (CTS) (Chinshan NPP) or standard TS (STS) (Kuosheng and Maanshan NPPs). In 1988, the AEC asked the Chinshan NPP to replace the CTS with the STS (NUREG-0123, Rev. 4). However, in the early 1990s, the TPC became aware of the development of the improved STS (or simply the improved TS) in the USA and initiated a project to convert the Chinshan TS to the improved TS (ITS).

The TPC eliminated some contents from ITS, such as fire-fighting equipment, Core Operating Limits Report, radiation protection and environmental monitoring operations, snubbers, equipment checklists, meteorological instruments, water chemistry, etc., and transferred them to Technical Requirement Manual or program control. The TPC displayed limiting Conditions for Operation (LCO), appropriate timing, and surveillance requirements of the equipment for related safety system equipment in a more logical and consistent format. The TPC also enhanced each LCO of the specification and the technical basis description for the surveillance requirements. By clarifying the purpose and basis of each specification of the regulation, the TPC will be able to understand the content of the regulation and implement it correctly according to the regulations, and further improve the operation safety of the power plant.

During the course of the above-mentioned TS conversion, the AEC agreed to the TPC's proposal to convert the CTS of Chinshan NPP directly to the ITS based on "NUREG-1433 Revision 0" in 1992, which was later updated to be "NUREG-1433 Revision 1" in 1995. Finally, on February 26, 2002, after the scheduled outage of the 18th end of cycle (EOC-18) of Unit-2, the ITS was implemented in the Chinshan NPP.

Both the TPC and the AEC spent a lot of time and energy on these TS conversion project-related affairs. In converting the TS, dozens of programs and hundreds of procedures were reviewed and revised. The entire operating crew of the Chinshan NPP underwent several rounds of training.

The Chinshan NPP is the first NPP to be erected in Taiwan and operated adhering to its CTS for about 24 years. Then, on Feb. 26, 2002, the Chinshan NPP converted its customer TS into the improved technical specifications. At the time when the Chinshan NPP adopted the ITS, unit 1 of the plant was in normal operation, while the unit 2 was shut down for refueling outage. Although the conversion process was very demanding, the outcome of the implementation of the ITS was very rewarding. Therefore, the standard TSs for both the Maanshan and the Kuosheng NPP were also converted into the ITS in September 2004 and January 2008, respectively.

When the operating licenses of Chinshan and Kuosheng NPPs expire and enter the decommissioning period, the TPC must still temporarily store the nuclear fuels in the reactor vessel before completing building the dry storage facilities and making them ready for use. TPC submitted corresponding technical specifications for the early transition stage prior to removing all the spent fuel from the reactor vessel, in accordance with the essential regulatory requirements identified in the review of the decommissioning plan. As a result, these technical specifications formed the basis for maintaining the availability of fuel safety-related system equipment and related testing requirements. For Chinshan NPP, the TPC proposed the "Pre-Defuel Technical Specifications of Chinshan Plant" on December 1, 2017, and submitted it to the AEC for review, which approved the document on November 30, 2018. As for Kuosheng NPP, the TPC submitted the "Pre-Defuel Technical Specifications of Kuosheng Plant" to the AEC for review on December 8, 2020. After review, the AEC approved the document on September 29, 2021.

6.3.5 International Cooperation

The AEC participated in the USNRC's Cooperative Severe Accident Research Program (CSARP), the Exchange of Technical Information and Cooperation in Nuclear Regulatory and Safety Research Matters, the Thermal-Hydraulic Code Applications and Maintenance Research (CAMP), and the RAdiation protection code analysis and Maintenance Program (RAMP), as well as the OECD/NEA's Cooperative Program on Decommissioning (CPD) and the Component Operational Experience, Degradation and Ageing Program (CODAP). A Memorandum of Understanding (MOU) on Nuclear Cooperation between the AEC and the State Office for Nuclear Safety (SÚJB) of the Czech Republic was also signed.

After the Fukushima Daiichi accident, countries around the world that are involved in nuclear power have boosted nuclear safety measures and emphasized the necessity of international cooperation and information sharing. A Memorandum of Understanding between the Association of East Asian Relations of Taiwan and the Interchange Association of Japan for the Mutual Cooperation in the Field of Nuclear and Radiation Safety Regulation in the Peaceful Use of Nuclear Energy was signed on

November 20, 2014, to facilitate this goal. Through the first AEC-NRA Nuclear Regulatory Information Exchange Meeting held in July, 2015 in Japan, the AEC and the Nuclear Regulation Authority (NRA) communicated face to face, shared their nuclear regulatory experiences and discussed the items and issues for future collaboration. Both sides signed a Modification to the Memorandum on September 21, 2017 to establish a notification mechanism for nuclear emergencies and incidents, which marked a step towards nuclear energy information exchange between these two countries.

"The Agreement for Cooperation between the Government of the Republic of China and the Government of the United States of America Concerning Civil Uses of Atomic Energy" has always been an important foundation of mutual nuclear energy cooperation and exchanges between Taiwan and the US. The original agreement expired on June 22, 2014. After years of constructive communication and negotiation on the contents of a new agreement, a new "Agreement for Cooperation between the American Institute in Taiwan (AIT) and the Taipei Economic and Cultural Representative Office in the United States (TECRO) Concerning Peaceful Uses of Nuclear Energy" was signed on December 20, 2013 in Washington D. C., United States, by authorized representatives from both sides and entered into force on June 22, 2014. Other international agreements by the AEC include:

- Agreement between AEC and NRC for the exchange of technical information and cooperation in nuclear safety matters

  This agreement represents the AEC and the USNRC acting on behalf of TECRO and AIT respectively, who have a mutual interest in a continuing exchange of information pertaining to regulatory matters and the standards required or recommended by their designated representatives for the following areas: regulation of safety and security for nuclear facilities and radioactive materials, the implementation of safeguards, emergency preparedness, radiation protection, the environmental impact of nuclear facilities and radioactive materials, and nuclear safety research programs.

- Statement of intent (SOI) regarding nuclear and radiological incident response and emergency management capabilities

  This SOI represents the AEC and the Department of Energy of the United States of America (DOE) acting on behalf of TECRO and AIT, respectively. Both sides are acknowledging their commitment to combating nuclear/radiological terrorism and promoting international nuclear and environmental safety and security. They are also recognizing the common goal held by the participants to enhance emergency management capacities as essential to an effective worldwide nuclear and radiological incident response and emergency management program; the importance of the principles set out in the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency of September 26, 1986 (the Assistance Convention), and the Convention on Early Notification of a Nuclear Accident of September 26, 1986 (the Early Notification Convention); and the current threat of a nuclear and/or radiological incident and that advanced measures are required to coordinate timely and effective worldwide assistance to respond to and mitigate its effects.

- Framework cooperation agreement between Taiwan and France in the field of radiation protection and nuclear safety

The parties to this Agreement are the AEC and the French Institute for Radiation Protection and Nuclear Safety (ISRN). The areas of cooperation covered by this Agreement may include the following:(a) Fuel Cycle, radioactive waste management, and spent fuel storage and disposal; (b) Decommissioning of nuclear facilities; (c) Nuclear emergency preparedness and response; (d) Notification of severe nuclear accidents and assistance in the event of nuclear accident at all types of nuclear facilities; (e) Nuclear science and nuclear safety; (f) Research infrastructure; (g) Radiation protection and environmental radiation monitoring.

- Agreement between the International Atomic Energy Agency, the government of the Republic of China and the government of the United States of America for the application of safeguards

WHEREAS the Government of the United States of America and the Government of the Republic of China have agreed to continue cooperating on the civil uses of atomic energy under their Agreement for Cooperation of 18 July 1955, which requires that equipment, devices and materials made available to the Republic of China by the United States of America be used solely for peaceful purposes and establishes a system of safeguards to that end; WHEREAS the Agreement for Cooperation reflects the mutual recognition of the two Governments of the desirability of arranging for the Agency to administer safeguards as soon as practicable; WHEREAS the Agency is, pursuant to its Statute and the action of its Board of Governors, now in a position to apply safeguards in accordance with the Agency's Safeguards Document and Inspectors Document; WHEREAS the two Governments have reaffirmed their desire that equipment, devices and materials supplied by the United States of America under the Agreement for Cooperation or produced by their use or otherwise subject to safeguards under that Agreement shall not be used for any military purpose and have requested the Agency to apply safeguards to such materials, equipment and facilities as are covered by this Agreement.

- PROTOCOL ADDITIONAL TO THE AGREEMENT(S) BETWEEN TAIWAN AND THE INTERNATIONAL ATOMIC ENERGY AGENCY FOR THE APPLICATION OF SAFEGUARDS

Since Taiwan is not a member state of the IAEA, it was unable to sign this protocol additional to the agreement. However, on September 14, 1998, Taiwan completed the process of adopting the provisions and obligations of the protocol additional to the agreement by exchanging letters with the IAEA. The contents of this protocol include:

(a) The country concerned is required to report the complete movement path, storage location, and related information of its nuclear fuel cycle (from the source to the final nuclear waste process), including information on all buildings at the site, and the inspectors of the IAEA have the right to enter the building to inspect.

(b) If there is research and development information related to the nuclear fuel cycle, the country concerned is required to report it to the IAEA.

(c) The country concerned shall report the location and information of the manufacture and export of sensitive nuclear energy technologies.

(d) The IAEA reserves the right to collect environmental samples at any location that it deems relevant, regardless of whether the country concerned has reported it or not.

(e) The country concerned shall grant one-year multiple-entry visas to the inspectors of the IAEA.

(f) The IAEA has the right to access and utilize any international communication systems, including satellite systems and other forms of remote communication.

Since 1984, the TECRO-AIT Joint Standing Committee meeting on civil nuclear cooperation has been a regular annual event that alternates between Taiwan and the USA. The meeting consists of four groups that cover various aspects of nuclear issues, such as: (1) reactor regulation and regulatory research, (2) waste management and environmental restoration, (3) nuclear science, technology, security, and safeguards and (4) emergency management. This meeting provides an excellent opportunity for Taiwan to exchange and learn from the USA's experience on nuclear regulations and operations.

Moreover, in order to improve the technology of domestic emergency response readiness and strengthen the knowledge and ability of the staffs involved in the response team, the AEC actively cooperates with relevant international organizations and neighboring countries. It has conducted regular communication tests between the AEC and the headquarters of the IAEA, the USNRC, and the USDOE/NNSA (National Nuclear Security Administration) for several years.

The TPC has established good rapports with many international organizations. The TPC remains a member of the World Association of Nuclear Operators (WANO) to date. Based on the agreement between the TPC and the aforementioned organizations, the TPC participates in several mutual cooperation programs every year, including but not limited to the following:

- Sharing operating experience and good practice information among members,
- Joining in-plant, corporate and pre-startup peer reviews,
- Member support missions (MSM) and exchange visits, and
- Gaining professional and technical development by attending workshops, seminars, leadership courses and expert meetings.

Nuclear energy technology and its applications have gained widespread recognition from the international community. In the nuclear energy field, international cooperation in safety regulations and research and development has increased to enhance the safety of nuclear energy-related activities.

The AEC has actively participated in several collaborative events and training seminars sponsored by the OECD/Nuclear Energy Agency and the IAEA on reactor safety, decommissioning and decontamination, environmental monitoring, and nuclear safeguards, and will continue to seek opportunities for further cooperation. Regarding international nuclear safeguards oversight, the IAEA adheres to the spirit of the United Nations "Treaty on the Non-Proliferation of Nuclear Weapons" and the IAEA Additional Protocol to conduct nuclear safeguards oversight in Taiwan.

The Nuclear Energy Society, Taipei (NEST) represents societies and associations related to the nuclear energy and radiation fields. It is the main channel for Taiwan to communicate with the international nuclear energy community on nuclear safety enhancement. NEST has been an influential member of the Pacific Nuclear Energy Council (PNC) and the International Nuclear Societies Council (INSC) since 1990 and, in 1992, successfully hosted the Eighth Pacific Basin Nuclear Energy Conference (PBNC). NEST consistently sends representatives to the biennial PBNC.

6.3.6 Probabilistic Risk Assessment (PRA) and Risk-Informed Application

The development and application of the probabilistic risk assessment (PRA) technology in Taiwan can be divided into three phases. The first phase started in 1982, when the AEC launched a PRA program for the domestic NPPs. Moreover, in 1985, the AEC accomplished the establishment of the PRA analysis model for the Kuosheng NPP. Furthermore, in 1987, the AEC finalized the establishment of the PRA analysis model of the Maanshan NPP. The objectives were to identify the possible core melt scenarios and their associated frequencies caused by the internal events as well as the external events, including earthquakes, typhoons, internal fires and internal floods.

Since the 1990's, the increasingly competitive power generation market has demanded broader initiatives for reducing operation and maintenance (O&M) costs while maintaining plant safety. It is believed that the so-called "risk informed" approach is appropriate to be used to achieve this goal without impairing the safety. The second phase of domestic PRA technology development has been dedicated to the application of risk-informed technology in the O&M of NPPs. In this phase, for example, a project entitled "Establishment and Application of TPC Integrated Risk Monitor (TIRM)" was conducted mainly by the INER and sponsored by the TPC to develop an integral risk management system based on the plant specific living PRA models.

In the third phase, the PRA models of nuclear power plants in Taiwan have been verified by the peer review process to comply with the standards of American Society of Mechanical Engineers (ASME) and are regularly updated to reflect changes in plant design (including improvements after the Fukushima accident). In 2008, the "MIRU" software (Maintenance Integrated Risk Utilities), developed by TPC and INER using the risk-informed concept, was implemented in all of the NPPs in Taiwan for maintenance scheduling and associated risk assessment. Currently, the MIRU program is still in use at Kuosheng and Maanshan NPPs. Prior to conducting the maintenance actions including the surveillance tests, post-maintenance tests, corrective actions and preventive maintenance, the risk imposed by this maintenance practice is assessed and controlled for the SSCs which are judged as important to safety by the risk-informed evaluation.

6.3.7 Corrective Action Program

In both TPC's Kuosheng and Maanshan NPP, there is a corrective action program (CAP) of the plant itself. This CAP program integrates all the mechanisms for resolving various problems of the plant into a system to carry out the tasks of problem identification, classification, correction, follow-up, and analysis, as well as resource integration. The purpose of the integrated CAP system is to enhance and improve the analyses of root cause and common-cause,problem trending, and the evaluation of the effectiveness of the corrective actions and the plant performance.

Each operating NPP regularly holds a review meeting of the CAP to review the deteriorating trend of the plant's SSCs and identify the weakness of plant system. In the meantime, the NPP reports to the nuclear managers of superior levels via the "safety culture implementation meeting" held quarterly by the Department of Nuclear Generation (DONG) in the TPC Headquarters to review the weakness of the nuclear systems. At the end of 2016, TPC's staff visited the Oyster Creek NPP for benchmarking and learned about the overall classification and implementation of the US CAP. In 2017, TPC began developing the CAP Manager management system. The director of the simulation center is assigned as the CAP manager. A CAP supervision team is then formed to improve the effectiveness of the CAP Information System Database and to conduct the Station Ownership Committee (SOC) and Management Review Committee (MRC) meetings. In these meetings, plant weaknesses and recurring occurrences are reviewed on a regular basis. CAP supervision team members also develop corrective actions and track the improvements of plant performance.

6.3.8 Research and Development Programs in Nuclear Safety

The Institute of Nuclear Energy Research (INER), established in 1968, is the national R&D institute dedicated to atomic energy technologies. The research and development fields are broadly divided into (1) nuclear safety and nuclear back-end; (2) people's livelihood radiation application; (3) green energy and system integration. INER is committed to innovative research and development. With the existing system integration capabilities, it has accumulated considerable marketable technologies and patents. Through the promotional activities, including technology transfer, technical services, and cooperative development, the INER has assisted domestic enterprises in product development, innovative process and system improvements to achieve excellent results.

In terms of nuclear safety and nuclear back-end development, INER is not only committed to conducting research on the operation safety of nuclear energy facilities, but also to developing the technology of nuclear facilities decommissioning, radioactive waste treatment/disposal to achieve good performance in the operation, decommissioning, and waste management of nuclear facilities. INER has recently successfully developed a large-scale, low-cost and low-radioactive waste container and transferred the related technology to domestic manufacturers, and it is expected to be promoted and applied in the decommissioning work of domestic nuclear power plants in the future. Moreover, with the completion of the first domestic report that focuses on the preliminary safety demonstration of the high-level radioactive waste disposal, INER has joined the world's pioneers in the disposal technology. In light of the Fukushima Nuclear Accident, INER has also completed the localization of the assessment technology for the earthquake resistance of nuclear power plants, which effectively improves the reliability of the safety system of nuclear power plants.

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In terms of green energy and system integration, INER has not only achieved productive outcomes in energy creation, energy storage, energy saving and system integration, but also actively promoted these achievements to industrial applications. In 2021, 9 technologies were transferred to private manufacturers, including "Arc Plasma Specialized System Coating Large-area Tungsten Trioxide Thin Film Technology" and "All-solid-state Lithium Batteries", and the total contract value exceeded NTD 50 million (USD 1.6 million). In cooperation with the Executive Yuan's "Smart Grid Master Plan", INER also actively participates in the forward-looking infrastructure project to accelerate the domestic development of smart power distribution, power generation, power grid management and other fields, and incorporates technologies related to net zero carbon emissions into the development plan to contribute more to the government's efforts in carbon reduction.

In order to showcase and disseminate the R&D achievements, INER actively participates in global patent innovation expo and major prize-winning event both at home and abroad. Among them, the patented technology "Intelligent Distribution Network Management System" won the "2021 R&D 100 Awards", which is known as the Oscar of the global technology industry. At the Taiwan Innotech Expo held in September 2021, 2 patented technologies of INER won the platinum award representing the highest honor, 3 gold medals, 2 silver medals and 3 bronze medals. The winning rate is about 77% which is much higher than the average winning rate (58%) of the event.

In the future, INER will be transformed into a Non-Departmental Public Bodies in order to be in line with the ongoing organizational transformation of the Executive Yuan. In response to the process of incorporation, INER will also focus on the management strategy. Envisioning the future development of nuclear energy safety, radiation protection, nuclear back-end technology, and the use of nuclear energy for human welfare, and 2050 net-zero emissions, INER will take steady steps to face various challenges, embrace a new future, realize a low-carbon society and improve people's well-being. INER aims to become an applied research and development organization that aligns itself with the world.

6.3.9 Response measures to COVID-19

The AEC's response measures to COVID-19

The infection of COVID-19 could lead to the closure of office spaces or isolation of AEC staff and adversely affect the regular operation and the maintenance of staffing. To prevent AEC staff members from contracting "Severe Special Infectious Pneumonia" (hereinafter referred to as COVID-19), The AEC established "the Epidemic Response Measures to Severe Special Infectious Pneumonia (COVID-19) (hereinafter referred to as the Epidemic Response Measures)" on January 30, 2020. In addition, the minister of the AEC established an epidemic response team to coordinate the AEC's decisions of epidemic prevention; the deputy minister of the AEC established a taskforce to strengthen epidemic prevention and to supervise and implement various epidemic prevention operations. The aforementioned two groups meet regularly (every 1-2 weeks) to discuss, understand and enhance the various epidemic prevention actions of the AEC. In addition, in order to ensure the continuous operation of the core functions of various radiation workplaces and nuclear disaster response operations in Taiwan, the following paragraphs describe the epidemic prevention measures in terms of nuclear safety, radiation protection, the operation of the Nuclear Safety Supervision Center, and nuclear safety exercises.

- Regarding the Nuclear safety: In consideration of the outbreak of COVID-19, to avoid the impact on the stable operation of nuclear power plants and nuclear safety, the AEC requested the TPC to urge all its nuclear power plants to implement adequate prevention and contingency plans as soon as possible, depending on the development of the epidemic. The AEC successively sent letters to request the TPC to implement various epidemic prevention measures and communicate them effectively. Based on the "Strengthening Epidemic Prevention Management Measures of Nuclear Power Plants" and "Strengthening Epidemic Prevention Management Measures During the Out-age of Kuosheng NPP," the TPC has implemented measures, including establishing a response team to prevent the spread of the COVID-19 epidemic, establishing an epidemic notification system, and ensuring the hygiene and safety of the control room, developing response measures for the quarantined on-duty personnel, and strengthening measures during the outage period. The AEC also verified implementing various epidemic prevention measures via on-site inspections.

- Regarding the nuclear safety oversight: The "Precautions for On-duty Personnel of the Nuclear Safety Duty Center in Response to COVID 19" has been formulated to ensure the health of the on-duty personnel and the safety of the Nuclear Safety Supervision Center. A backup site of the Nuclear Safety Supervision Center has been established at the Institute of Nuclear Energy Research, and regular tests are performed to ensure the normal operation of nuclear safety oversight and incident notification.

- Regarding the nuclear safety exercise: the AEC will continue to monitor the development of the epidemic closely. If the exercise (held in August and September each year) is still affected by the epidemic, the AEC will implement a backup plan to adjust the exercise scale accordingly, make flexible arrangements, and prioritize the disaster management exercise of the public sector. In accordance with the instructions from the Central Epidemic Command Center (CECC), the AEC will carry out various epidemic prevention measures effectively and complete the relevant nuclear accident response preparations comprehensively, following the principle of "epidemic prevention is the priority, and conducting the exercise rigorously."

The AEC reviews and revises the measures according to the development of the epidemic on a rolling basis. The execution of Epidemic Response Measures were eased gradually and lifted in mid 2023 as the situation of pandemic was subsiding.

The TPC's response measures to COVID-19

In response to the raging and substantial spread of the COVID-19 pandemic around the world, the TPC has formulated the "Epidemic Prevention Management Measures for Nuclear Power Plant", requiring nuclear power plants to strengthen the management of visitors, and must comply with the TPC's "Epidemic Prevention Management Measures for Nuclear Power Plant" management measures:

- Before entering the power plant, the visitors need to fill in the health declaration and contact history questionnaire to confirm that the visitors have no abnormality and have not accessed the travel warning area announced by the CDC in the past 14 days.
- Establishing lists of incoming personnel, including names and contact numbers, and keeping them for half a year.
- Take the visitors' body temperature at the main entrance and record the body temperature on the visitor list. If a body temperature (forehead temperature) $\geq 37.5^{\circ}C$ or the visitors appear suspected symptoms of infectious diseases announced by the CDC, entering into the NPP is prohibited.
- Use alcohol-based hand sanitizer at the main entrance to clean visitors' hands.
- Follow social distancing requirements after entering the NPP.
- Non-essential visitors are prohibited from entering the NPP.

In addition, the entry of foreign visitors (such as technical workers/technicians, contractors, etc.) into the NPP is also included in the "Epidemic Prevention Management Measures for Nuclear Power Plant" for enhanced management:

- The strengthened epidemic prevention and management measures for the foreign visitors entering NPP include:

(1) Establish a single contact point in the NPP.

(2) When personnel enter the NPP for whole-body counting or training, they must be placed under the control of dividing spaces and separating routes.

(3) Plan fixed moving paths for personnel.

(4) Set up separated office spaces.

(5) The office spaces are disinfected every week.

(6) Access to non-work-related places is prohibited.

(7) When contacting other personnel in the NPP, both parties must wear masks at all times.

(8) After the group activities (such as meetings, seminars, and training), the NPP personnel should disinfect meeting places (such as meeting rooms and classrooms).

(9) Self-health management is required (taking body temperature every day, wearing a mask, washing hands/sanitizing hands frequently, maintaining social distance, avoiding groups, complying with epidemic prevention measures, etc.).

- If foreign visitors confirm diagnosis within 21 days after leaving the NPP, who must take the initiative to notify the contact person of the NPP.

- If foreign visitors confirm the diagnosis, the NPP personnel should activate the follow-up process under Appendix 1, “The response measures for suspected symptoms or confirmed cases in Nuclear Power Plant” of “Epidemic Prevention Management Measures for Nuclear Power Plant.” The process includes notification, establishing a response team, epidemic investigation, site disinfection, etc.

The TPC will continue to require the NPPs to implement epidemic prevention measures and self-health management to prevent the epidemic from affecting the normal operation of NPPs.

ARTICLE 7. LEGISLATIVE AND REGULATORY FRAMEWORK

(1)Each Contracting Party shall establish and maintain a legislative and regulatory framework to govern the safety of nuclear installations.

(2)The legislative and regulatory framework shall provide for:

- **(i) the establishment of applicable national safety requirements and regulations;**
- **(ii) a system of licensing with regard to nuclear installations and the prohibition of the operation of a nuclear installation without a license;**
- **(iii) a system of regulatory inspection and assessment of nuclear installations to ascertain compliance with applicable regulations and the terms of licenses;**
- **(iv) the enforcement of applicable regulations and of the terms of licenses, including suspension, modification or revocation.**

7.1 Legislative and Regulatory Framework in the Republic of China (Taiwan)

The Atomic Energy Act is the fundamental law that provides the legislative and regulatory framework for the utilization of nuclear energy in the Republic of China (Taiwan). This Act was passed by the Legislative Yuan, which is the national parliaments, and signed by the President in 1968, with a subsequent modification in 1971. The objectives of the Atomic Energy Act are to promote the research and development (R&D) of the atomic energy science and technology, and also the resource development and peaceful utilization of the atomic energy. Article 3 of the Atomic Energy Act stipulates that the "Responsible Agency" for the Act shall be the Atomic Energy Council (AEC). The AEC of the Republic of China (Taiwan) was founded in 1955 at the ministerial level of the Executive Yuan, which is the Cabinet of this country. The principal mission of the AEC is described in Article 8 of this report.

To ensure the adherence to the principle of “administration by law,” the Act of the Administrative Procedure was put into effect in 1999 in order to enhance the protection of human rights in the course of litigation and to improve the administrative efficiency. Accordingly, previous governmental regulations without approval or authorization by the Legislative Yuan would lose their legality after a buffer period of 2 years. In response to the promulgation of the Act of the Administrative Procedure, many major modifications of the Atomic Energy Act as well as related regulations and guidelines have been proposed, approved by the Legislative Yuan if necessary, and then implemented.

The related draft Acts and Laws prepared by AEC were submitted to Executive Yuan for review first, and then sent to Legislative Yuan for deliberation. The Education and Culture Committee of the Legislative Yuan is responsible for the bills of AEC, and thus the AEC will provide a detailed description of the proposed draft Acts and Laws to the committee members. After necessary modifications are made and the draft Acts and Laws are approved by the committee, the formal approval of the Acts and Laws will be made in the Legislative Yuan’s Conference. The new Acts and Laws will be promulgated by the President and then become effective. As the Regulations are authorized by the related Acts and Laws, the AEC may prepare or modify the Regulations based on actual regulatory requirements. The Regulations will be reviewed by the Advisory Committee on Nuclear Legislation (or Legal Affairs Committee) and go through the AEC's internal approval procedure for their promulgation.

In the following sections, the existing statutes, regulations and requirements will be presented. Selected contents of these new laws will be provided as additional information.

7.2 Nuclear Regulatory Laws, Regulations and Requirements

This section presents the seven fundamental laws for the regulation of activities related to nuclear energy and radiations, the Enforcement Rules associated with these laws, and the relevant regulations.

7.2.1 Fundamental Laws

The seven fundamental laws for nuclear regulation in this country are the Atomic Energy Act, the Nuclear Reactor Facilities Regulation Act, the Ionizing Radiation Protection Act, the Nuclear Emergency Response Act, the Nuclear Materials and Radioactive Waste Management Act, the Nuclear Damage Compensation Law, and the Act on Sites for Establishment of Low Level Radioactive Waste Final Disposal Facility. The Atomic Energy Act was passed by the Legislative Yuan and subsequently promulgated by the President in 1968 and amended in 1971, while the Nuclear Damage Compensation Law was initially promulgated in 1971 and amended twice in 1977 and 1997 respectively. The remaining Laws, except for the Act on Sites for Establishment of Low Level Radioactive Waste Final Disposal Facility which was promulgated in 2006, were all promulgated during the period of 2002 to 2003.

(1) Atomic Energy Act

The regulations on nuclear installations are governed by the Atomic Energy Act. This Act consists of 34 articles, which are grouped into 9 chapters as follows:

- General Principles,
- Responsible Agency for the Atomic Energy,
- Research and Development of the Atomic Energy Science and Technology,
- Development and Utilization of the Atomic Energy Resources,
- Regulatory Control of Nuclear Materials, Fuels, and Reactors,
- Radiation Protection,
- Encouragement, Patent and Compensation,
- Penal Provisions, and
- Supplementary Provisions.

(2) Nuclear Reactor Facilities Regulation Act

The Nuclear Reactor Facilities Regulation Act, promulgated in January 2003, is intended to regulate nuclear facilities in order to protect the public health and safety. This Act comprises 44 articles grouped into 5 chapters as follows:

- General Principles,
- Regulations of Construction and Operation,
- Regulations of Off-commissioning and Decommissioning,
- Penal Provisions, and
- Supplementary Provisions.

(3) Ionizing Radiation Protection Act

The Ionizing Radiation Protection Act, promulgated in December 2002, is intended to regulate the regulations on radiation protection. This Act consists of 57 articles that are grouped into 5 chapters as follows:

- General Principles,
- Radiation Safety and Protection,
- Management of Radioactive Material, Equipment Capable of Producing Ionizing Radiation,
- Penal Provisions, and
- Supplementary Provisions.

A description of the evolution of the Ionizing Radiation Protection Act is given in Article 15 of this report.

(4) Nuclear Emergency Response Act

The Nuclear Emergency Response Act was promulgated in December 2003 to enhance the emergency response system for nuclear accidents, and to establish a consolidated emergency response function so as to ensure the safety and health of the public and to protect their property. This Act comprises 45 articles that are grouped into 7 chapters as follows:

- General Principles,
- Organizations and Responsibilities,
- Preparedness Measures,
- Response Measures,
- Recovery Measures,
- Penal Provisions, and

- Supplementary Provisions.

(5) Nuclear Materials and Radioactive Waste Management Act

The Nuclear Materials and Radioactive Waste Management Act, promulgated in December 2002, is intended to regulate the radioactive material, to prevent radioactive hazards and to protect the public health and safety. This Act consists of 51 articles that are grouped into 5 chapters as follows:

- General Principles,
- Administration of Nuclear Materials and Nuclear Fuel,
- Administration of Radioactive Wastes,
- Penal Provisions, and
- Supplementary Provisions.

(6) Nuclear Damage Compensation Law

The compensation for nuclear damages resulting from the peaceful uses of atomic energy is governed by the Nuclear Damage Compensation Law. This Law was promulgated in 1971 and amended twice in 1977 and 1997 respectively. It comprises 37 articles that are grouped into 5 chapters as follows:

- General Provisions,
- Liabilities for Damage Compensation,
- Maximum Amount and Guarantee for Liabilities,
- Right to Claim for Damage Compensation, and
- Supplementary Provisions.

A more detailed description of the Nuclear Damage Compensation Law is given in Article 11 and Article 16 of this report.

(7) Act on Sites for Establishment of Low Level Radioactive Waste Final Disposal Facility

The Act on Sites for Establishment of Low Level Radioactive Waste Final Disposal Facility was promulgated in May 2006, consisting of 21 articles. This Act is designed for selecting the sites of final disposal facility of low level radioactive waste (“disposal facility” for short hereinafter) and ensuring the requirements on safety and environmental protection.

7.2.2 Enforcement Rules

The seven fundamental laws mentioned above are laws with general and fundamental principles and concepts. Except for the Act on Sites for Establishment of Low Level Radioactive Waste Final Disposal Facility, necessary enforcement rules for implementing these Laws have been established to address the details. The status of these enforcement rules is shown below:

(1) Enforcement Rules for the Atomic Energy Act

Under Article 33 of the Atomic Energy Act, the Enforcement Rules for the Atomic Energy Act were promulgated by the AEC on December 7, 1976. This Enforcement Rules have been amended several times and the latest version of the amendment was promulgated on November 22, 2002.

(2) Enforcement Rules for the Implementation of Nuclear Reactor Facilities Regulation Act

Under Article 43 of the Nuclear Reactor Facilities Regulation Act, the Enforcement Rules for the implementation of the Nuclear Reactor Facilities Regulation Act were promulgated by the AEC on August 27, 2003. The Enforcement Rules were amended on November 16, 2018.

(3) Enforcement Rules for the Ionizing Radiation Protection Act

Under Article 56 of the Ionizing Radiation Protection Act, the Enforcement Rules for the Ionizing Radiation Protection Act were promulgated by the AEC on December 25, 2002 and last amended on February 22, 2008.

(4) Enforcement Rules for the Implementation of the Nuclear Emergency Response Act

Under Article 44 of the Nuclear Emergency Response Act, the Enforcement Rules for the Nuclear Emergency Response Act were promulgated by the AEC on March 3, 2005 and last amended on October 5, 2022.

(5) Enforcement Rules for the Nuclear Materials and Radioactive Waste Management Act

Under Article 50 of the Nuclear Materials and Radioactive Waste Management Act, the Enforcement Rules for the Nuclear Materials and Radioactive Waste Management Act were promulgated by the AEC on July 30, 2003 and amended twice on January 24, 2008 and April 22, 2009 respectively.

(6) Enforcement Rules for Nuclear Damage Compensation Law

Under Article 36 of the Nuclear Damage Compensation Law, the Enforcement Rules for the Nuclear Damage Compensation Law were promulgated by the AEC on March 25, 1998.

7.2.3 Regulations

The AEC has issued various regulations in addition to the seven fundamental laws described above. These regulations include administrative regulations, technical standards, and working notices that are essential for the effective implementation of these laws. As authorized by the corresponding law, the AEC has promulgated 15 regulations for the Nuclear Reactor Facilities Regulation Act, one regulation for the Nuclear Damage Compensation Law, 23 regulations for the Ionizing Radiation Protection Act, 18 regulations for the Nuclear Materials and Radioactive Waste Management Act, and seven regulations for the Nuclear Emergency Response Act. The titles of these regulations are listed in Tables 7.1 through 7.5.

Table 7.1 Regulations Related to the Nuclear Reactor Facilities Regulation Act

No.	Names of Related Regulations
1	Enforcement Rules for the Implementation of Nuclear Reactor Facilities Regulation Act
2	General Safety Design Criteria of Nuclear Reactor Facilities
3	Regulations on the Scope of Inspection and on the Certification of Authorized Inspection Agencies for Nuclear Reactor Facilities
4	Regulations on the Dedication of Commercial Grade Items and Certification of Dedication Agency
5	Regulations for Restart of Nuclear Reactor Facilities
6	Regulations for Reportable Events and Immediate Notification of Nuclear Reactor Facilities
7	Regulations on Operator Licensing Process of Nuclear Reactor Facilities
8	Quality Assurance Criteria of Nuclear Reactor Facilities
9	Fees for Regulatory Services under the Nuclear Reactor Facilities Regulation Act
10	Regulations for the Review and Approval of Applications for Operation License of Nuclear Reactor Facilities
11	Regulations for the Review and Approval of Applications for Construction Permit of Nuclear Reactor Facilities
12	Regulations Governing Implementation of Physical Checkup for Nuclear Reactor Facilities Operators
13	Regulations for the Review and Approval of Applications for Off-commissioning of Nuclear Reactor Facilities
14	Regulations for Entrusted Inspections of Nuclear Reactor Facilities
15	Regulations on the Permit Application and the Management for Decommissioning of Nuclear Reactor Facilities

Table 7.2 Regulations Related to the Ionizing Radiation Protection Act

No.	Names of Related Regulations
1	Enforcement Rules for the Ionizing Radiation Protection Act
2	Safety Standards for Protection against Ionizing Radiation
3	Regulations for the Safe Transport of Radioactive Material
4	Standards for Establishment of Radiation Protection Management Organizations and Radiation Protection Personnel
5	Accreditation and Administrative Regulations for Personal Radiation Dose Evaluation Agencies

No.	Names of Related Regulations
6	Administrative Regulations for Radiation Protection Personnel
7	Standards for Radiation-Caused Serious Environmental Contamination
8	Standards for Limiting Radioactivity in Commodities
9	Administrative Regulations for Radioactive Material and Equipment Capable of Producing Ionizing Radiation and Associated Practice
10	Regulations for Administration of Radiation Protection Service Related Business
11	Regulations for Management of Radiation Workplaces and Environmental Radiation Monitoring outside Them
12	Administrative Regulations for Operators of Radioactive Material or Equipment Capable of Producing Ionizing Radiation
13	Administrative Regulations for the Operators of Production Facilities of Radioactive Material
14	Administrative Regulations for Operators of High Intensity Radiation Facilities
15	Regulations Governing Radiation Protection and Control for Military Institutions
16	Standards for Exemption from Regulation for Radiation Sources
17	Standards of Fees Collection for Ionizing Radiation Protection Control
18	Regulations on the Prevention and Management of Incidents of Radioactive Contaminated Buildings
19	Administrative Regulations on Establishment of Medical Exposure Quality Assurance Teams and Assignment of Specialists and Commissioning of Jobs to Relevant Organizations
20	Standards for Medical Exposure Quality Assurance
21	Regulations on the Management of Naturally Occurring Radioactive Materials
22	The Special Medical Surveillance Examination Items of Radiation Worker
23	Annual Detection Items of Radioactive Material and Equipment or Facilities Capable of Producing Ionizing Radiation

Table 7.3 Regulations Related to the Nuclear Emergency Response Act

No.	Names of Related Regulations
1	Enforcement Rules for the Implementation of the Nuclear Emergency Response Act
2	Regulations for Nuclear Emergency Classification, Notification and Response
3	Regulations for Emergency Response of the Research Nuclear Reactor Facility
4	Regulations for the Income and Expenditure, the Safekeeping and the utilization of the Nuclear Emergency Response Fund

No.	Names of Related Regulations
5	Regulations on the Disclosure of Information about Potential Radiation Disasters
6	Classification, Content, Model, Method and Announcement Timing of Alarm Signal Needed during the Nuclear Emergency Response
7	Reference Guidelines for Decision Making on Public Protective Actions in a Nuclear Accident

Table 7.4 Regulations Related to the Nuclear Damage Compensation Law

No.	Names of Related Regulations
1.	Enforcement Rules of Nuclear Damage Compensation Law

Table 7.5 Regulations Related to the Nuclear Materials and Radioactive Waste Management Act

No.	Names of Related Regulations
1	Enforcement Rules for the Nuclear Materials and Radioactive Waste Management Act
2	Regulations for the Review and Approval of Applications for Construction License of Radioactive Wastes Treatment, Storage and Final Disposal Facilities
3	Regulations on Final Disposal of Low Level Waste and Safety Management of the Facilities
4	Regulations on Treatment and Storage of Radioactive Waste and Safety Management of the Facilities
5	Regulations for the Review and Approval of Applications for Construction License of Nuclear Source Material and Nuclear Fuel Production and Storage Facilities
6	Fees on Regulatory Services under the Nuclear Materials and Radioactive Waste Act
7	Regulations for Awards for Radioactive Materials Research and Development
8	Regulations on Clearance Level for Radioactive Waste Management
9	Regulations for the Nuclear Fuels Operational Safety Management
10	Regulations for the Nuclear Source Materials Operational Safety Management
11	Operational Regulations Governing Nuclear Safeguards
12	Regulations on the Nuclear Source Material Mine and Minerals
13	Regulations for the Operation Permit of Radioactive Waste
14	Regulations on the Final Disposal of High Level Radioactive Waste and Safety Management of the Facilities
15	Regulation for Entrusting Inspection on Radioactive Waste Facilities

No.	Names of Related Regulations
16	Regulations on the Range and Criteria of the Forbidden Areas of Low Level Radioactive Waste Final Disposal Facility
17	Regulations on Naturally Occurring Radioactive Material Waste Management
18	Regulations on Qualifications of Personnel Operating Radioactive Waste Treatment Facilities

7.3 Enforcement

Under the Nuclear Reactor Facilities Regulation Act, the AEC has the authority to conduct inspections, to revoke licenses, to issue orders, and to impose penalties, etc., as needed.

Articles 4 to 20 of this Act empower the AEC to license the operation of nuclear reactor facility. Articles 21 to 28 empower the AEC to audit the off-commissioning and decommissioning of a nuclear reactor facility. Articles 29 to 40 empower the AEC to impose civil or criminal penalties on the entity for the violation of the Act.

The AEC has the right to inspect the facilities at any time during the construction, operation, and decommissioning of a nuclear reactor facility, and to require the licensee to submit relevant materials. The licensee shall not evade, interfere with or refuse to comply with the inspections and submission requests. If there is anything not conforming to the prescription or if the public health/safety or environmental ecology may be endangered, the AEC will order the licensee to improve the situation or take any other necessary measures within a prescribed time period. If the situation is severe, the licensee does not improve it nor take necessary measures within the prescribed period, the AEC may order the licensee to cease the working on the scene, or operation thereof, or may revoke the license or permit the operation under a limited power. When impose any of these penalties on the licensee, the competent authorities shall notify the licensee by a document detailing the rationale. When the situation is urgent, the administrative measures may be made verbally at first and the text of administrative measures in written shall be served supplementally upon the licensee within seven days.

The Nuclear Reactor Facilities Regulation Act also specifies the methods and levels of penalties, including criminal and civil penalties.

7.4 Amendment of Regulations

The AEC regularly reviews the nuclear regulations in this nation, especially after a significant nuclear-related event occurs. The AEC may amend a regulation if necessary to reflect the lessons learned from such events. For example, following the Fukushima Daiichi NPP accident in March 2011, the AEC revised some of its nuclear regulations to enhance safety standards. Moreover, since the operating licenses of the domestic nuclear power plants began to expire in 2018 and entered the decommissioning phase, the AEC also amended the regulations related to the safety regulation of decommissioning, taking into account the international regulations and the practical regulation needs in this nation. The following sections will present some typical regulatory amendments made by the AEC.

7.4.1 Regulations Related to the Nuclear Reactor Facilities Regulation Act

Enforcement Rules for the Implementation of Nuclear Reactor Facilities Regulation Act:

The AEC enacted the "Enforcement Rules for the Implementation of Nuclear Reactor Facilities Regulation Act" in accordance with Article 43 of the Nuclear Reactor Facilities Regulation Act and last amended them on November 16, 2018. These enforcement rules specify the following: the plans and contents formed by the licensee to be submitted before nuclear reactor facilities have been firstly loaded with the nuclear fuel; the criteria for demarcating the exclusion area and the low population zone; the requirements of application when a licensee applies for the initial loading of the nuclear fuel; the integrated safety analysis report to be submitted for review and approval prior to a six-month period before the expiry of every decennium; the deadlines for submitting the respective reports or records by the licensee pursuant to Article 10 of the Nuclear Reactor Facilities Regulation Act; the extent of significant safety items provided under Article 13 of the Nuclear Reactor Facilities Regulation Act; the circumstances to be denoted provided that the public health/safety or the environmental ecology may be hazarded during the construction of nuclear reactor facilities; the circumstances to be denoted provided that the public health/safety or the environmental ecology may be hazarded during the operation of nuclear reactor facilities; the required functions of the safety-related structures, systems and components of nuclear reactor facility under the circumstances of normal operation, anticipating operating occurrence, design base accident, external and natural disaster; the quality assurance activity of design, manufacture, inspection, testing and replacement for the nuclear-graded items; the regulations on the import, export or remove of nuclear reactor or other matters designated by the competent authorities; the regulations on the time period for the completion of decommissioning of nuclear reactor facility; the limits of radiation doses in the post-decommissioning site of nuclear reactor facility; and other decommissioning-related regulations.

Regulations on the Permit Application and the Management for Decommissioning of Nuclear Reactor Facilities:

The AEC promulgated the "Regulations on the Permit Application and the Management for Decommissioning of Nuclear Reactor Facilities" on July 14, 2004 and last amended them on November 16, 2018. The areas of the latest revision emphasize and amend the review procedure of the decommissioning permit application, the contents of the decommissioning plan, the fuel safety, environmental radiation safety, radioactive liquid and gas disposal and worker safety. Furthermore, the regulation, referring foreign regulatory experience, describes the application of completion and associated reports and the retention time of related technical documentation of the plan to enhance the regulatory measures during decommissioning.

Fees for Regulatory Services under the Nuclear Reactor Facilities Regulation Act:

The AEC promulgated the "Fees for Regulatory Services under the Nuclear Reactor Facilities Regulation Act" on September 14, 2012 and last amended them on November 8, 2018. These standards establish the basis for the fees for various regulatory services, such as: the review fee for each nuclear power reactor applying for construction permit; the review fee for each nuclear power reactor applying for operating license; the review fees for a power generation nuclear reactor facility submitting the rated thermal power uprate safety analysis report; the annual construction inspection fee for each nuclear power reactor unit; the annual inspection fee for each operating nuclear power reactor; the annual nuclear fuel inspection fee for each operating nuclear power reactor; the review fee for each transient thermal-hydraulic safety analysis technical report; the review fee for each operating nuclear power reactor conducting ten-year integrated safety assessment; the review fee for operating nuclear power reactor applying for decommissioning permit; the annual decommissioning inspection fee; the fee for each applicant for initial or re-qualification examination for reactor operator license of a power generation nuclear reactor facility; an issuance fee for license/permit of construction, operating, reactor operator, or senior reactor operator of a power generation nuclear reactor facility; and the review fee for the dedication of commercial grade items and certification of dedication agency, certification of authorized inspection agencies for nuclear reactor facilities during construction, and certification of authorized inspection and testing agencies for nuclear reactor facilities during operation.

7.4.2 Regulations Related to the Ionizing Radiation Protection Act

Regulations for Management of Radiation Workplaces and Environmental Radiation Monitoring outside Them:

The AEC promulgated the “Regulations for Management of Radiation Workplaces and Environmental Radiation Monitoring outside Them” on December 25, 2002 and amended them twice, in December 2003 and October 2004. These regulations require facility operators of radiation workplaces (including nuclear reactor facilities, radioactive waste final disposal facilities, independent radioactive waste storage installation and other facilities assigned by the competent authority) to submit an environmental radiation monitoring plan and report to the competent authority for approval before conducting environmental radiation monitoring, as specified in Article 19 of the regulations.

However, the aforementioned “environmental radiation monitoring plan” only applies to those radiation workplaces before or during operation, and does not cover the phases of decommissioning, such as during and after decommissioning.

Therefore, the AEC amended the Regulations on June 27, 2016 and expanded the scope of Article 19 of the Regulations to include those radiation workplaces that are in suspension, decommissioning or post-decommissioning phases. The licensee of these radiation workplaces must submit an environmental radiation-monitoring plan to the AEC for approval and implementation within three years.

7.4.3 Regulations Related to the Nuclear Emergency Response Act

Amendment of Enforcement Rules for the Implementation of the Nuclear Emergency Response Act:

The AEC amended the “Enforcement Rules for the Implementation of the Nuclear Emergency Response Act” on October 5, 2022 to reflect the following changes:

(1) The frequency of the revision of EPZ.

(2) The frequency of the revision of analysis and planning of the public protective measures.

(3) The date on which the amendments of the rules come into force.

<u>Amendment of Regulations for Nuclear Emergency Classification, Notification and Response:</u>

The AEC amended the "Regulations for Nuclear Emergency Classification, Notification and Response" on January 28, 2016. According to Article 3, Paragraph 2 of these regulations, Taipower Company submitted the nuclear accident classification and assessment procedures of the three operating nuclear plants to the AEC for approval. The AEC convened a review meeting on May 25, 2016 and approved the procedures on June 7, 2016. The approved procedures were published on the AEC website.

<u>Amendment of Regulations on the Disclosure of Information about Potential Radiation Disasters</u>

The AEC amended the "Regulations on the Disclosure of Information about Potential Radiation Disasters" on March 3, 2017, in accordance with Article 22 of the "Disaster Prevention and Protection Act." These regulations define the radiation disaster potential area as the places that may cause radiation disasters, such as the locations of nuclear reactor facilities, the operation places of Class I or Class II sealed radioactive materials, and the storage sites of radioactive materials and radioactive waste. The AEC published 82 sites in this category on its website on May 6, 2021.

<u>Amendment of Classification, Content, Model, Method and Announcement Timing of Alarm Signal Needed during the Nuclear Emergency Response:</u>

The AEC promulgated the "Classification, Content, Model, Method and Announcement Timing of Alarm Signal Needed during the Nuclear Emergency Response" on January 13, 2017, in accordance with Article 35 of the "Disaster Prevention and Protection Act." The AEC revised these regulations on February 24, 2023.

7.4.4 Regulations Related to the Nuclear Materials and Radioactive Waste Management Act

<u>Amendment of Regulations for Awards for Radioactive Materials Research and Development</u>

The AEC promulgated the "Regulations for Awards for Radioactive Materials Research and Development" on December 29, 2004 and amended them on May 18, 2018. These regulations provide the guidelines for granting awards to outstanding contributors for their achievements in radioactive materials management technology and final disposal research and development. To enhance the quality and prestige of the awards, the AEC changed the frequency of the awards from annual to biennial, following the example of the "Atomic Energy Safety Awards."

<u>Amendment of Scope and Certification Criteria for Prohibited Areas of the Sites of Low-level Radioactive Waste Final Disposal Facilities</u>

The AEC promulgated the "Scope and Certification Criteria for Prohibited Areas of the Sites of Low-level Radioactive Waste Final Disposal Facilities" on November 17, 2006 and revised them on March 23, 2017. These criteria aim to implement the indigenous people policy objectives proposed by the President and to comply with Article 31 of the Indigenous Peoples Basic Law. The main revision is to add Paragraph 1 of Article 6, which states that the area of the indigenous peoples designated as candidate sites for disposal facilities can not be developed without the consent of the indigenous peoples and in accordance with Article 31 of the Indigenous Peoples Basic Law.

Amendment of Regulations for the Review and Approval of Applications for Construction License of Radioactive Wastes Treatment, Storage and Final Disposal Facilities

The AEC promulgated the “Regulations for the Review and Approval of Applications for Construction License of Radioactive Wastes Treatment, Storage and Final Disposal Facilities” on April 7, 2004 and revised them on August 7, 2020. The revision emphasizes public participation and information transparency, requiring the applicant of a construction license for radioactive waste treatment, storage or final disposal facilities to hold public information sessions and provide information materials related to the facility safety analysis for public communication, before submitting the application.

Amendment of Regulations on Treatment and Storage of Radioactive Waste and Safety Management of the Facilities

The AEC promulgated the “Regulations on Treatment and Storage of Radioactive Waste and Safety Management of the Facilities” on October 8, 2003 and revised them on May 13, 2021. These regulations recognize that each stage (production, treatment, containment, storage, transport, and final disposal) of the radioactive waste management is interrelated, and that the radioactive waste container is an integral part of the radioactive waste management. Therefore, the revision requires that the applicant for the use of radioactive waste container must submit a report describing the technical feasibility of the container in each stage of the radioactive waste management operations.

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ARTICLE 8. REGULATORY BODY

1. **Each Contracting Party shall establish or designate a regulatory body entrusted with the implementation of the legislative and regulatory framework referred to in Article 7, and provided with adequate authority, competence, and financial and human resources to fulfill its assigned responsibilities.**

2. **Each contracting Party shall take the appropriate steps to ensure an effective separation between the functions of the regulatory body and those of any other body or organization concerned with the promotion or utilization of nuclear energy.**

The AEC was founded in 1955 at the ministerial level under the Executive Yuan as a Cabinet member. The Atomic Energy Act was passed in 1968 to give AEC the exclusive regulatory authority to ensure that the civilian use of nuclear energy and materials is conducted with proper regard for the public health and safety. The AEC's principal mission in the initial founding period was limited to the management of international affairs concerning the atomic energy and the promotion of the peaceful applications of the atomic energy in this country.

The AEC's mission is to ensure that the civilian use of nuclear energy and materials, including radioactive materials, is conducted with proper regard for the public health and safety, and to protect the environment from the radiation released from nuclear reactors, radioactive materials, radioisotope production facilities, and nuclear waste facilities. The basic charter for these regulatory responsibilities is the Atomic Energy Act of 1968 (as amended in 1971), through which the Legislative Yuan (i.e. the Parliament) created a national policy of developing the peaceful uses of atomic energy. That statute has been amended or proposed for amendment over the years to cope with technology developments and worldwide changing perceptions of regulatory needs, such as the more specialized statutes prescribing the AEC's duties with regard to the treatment and disposal of low-level and high-level radioactive wastes, decommissioning, safety reviews, and import/export control.

In more than 40 years since 1978, the first, second and third nuclear power plants were successively connected to the power grid. At the same time, radioisotope applications in the medical, agricultural, industrial and research fields grew rapidly. Therefore, the most important tasks for the AEC have been shifted to regulating nuclear reactor safety, radiation protection, radioactive waste management, and conducting relevant regulatory researches.

The AEC, in the execution of the aforementioned regulatory tasks and R&D works, upholds the following principles: safety first, reasonable regulation, streamline administration and convenience to the people. Safety is the first priority in the development and application of nuclear technologies.

The AEC has the authority to regulate all sources of radiation, whether naturally occurring or man-made, in addition to the nuclear materials such as uranium and thorium. The AEC also has the authority to regulate the radiation produced by machines, such as the X-rays machine or linear accelerators.

The AEC's licensing authority also covers the medical sector which uses radioisotopes or machine-produced radiation in the relevant hospitals, the academic and research institutions, and the production and distribution of radiopharmaceuticals.

The AEC's responsibilities encompass the regulation and oversight of nuclear safety, nuclear safeguards and nuclear security, by which the agency ensures the safety of nuclear facilities and their equipment and radioactive materials and protects them against radiological sabotage, loss, thefts and misuse.

In order to gain sufficient trust of the public on regulating nuclear power operation in this nation, the AEC makes reports and information of its nuclear regulation open to the public and increased the frequency of holding press conference. The AEC also visits and holds dialogue with the environmental protection groups and nuclear-concerned organizations as frequently as possible, and had a communication meeting with them based on the needs.

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8.1 Structure of the Regulatory Body

This section describes the structure of the AEC. It covers the Council itself, various offices, affiliated agencies and advisory committees as shown in Figure 8.1.

8.1.1 Atomic Energy Council

The Atomic Energy Council is composed of more than 10 commissioners, mostly representatives of relevant ministries or agencies within the Executive Yuan and experts from the academia. There are four technical departments and four administrative units within the AEC headquarters in addition to five advisory committees on nuclear policy and safety. Furthermore, under the AEC's supervision, there are three affiliated agencies, namely, the Institute of Nuclear Energy Research (INER), the Fuel Cycle and Materials Administration (FCMA) and the Radiation Monitoring Center (RMC).

The Minister of the AEC presides over the Council with the assistance of two Deputy Ministers and the Chief Executive Secretary to oversee the Council affairs and supervises the affiliated agencies.

The Council is chaired by the Minister of the AEC, who is supported by two Deputy Ministers and the Chief Executive Secretary. They are responsible for the Council affairs and oversee the affiliated agencies.

The Council's administration is comprised of four technical departments and four administrative units, as well as a mission-oriented unit. The technical departments are: the Department of Planning, the Department of Nuclear Regulation, the Department of Radiation Protection, and the Department of Nuclear Technology. The administrative units are: the Department of General Administration, the Office of Personnel, the Office of Accounting, and the Office of Civil Service Ethics. The mission-oriented unit is the Office of Congressional Liaison, which is independent from these departments.

The five advisory committees are: (1) the Advisory Committee on Nuclear Facility Safety, (2) the Advisory Committee on Ionizing Radiation Safety, (3) the Advisory Committee on Radioactive Materials Safety, (4) the Advisory Committee on Nuclear Legislation, and (5) the Advisory Committee on Nuclear Emergency Response Fund.

The AEC headquarters has approximately 240 personnel on its payroll with a budget of NT$ 520 million for the fiscal year 2022 (excluding the budget of the three affiliated agencies), as shown in Table 8.1.

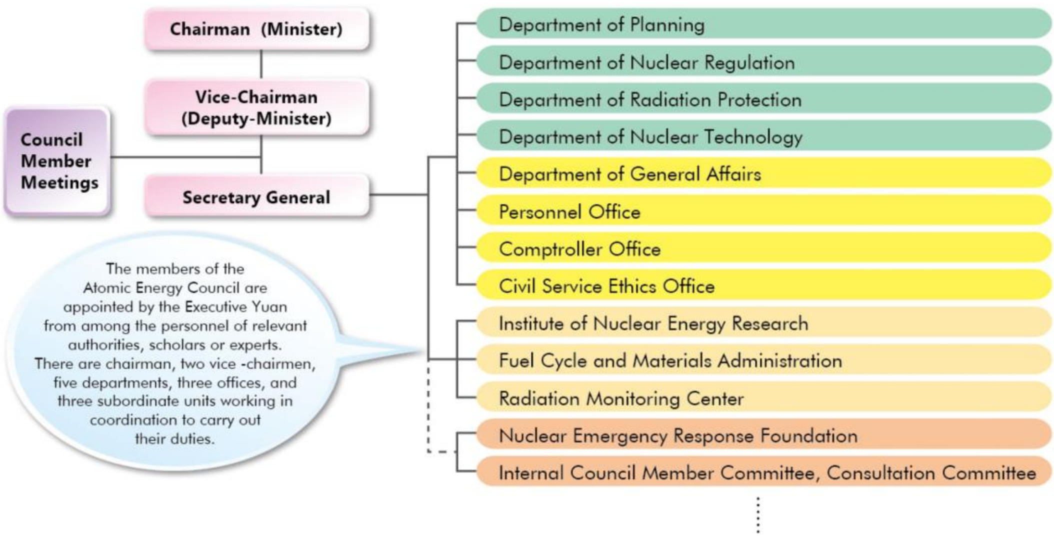

Figure 8.1 Organization Chart of the AEC

Table 8.1 Budget and Staffing by Appropriation

Appropriation	Budget (Million NT Dollars)			FY Staffing (Man-year)		
	FY2020	FY2021	FY2022	FY2020	FY2021	FY2022
AEC Headquarters	542	521	522	241	241	240
INER	1,780	1,788	1,700	789	789	789
FCMA	87	86	86	43	43	43
RMC	92	68	73	31	31	31
Total	2,501	2,463	2,381	1,104	1,104	1,103

8.1.2 Offices of the Atomic Energy Council

The following sections outline the responsibilities of the various organizations that are part of the AEC or that operate under its supervision.

(1) Department of Planning

The Department of Planning is responsible for the following main duties:

- Developing and implementing policies on nuclear science and technology, as well as planning, integrating, controlling and assessing related programs, activities and R&D projects,
- Establishing and maintaining communication and cooperation with domestic and overseas organizations on nuclear science and technology,
- Coordinating, implementing, supervising and assessing nuclear safeguards activities,
- Planning and managing human resources on nuclear science and technology, including overseas training programs,
- Planning and facilitating educational programs on nuclear science,
- Transferring patents on nuclear science and technology,
- Performing other planning assignments.

(2) Department of Nuclear Regulation

The Department of Nuclear Regulation (DNR) has the following primary responsibilities:

- Regulating the safety of the design, construction, operation, and decommissioning of nuclear reactor facilities,
- Implementing the review of decommissioning plans of nuclear reactor facilities,
- Issuing licenses of construction, operation, and decommissioning permit for nuclear reactor facilities,
- Reviewing the final safety analysis report and revising the technical specifications of nuclear reactors facilities ,
- Licensing nuclear reactor operators,
- Investigating and evaluating abnormal events occurred at nuclear reactor facilities,
- Performing other regulatory tasks related to nuclear safety.

(3) Department of Radiation Protection

The Department of Radiation Protection (DRP) has the primary responsibility of ensuring the radiation safety of nuclear facilities, environment, and the medical and non-medical applications of radioactive materials and equipment capable of producing ionizing radiation. The major tasks are:

- Radiation protection and environmental radiation control of nuclear facilities,
- Radiation protection and environmental radiation control of radioactive waste storage and disposal sites,
- Issuing licenses for radioactive materials and equipment capable of producing ionizing radiation and the related operating personnel,

- Controlling ionizing radiation site and its environmental radiation,
- Developing and amending regulations for radiation safety,
- Certifying radiation protection personnel,
- Reviewing radiation safety assessment reports,
- Assessing and controlling the proficiency in radiation protection of radiation workers,
- Handling and investigating radiation incidents,
- Performing other assigned responsibilities.

(4) Department of Nuclear Technology

The Department of Nuclear Technology (DNT) is the government's main authority for nuclear security and radiological emergency response. DNT ensures the country's protection by developing, implementing and coordinating programs and systems that act as a last line of defense in case of a nuclear incident or radiological accident. DNT's top priority is to minimize the impacts of emergencies on worker and public health and safety, and the environment. The major tasks of DNT are:

- Developing regulations for nuclear emergency response,
- Planning and evaluating nuclear emergency preparedness and exercises,
- Regulating and supervising nuclear emergency response and nuclear security operations,
- Operating and maintaining the National Nuclear Emergency Response Center,
- Coordinating and integrating nuclear and radiological emergency,
- Operating and maintaining the Nuclear Safety Duty Center,
- Managing information system and cybersecurity,
- Performing other assigned responsibilities.

(5) Office of Congressional Liaison

The Office of Congressional Liaison has the following primary responsibilities:

- Strengthening the liaison between the AEC and the congressional organizations, and enhancing the understanding of the AEC activities by the congressional members to facilitate the AEC's administration. This office monitors legislative proposals, bills, and hearings, and informs the AEC of the views of the Parliament on the AEC policies, plans, and activities. The major tasks of the Office of Congressional Liaison are:
- Conducting the liaison between the congressional organizations (including the Legislative Yuan and the Control Yuan) and the AEC,
- Conducting the liaison and communication with the administrative units of the congressional organizations,
- Communicating with the congressional members, including their assistants and staff, about the AEC's activities,
- Communicating with the congressional liaison offices of other ministries under the

Executive Yuan,

- Collecting the information about the interpellation of the congressional members and the related concerns,
- Responding to the related matters requested by the congressional members.

(6) Administrative Units

The AEC has four administrative units: the Department of General Administration, the Office of Personnel, the Office of Accounting, and the Office of Civil Service Ethics. The Department of General Administration handles documentation and property management as well as the administrative support to all other departments and offices. The Office of Personnel and Office of Accounting manages the general administrative matters related to their respective fields. The organization of Civil Service Ethics supervises the ethics of the government employees across the nation, executes the anti-corruption work, protects official secrets, and prevents the impairment and sabotage of the public agencies. Therefore, the Office of Civil Service Ethics of the AEC performs the similar jobs within the AEC.

8.1.3 Affiliated Agencies

(1) Institute of Nuclear Energy Research

The Institute of Nuclear Energy Research (INER) is a specialized institute under the Atomic Energy Council, founded in 1968. It focuses on nuclear energy and radiation applications. The main research and development areas are: (1) nuclear safety and nuclear back-end, (2) radiation applications for people's livelihood, (3) green energy and system integration. As a national laboratory, the INER's missions are as follows. For more information related to the research and development in nuclear safety, please see Subsection 6.3.8.

- Research and development in nuclear safety and radiation protection,
- Research and development in nuclear reactor technology,
- Research and development in nuclear fuels and materials,
- Research and development in technology for developing atomic energy resources,
- Research and development in radiochemistry and nuclear chemistry,
- Applications of atomic energy in medical care, agriculture, industry and life science,
- Research and development in radioactive waste processing technology,
- Research and development in nuclear physics and neutron physics,
- Research and development in radioactive materials analysis technology,
- Research and development in nuclear system and engineering technology,
- Research and development in nuclear instrument,
- Research and development in environmental science and technology related to nuclear energy,
- Research and development in basic science and technology related to nuclear energy,

- Assigned responsibilities by the AEC,
- Research and development in other technology related to nuclear energy.

(2) Fuel Cycle and Materials Administration

The Fuel Cycle and Materials Administration (FCMA) is a subsidiary agency under the Atomic Energy Council, established in 1981 as the Radioactive Waste Administration (RWA). It was responsible for regulating the radioactive waste from the nuclear power stations and other small producers (i.e., from research, medical, industrial, and other facilities). It also operated the first low level radioactive waste storage facility located in Lan-Yu, a small offshore island of Taiwan. This was designed to store all the solidified low-level radioactive wastes generated in the country, especially those from the operation of NPPs of the TPC. The facility was transferred to the TPC in July 1990.

The RWA changed its name to FCMA in January 1996. Its roles as a radioactive waste regulator were clearly separated from the producer (TPC) and the Administration's authority was enhanced. In addition to licensing various waste treatment and storage facilities and disposal sites, FCMA also devoted lots of efforts to regulating wastes from small producers, technologically enhanced naturally-occurring radioactive materials and nuclear source materials.

In summary, FCMA is responsible for the safety regulation of the treatment, storage, transport and final disposal of radwaste, and the import, export, storage, and transfer of nuclear source materials and nuclear fuels. Its major tasks are:

- Licensing of facilities associated with the construction and operation of installations for radwaste treatment, storage, and disposal,
- Regulation and inspection for the treatment, storage, transport, disposal, import and export of radwaste,
- Regulation and inspection for the import, export, storage, utilization, discard, and transfer of nuclear source materials,
- Regulation and inspection for the import, export, storage, discard, and transfer of nuclear fuels,
- Development of regulations and technical standards for the radioactive material,
- International cooperation with respect to radioactive material regulation,
- Education and public communication with respect to radioactive material regulation,
- Policy and strategy development for the management of radioactive material.

(3) Radiation Monitoring Center

The Radiation Monitoring Center (RMC) is a specialized agency under the Atomic Energy Council that monitors natural ionizing radiation in the environment and man-made ionizing radiation in the vicinity of nuclear power stations, nuclear research reactors, and radioactive waste facilities. It was established in 1974 as the Taiwan Radiation Monitoring Station (TRMS). In July 1996, it changed its name to the RMC.

The major tasks of this Center are:

- Formulation and implementation of the environmental radiation measurement plans,

- Measurement of the natural ionizing radiation in the environment,
- Radioactive fallout detection,
- Measurement of radioactivity level in foods and drinking water,
- Measurement of the ionizing radiation in the immediate environment of nuclear and other radiation emitting facilities,
- Measurement of the environmental radiation arising from treatment, storage, transport and final disposal of radioactive wastes,
- Monitoring and radioactive analysis of radiation hazards by nuclear accidents,
- Assessment of radiation exposure of the public,
- Research and development of the radiation measurement technology,
- Providing information of radiation detecting, monitoring, and assessing results regularly, and announcing abnormal conditions of radiation detection results immediately,
- Other tasks related to the environmental radiation monitoring.

8.1.4 Advisory Committees

The AEC has seven advisory committees that deal with technical or nuclear-related issues. Five of these committees are permanent, while the other two are ad hoc and convene only when necessary. This section describes the composition and roles of these committees within the AEC.

(1) Advisory Committee on Nuclear Facility Safety

The Advisory Committee on Nuclear Facility Safety is composed of 13 to 19 members with expertise in science and engineering. It provides advice to the AEC on safety regulation of existing nuclear reactor facilities, such as safety issues, regulatory requirements and other regulatory issues. The statute requires that the Committee review certain types of applications, such as the license applications for nuclear power reactors or research reactors. Before issuing a license, the AEC will consult the advice from the Committee.

(2) Advisory Committee on Ionizing Radiation Safety

The Advisory Committee on Ionizing Radiation Safety is composed of 13 to 19 members with expertise in science and engineering, including radiology, physicians, inspection standards and public communication. This Committee provides advice on radiation safety issues and gives expert opinions on the related uses of radiation sources, for the AEC’s reference.

(3) Advisory Committee on Nuclear Legislation

The Advisory Committee on Nuclear Legislation (or Legal Affairs Committee) is composed of 11 to 15 members from relevant agencies within the Executive Yuan and private sectors with law or nuclear related expertise. This Committee provides advice to the AEC on proposed nuclear laws and regulations and their amendments before they are submitted to Executive Yuan. The laws then need to be delivered to Legislative Yuan for approval. The other tasks include advising on regulation implementation, dealing with lawsuits against the AEC, and handling appeals from citizens.

(4) Advisory Committee on Radioactive Materials Safety

The Advisory Committee on Radioactive Materials Safety is composed of 11 to 15 members with expertise in science and engineering. This Committee provides advice on radioactive material safety issues, the final disposal of radioactive waste, and other matters related to radioactive waste management. The committee will also advise on the review and safety regulation of major radioactive material facilities.

(5) Advisory Committee on Handling of State Compensation Cases

The Advisory Committee on Handling of State Compensation Cases is composed of 6 to 8 members from scholars and the AEC senior staff, with the scholars as the majority. The role of this committee includes negotiating and deliberating the state compensation cases and confirming the compensation authority of the state compensation and litigation on the state compensation cases.

In addition to these 5 regularly operated advisory committees mentioned above, there are two more advisory committees chaired by the AEC Minister, namely, the Advisory Committee on Nuclear Accident Investigation and Evaluation, and the Implementation Committee on Nuclear Emergency Recovery Measures. In case of a major nuclear accident, these two committees will be convened. The Advisory Committee on Nuclear Accident Investigation and Evaluation is composed of 13 to 17 members, and will be established after a major nuclear accident and damage claims from the public. The responsibilities of this Committee include: determining the extent of a nuclear accident and investigating its cause, investigating and evaluating the nuclear damage, recommending compensation, relief and rehabilitation measures for the nuclear accident, and recommending improvements of safety protections of nuclear installations. Reports of the aforementioned investigation, evaluation, and recommendation shall be prepared for public announcement. When the victims of a nuclear accident seek compensation by way of a judicial proceeding, the court may take into account these reports

(1) Advisory Committee on Nuclear Accident Investigation and Evaluation

The Advisory Committee on Nuclear Accident Investigation and Evaluation is composed of 13 to 17 members, and will be established after a major nuclear accident and damage claims from the public. The responsibilities of this Committee include: determining the extent of a nuclear accident and investigating its cause, investigating and evaluating the nuclear damage, recommending compensation, relief and rehabilitation measures for the nuclear accident, and recommending improvements of safety protections of nuclear installations. Reports of the aforementioned investigation, evaluation, and recommendation shall be prepared for public announcement. When the victims of a nuclear accident seek compensation by way of a judicial proceeding, the court may take into account these reports.

(2) Implementation Committee on Nuclear Accident Recovery Measures

In case of a major nuclear accident and recovery actions are needed after the accident, the Implementation Committee on Nuclear Accident Recovery Measures will be convened to perform the recovery measures. This committee, which is not an advisory type of committee, is also chaired by AEC Minister. The Implementation Committee on Nuclear Accident Recovery Measures is composed of 19 to 23 members from the AEC, Ministry of Interior, Ministry of National Defense, Ministry of Finance, Ministry of Economic Affairs, Ministry of Transportation and Communication, Directorate-General of Budget Accounting and Statistics, Government Information Office, Department of Health, Environmental Protection Administration, Financial Supervisory Commission, Council of Agriculture, National Communications Commission, the Local Government, the TPC and the relevant neighboring public around the said NPP. The role of this committee covers the following areas: determining the recovery measures and supervising the implementation of these measures, notifying the relevant government agencies of various levels and the nuclear reactor facility licensee to implement relevant recovery measures, coordinating the dispatch of manpower and resources for recovery, announcing orders for public protective actions during the recovery period, issuing press releases for recovery, and carrying out any other recovery measure.

8.2 Financial and Human Resources of the Nuclear Regulatory Body

This section examines the budget and funding of the AEC, its human resources, and its financial management.

8.2.1 Financial Resources

Since the AEC and its three affiliated agencies, INER, FCMA, and RMC are government organizations, their major operational budgets all come from the government. The annual budget of the AEC together with its affiliated agencies is submitted through the Executive Yuan channel and has to be approved by the Legislative Yuan (LY) in advance before the fiscal year starts. The annual budgets in 2022 are NT$522 million for the AEC headquarters, NT$1.7 billion for the INER, NT$86 million for the FCMA, and NT$73 million for the RMC. The total annual budget for the AEC all together amounts to NT$2.38 billion in 2022. The Office of Accounting is responsible for the management of the annual budget of the AEC headquarters, INER, FCMA and RMC.

8.2.2 Fees Collected from the Licensees

The AEC collects two types of fees from the licensees based on the Fees for Regulatory Services under the Nuclear Reactor Facilities Regulation Act and the Fees on Regulatory Services under the Nuclear Materials and Radioactive Waste Act. These fees are reimbursed as part of the government income to fulfill the annual budget balance requirement. The first category consists of the fees of AEC's review for the license applications of nuclear reactor facility and for safety assessment, to issue new licenses or renewed licenses, and to review nuclear fuel reloads licensing documents and specific topic reports. The second category consists of the annual fees to recover the generic regulatory activities (e.g., inspection, testing and research) and other regulatory fees that are not covered by license applications and safety assessment activities. The amounts of these two kinds of fees are based on the manpower requirement and their salaries approved by the Parliament.

8.2.3 Nuclear Emergency Response Fund

To implement the preparedness measures for the nuclear emergency response and to support the response operations during the occurrence or possible occurrence of an accident, based on Article 43 of the Nuclear Emergency Response Act, a Nuclear Emergency Response Fund (NERF) has been established. A sum of 38 million NT Dollars is collected from each nuclear power plant every year by the AEC for the fund. The administration regulation for income and expenditure, the custody, and the utilization of the fund are enacted by the Executive Yuan. The NERF management committee, composed of 9~13 members, is responsible for the annual budget review and approval together with the fund performance review and audit the utilization of the fund . The uses of the fund include:

- The expenses incurred by the AEC when conducting exercises;
- The expenses incurred by the AEC when implementing actions involving the operations of the National Nuclear Emergency Response Center; planning, supervision, and coordination of preparedness, training, and exercise; personnel grouping and training, and equipment testing and maintenance; inspection and testing of preparedness measures of nuclear emergency response; compilation and revision of operational procedures; planning and implementation of research and development items and other relevant items;
- The expenses incurred by AEC when implementing actions carried out by the Regional Nuclear Emergency Response Centers to conduct personnel grouping, training and exercise; installing, testing, and maintaining equipment and facilities; storing, inspecting, and dispatching public protective materials and equipment; and planning and implementing items of other emergency response and preparedness measures;
- The expenses related to emergency response operations upon the occurrence of a nuclear accident;
- The expenses for management and general affairs.

8.2.4 Human Resources

(1) Recruitment and Hiring Process

The staff size of the AEC headquarters, INER, FCMA and RMC are 240, 789, 43, and 31, respectively in the fiscal year 2020. As all the staff members are public officials and have specific knowledge or skills in this field, the turnover rate of the staff in the AEC is relatively low. The recruitment of new employees is mostly dependent on the availability of positions provided by the government each year that takes into account the retirement or departure of current staff. The Civil Service Level 2 and 3 senior “Examinations” will be held usually once a year by the Ministry of Examination of the Examination Yuan based on the request of all the government organizations. The qualified personnel who pass the above-mentioned examination in Nuclear Engineering, Radiation Safety or other Engineering Fields as required will be trained for one month and then dispatched to the AEC or its affiliated agencies.

(2) Training and Inspector Qualification

The AEC has been entrusted by the Civil Service Protection and Training Commission to conduct the practical training of atomic energy professional regulations for those who passed the Level 3 Civil Service Senior Examinations in the nuclear engineering and radiation safety categories. In addition, with limited training resources, other technical category recruits are also included in this training program to maximize the benefit. Participants will gain an overall understanding of AEC’s organization and functions, laws and regulations, as well as the regulatory practices.

The new employees of the AEC headquarters will receive on-job training in the related sections of the departments they serve. They will also be required to get familiar with the regulations and guides for the implementation of the inspection works. The senior staff members are required to help train the new employees on the regulatory requirements and the inspection skills. Seminars, technical discussions, AEC web information and walk-throughs of the NPPs also provide effective ways to train the new employees to keep up with all the up-to-date information and thus help improve their inspection capability.

The nuclear power plant inspector qualification system established in the AEC headquarters has proved to be an effective way to continuously enhance the knowledge and skills of the staff of the AEC. The inspectors are divided into five categories: NPP inspectors, radiation protection inspectors, nuclear security and emergency response inspectors, radioactive materials management inspectors, and NPP decommissioning inspectors. Except for the nuclear safety emergency response inspectors, each category further includes two levels of inspector, the inspector and the senior inspector. To become an inspector, a new employee has to complete the self-study, on-job training, and ~~finish~~ several fundamental training courses and other related professional courses. Then, after completing all the required training and passing the required examinations and evaluations, he or she may obtain an inspector certificate in order to formally serve as a qualified inspector. The inspector/senior inspector certificate is issued by the AEC and has a validity period of 6 years. An inspector may apply for a senior inspector position if he or she has served as an inspector for at least a certain amount of years (6 years for the NPP inspector, 4 years for the radiation protection inspector,6 years for the radioactive materials management inspector, and 6 years for the NPP decommissioning inspector). In doing this, the applicant has to repeat the self-study and on-the-job training with advanced training courses and then obtain a senior inspector certificate in order to formally serve as a qualified senior inspector after passing the required examinations and evaluations.

8.3 Position of the AEC in the Government

This section defines the relationship of the AEC and the other Ministries of Executive Yuan (i.e. the Cabinet), the local counties, and the Legislative Yuan (i.e. the Parliament).

8.3.1 Executive Yuan

This section defines the relationship between the AEC and the various related ministries of the Executive Yuan. These ministries (or their branches) are: the Ministry of Economic Affairs (MOEA), the Environmental Protection Administration (EPA), the Ministry of Health and Welfare (MOHW), the Ministry of Labor (MOL), the Ministry of Foreign Affairs (MOFA), and the Directorate General of Budget, Accounting and Statistics (DGBAS).

(1) Ministry of Economic Affairs (MOEA)

The Ministry of Economic Affairs is in charge of the matters regarding national economic administration and construction. Its major functions include the industrial development, international trade, intellectual property, standard, metrology and inspection, investment and technology transfer, guidance and assistance for small and medium enterprises, technology development, state-owned corporation and natural resources (energy, water and geology), etc. For more information, please refer to

Subsection 8.4.

The TPC, established on May 1, 1946, is one of the State-Owned Corporations under the supervision of the MOEA. The number of TPC's employees is approximately 28,079 and its assets are worth 6,000 billion NT Dollars in 2022. Its main mission is to ensure the stable supply of electric power with good quality and reasonable price.

(2) Environmental Protection Administration (EPA)

The Environmental Protection Administration, a ministry-level agency within the Executive Yuan, was established in 1987 with the mission of protecting and improving the environment nationwide. Its major functions include air quality protection and noise control, water quality protection, waste management, environmental sanitation and toxic substance management and dispute resolution for environmental pollution. The organizations under the EPA are Bureau of Environmental Inspection, Environmental Analysis Laboratory and Environmental Professionals Training Center.

After the enactment of the Environmental Impact Assessment Act in December 1994, the review of the environmental impact assessment reports of a new nuclear power station or other nuclear facilities, e.g., the spent fuel interim storage facility (or the independent spent fuel storage installation) and the low-level radioactive waste repository, was shifted from the AEC to the EPA.

The EPA was reconstructed into Ministry of Environment on August 22, 2023.

(3) Ministry of Health and Welfare (MOHW)

The Ministry of Health and Welfare is responsible for the health of the general public. It has the authority to regulate hospitals and medical related equipment and facilities. The AEC works with the Ministry of Health and Welfare to issue licenses for hospital workers who operate the X-ray units or accelerators, or handle the radioisotopes or radiopharmaceuticals that release radiation.

(4) Ministry of Labor (MOL)

The AEC keeps track of the legislations proposed by the Ministry of Labor, especially the Acts and regulations on occupational health and safety that may affect radiation workers in the nuclear power stations and hospitals. For example, the Occupational Health and Safety Act stipulates the physical examination requirements for radiation workers.

(5) Ministry of Foreign Affairs (MOFA)

The AEC collaborates with the Ministry of Foreign Affairs on the following matters: the cooperation with international organizations such as the IAEA and the Nuclear Energy Agency of the Organization for Economic Cooperation and Development (OECD/NEA), the policy development for nuclear issues that are within the AEC's purview, and the program planning and coordination of nuclear safety assistance to other countries.

(6) Directorate-General of Budget, Accounting and Statistics (DGBAS)

The Directorate-General of Budget, Accounting and Statistics is the authority responsible for budget, accounting and statistics affairs within the central government as well as local county governments. The AEC submits the annual budget requests, including proposed personnel requirements, to this agency for review and approval.

For the relationship of the AEC and other ministries under a possible nuclear accident, such as the Ministry of National Defense and the Ministry of Interior, please refer to Subsection 16.2.3.

8.3.2 Local Counties

The Atomic Energy Act of 1968 granted the AEC with preemptive authority over the health and safety regulation of the nuclear energy. As a result, the general rule is that the nuclear safety, like aviation safety, is the exclusive domain of the Central Government and not be regulated by the local governments or counties.

However, some local counties have shown their interest in matters relating to nuclear safety; for example, New Taipei City Government and Pintung County Government have established the Nuclear Safety Monitoring Council. In response, the AEC expressed its intent to cooperate with the local counties in the area of nuclear safety by keeping the counties informed of matters which they are interested in and invited the county officials to observe AEC's inspection activities.

The TPC, the largest producer of radioactive wastes in this country, also plays a major role in communicating with the local counties and townships on selecting the site of low-level or high-level waste repositories.

8.3.3 Legislative Yuan

The Constitution states that the Legislative Yuan (LY), composed of the public-elected representatives, shall be the supreme legislative body of the country and shall exercise the legislative power on behalf of the people. In terms of its competence, power, and function, the Legislative Yuan is equivalent to a parliament in other democracies.

According to Article 5(1) of the Articles of the Legislative Yuan's Procedure Committee, the Education and Culture Committee is responsible for the related bills of the Ministry of Education, the Ministry of Culture, the National Palace Museum, the Government Information Office, the Academia Sinica and the AEC. According to Article 2 of the Articles of each LY's Committee, each Committee shall review bills assigned by the LY's Conference and petitions of the public. At the beginning of a session, legislators may invite government representatives to provide reports or make presentations at the committee meetings and give their comments on these issues.

8.4 Separation of Functions of the Regulatory Body from Those of Bodies Promoting Nuclear Energy

Separation of Functions of the AEC from the MOEA

Based on the Atomic Energy Act, the AEC has the regulatory authority for the nuclear power and radioactive materials. The MOEA under the Executive Yuan is responsible for maintaining the stable supply of electricity. The Bureau of Energy (BOE) is a subordinate agency of the MOEA for developing the national energy policy. The BOE also has the responsibility of forecasting and promoting the supply and demand of electricity. The MOEA used to play the role of promoting various types of energy, while the AEC focused on the safety regulation for nuclear energy utilization. The functions of the AEC are well separated from the MOEA. The Taiwan Power Company, as a State-Owned Corporation, is supervised by the MOEA and is responsible for ensuring nuclear power operation safety through various efforts including research and demonstration projects and the accumulated experiences on construction and operation of nuclear power plants.

8.5 Measures to Enhance Transparency of Nuclear Safety Information

Increasing public participation and ensuring public openness of regulatory information are the key items of governance to be carried out continuously by the AEC. By encouraging public participation and listening to public opinions, the AEC can improve its communication and effectiveness in dealing with safety regulation matters. In addition, by disclosing the regulatory related information on external websites, it can achieve the transparency of information, allowing citizens to access the correct regulatory information.

To increase public participation, the AEC established the Public Participation Platform in 2016. For issues related to safety regulation transparency, such as public hearings, visiting activities, meetings or conferences related to decommissioning of nuclear power plants, the general public can be fully informed of the issues involved in policy making or evaluation, through a two-way communication process. Furthermore, the public opinions and suggestions will be actively sought and considered as references when making decisions. In 2021, the AEC further upgraded the Public Participation Platform to the Public Participation Committee, where experts, scholars, disinterested community members or representatives of civil groups will be invited by the AEC to discuss with the staff members of related businesses in the AEC, providing suggestions regarding the issues related to public participation within the operations of the AEC, such as agendas setting, participation and interaction of general public, feedback and follow-up of opinions, or other issues that enhance public participation and public communication, so as to promote public participation and improve the effectiveness of dealing with safety regulation issues.

Regarding the transparency of regulatory information, the information related to regulatory operations, including important policies, laws, nuclear regulations, radiation protection, emergency response, environmental radiation monitoring, and radioactive material management, is available on the AEC website. This information also covers international cooperation and the aforementioned public participation. Furthermore, to comply with the policy of open data of Taiwan government, the AEC has also set up a dedicated area on the website, providing data with a certain quality in an open format.

The TPC also ensures the transparency of nuclear power by providing the public with comprehensive and timely information of nuclear power plants, such as the real-time operational status of NPPs, the environmental radiation level, and other relevant topics. This enables the general public to gain more insight into the achievements of nuclear power safety.

To promote the transparency of decommissioning regulation information and the public participation, the AEC has established a dedicated regulatory area of nuclear power plant decommissioning on the external website, offering the general public access to the regulatory operation information related to decommissioning. Before completing the review of the nuclear power plant decommissioning plan, the AEC will also submit the decommissioning plan to the local government where the nuclear power plant is located, for opinions. Moreover, local hearings and on-site investigations will be held, with local governments, legislators, village chiefs, local residents, associations and civil groups being invited; and the local village chiefs and the opinion leaders will be visited, as well. Through these related activities, the decommissioning operation and safety regulation will be explained, and the opinions from the local citizens and public groups will be collected, which are taken as the references for the review and regulation operation, thereby improving the decommissioning safety regulation. If citizens have any opinions on the decommissioning safety regulation, they can also submit them through the chairman's mail box on the AEC website.

A summary of the public participation activities related to nuclear power plant decommissioning regulation from 2019 to 2022 is presented below:

- In March, 2019, the on-site investigation and the local hearing were held once respectively, before reviewing the decommissioning plan of Kuosheng NPP.
- In July and August 2020, the on-site investigation was held twice and the local hearing was held once, before accomplishing the review of the decommissioning plan of Kuosheng NPP.
- In May 2021, the local hearings were held for the decommissioning regulation of Chinshan and Kuosheng NPPs.
- In November 2021, the local hearings were held before reviewing the decommissioning plan of Maanshan NPP.
- In March 2022, the on-site investigation was held twice for the decommissioning plan of Maanshan NPP.

Furthermore, in the event of earthquakes and severe weather, such as torrential rain and typhoons, the AEC will also publish up-to-date information of the condition of nuclear power plants and response measures taken on its website, and continuously monitor plant response activities, to strengthen the oversight of nuclear power plants.

ARTICLE 9. RESPONSIBILITY OF THE LICENSE HOLDER

Each Contracting Party shall ensure that prime responsibility for the safety of a nuclear installation rests with the holder of the relevant license and shall take the appropriate steps to ensure that each such license holder meets its responsibility.

9.1 Prime Responsibility of the License Holder for the Safety of Nuclear Installations

As stipulated in Articles 5 and 7 of the Nuclear Reactor Facilities Regulation Act, the holder of the construction license (CL) of a nuclear reactor facility bears the responsibility to construct an NPP safely as approved and with the conditions imposed by the regulatory body at the time when the CL was issued. Similarly, as specified in ~~the~~ Articles 6 and 7 of this Act, after the construction was completed and the application for operating an NPP was granted, the holder of the operating license (OL) shall undertake the responsibility for operating the NPP safely as approved to ensure that the health and safety of the public are protected.

To sum up, based on the nuclear regulation laws in Taiwan, the prime responsibility for the nuclear safety of the operating NPPs and the NPP under construction lies with the license holder, which in Taiwan is the TPC.

9.1.1 Organization of the Taiwan Power Company and Mechanism for the License Holder to Empower Its Prime Responsibility for Safety

As illustrated in Figure 9.1, the latest organizational structure of the TPC consists of four main divisions (including the Distribution and Service Division, Transmission System Division, Nuclear Power Division, and Power Generation Division), one research institute (the Taiwan Power Research Institute), several offices, many departments and about seven committees that are responsible for addressing cross-departmental issues.

On December 17, 2015, the TPC announced that its nuclear sector will be reorganized and later the Nuclear Power Division was established on January 4, 2016. As shown in Figure 9.2, the TPC Nuclear Power Division is composed of Department of Nuclear Generation (DONG), Department of Nuclear Safety (DNS), Department of Nuclear Engineering (DNE), Department of Nuclear Back-end Management (DNBM), Nuclear Safety Committee (NSC) and a Planning Office as well as the Nuclear Emergency Planning Executive Committee (NEPEC). The Chief Executive Officer (CEO) of this Nuclear Power Division is a vice president (in Nuclear) of the TPC, while the deputy-CEO is a Chief Engineer.

TPC has one NPP in operation and two under decommissioning. Each NPP has two identical nuclear units. As illustrated in Figure 9.3, the general organization chart of a TPC's NPP shows that there are one Plant General Manager (PGM) and three Deputy Plant General Managers (DPGM) in each of the operating NPPs. Among these 3 DPGMs, one is in charge of the operation. DPGMs will act as assistants to the PGM and, if the PGM is absent or not available, one of the three DPGMs will assume the authorities to act as the PGM.

As stated in the approved FSAR of each operating NPP, the license holder of the plant shall be responsible for the design, construction and safe operation of the plant. The FSAR of each plant also defines the responsibilities of the operational staff to carry out their duties for safely operating the plant. The PGM shall bear the principal responsibility for all phases of operation and maintenance. He is responsible for the safe, orderly, and efficient operation of the NPP and for the adherence of operation to the requirements of the operating license and technical specifications (TS). He is also responsible for the training and retraining of the reactor operators (ROs) and senior reactor operators (SROs) as well as maintaining a qualified staff of technical and operational personnel for his plant. A PGM reports to the vice president of Nuclear of the TPC via the Director of DONG and implements the policies as set forth by the TPC management as well as those prescribed by the Nuclear Safety Committee (NSC) at the TPC headquarters.

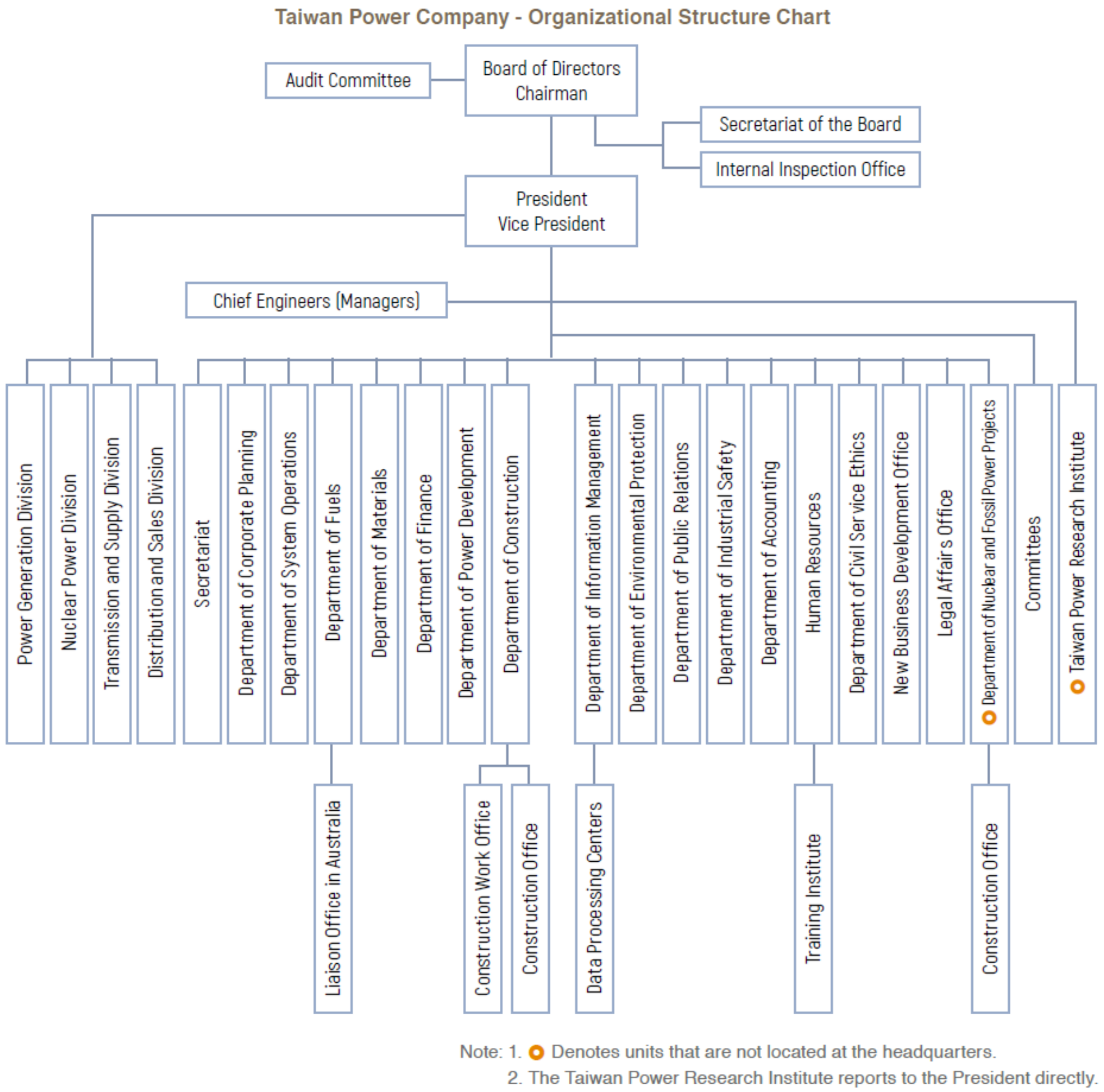

Figure 9.1 Organization Chart of Taiwan Power Company

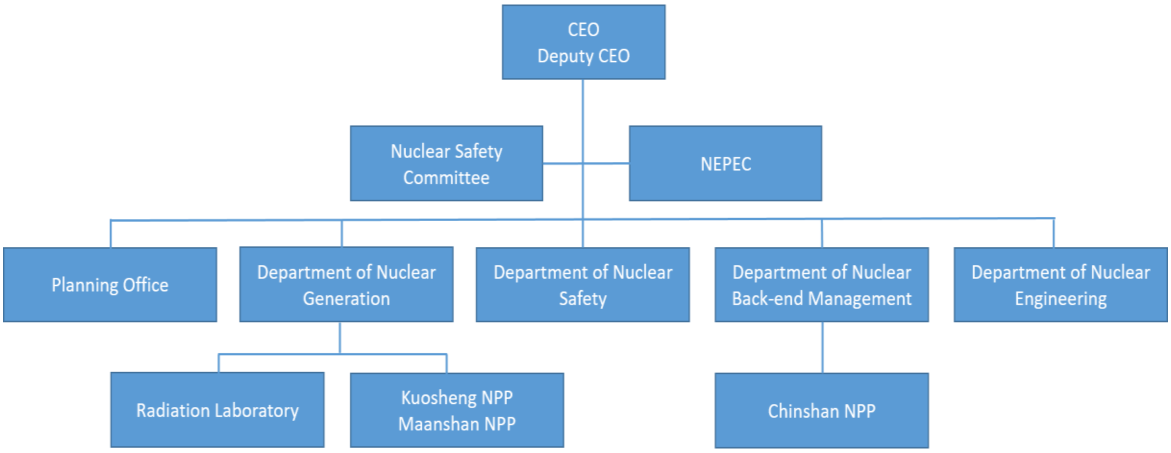

Figure 9.2 Organization Chart of the TPC Nuclear Power Division

If the PGM and all three DPGMs are not available, the PGM will delegate his responsibility to the Operation Section Manager. When the PGM, three DPGMs and the Operation Section Manager are all not onsite, such as after office hours, the on-duty Shift Manager (SM) of the plant will be responsible for the operation of the plant and the observance of the requirements of the OL and TS.

The Operation Section Manager oversees the plant operation and performance under the guidance of the DPGM in charge of operation and works closely with the managers of other technical sections. The Operation Section Manager must have a valid SRO license issued by the AEC.

The SMs of the plant receive technical direction from the Operation Section Manager, but report directly to the DPGM in charge of operation. The SMs who must have valid SRO licenses issued by the AEC are responsible for the plant operation during their shifts and have the authority to shut down the reactor if necessary based on their judgment.

The main responsibility of the on-duty Shift Leaders (SL) of the nuclear units is to control the nuclear power reactor units and meet the plant load demand. They must have valid SRO licenses issued by the AEC, too. In case of an emergency event, if the SM is not available, the on-duty SL of a unit has the authority and responsibility to act on behalf of the SM. Currently, the on-duty SL is fully staffed and must have the SRO license, all meeting the requirement of technical specification.

In each NPP, there is a Station Operation Review Committee (SORC) established to advise the PGM on matters concerning nuclear safety. In an operating NPP, the SORC is responsible for reviewing all safety-related affairs and providing recommendations to the PGM. For example, one of the major responsibilities of the SORC includes the review of:

- Procedures newly prepared or revised
- All proposed test or corrections which may affect the nuclear safety systems or components,
- Amendment of the TS,

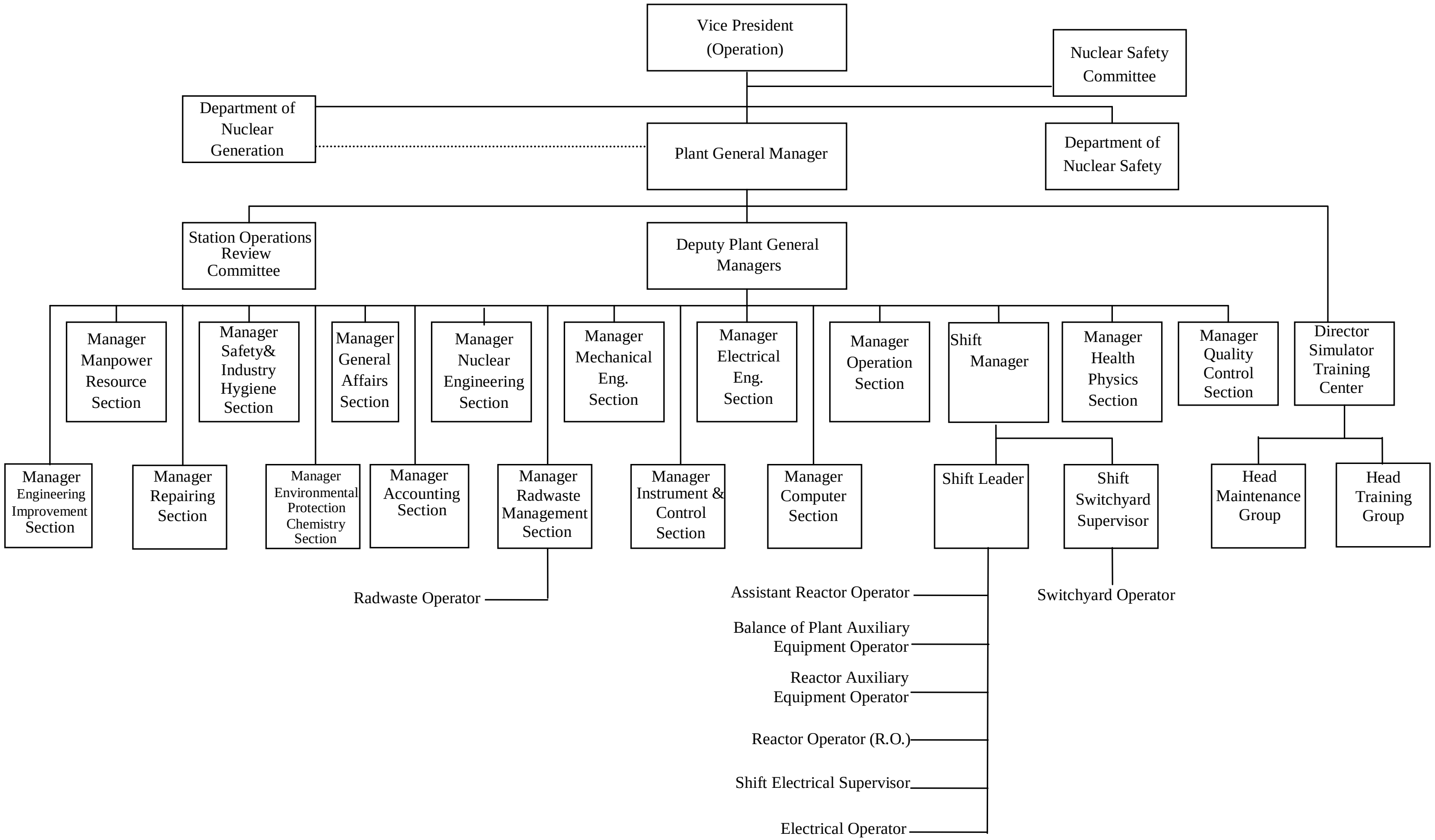

Figure 9.3 General Organization Chart of the TPC’s Nuclear Power Plant

- All proposed changes or modifications which may affect the nuclear safety systems or components,

- All TS violation events,

- All reportable event reports,

- Plant emergency plan, and etc.

Whenever a plant operating procedure is newly prepared or revised, it will be reviewed by the SORC of the NPP, and then approved by the Plant General Manager.

At TPC headquarters, both the Department of Nuclear Generation (DONG) and Department of Nuclear Safety (DNS) are responsible for providing support and guidance to the plant staff to safely operate the plant. However, the final responsibility rests solely on the TPC (the license holder).

9.1.2 Mechanism for the License Holder to Maintain Open and Transparent Communication with the Public

With a sincere attitude and fair viewpoints**,** the TPC presents information about the company in six aspects to the public through its website, including the information on management, power generation, demand & supply of electricity, customers, environment, and construction engineering. In the aspect of power generation, for example, one can obtain information from TPC's website about the current status and performance records of the fossil power and/or nuclear power management, renewable energy, electricity purchased by TPC from the independent power producers (IPP) (i.e., private utilities), and measures in response to the Fukushima Daiichi nuclear accident.

Moreover, the TPC formed a "Nuclear Communication Team (NCT)" to act as a communication channel about the nuclear affairs between the general public and the TPC. The ways in which this NCT communicated with the public including:

- Regularly hosting international nuclear conferences to have foreign experts deliver speeches about nuclear related knowledge to the public.

- Dispatching trained employees from nuclear sectors of the TPC to communicate face-to-face with the public, students and private companies.

- Creating a specific website to discuss the fundamental nuclear knowledge and publish information about specific nuclear-related topics and regularly updating the contents of this website.

- Publishing newsletters to actively counter incorrect reports on the media.

More information about the licensee's transparent policy can be seen in Subsections 10.3 and 19.10.

9.1.3 Mechanism for the License Holder to Ensure Having Appropriate Resources (Technical, Human, Financial) for On-site Accident Management and Consequence Mitigation

As illustrated in Figure 9.2, there is a Nuclear Emergency Planning Executive Committee (NEPEC) under the TPC Nuclear Power Division in TPC Headquarters which is responsible for emergency response to nuclear accidents. In case a nuclear accident were to occur at an NPP, the NEPEC will be in charge of directing and coordinating the manpower, materials and financial support to the onsite emergency response actions in order to mitigate the impact and recover from the accident. Whenever offsite supports are needed in emergency response to a nuclear accident onsite, the NEPEC may report to the National Nuclear Emergency Response Center (NNERC), which is under the Executive Yuan (refer to subsection 16.1.1.1), to ask for help.

The Chairman of NEPEC is also the Vice President of the TPC. As depicted in Figure 9.4, the NEPEC is composed of 10 groups: Dose Assessment, Accident Assessment, Environmental Monitoring, Maintenance Support, Regulatory Planning, Exercise Planning, Operational Support, Public Relation, Logistic Support, and Finance & Accounting. Under the supervision of NEPEC, there is also an Emergency Operation Facility (EOF) staffed by technical people dispatched from the groups of Operational Support, Dose Assessment, Accident Assessment, and Environmental Monitoring of NEPEC.

The EOF is a TPC (the licensee) controlled and operated offsite support center. It has the following facilities for:

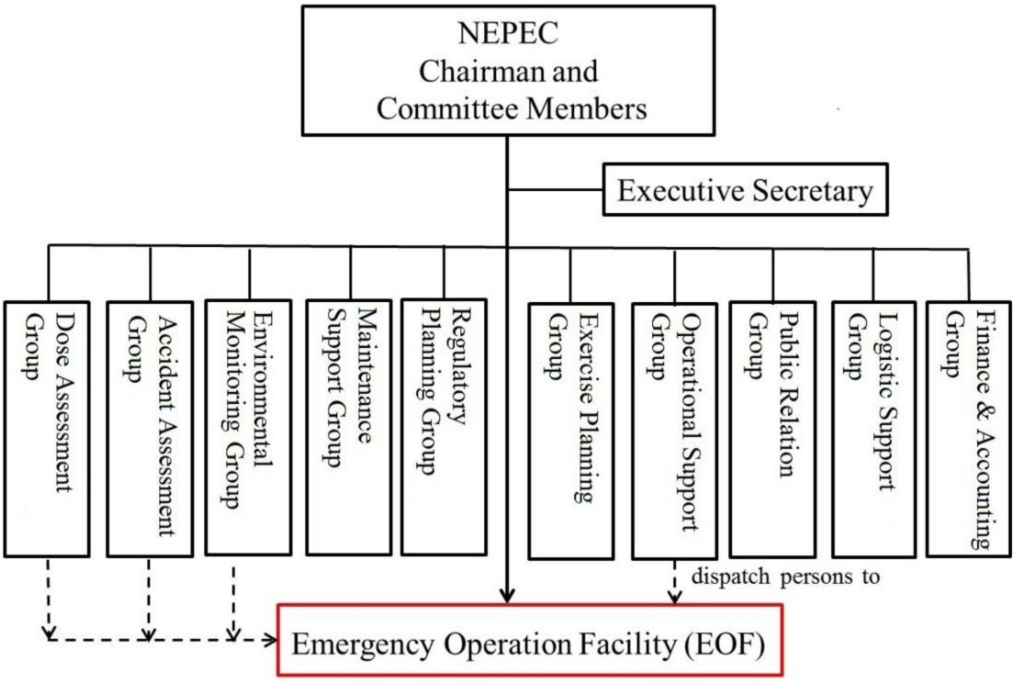

Figure 9.4 Organization Chart of the Nuclear Emergency Planning Executive Committee (NEPEC)

- Management of overall licensee (TPC) emergency response,
- Coordination of radiological and environmental assessment,

- Determination of recommended public protective actions, and
- Coordination of emergency response activities with central and local government organizations.

9.2 Mechanism for the Regulatory Body to Ensure that the License Holder Will Meet Its Prime Responsibility for Safety

The AEC, in accordance with the Atomic Energy Act of 1968 (as amended in 1971) and the Nuclear Reactor Facilities Regulation Act of 2003, has the responsibility to verify that the license holder of a nuclear installation complies with the license conditions throughout the lifetime of the plant. It is the AEC's responsibility to ensure that the license holder fulfills its legal duties, meets the regulations and carries out all the terms and conditions as specified in the licenses. Application for the construction or operating license of a nuclear power installation requires the approval of the AEC as described in Subsection 6.2.3.1 of this report.

During the construction stage, the AEC will conduct a comprehensive review of the safety design of an NPP and the capability of the applicant to design, construct, and safely operate a nuclear facility. In the meantime, the AEC will carry out various inspections to supplement the safety review as well as to ensure that the construction and its quality are in compliance with the requirements of the construction license.

The AEC will conduct inspections on the pre-operational tests performed by the operating license applicant, to verify that the NPP is constructed according to the approved design and licensing documents. After fulfilling all the requirements for the initial fuel loading as specified in Subsection 6.2.3.1 and obtaining an approval from the AEC, the applicant can start the initial loading of the nuclear fuel. Then, with the completion of all the startup tests (or power tests), including the systems' functioning benchmarks, criticality tests and power ascension tests, and an approval from the AEC, the applicant will receive an operating license for commercial operation. After the operating license is issued, the AEC will continue, by using all kinds of regulatory means including reviews and inspections, to make sure that the licensee maintains the operation safety of its NPPs.

The operation of an NPP must undergo periodic inspections from the AEC to ensure that the performance of the plant remains in compliance with the technical standards prescribed in the relevant provisions, and that other aspects are consistent with what they were during the pre-operational inspections.

The licensee is required to submit reports on operation, radiation safety and environment monitoring, emergency events, radioactive waste production, in-service inspections and tests, and the dose evaluation on the residents near the plant to the AEC regularly or within a required period after the occurrence of an event. By reviewing these reports, the AEC will be able to understand the safety conditions of an NPP better.

Additionally, the AEC regularly holds a regulatory meeting with the TPC's high-ranking staff members from the headquarters such as the Vice President of Nuclear, managers from the DONG and/or DNS to discuss and exchange opinions on nuclear safety issues of mutual or individual interest. This kind of regulatory meeting between the regulatory body and the license holder is believed to be beneficial to the promotion of nuclear operational safety.

In the event of a violation of the regulations, the AEC will immediately request the license holder to take corrective and preventive measures so as to secure the safety of the NPP. For example, if the operator of an NPP failed to meet the license conditions, the AEC may order the revocation of the license or the suspension of the license for a given period of time. Failure of an NPP to conform to the conditions imposed on the construction or operating license would subject the licensee to enforcement actions, which may include receiving a formal violation notice, having the license modified, suspended or revoked, and/or receiving a fine notice. The AEC may also order specific corrective actions or transfer the violation case to the court to ask for penalties including criminal prosecution or a fine. More information about the penalty for violations of regulations can be found in Subsection 19.7.

9.3 Prime Responsibility of the License Holder for the Decommissioning of Nuclear Installations

According to Article 23 of the Nuclear Reactor Facilities Regulation Act, the holder of the operating license (OL) of a nuclear reactor facility shall be responsible for filing an application, attaching the decommissioning plan, with the AEC three years before the scheduled permanent cessation of operation of the nuclear reactor facility. The decommissioning shall not commence until the application has been reviewed and approved by the AEC in accordance with the following requirements and a decommissioning permit has been granted:

1. The activities of decommissioning shall be sufficient to protect the public health and safety;

2. The impact to the environmental protection and ecological protection shall comply with the prescription under relevant laws/statutes and decrees;

3. The activities of radiation protection and the administration of radioactive materials shall be complied with the prescription under relevant laws/statutes and decrees;

4. The technical, the management ability and the financial data, etc., of the applicant shall be competent to execute the decommissioning.

The regulations for the documents required for applying for a nuclear reactor facility decommissioning permit, review and approval procedures, and other matters are described in the “Regulations on the Permit Application and the Management for Decommissioning of Nuclear Reactor Facilities,” amended by the AEC in 2018.

Moreover, according to the Nuclear Reactor Facilities Regulation Act, a decommissioning plan must be submitted by the licensee three years prior to the scheduled permanent end of a nuclear reactor’s operating life, and TPC submitted the Chinshan decommissioning plan to AEC on 24 November 2015, and it was approved by AEC on 28 June 2017. Following the approval of the environmental impact assessment by the Environmental Protection Administration on 2 July 2019, the Chinshan nuclear power plant finally received the decommissioning permit on July 12, 2019, which came into effect on July 16, 2019. The decommissioning plan for the Chinshan NPP can be divided into four major phases and the decommissioning itself will be completed within 25 years after obtaining the decommissioning permit. The TPC is now undertaking the first phase in the decommissioning plan (an 8-year transition phase), including the tagging out and drainage of systems that cease operation, conducting maintenance and test on systems that are necessary to be operational, dismantling transmission line between main transformer and 345 switchyard and gas turbine building, the radiological characteristic survey, the construction of an indoor Spent fuel dry storage facilities , the establishment of radioactive waste management area, and the planning of dismantling.

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ARTICLE 10. PRIORITY TO SAFETY

Each Contracting Party shall take the appropriate steps to ensure that all organizations engaged in activities directly related to nuclear installation shall establish policies that give due priority to nuclear safety.

10.1 Overview of the Arrangements and Requirements to Prioritize Safety

10.1.1 Nuclear Safety Policy

The Atomic Energy Council (AEC) was founded as a ministerial level government entity in 1955 to handle the international affairs in the field of nuclear energy. Then, on May 7, 1968, the “Atomic Energy Act” was promulgated and in accordance with this Act (which was amended later in 1971), the AEC became a ministry-level organization under the Executive Yuan (the Cabinet) as established by law. To serve as the Nation’s governing authority of atomic energy related affairs, the AEC holds the responsibilities over safety regulation of nuclear facilities and radiation workplaces, and protection of the public and the environment from the adverse effects of radiation associated with nuclear materials and facilities. To ensure the safety of atomic energy applications, the AEC strictly implements the laws for nuclear safety regulation, radiation protection, environmental radiation detection, and management of radioactive wastes. For the regulation of nuclear and radiation safety, the AEC upholds the principles of “safety first, reasonable regulation, and simplified process for the people”. The AEC will continue to strengthen the capability of response to nuclear incidents, and to reinforce safety regulation for the application of ionizing radiation in domestic medical, agricultural, academic and industrial sectors, so as to ensure the health and safety of radiation workers and the general public. In addition, the AEC will exert more efforts in enhancing the transparency of nuclear safety information to the public.

10.1.2 Commitment to Nuclear Safety

The AEC is the governing authority for the regulation of all atomic energy related affairs in the country. “Safety” has always been the top priority in the AEC’s line of responsibilities. For effectively carrying out its mandates, the AEC will keep on exerting its greatest efforts in the development of relevant Acts and regulations, improvement of regulatory mechanisms, enhancement of technical expertise and professional competence, and fostering of the safety culture. To earn the public trust, the AEC is committed to ensuring the highest standards of nuclear safety and radiation protection.

In order to enhance the safety of nuclear power plants, the TPC announced a “Nuclear Power Operational Safety Policy” at the initial stage of the safety culture development period. In March 2017, the AEC suggested that the nuclear back-end management should be included in the policy because the Chinshan NPP would enter the decommissioning phase. The TPC revised the “Nuclear Power Operational Safety Policy Statement” on April 13, 2017. This revision mainly incorporated the operational safety of the nuclear energy back-end into the policy statement, and the newly revised nuclear energy operational safety policy statement is as follows:

The TPC follows the nuclear regulations and considers the nuclear energy operation safety as the most important prerequisite, and ensures the operation safety of nuclear energy units and the back-end operation of nuclear energy, protects the safety and health of the public, and avoids the environment suffering from the harmful effects of ionizing radiation. In order to achieve these safety goals, the nuclear safety management is the first priority task of nuclear power operation. In order to promote the performance of the nuclear power operational safety, all colleagues in the nuclear operation departments have to collaborate to develop good nuclear safety culture with a proactive and responsible attitude, and a sense of mission and honor. The safety culture has to be demonstrated in every daily practice as well. It is expected that all these efforts will make the TPC's nuclear safety operation progress from good to excellence.

10.2 Licensee Nuclear Safety Culture

The AEC continually reminds and encourages the TPC to foster a safety culture. In the aftermath of the Chernobyl accident in 1986, the International Nuclear Safety Advisory Group (INSAG) of the IAEA stressed that the safety culture should be well established, understood and respected throughout the organizations of nuclear installations. Under the leadership of the IAEA, significant discussions and developments in this area have been made ever since. Following this international trend, the TPC has developed its own safety-culture fostering program by referring to the associated IAEA reports since 1988.

10.2.1 Safety Culture Implementation Plan

In the year 1989, the TPC became one of the founding members of the World Association of Nuclear Operators Tokyo Center (WANO-TC) by signing an agreement to join. Through various exchanges and KPI indicators with WANO members and WANO peer review, the company maintains the operating philosophy of "Safety First" for industrial safety, radiation safety and nuclear safety during its operation. After going through the processes of instruction by consultants, organization changes, trainings, meetings and discussions, the TPC established a "Safety Culture Implementation Plan" in 1993 and has been implementing this plan since 1994.

10.2.2 Safety Culture Reinforcement Plan

In July, 1996, the TPC issued the "Prevention Measures for Human Errors in Nuclear Power Plant" to reduce incidents caused by the operators. Furthermore, the TPC initiated a "Nuclear Safety Culture Reinforcement Plan" in 1997 to elevate the safety culture to a higher standard. In addition, there are 12 indicators divided into 2 categories that were selected to evaluate the performance of "Nuclear Safety Culture Reinforcement Plan". Along with the above programs, the TPC also conducted the safety culture assessment to evaluate the effects of these programs on safety performance and to identify the weaknesses. This assessment included two parts: one was the safety culture indicators review and the other was the performance evaluation. For the latter part, a team consisting of members from the TPC head offices and the nuclear power plants visited each plant site for the safety culture performance evaluation. In addition, the Commission of National Corporations of the MOEA, which is the supervisory organization of the TPC, also organized a team with experts from universities, government agencies and news media to assess the plant safety culture annually. All findings by these teams were fed back to the plants for the improvement of safety culture.

10.2.3 TPC Safety Culture Enhancement Plan

Drawing on lessons learned from the Fukushima NPP accident, an enhancement on safety culture program has been developed by the TPC since June 2011 to ensure a high level of nuclear safety for protecting people's life and property. In addition to this program, the TPC has responded to the items as follows:

- The recommendations of annual nuclear safety culture task force of State-owned Enterprise Commission of the MOEA;
- The post-implementation review of each nuclear power plant;
- Decommissioning commitments of Chinshan NPP.

The TPC continually reviews and revises the scoring methodology and applicable units for performance ratings. This advanced SC program covers 4 major areas: management effectiveness, contractor management, risk management and personnel performance.

10.3 Nuclear Safety Regulatory Action of the Regulatory Authority

The Atomic Energy Act is the fundamental Act that provides the legislative and regulatory framework for the utilization of nuclear energy. The objectives of this Act are to promote the research and development of the nuclear energy science and technology, and the development and peaceful uses of nuclear resources. The Atomic Energy Act was first promulgated in 1968 and then amended in 1971. The Article 3 of this Act stipulates that the "Responsible Agency" for the Act shall be the AEC.

The major tasks of the AEC in its initial years were limited to the management of international affairs concerning atomic energy and the promotion of the peaceful applications of the atomic energy in the country. The most important tasks of the AEC have gradually evolved to include safety regulation, radiation protection, nuclear waste administration, and R&D for the nuclear technology and civilian nuclear applications. The legislative and regulatory framework, Acts, regulations, and requirements associated with the nuclear safety are presented in Article 7, while the structure and responsibilities of the AEC are introduced in Article 8 of this report.

10.3.1 Licensing

Typical and of utmost importance in licensing is the construction and operation of NPPs. As is presented in Subsection 6.2.3.1, a two-step licensing review process is followed for the issuance of construction, initial fuel loading, and start-up test permits, before an operating license (OL) is issued. An operating license will be granted to the applicant after a detailed review of the updated FSAR and start-up test results by verifying the compliance with licensing requirements. As plant operators play a key role in their dynamic responses to normal operations and anomalies, their qualification and ability are crucial for nuclear safety. Plant reactor operators (ROs) and senior reactor operators (SROs) are required to pass stringent tests, including written examination, plant walk-through and simulator operation, before they are authorized to work at the main control room (MCR) of the plant.

In accordance with the Nuclear Reactor Facilities Regulation Act of Taiwan and pertinent IAEA safety standards, the licensee is required to conduct Periodic Safety Reviews (PSRs) every 10 years for the operating NPPs in Taiwan. The 10-year integrated safety assessment report (ISAR) includes chapters on operation safety, radiation safety, nuclear waste administration, major plant modifications, aging management of SSCs, seismic re-evaluation, lessons learned from significant events, and feedback from domestic and foreign experiences and research results.

10.3.2 Inspections and Regulatory Actions

While safety evaluations aim to ensure compliance between licensing documents and safety requirements, the regulatory inspections concentrate on whether the work and performance of NPPs meet the design requirements set forth in the licensing documents. Various types of regulatory inspections, such as resident inspections, regular inspections, refueling outage inspections, project team inspections, and special team inspections, as well as unannounced inspections, are implemented. Resident inspection is carried out by resident inspectors stationed at each nuclear power plant, who verify the daily operation items and selected surveillance and important operations of each power plant unit, oversight the site conditions and report it back to the AEC. Periodic refueling outage inspection is to verify the various maintenance and relevant work during the refueling outage, and ensure the quality of the relevant activities. Project and special team inspections are to conduct team inspections of specific matters, and when necessary, external experts will be enlisted to participate in the inspection work. In addition, each nuclear power plant will undergo an unannounced inspection every six months.

For the inspection findings, the AEC will also take various regulatory measures in accordance with their nature and degree of impact on safety. These include issuing notices of improvement, violations and penalties. For licensees who do not comply with the regulations or pose a risk to public health and safety or the environment, they will be ordered to improve within a time limit or take other necessary measures. For those who commit serious violations and fail to improve or take necessary measures within the time limit, they may be ordered to halt the specific on-site operations or plant operation, or subjected to load-limited operation, license revocation, or fines.

10.3.3 Reactor Oversight Process

In order to provide the public with an easy way to understand the safety levels of the operating NPPs, the AEC has adopted the reactor oversight process (ROP) of the USNRC and developed the domestic ROP in late 2004. The performance indicators (PI) associated with initiating events, mitigating systems, barrier integrity, emergency preparedness, and nuclear security are evaluated in this system regularly. The results of the evaluations are translated into green, white, yellow or red colors to reflect the different levels of safety concern for each existing NPP. The public can easily tell how safe the plants are from the website of the AEC. These colors are also important references for the AEC to decide the frequencies and scopes of inspections for each NPP.

The AEC has posted the performance indicators of nuclear power plants and significance determination process (SDP) evaluation results of inspection findings on its website since 2004 and 2006, respectively. Inspectors conduct inspection and initial screening of the findings.

The PRA is used to assess the probability, progression and consequences of equipment failures or transient conditions to derive numerical estimates that provide a consistent measure of the safety of the reactor facility. The AEC has been developing and using PRA as a tool to enhance the evaluation of the safety of NPPs since 1982. The “PRA Model Based Risk Significance Evaluation Tool” (PRiSE) developed by the INER is used by the

AEC for risk significance estimation and justification in SDP. The TPC has been submitting to AEC the PRA results from data updates every 3 to 5 years since the late 1990s. The TPC is committed to following the PRA standards to build-up, update and maintain the PRA models.

10.4 Independent Safety Assessment and Voluntary Activities

10.4.1 WANO Safety Review

The TPC has invited several international nuclear groups, such as the World Association of Nuclear Operators (WANO), for safety reviews and discussions. Based on the suggestions of the aforementioned international specialists, the TPC has implemented many improvements. For example, they have improved the housekeeping, revised operating procedures, enhanced the head office's governance and supervision structure and system for nuclear power plants, upgraded basic maintenance skills, and established comprehensive risk management procedures, etc. At the same time, they have lowered the threshold of human performance enhancement system (HPES) to deal with the human errors that have not caused significant adverse consequences, and hence, to further reduce the risk caused by human errors.

10.4.2 Voluntary Activities and Good Practices Related to Safety

One of the many voluntary activities related to nuclear safety is the experience feedback. This activity involves collecting and studying the worldwide operational and regulatory information by the AEC and the TPC, in order to learn from the previous experiences. Causes of abnormal events are investigated to check if similar situations exist in domestic facilities. Good practices are assimilated and disseminated among their staff members. In addition, safety issues experienced by any domestic plant would be reported to the other plants, so that similar mistakes can be avoided and good safety measures can be shared. To share the important operating and maintenance experiences among plants, the TPC implemented a program, namely, the Operating Experience (OE) program, to be applied to all its nuclear installations. It turned out that the OE program is a powerful tool for seeking ways of improving the performance of a nuclear power plant. In addition to the experience feedback program, a lot of additional efforts have been made to enhance the safety of nuclear facilities. Some examples are outlined as follows.

(1) Regulatory Conference

The AEC and the TPC hold regular meetings to discuss issues related to the safety **o**f NPPs, such as recent nuclear activities topics in the other countries, the malfunction and abnormal occurrences, safety improvement measures, etc. The purpose of these meetings is to reach consensus on the nuclear safety concerns and their remedies. The semiannual decommissioning regulation meetings have been held regularly since May 2019, with a view to discussing issues on decommissioning safety regulation.

(2) Investigation of Reactor Scrams

The two operating nuclear power units in Taiwan are designed and manufactured by vendors from the United States. Consequently, all essential activities for the NPPs, such as design, purchasing, fabrication, handling, shipping, storage, cleaning, erecting, installation, inspection, testing, operation, maintenance, repair, refueling, and modification, must comply with codes and standards similar to those issued by the

USNRC. Therefore, in the earlier years of operations of these NPPs, the permission for restarting an unit after its refueling outage was not required by the AEC. However, in order to reduce the frequency of nuclear unit scrams, the AEC decided in 1987 that any nuclear unit restart after its refueling outage would require AEC approval to ensure the maintenance quality of structures, systems, and components (SSCs) of the facility and to improve the plant performance.

Furthermore, if a reactor scram occurs, the TPC must report to the AEC the consequence and the probable root causes of the scram within two hours of its occurrence. The AEC may authorize the reactor to restart only when the root causes are identified, safety assessments are adequate, and necessary corrective actions have been taken. If an operating unit requires a safety-related design modification or equipment change, the TPC has to submit the application beforehand with necessary documents explaining its causes, procedures of modification, safety assessment and so on. The AEC will review these documents and monitor all the related activities until the modifications are successfully completed

(3) Investigation of Plant Abnormal Occurrence

Within 30 days of the occurrence of an abnormal event, the TPC has to investigate the root causes, propose corrective measures and submit a report to the AEC. The AEC will review the corrective actions and dispatch inspectors for field inspection if necessary. The implementation of the measures will be monitored by the AEC until the issue is resolved.

(4) Investigation of Plant Equipment Malfunction

In the event of an equipment malfunction that is significant to safety, the TPC has to investigate the root causes, propose corrective measures and submit a report to the AEC for review. The implementation of the measures will be monitored by the AEC until the issue is satisfactorily resolved.

(5) Development of Severe Accident Management Guidelines

Following the Three Mile Island (TMI) accident in 1979, the nuclear industry conducted a large-scale severe accident research to understand the phenomena and develop the analysis code for improving the prediction capability. The goal of the severe accident research was to develop the Severe Accident Management Guidelines (SAMGs) for the plant staff to mitigate the severe accident. By the end of 2003, the TPC had established its own SAMGs specific to the Chinshan, Kuosheng and Maanshan nuclear power plants, respectively. The development of the SAMG included the evaluation of the system status (hardware capability), plant control parameters (instrumentation availability), establishment of the interface between the emergency operating procedures (EOP) and the SAMG, verification of the SAMG and training of the operators.

After the Japan’s Fukushima Daiichi Accident in 2011, an Accident Management Team (AMT) has integrated the information of NEI 14-01 revision 0 emergency response procedures and guidelines for beyond design basis events and severe accidents, Boiling Water Reactor Owners Group (BWROG), Pressurized Water Reactor Owners Group (PWROG) and Nuclear Energy Institute (NEI) to develop abnormal operating procedures (AOPs), emergency operating procedures (EOPs), FLEX (diverse and flexible coping strategies (NEI 12-06)) support guidelines (FSGs), extensive damage mitigation guidelines (EDMGs), SAMG and specific major incident guidelines (SMI). These procedures and guidelines of Chinshan, Kuosheng and Maanshan NPPs are expected to enhance the severe accident management capability of the plant staff.

(6) Corrective Action Program

Based on the WANO's guidelines, the Maanshan NPP initiated its Corrective Action Program (CAP) in early 2007. Importance levels of these problems are also evaluated according to the significance of their impacts on plant safety and operability. Resources for corrections are then allocated according to the importance levels. In order to integrate CAPs of different NPPs, the Headquarters of the TPC started to develop a unified CAP for all existing NPPs in 2009. This program aims to integrate individual problem-solving mechanisms at the Chinshan, Kuosheng and Maanshan NPPs, so that the identification, categorization, correction, tracking, analysis, and resources integration for operational and maintenance problems can be implemented effectively. The root cause analyses, common cause analyses, trend analyses, evaluation of the effectiveness of corrective actions, and performance indicators associated with the NPP operation will be reinforced through this program. In addition, the management at the TPC Headquarters and information and resource sharing associated with the corrective actions can be effectively improved as well.

(7) Performance of the Maintenance Rule

To regulate the maintenance effectiveness of the NPP, USNRC issued "Maintenance Rule" (MR) in 1991 and required all US NPPs to implement this rule in 1996. The operational safety and performance of US NPPs were improved significantly since the implementation of the MR. In line with activities for the promotion of the operational performance such as License Renewal, self-regulated on-line maintenance and maintenance optimization, the TPC required its operating NPPs to implement the MR in August 2004.

(8) Improvement of the Technical Specifications

To address the shortcomings, Chinshan, Kuosheng, and Maanshan NPPs adopted the so called "Improved TS" (ITS) in February 2002, January 2008, and September 2004, respectively. In these ITSs, fire extinguish equipment, radiation protection and environmental monitoring, snubbers, equipment lists, meteorological instruments, and water chemistry are removed and controlled by the technical manual or specific programs. The improvements of the formats and contents make the operators understand the meanings of the TS much easier. In addition, the administrative burden associated with the implementation of TS was reduced, and hence, the operational performance was improved.

(9) Investigation of Near-Miss Events

The near-miss events are those events that involve some component failures or malfunctions, but the severity of which does not reach the level of an abnormal event. These events are divided into eight categories as follows: 1. work safety, 2. operation, 3. maintenance, 4. radiation safety, 5. nuclear safety, 6. traffic, 7. work process related, and 8. others. In order to further improve the NPP safety, the TPC established a "Near-Miss Team" to deal with this kind of events in 2002. The Near-Miss report form is available on the intranet system of the TPC, and the employees and contractors can initiate the near-miss reports and submit them to the Near-Miss team through intranet. The team will review the reports, investigate the root causes, and provide corrective actions when necessary. Rewards based on the benefit obtained will be given to the person or persons who submit the near-miss reports. In addition, the near-miss experience feedbacks are available in the intranet. Anyone in the TPC can access this valuable information and prevent similar errors from occurring again.

(10) Installation of Automatic Seismic Trip System (ASTS)

Following the disastrous Chi-Chi earthquake (M=7.3) that occurred on September 21, 1999, the AEC required the installation of an ASTS at each of the TPC's six operating nuclear units to further ensure plant safety. Installations and tests were completed in November 2007, and the systems have been in service ever since.

(11) Development of Specific Major Incident Guidelines

EOP and SAMG are symptom-based procedures to cope with severe accidents, depending on real-time operational parameters to mitigate the event consequence. For the compound severe accidents, such as the Fukushima nuclear accident, their impact on NPPs will be more widespread rather than focused on one system or one area. Considering this fact, the TPC has developed the specific major incident guidelines (SMI). The SMI is specifically designed to stop event progression, taking immediate actions to prevent core damage. SMI will be integrated with EOPs, SAMGs, and EDMGs similar to the Recommendation 8 of the USNRC Near-Term Task Force. The SMI guides the plant operators' conduct of reactor depressurization, core cooling water injection, and containment venting to prevent BWR and PWR from encountering core damage by beyond design basis accidents (BDBA) such as: (1) events severer than SSE earthquake and tsunami, (2) SBO, and (3) loss of UHS. Figure 10.1 shows the flow chart of SMI. The R&D experience of the TPC's SMI was presented and discussed at the international organization BWR Owners Group (BWROG) committee. The official edition of EPG/SAG Rev.4 was released in 2018. More information about the TPC's SMI is given in Subsections 18.4 and 19.4.2.

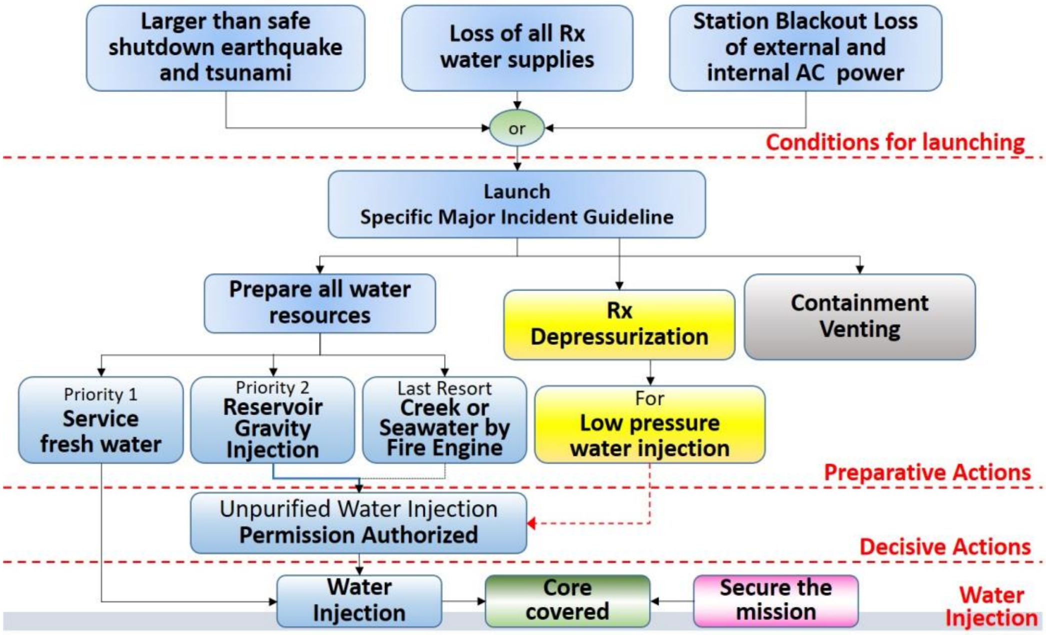

Figure 10.1 The Flow Chart of SMI

ARTICLE 11. FINANCIAL AND HUMAN RESOURCES

1. **Each Contracting Party shall take the appropriate steps to ensure that adequate financial resources are available to support the safety of each nuclear installation throughout its life.**
2. **Each Contracting Party shall take the appropriate steps to ensure that sufficient numbers of qualified staff with appropriate education, training, and retraining are available for all safety-related activities in or for each nuclear installation, throughout its life.**

11.1 Financial Resources

11.1.1 Financial Requirements

According to the Nuclear Reactor Facilities Regulation Act of 2003 (Articles 5 and 6), the Regulations on the Review and Approval of Applications for Construction License of Nuclear Reactor Facilities of 2004 (Article 3), the Regulations on the Review and Approval of Applications for Operating License of Nuclear Reactor Facilities of 2004 as amended in 2005 (Article 14), and the Enforcement Rules of the Atomic Energy Act of 1976 as amended in 1996 (Article 15), the license applicant of an NPP must have, in addition to the technical and management capabilities, adequate financial resources for the safe operation of the nuclear facility throughout its lifetime to qualify for a construction license (CL) (which was previously called a construction permit), an operating license, or the nuclear fuel license.

According to the Nuclear Damage Compensation Law of 1971 (as amended in 1977 and 1997)**,** the license holder is responsible for compensating the individuals whose health (or lives) and property are damaged by a nuclear accident. Under this Law, the compensation liability is limited to a total amount of 4.2 billion NTD. Following the Fukushima accident, the AEC proposed an amendment of the Nuclear Damage Compensation Law, which would increase the limit of compensation liability from the current 4.2 billion NTD to 15 billion NTD.

11.1.2 Financial Resources Requirements of the Construction Licensee

According to Article 2 of the Regulations on the Review and Approval of Applications for Construction License of Nuclear Reactor Facilities of 2004, a qualified applicant for a CL of a nuclear reactor facility must be a legal company with assets exceeding 100 billion NTD.

11.1.3 Financial Provisions for Decommissioning and Radioactive Waste Management

According to the provisions of Paragraph 1 of Article 89 of the Electricity Act—during the operation of its nuclear power plant, the power generation industry should allocate sufficient funds to serve as a nuclear power generation back-end management fund. The TPC estimated the total cost for these nuclear backend activities on the basis of the installed capacity, projected quantity of the radioactive waste, the commodity price index (CPI) and the international experiences. This fund has been collected on the basis of the amount of electricity generated by the NPPs since 1987. In the first two years, the sharing rate of electricity for the fund was set at NT$ 0.14 per kilowatt-hour (kWh) of electricity generated by the nuclear power and was gradually raised to NT$ 0.17/kWh in 1993 and then to NT$ 0.18/kWh in 1998. In 1999, “Rules for Control and Application of the Nuclear Backend Fund” was promulgated and became effective. The management of the backend fund and the collection rate for this fund were thus based on this Rule. The collection rate for the Nuclear Backend Fund was between NT$0.14 and NT$ 0.18 per kWh in the past. In recent years, the rate has been NT$ 0.17/kWh. On January 10, 2018, the Ministry of Economic Affairs promulgated the "Regulations for the Collection of Nuclear Power Generation Back-end Management Funds", and thereafter, the financing method for the back-end management of nuclear power generation changed to an average annual fixed amount method. The amount of the fund would be determined by the Ministry of Economic Affairs. According to the " Regulations for the Fees of Back-end Operating Fund for Nuclear Power Generation", the charge estimate for the back-end expenses of nuclear power generation shall be reassessed by the back-end and disposal agencies every five years and reported to the Ministry of Economic Affairs for approval. If there is a major change in the due period, it shall be re-estimated and submitted for approval. On September 3, 2020, the Ministry of Economic Affairs approved a back-end fund of NT$ 472.9 billion, and stipulated that the cost would be allocated by an average annual apportionment of a fixed amount of 21.669 billion**.** This estimate has considered the current social situation and the requirements of nuclear regulations**,** and referred to the latest international technical information on decommissioning. As of the end of July 2022, the net amount of the backend fund came to NT$ 414.565 billion.

An ad hoc committee, established under the Ministry of Economic Affairs (MOEA), is in charge of the management of this fund. This Committee, known as the Nuclear Backend Fund Management Committee, consists of 14 members from related government organizations, universities or colleges, and research institutes. In the meantime, the AEC has been closely monitoring the fund-related activities since the establishment of this fund.

The cost of the treatment of radioactive waste generated from plant operation, waste volume reduction, improvement of the waste treatment facilities, operation and maintenance of the on-site waste storage facilities, and on-site transportation is covered by the maintenance cost of the plant. Some of the aforementioned items may be included in the nuclear backend fund when meeting the legal use purposes of the nuclear backend fund.

The Department of Nuclear Backend Management (DNBM) at the TPC headquarters is in charge of the planning and implementation of the radioactive waste disposal programs and future decommissioning of the TPC’s NPPs. The Radwaste Management Section of each NPP handles the treatment and storage of the radioactive waste generated by its own plant.

11.1.4 Financial Protection Program for Liability Claims Arising from Nuclear Accidents

The Nuclear Damage Compensation Law, enacted in 1971 (the latest amendment was announced in May 1997), regulates the compensation for nuclear damage arising from the peaceful use of atomic energy. The Act clearly states that "after a nuclear accident occurs, its operator is liable for compensation for the nuclear damage caused". The term "nuclear damage" refers to the damage caused by radioactivity or radioactivity combined with toxic, explosive or other hazards resulting from nuclear fuel, radioactive products, wastes or nuclear materials transported to and from a nuclear facility (such as a nuclear power plant), including loss of life, personal injury or property damage. The term "nuclear accident" refers to a single event or several events occurring simultaneously or successively that cause nuclear damage from the same cause.

According to the current “Nuclear Damage Compensation Law” (Articles 11 and 24), if a nuclear accident occurs in a nuclear power plant, the licensee is liable for the nuclear damage caused, and for each nuclear accident, the maximum amount of compensation liability is capped at NT$ 4.2 billion. The licensee has a right of recourse against a person who has caused nuclear damage as a result of an intentional personal behavior (Article 22). In addition, in order to ensure that the nuclear power plant licensee maintains adequate financial security to cover the liability, the Act (Article 25) requires the licensee to maintain a liability insurance or financial security adequate to meet the nuclear damage liability limit, and to obtain approval by the AEC.

In addition, according to the current (amended on May 14, 1997) “Nuclear Damage Compensation Law” (Article 28), the right to claim compensation for nuclear damage starts when the claimant becomes aware of the damage and the nuclear facility operator who is responsible for compensation, and it will be extinguished if it is not exercised within 3 years; the same applies to those who have been more than 10 years from the time of the nuclear accident.

11.2 Human Resources

11.2.1 Requirements for Personnel Qualification, Training and Retraining

Item 4 of Article 23 and item 3 of Article 26 of the Atomic Energy Act of 1968 (as amended in 1971) and the Enforcement Rules of this Act (Articles 38 to 43) stipulate that only the relevant license holders approved by the AEC can operate nuclear reactors or handle radioactive materials, radioisotopes, or machines that generate radiations. In the early 2000s, the Nuclear Reactor Facilities Regulation Act (2003), the Ionizing Radiation Protection Act (IRPA) (2002), and the Nuclear Materials and Radioactive Waste Management Act (2002) as well as their Enforcement Rules were promulgated.

Article 5 of the Nuclear Reactor Facilities Regulation Act of 2003 stipulates that without a construction license (CL) granted by the AEC, the construction of a nuclear reactor facility cannot commence. After the completion of the construction work of a nuclear reactor facility, the facility can only be operated with an operating license (OL) issued by the AEC (Article 6). Furthermore, to operate a nuclear power reactor, all the control room operators must have licenses of reactor operator (RO) or senior reactor operator (SRO) issued by the AEC in advance (Article 11). The qualification requirements for ROs are stipulated in Articles 4 and 5 as well as Appendix 2 of the Regulations on Nuclear Reactor Operators’ Licenses of 2004 as amended in December 2009.

Article 29 of the Ionizing Radiation Protection Act of 2002 requires that one must obtain a certificate of permission or an approval for registration (hereafter in this section and the following subsections, the one who has obtained a certificate of permission or an approval for registration will be referred to as a licensee) to handle radioactive materials, operate ionizing radiation generating equipment, or conduct a radiation practice. Article 7 of this Act further requires that the licensee must establish a radiation protection management sector or have licensed radiation protection personnel in order to implement radiation protection practices. Articles 30 and 31 of this Act require that one must have a certificate of radiation safety to handle radioactive materials or to operate an ionizing radiation generating equipment, while one must have an operator license to operate a production facility of radioactive materials. Article 14 stipulates that one must be at least 18 years old to do or participate in radiation-related activities.

For a pregnant woman employee working in the radiation control area, the licensee must re-evaluate her working condition and make necessary adjustments to her job arrangement. The requirements for setting up a radiation related facility or business are given in the Standards for Establishment of Radiation Protection Management Organizations and Radiation Protection Personnel of 2002. On the other hand, the qualification requirements for radiation protection personnel are stipulated in the Administrative Regulations for Radiation Protection Personnel of 2002 as amended in 2011, while those for operators are stipulated in the Administrative Regulations for Operators of Radioactive Material or Equipment Capable of Producing Ionizing Radiation of 2002 as amended in 2009 and the Administrative Regulations for the Operators of Production Facilities of Radioactive Material of 2003 as amended in 2012.

According to Article 27 of the Nuclear Materials and Radioactive Waste Management Act of 2002, a radioactive waste (RW) treatment facility must be operated by the personnel who meet the Regulations on Qualifications of Personnel Operating Radioactive Waste Treatment Facilities issued in 2009.

(1) Training Requirements for Regulatory Staff

The AEC provides its staff with a systematic training program to keep their professional capabilities up-to-date and to meet the ever-increasing regulatory challenges. For example, a course on BWR or PWR technology and simulator training is a pre-requisite for a resident inspector at the NPP. After completing this course, a training on the advanced technology is then required in order to enhance the capability of the inspectors. In addition, the AEC regularly sends several appointed staff members to the overseas regulatory agencies and/or research institutes in the nuclear advanced countries for on-the-job training. Also, the AEC regularly trains its NPP inspectors and reviewers with the nuclear power plant-related professional courses.

The AEC’s inspection personnel are divided into five categories, depending on their areas of expertise: nuclear power plants (NPPs), radiation protection, nuclear safeguards and emergency response, radioactive materials management, and nuclear power plants decommissioning respectively. Each category of the AEC’s inspection personnel has two levels of inspector licenses: Inspector and Senior Inspector. There is also the RO/SRO examiner who is responsible for administering the qualification examinations for the candidates of nuclear reactor operators.

(2) Regulatory Requirements for Reactor Operators

As per Appendix 1 of the Regulations on Nuclear Reactor Operators’ Licenses (as amended in December 2009), the minimum number of reactor operators on-duty in the main control room (MCR) of an operating NPP with twin units is also specified in the technical specifications (TS) of the FSAR.

The AEC issues nuclear power plant reactor operator licenses for operators and senior operators. An RO can also apply for an SRO license. In this case, they must have: (1) an RO license for the same NPP that they are applying the SRO license for and (2) at least two years of reactor-operating experience, in addition to a qualified physical condition.

To obtain an RO license, the candidate must pass the relevant regulatory examinations. After the candidate has successfully passed the AEC examinations and internship, the application for the operator license must be submitted through the licensee of the NPP, and then the AEC will issue the operator license.

(3) Regulatory Requirements for Radiation Protection Personnel

As stipulated by Article 2 of the Administrative Regulations for Radiation Protection Personnel of 2002 as amended in August 2011, the radiation protection personnel can be classified into two levels: the Radiation Protection Personnel and the Senior Radiation Protection Personnel.

(4) Regulatory Requirements for Radioactive Waste Operators

As per Article 2 of the Regulations on Radioactive Waste Operators of 2009, operator levels of the radioactive waste (RW) treatment facility can be classified into two categories: the RW operator and the senior RW operator.

(5) Licensee's Training and Retraining for Its Employees

Under the Nuclear Reactor Facilities Regulation Act of 2003, only the reactor operator license holder approved by the AEC can operate a nuclear reactor. The Ionizing Radiation Protection Act (IRPA) of 2002 requires that anyone who handles ~~the~~ radioactive materials or operates ionizing radiation generating equipment (e.g., the X-ray machine) must have a radiation safety certificate and anyone who operates a radioactive material production facility must have an operation personnel certificate. The IRPA further requires that depending on the scope and business of a radiation practice, the licensee shall set up a radiation protection management sector or have radiation protection personnel. On the other hand, the Nuclear Materials and Radioactive Waste Management Act of 2002 requires that the operator of a radioactive waste (RW) treatment facility must be qualified.

A summary of the nuclear related licenses and certificates as required above is as follows:

- License for senior reactor operator (SRO),
- License for reactor operator (RO),
- Certificate for radiation protection personnel,
- Radiation safety certificate,
- Certificate for senior RW operator, and
- Certificate for RW operator.

As of December 2021, the TPC employs 398 nuclear related license (or certificate) holders (including RW operators) who work in the NPPs, as shown in Table 11.1. These license (or certificate) holders are required to take retraining programs conducted by the TPC for their specific types of licenses at regular intervals.

Table 11.1 Number of Nuclear-Related License (or Certificate) Holders Employed by the TPC (As of DEC 2021)

Type of License/Certificate	Chinshan	Kuosheng	Maanshan
Senior Reactor Operator	22	25	30
Reactor Operator	17	23	34
Radiation Protection Personnel	24	35	18
Radiation Safety	12	22	27
Senior RW Operator	3	13	6
RW Operator	24	37	26
Subtotal	102	155	141
Total	398		

11.2.2 Human Resources of the Licensee

As of mid-March 2022, the TPC had a total of 27,545 employees. Among them, 2,064 were working in the nuclear sectors, including 330, 538 and 551 employees working in CS, KS and MS NPPS, respectively.

The Nuclear Safety Committee (NSC) in the headquarters of the TPC is an advisory body for deliberating and decision consulting on nuclear safety issues. To form this Committee, the TPC invites experts from universities/colleges, research institutes, and industries as the Committee members in addition to those who are nuclear-related department directors. Similarly, in each NPP, there is a Station Operation Review Committee (SORC) that advises the Plant General Manager (PGM) on matters concerning nuclear safety.

In order to be eligible to work in an NPP, a contractor's employee must have the maintenance certificate of related equipment, pass the physical examination and undergo training in advance on courses of security, industry safety, radiation protection, emergency planning, environmental protection, waste management, quality control (QC), etc.

The mechanical, electrical, I&C, and repairing maintenance groups of the TPC's NPP regularly collaborate with the contractors to send their qualified technicians to participate in the regular plant maintenance or temporary emergent repair jobs. In case of a nuclear accident, and if the Operation Support Center (OSC) does not have enough manpower to deal with the emergency, the contractors' technicians will enter the plant to assist in handling the case.

In addition to the above-mentioned regular O&M contractors, other contractors such as the reactor vendors (GE and W), A/E consultants (e.g., Pacific Engineers & Constructors, Ltd. (PECL), Bechtel Group, E&C Engineering Corp. (E&C), Ebasco Services, Inc., etc.), and the international nuclear organizations (WANO, etc.) may also provide technical supports for severe accident management if necessary.

11.2.3 Other Human Resources

In addition to the existing manpower resources within the TPC, domestic sources of supporting manpower for nuclear operational safety may come from research institutes, universities and the industries. The Institute of Nuclear Energy Research (INER) is an important provider of technical support to ensure the operational safety of the NPPs. As of July 2022, INER has 1028 employees, including budget and contract employees.

The National Tsing Hua University (NTHU) is located at Hsinchu City, which is about 90 km south of Taipei, and offers comprehensive undergraduate and graduate level education in nuclear engineering. NTHU is one of the top universities in Taiwan. The Department of Engineering and System Science was formerly the Department of Nuclear Engineering, which was founded in 1964 and offered the Bachelor, Master, and Doctoral degrees in the engineering field. This department provides complete nuclear engineering education and is a major nuclear engineering personnel training institute in Taiwan. This department provides multidisciplinary training in mechanical, electrical and material engineering, as well as the capability of system integration. To emphasize the importance of system integration in modern engineering and promote the diversity in teaching and research, the department changed its name to the Department of Engineering and System Science in 1997. In response to the renaissance of nuclear power around the world in 2000s, the University established the Institute of Nuclear Engineering and Science in 2007 and the Interdisciplinary Program of Nuclear Science under the College of Nuclear Science in 2009. In the meantime, TPC has been offering scholarship to designated numbers of students of the College of Nuclear Science for years to attract more involvement of the younger generations in this field.

In addition to the NTHU, a non-profit association in the private sector, the Nuclear Science and Technology Association (NuSTA) offers a nuclear technology-training program to provide courses and lectures on nuclear technologies for the public and industries that are interested in learning about nuclear energy or getting more up-to-date information on nuclear technology. The NuSTA's manpower consists mainly of retired specialists from domestic nuclear organizations such as AEC, INER and TPC.

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ARTICLE 12. HUMAN FACTOR

Each Contracting Party shall take the appropriate steps to ensure that the capabilities and limitations of human performance are taken into account throughout the life of a nuclear installation.

12.1 Overview of Human Factors and Organizational Issues for the Safety of NPPs

The interface between a mechanical system and its operators is usually known as the human factor. The human performance of plant staff depends on the individuals' capabilities, limitations and attitudes, as well as on the quality of instructions and training provided. The goal of the human factor studies is to minimize the potential for human error by identifying and addressing factors that may adversely influence human performance.

Human performance is a very important factor in all phases of the plant lifecycle including design, commissioning, operation, maintenance, surveillance, modification, decommissioning and dismantling. More detailed descriptions of the consideration of human factors and man-machine interface (MMI) are provided in Subsection 18.3 of this report.

Quality management of plant staff is also crucial, because the way in which the work is organized, staffed and rotated, supervised, evaluated and rewarded will determine the effectiveness, productivity and safety of the facility. The accidents at Three Mile Island (TMI), Chernobyl, and Fukushima NPPs were, in part, caused by human errors. One key issue is to strengthen the human and organizational aspects of nuclear safety in operating and regulatory organizations. In order to ensure the highest level of nuclear safety with the quality control of human performance in Taiwan, a nuclear safety management system was established to coordinate the top-down processes of AEC, TPC headquarters, and NPPs as shown in Figure 12.1.

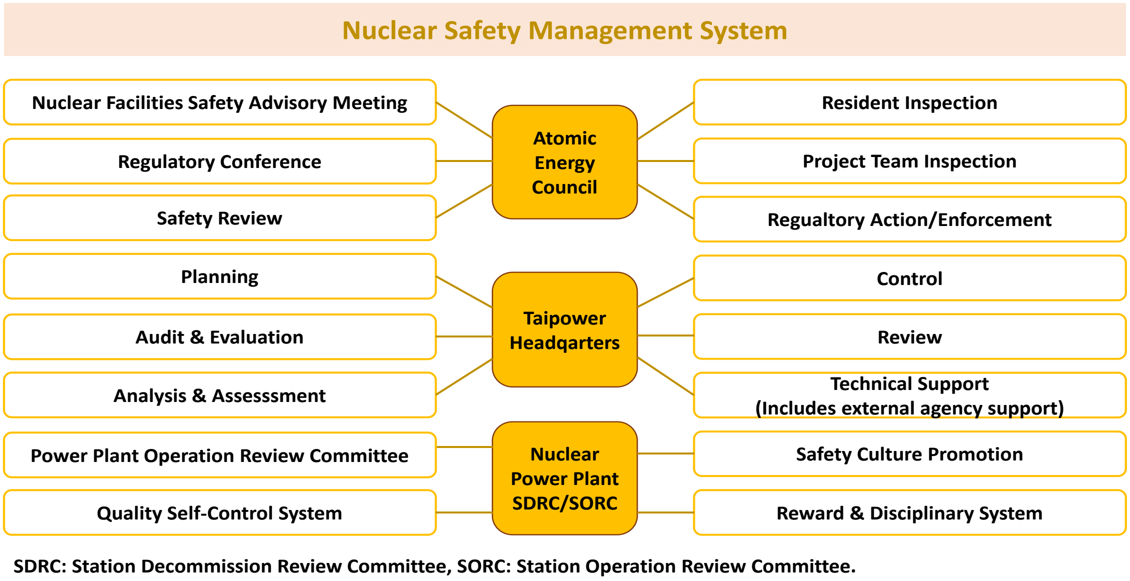

Figure 12.1 A Nuclear Safety Management System in Taiwan

12.2 Human Factors in the Design of NPPs and Subsequent Modifications

To operate an NPP, one must have a valid reactor operator (RO) license, and to obtain a license for operating an NPP, the trainee has to pass the written and practical exams administered by the AEC. The AEC also monitors the human performance during plant operation through inspections, safety reviews, and regulatory meetings. For those licensed operators, regular re-training courses are required to maintain their capabilities of dealing with normal and abnormal operating conditions.

To minimize the risk of misjudgment of and the erroneous operation by reactor operators, the TPC provides long-term and short-term training programs for its operators on a regular basis. An prospective operator trainee needs to learn the basic knowledge of nuclear installation through the in-house training curriculum, followed by operating practice with the full-scope main control room (MCR) simulator. (In Taiwan, every nuclear power station has its own simulator). After passing all the examinations associated with these training courses, the trainee will become a candidate of the RO and be assigned to an operating shift of the relevant NPP for the on-the-job training under the guidance and supervision of a senior reactor operator (SRO). In addition, to minimize human errors of the reactor operators by reducing their workload and consolidating the educational and training programs, the TPC has changed the reactor operator's working system of the Kuosheng and the Maanshan NPP from a five-group three-shift scheme to a six-group three-shift scheme. Among the six groups, three groups rotate for the reactor operation, while the other three groups will take training courses, have day-offs, or perform routine works, respectively. Routine works may include evaluations and surveillance tests for the safety-related systems.

12.3 Methods to Prevent, Detect, and Correct Human Errors

To ensure the quality of maintenance works, the TPC has established a Maintenance Training Center for the training of its plant maintenance staff and workers from the contractors regularly. The maintenance personnel are trained according to their levels of knowledge and skill. The training courses include the basic principles, mock-up training, on-the-job training, and the experience feedback seminars.

The operating experiences, both worldwide and domestic, are regarded as valuable sources for proactively preventing the occurrence of repeated events in local NPPs. Through this practice, lessons are learned from such documents as General Electric Service Information Letter, Westinghouse Technical Bulletins, and information from BWROG, PWROG, WANO Networks, NRC bulletin, and the TPC's Reportable Event Reports (RER). Through the process of event screening, evaluation, and analysis, the conclusions will be shared by the relevant TPC nuclear power plants via an operating experience (OE) feedback system. The affected nuclear power plants will follow the documents and incorporate countermeasures into plant procedures, training, or equipment conditions. The WANO documents such as significant operating experience reports (SOERs) and significant event reports (SERs) are considered as essential sources in the learning of international operating experiences. In particular, the identified root causes, the relevant corrective actions and the recommendations given by the SOERs and SERs are very valuable and will be used by the plant operators to prevent potential events in advance.

To achieve the purpose of reducing human errors, ten preventive measures are shown below and reiterated in the TPC's safety culture enhancement program:

- Double checking,
- Potential risk evaluation,
- Tool box meeting,
- Self checking,
- Adherence to procedure,
- Conservative decision making,
- Enforcing the coordination within the operation and maintenance (O&M) Group,
- Reducing the human errors of vendors and contractors,
- Experience feedback and training, and
- Root cause analysis of human error type events.

To prevent the occurrence of a severe accident, emergency operating procedures (EOPs) of Chinshan, Kuosheng and Maanshan NPPs were established by the TPC. Furthermore, the severe accident management guidelines (SAMGs) of Chinshan, Kuosheng and Maanshan NPPs were also developed in 2003 for the AMT to mitigate the severe accident. The corresponding training on both EOPs and SAMGs are performed to reduce human errors. To minimize misjudgment and erroneous operation by the AMT, the TPC has developed a severe accident engineering simulation code (a TPC version of MAAP4) for training purpose. The AEC will also audit/inspect the associated performance via emergency preparedness drills.

To evaluate the plant safety, the INER and the TPC have jointly developed the living probabilistic risk assessment (PRA) models for all operating NPPs in 1996. The human reliability analysis (HRA) is an important component of these models. The HRA is used to evaluate the human error probabilities (HEPs) for the human actions defined by the model analyst, taking into account factors such as man-machine interface, complexity of task, working environment, stress, timing, training, procedure, experience, etc. The HEPs include the probability of incorrect calibration of the instruments, the probability of misalignment of flow paths. The results from the HEP are also incorporated into the relevant training courses and found to be very useful for reducing human errors in plant operation.

For contractors, the TPC has implemented preventive measures to ensure the safety of the contracted works.

12.4 Managerial and Organizational Issues

To ensure that the managerial and organizational aspects of a nuclear power plant are properly addressed, the AEC requires the plant owner to describe the personnel organizations including reactor operators, maintenance personnel, and administrative staff in the PSAR and FSAR. This requirement is stipulated in the Enforcement Rules of Nuclear Reactor Facilities Regulation Act. The TPC has to operate the nuclear power stations according to the organizations approved by the AEC.

Whenever a human error event occurs, the plant operator needs to prepare a human performance enhancement system (HPES) report and hold a system diagnostic meeting to find out which barrier for preventing human errors has been breached. Corrective actions will then be proposed based on the conclusions.

12.5 Role of the Regulatory Body and the Facility Operator

12.5.1 Role of the Regulatory Body

The importance of human behavior in ensuring the safety of nuclear installations has been demonstrated in the accidents at TMI and Chernobyl. To prevent the occurrence of human errors in the nuclear power station, the AEC requires the TPC to include human factors in the stages of planning, design, construction, and operation of a nuclear power plant. Through the reviews of PSAR and FSAR, the AEC conducts safety examination associated with human engineering design. In the stage of construction, the AEC ensures that all designs related to human factors are constructed according to the safety analysis reports by conducting plant inspections. In the stage of operation, the AEC checks the human performance through resident inspection, outage inspection, regulatory meetings, and so on. To enhance the human performance, the AEC conducts many special regulatory activities, such as requiring the incorporation of the post-TMI and post-Fukushima action items to all the TPC's operating nuclear power plants to prevent the occurrence of similar human errors.

As mentioned in Subsection 11.2.1, the AEC also provides its staff with systematic training to keep their professional capability updated for meeting ever-increasing regulatory challenges. For example, advanced technology training courses are offered to enhance the regulatory capability of the inspectors. In addition, selected staff members are sent to countries with advanced nuclear technology for on-the-job training (OJT).

12.5.2 Role of the Facility Operator

To maintain good human performance in the nuclear power plants, the TPC plays a key role in the prevention, detection, and correction of human errors. The AEC's requirements related to the human factors are the baselines for the TPC to follow. In addition, the TPC has invested a lot of efforts to prevent human errors and improve human performance. These efforts include fostering safety culture, preparing and revising operational manuals, providing better training for operators and maintenance personnel, and performing related R&D programs.

ARTICLE 13. QUALITY ASSURANCE

Each Contracting Party shall take the appropriate steps to ensure that quality assurance programs are established and implemented with a view to providing confidence that specified requirements for all activities important to nuclear safety are satisfied throughout the life of a nuclear installation.

13.1 Quality Assurance Programs

This chapter describes the quality assurance (QA) policy, requirements and programs that are applied to NPPs in stages such as design, procurement, manufacturing, construction, commissioning, operation, maintenance, and decommissioning.

Each applicant for a construction license (or the “construction permit” as previously referred to) of a nuclear power plant is required by the Nuclear Reactor Facilities Regulation Act to describe the quality assurance related activities including design, construction, and inspection programs in its PSAR. A construction license will be issued after the PSAR is reviewed and approved by the AEC. To verify the implementation of the QA program during the design and the construction stages, the AEC will perform inspections in accordance with Article 14 of the Nuclear Reactor Facilities Regulation Act.

A policy statement for the quality assurance program is submitted as part of the PSAR and FSAR to the AEC for review. Based on the principles provided in the total quality management policies, the TPC established its QA policy statements as follows:

(1) A total quality management system shall be established based on the national or international standard. The total quality management shall be carried out with continuous improvement activities to enhance the service quality for the customer’s satisfaction.

(2) In addition to the policy described above, nuclear safety-related items and activities shall also be implemented based on a nuclear quality assurance program in accordance with the requirements of the Nuclear Reactor Facilities Regulation Act. All commitments to the regulation shall be met to assure the nuclear safety and public health.

Specifically, a nuclear project QA program is required before a nuclear facility is to be built. In the meantime, a nuclear operation QA program is established for the safe operation of a licensed nuclear power facility. Both QA programs follow Appendix B to the 10 CFR 50 of U.S.A.

For a nuclear facility to be built, a Nuclear Project QA Program shall be established first. This program applies to safety-related items and their associated activities from planning, design, procurement, fabrication, and construction, to preoperational testing for all new projects, as well as any other specific nuclear related works.

For each nuclear facility with an operating license, a nuclear operation QA program is established by the Department of Nuclear Safety of the TPC. All commitments made in the FSAR and other licensing application documents shall be adhered to in order to ensure nuclear safety and public health.

A decommissioning quality assurance program has been established by the TPC, according to the quality assurance requirements in the Guides of Decommissioning Plans for Nuclear Reactor Facilities and the Quality Assurance Criteria for Nuclear Reactor Facilities promulgated by the AEC. The decommissioning quality assurance program details the essentials, the responsibilities and the requirements of operations, and is now being applies to the decommissioning of Chinshan NPP and the decommissioning plans of Kuosheng and Maanshan NPPs. Related operational procedures have been set up to implement the decommissioning plan, to ensure the quality of decommissioning complies with the quality assurance program, as well as to protect the working personnel, the public health and the environmental safety.

13.2 Implementation and Assessment of Quality Assurance Programs

The purpose of the QA program is to assure the quality of the projects and to provide a solid foundation for nuclear safety and reliable power operation. To achieve the quality necessary for safety, the TPC implements the following management actions for its nuclear power stations:

- Develop and maintain an effective QA program,
- Audit and assess the effectiveness of the QA program,
- Provide feedbacks to the management on quality of performance.

The AEC conducts many activities to oversee the compliance of the construction, operation and decommissioning activities with the quality requirements. These activities consist mainly of the resident inspection, periodic inspection, special taskforce inspection and examination of the key holding points for the construction. A more detailed description of the execution of inspections is provided in Chapters 6 and 14 of this report.

In order to further improve the quality of procurement, the TPC has been a member of the Nuclear Procurement Issues Committee (NUPIC) since 2005. This committee was founded in 1989 to provide effective programs for the evaluation of suppliers furnishing safety related items and services to the nuclear industry. The NUPIC enables effective programs for the evaluation of suppliers furnishing safety related items and services to the nuclear industry through Joint Audits and Surveys with cooperative efforts of the NUPIC members. The quality of procurement has been greatly improved for the TPC and other members of NUPIC.

As a member of NUPIC, the TPC has the responsibility to establish an audit process and participate in NUPIC auditing activities. The TPC also attends conferences held by the NUPIC and collects information about the quality of suppliers periodically. A data bank of information of suppliers in nuclear fields is set up on the intranet of the TPC. This data bank includes background information, record of quality assurance, experience of utilization, and internal review results of all suppliers for safety-related items in nuclear industry. The following benefits have been found by using this data bank:

- Complete and correct information of suppliers can easily be obtained.
- Quality of safety-related items can be assured.
- Reliability of safety-related items can be increased.
- Cost of procurement for safety-related items can be reduced.
- Time of procurement for safety-related items can be shortened.

ARTICLE 14. ASSESSMENT AND VERIFICATION OF SAFETY

Each Contracting Party shall take the appropriate steps to ensure that:

(i) **Comprehensive and systematic safety assessments are carried out before the construction and commissioning of a nuclear installation and throughout its** lifetime**. Such assessments shall be well documented,** regularly **updated in the light of operating experience and significant new safety information, and reviewed** by **the regulatory body;**

(ii) **verification by analysis, surveillance, testing, and inspection is carried out to ensure that the physical state and the operation of nuclear installations** remain in compliance with **its design, applicable national safety requirements, and operational limits and conditions.**

14.1 Ensuring Safety Assessment throughout Plant Life

This section describes the procedures and standards to ensure that systematic safety assessments are carried out throughout the lifetime of the nuclear installation.

14.1.1 Safety Assessment before Operation Stage

The licensing process for nuclear installations, pursuant to the Nuclear Reactor Facilities Regulation Act and described in Articles 5 and 6 of this Act, involves two steps: applications for a construction license and an operating license. The applicant for a construction license or an operating license shall conduct comprehensive and systematic safety assessments to ensure that the public and environment are protected from radiation hazards which may accompany the operation of nuclear installations. The results of the assessments are documented in two reports, namely, the preliminary safety analysis report (PSAR) and the final safety analysis report (FSAR). Both of them need to be reviewed and approved by the AEC. In addition to these two reports, the applicant must also submit an environmental impact assessment (EIA) report to the Environmental Protection Administration (EPA) in order to fulfill the licensing requirements. More detailed descriptions of the requirements for the environmental impact assessment are provided in Subsection 17.2.1 of this report.

The “Regulations on the Review and Approval of Applications for Construction License of Nuclear Reactor Facilities” issued pursuant to Article 5 of the Nuclear Reactor Facilities Regulation Act, describe the required contents of the PSAR. Similarly, the “Regulations on the Review and Approval of Applications for Operating License of Nuclear Reactor Facilities” issued pursuant to Article 6 of the Nuclear Reactor Facilities Regulation Act, describe the required contents of the FSAR. Because the content is covered by the standard safety analysis report (SAR) of the country of origin of the supplier of nuclear steam supply systems (NSSS), the contents of PSAR and FSAR for the Chinshan, Kuosheng and Maanshan Nuclear Power Plants are essentially the same as that required in the country of origin.

14.1.2 Safety Assessment at Operation Stage

The safety assessment at the operation stage involves the following areas:

(1) FSAR Update

According to Article 15 of Regulations for the Review and Approval of Applications for Operating License of Nuclear Reactor Facilities, licensees are required to update their final safety analysis reports periodically to incorporate the latest information and analyses. The update of FSAR submitted as part of the application documents for the license should reflect the latest information developed. The description of the FSAR update is provided in Article 6 of this report. The requirements related to the FSAR update are described in this section. In addition, the requirements for the periodic safety review are also provided in this section.

For an operating nuclear power plant, the first update of FSAR shall be completed within two years after the operating license is granted. Subsequent revisions must be filed 6 months after each refueling outage. If one FSAR is shared by multiple units, the reference date will be determined in accordance with the second unit. In addition, the update after refueling outage will be based on the time when the refueling outage was completed.

(2) Periodic Safety Review

According to Article 9 of the Nuclear Reactor Facilities Regulation Act and Article 6 of its enforcement rules, the owner of a nuclear reactor facility shall submit an “Integrated Safety Assessment Report” (ISAR) to AEC for review at least 6 months before the end of every 10 years of operation. The major items in this report are as follows:

- Review of operating conditions, including operational safety, radiation safety and radioactive waste management,
- Review of items needed to be improved or reinforced, including review of reactor unit problems needed to be improved or reinforced and descriptions of commitments for improvement and reinforcement,
- Summary of the previous reviews and prospectives of items of paying attention to in the future and commitments of future improvements and schedules, and
- Other items requested by the AEC.

(3) PRA Update

The technology and application of PRA have been developed in this country for more than thirty years. The PRA models for the operating nuclear power plants have been established through the cooperation among the AEC, the TPC and the Institute of Nuclear Energy Research (INER) since 1982. By the end of 1996, the so-called “living PRA” models for these plants were further developed by the TPC and INER. These models have provided very useful and efficient tools for the operators to estimate the plant safety status. Several PRA application programs such as the establishment of “Taipower Integrated Risk Assessment and Management Model” and the establishment, maintenance and application of “Flood, Fire and Containment Safety Assessment Models” have also been performed by the PRA experts of both the TPC and INER. A technically acceptable PRA that complies with the PRA standard of ASME will be performed by the requirement of USNRC RG 1.200 in the peer review process. Plant-specific data is updated to the end of 2013. The modified PRA models have been applied to the analyses such as outage maintenance scheduling, risk analyses of plant modifications, and so on.

14.1.3 Design Changes

According to Article 13 of Reactor Facilities Regulation Act and Article 8 of Enforcement Rules for the Implementation of Nuclear Reactor Facilities Regulation, the following design or equipment changes require the AEC's approval in advance：

- Technical specifications change,
- Resulting in more than a minimal increase in the frequency of occurrence or the consequence of an accident previously evaluated in the FSAR,
- Resulting in more than a minimal increase in either the occurrence of a malfunction or the malfunction consequence of the structure, system, and component (SSC) important to safety previously evaluated in the FSAR,
- Creating a possibility for either an accident of a different type or malfunction of SSCs important to safety with a different result than previously evaluated in the FSAR,
- Changing of the design basis limit for a fission product barrier as described in the FSAR,
- Changing of the evaluation method used in establishing the design bases and safety analyses as described in the FSAR, and
- Others as required by the regulatory body.

For changes requiring the AEC's approval in advance, an assessment report should be submitted to the AEC. Then, the AEC will review the report and the changes cannot be performed until a satisfactory conclusion has been reached. Inspections will be conducted by the AEC during the process of design change. After the completion of the design changes, proof tests have to be performed to ensure that the performance of changes ~~fully~~ meets the design requirements.

14.1.4 Decommissioning Plan of Nuclear Power Plants

The nuclear energy policy is to decommission the NPPs as the operating license expires, so there is no life extension of nuclear power plants in Taiwan. As such, the TPC has established the nuclear power plant backend program. The work scope of this backend program includes:

(1) Decommissioning of the Nuclear Power Station

According to the Nuclear Reactor Facilities Regulation Act, the decommissioning of an NPP shall be completed in 25 years after the termination of its operating licenses, including the demolition of the facilities. Three years before the permanent shut-down of nuclear reactor facilities, operators must propose a decommissioning plan. The operating licenses for Unit 1 and 2 of the Chinshan NPP expired on December 5, 2018 and July 15, 2019, respectively. The operating licenses for Unit 1 and 2 of the Kuosheng NPP expired on December 27, 2021 and March 14, 2023, respectively. The operating licenses for Unit 1 and 2 of the Maanshan NPP will expire on July 27, 2024 and May 17, 2025, respectively. In accordance with this law, the TPC submitted the decommissioning plan of Chinshan NPP to the AEC in November 2015 and received the AEC approval on June 28, 2017. After the Decommissioning Environmental Impact Assessment report was approved by EPA on July 2, 2019, the

AEC issued the Decommissioning Permit of Chinshan NPP, which was effective on July 16, 2019.

The decommissioning plan of the Kuosheng NPP was submitted to the AEC on December 27, 2018. The AEC granted the approval on October 20, 2020. The decommissioning environmental impact assessment underwent the review process by the EPA and was completed on August 10, 2022. Then, the decommissioning environmental impact assessment was approved on January 6, 2023. At present, TPC is preparing for the decommissioning of Kuosheng NPP. The decommissioning plan of the Maanshan NPP was submitted to the AEC on July 26, 2021 for reviewing, and AEC has completed the review on April 24, 2023.

The TPC has devised a preliminary plan for the decommissioning of an NPP, which will perform the tasks in five stages:

(i) Tasks before decommissioning, including

- Preliminary investigation on the history and specific features of the site, decommissioning strategies and operations research,
- Preparation of the work plans and decommissioning plans (including the environmental impact assessment report), and
- Presentation of the topics and documents for approval.

(ii) Transitional period begins when the reactor is permanently shut down

(iii) Demolition of the plant

(iv) Site environmental Radiation survey

(v) Site recovery

During the early stage of the transition phase of the Chinshan and Kuosheng NPP decommissioning process, the safety regulation focuses on the temporary storage and removal of nuclear fuel in the reactors and the spent fuel pools, radiation characteristics survey, the isolation of disabled systems and equipment, and the detailed planning of decommissioning works and schedules for subsequent stages, etc.

During the early stage of the transition phase of the Maanshan NPP decommissioning process, the safety regulation focuses on the transfer of all the fuels from the reactors to the spent fuel pool for storage, the establishment of a spent fuel pool island, radiation characteristics survey, the isolation of disabled system equipment, and the detailed planning of decommissioning works and schedules for subsequent stages, etc.

The TPC has formed a task force for the mission in the preliminary stage and cross-function operations will be adopted to carry out the duties. The TPC has joined a decommissioning project led by the EPRI, which will provide relevant technical services (including visiting the plants undergoing decommissioning) and consultations. Moreover, the TPC had also participated in the CPD under the Organization for Economic Cooperation and Development (OECD) as an observer member and has since become an official member. In the future, the organization will be reformed if need be.

(2) Transfer, Interim Storage and Final Disposal of Spent Fuels as well as Final Disposal of Low Level Waste from Plant Operation and Decommissioning

The TPC adopts a three-stage, internationally applied strategy for the management of spent nuclear fuel (SNF). The three stages are: pool storage, dry cask storage and final disposal. All the spent fuels from Chinshan, Kuosheng and Maanshan NPPs are currently stored in the spent fuel pools (SFP) located in the plant sites. Thorough review in the areas of fuel mechanical design, thermal hydraulic design, neutronic design and event analysis have been conducted for the spent fuel re-racking and the subsequent second re-racking projects. The SFPs of the Chinshan and Kuosheng NPPs will reach their full capacities before their operating licenses expire.

Since the spent fuel pools of the Chinshan and Kuosheng NPPs are unable to accommodate the SNF produced over a 40-year period of operation, the TPC is currently planning to construct dry storage facilities to allow each power plant to carry out the decommissioning and dismantling work before the SNF (highly radioactive wastes) is sent to final disposal sites.

The TPC has been required to establish a probabilistic risk assessment approach to ensure plant safety while the fuels remain in the core and spent fuel pool.

A dry storage facility is licensed in two steps: a Construction License (based on the Preliminary Safety Analysis Report, PSAR) and an Operating License (based on the Final Safety Analysis Report, FSAR). According to Article 17 of the Nuclear Materials and Radioactive Waste Management Act (NMRWMA), AEC must confirm that the following four conditions are met before issuing the Construction License:

- The construction adheres to the prescription of the relevant international conventions.
- The equipment and the facilities are adequate to secure public health and safety.
- The impact on the environment shall conform to all relevant laws, statutes and decrees.
- The applicant possesses sufficient technology, management ability, and financial guarantee to operate the facilities.

More information about the dry storage facilities in Taiwan can be found in Article 19.9.2.

14.2 Verification by Analysis, Surveillance, Testing and Inspection

The AEC conducts various types of inspections on an operating NPP, such as resident inspections, periodic or planned outage inspections, unannounced inspections and taskforce inspections.

Before each fuel reload, licensees must submit a reload safety analysis report (RSAR) for a BWR unit or reload safety evaluation report (RSER) for a PWR unit to the AEC for review and approval. The AEC may require additional inspection or test as a result of the review. The nuclear power unit can only restart for the next fuel cycle after obtaining the AEC's approval.

In order to preserve the equipment and systems in optimal conditions and to ensure that the desired design functions of the equipment are sustained, periodic and planned maintenance should be performed. The maintenance activities such as inspections, measurements and adjustments shall comply with the requirements of the quality assurance program. The preventive maintenance in a nuclear power station is divided into two categories: the daily preventive maintenance and the planned preventive maintenance during outage.

In case the system parameters deviated from normal ranges or there was a failure of the structures, systems, and components (SSCs), the licensee shall immediately cease the operation of the unit and report it to the AEC, and then apply for continued operation after improvement. Depending on the degree of severity of the situation, a safety analysis may be required and an extensive review may be conducted.

14.3 Fukushima Lessons Learned

14.3.1 Comprehensive Safety Assessment of Nuclear Power Generation

After the Japan's Fukushima Daiichi Accident, the AEC conducted a thorough review of the lessons learned from the Fukushima accident and proposed the "Programs for Safety Reassessment" which was approved by the Executive Yuan on April 19, 2011. The purpose of this safety reassessment was to significantly improve the safety margin of the NPPs by a complete planning and review of the plants' resistance to earthquakes and tsunamis and by enhancing their rescue capacity in terms of power sources, cooling water sources, the SFP cooling and the coordination of resources and preparation.

The AEC has requested the TPC to reevaluate its capability to cope with extreme natural disasters including earthquakes, tsunamis, extreme rainfalls and mudslides, and to take possible countermeasures. The reassessment program consisted of three parts: (1) nuclear safety assurance, (2) radiation protection, and (3) emergency response and preparedness, which were implemented in two stages: near-term (by June 2011) and mid-term (by December 2011). The AEC finalized its review of the TPC's safety reassessment reports and issued the following documents:

- "Preliminary Assessment Report of Nuclear Safety" in May 2011.
- "The Near-Term Overall Safety Assessment Report for Nuclear Power Plants in Taiwan in Response to the Lessons Learned from Fukushima Daiichi Accident" in October 2011.
- "The Overall Safety Assessment Report for Nuclear Power Plants in Taiwan in Response to the Lessons Learned from Fukushima Daiichi Accident" in August 2012, which included the near-term and mid-term reassessment results.
- Regulatory orders in November 2012.

Apart from the requirements issued by the AEC after the safety reassessment, the TPC's Chinshan, Kuosheng and Maanshan NPPs have proposed 96 self-enhancement plans. By the end of 2014, 95 of these plans had been completed. The seismic hazard reevaluation, including the geological survey and the SSHAC level 3 process, was completed in 2020. As of now, 96 of these plans have been completed. These enhancement plans could be categorized into the following 4 areas:

(1) Enhancement of earthquake-resistant capabilities

(2) Enhancement of tsunami/flooding-protection capabilities

(3) Enhancement of event mitigation capabilities including:

- Backup power supply
- Water resources and injection

- SFP cooling
- Resources preparedness

(4) Establishment of specific major incident guidelines (SMI)

14.3.2 Stress Tests and Independent Peer Review

The AEC requested the TPC to perform the stress test to identify the "cliff-edge" effects based on the safety enhancement requirement of similar NPPs in the EU. The scope of the stress test of Taiwan's NPPs to be carried out was in accordance with the ENSREG stress test specifications. The TPC completed a series of stress tests for the operating NPPs to confirm that the overall assessment has helped to increase the capacity to protect the plant against hazards and to minimize the damage. The licensee's stress test summary reports of the Chinshan, Kuosheng and Maanshan NPPs were submitted by the TPC to the AEC in March 2012.

The AEC invited the Nuclear Energy Agency (NEA) of the Organization for Economic Cooperation and Development (OECD) to select experts who could conduct an independent peer review for Taiwan's stress tests of the Chinshan, Kuosheng and Maanshan NPPs. The NEA's independent peer review team visited Taiwan between March 4 and 20, 2013 and conducted a site visit to Kuosheng NPP.

The AEC also invited the EU to set up an independent peer review team for the stress tests on TPC's 4 existing NPPs. The peer review team visited Taiwan between September 23 and October 3, 2013, and performed a site visit to the Maanshan NPP.

14.3.3 Issuance of Regulatory Orders

After the post-Fukushima safety reevaluation, stress tests, and independent peer review, the AEC imposed the following regulatory orders/requirements to the TPC to improve the capability of NPPs to cope with extreme natural disasters, while the TPC may submit alternative plans, subject to AEC approval, to provide the equivalent function to meet the requirements of regulatory orders:

(1) Adopt the conclusions of the following 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 action
- 4.2 Equipment covered under 10 CFR 50.54(hh)(2)
- 5.1 Reliable hardened vents for BWR Mark I, Mark II, Mark III and PWR dry large containments, and all the vent systems have the function of filtering.
- 7.1 SFP instrumentation
- 8 Strengthening and integration of EOPs, SAMGs, and EDMGs (& SMIs)
- 9.3 Emergency preparedness regulatory actions (staffing and communications)

(2) Follow-up the Tier 2 & Tier 3 Recommendations by USNRC NTTF

(3) Follow-up the ENSREG's action plans from EU stress tests

(4) Implement special countermeasures for issues related to seismic, tsunami, and SBO by following good international practices as follows:

- To conduct survey on the newly found faults of Sanchiao and Hengchun near NPPs in October 2013.
- To install additional seismic instrumentation for monitoring and system identification
- To re-evaluate the hazard by using state-of-the-art methodology and incorporating the new findings
- To model the mechanism of seismic and tsunami hazards and the resulting risks
- To improve the water tightness of buildings (or build seawall or tidal barrier) to the level 6 meters above current licensing bases
- To strengthen the structure of non-seismic qualified TSC
- To build a seismic isolation TSC building

(5) Give additional considerations for the SBO rule as follows:

- To include seismic, tsunami, salt fog and landslides damage
- To assess specific natural events with high hazard
- To study the initiating event frequency of LOOP
- To consider the fact that Taiwan is a north-south elongated island surrounded by the sea with isolated grid and without backup

(6) Perform countermeasures for SBO as follows:

- To improve emergency DC power supply –Under the condition that the load should be able to sustain the whole plant for the first 8 hours, and the unnecessary load could be removed for the next 16 hours, the capacity of the safety-related battery bank could be sufficient to supply 24 hours.
- To install an additional seismic qualified gas-cooled EDG (the 6th EDG)
- To install an alternate UHS

(7) Install passive autocatalytic recombiners (PAR) to prevent hydrogen explosions

(8) Enhance the water-tight capabilities for the fire doors of essential electrical equipment rooms

(9) Enhance the seismic resistance for the fire brigade buildings to cope with the beyond design basis earthquake (BDBE)

(10) Improve the seismic resistance of raw water reservoir and consider the installation of the impermeable liner

(11) Improve the reliability of offsite power supplies

(12) Consider the RCP seal LOCA issue of PWR plant

The FLEX strategy for coping with the beyond design basis event of the Maanshan NPP involves using a portable medium-pressure injection pump to provide external water supplementation to the secondary side steam generator. The Condensate Storage Tank is the water source. The water lines installed in between connect the pump and the Condensate Storage Tank.

More information about the post-Fukushima regulatory requirements/orders can be found in Subsections 18.4 and Annex 1.

14.3.4 Status of Implementation

Table 14.3 shows the implementation status of Post-Fukushima orders in Taiwan's NPPs.

The AEC reviewed the Fukushima accident and required the TPC to implement the following specific protections against complex disasters such as earthquakes and tsunamis:

(1) Enclosing the crucial sea water pumps in buildings,

(2) Locating the emergency diesel power generator at surface elevation,

(3) Making pneumatic cooling type diesel power generator supplying the backup power,

(4) Making pneumatic cooling type turbine power generator offering the backup power,

(5) Using raw water reservoirs relying on gravity for injecting water into the RPV,

(6) Enhancing the water-tightness of buildings to a height of 6 m above the current licensing basis,

(7) Executing the SMI action for injecting water into the RPV.

Table 14.1 Implementation Status of Post-Fukushima Orders in Taiwan's NPPs as of June, 2022

#	Name	Keywords	Current Status		
			CS[1]	KS	MS
1	XX-JLD-10101	seismic hazard (NTTF 2.1)	in progress	in progress	in progress
2	XX-JLD-10102	flood hazard (NTTF 2.1)	in progress	in progress	in progress
3	XX-JLD-10103	seismic and flooding risk	completed	completed	completed
4	XX-JLD-10104	DBT + 6m	completed	in progress	in progress
5	XX-JLD-10105	EE walkdowns (NTTF 2.3)	completed	completed	completed
6	XX-JLD-10106	SBO rule (NTTF 4.1)	completed	completed	completed

#	Name	Keywords	Current Status		
			CS[1]	KS	MS
7	XX-JLD-10107	2 EDGs always	completed	completed	completed
8	XX-JLD-10108	DC 8h, 24h load shedding	completed	completed	completed
9	XX-JLD-10109	SBO coping 24h	completed	completed	completed
10	XX-JLD-10110	6th (8th) EDG/GT	completed	completed	completed
11	XX-JLD-10111	Alternate UHS	completed	in progress	in progress
12	XX-JLD-10112	B.5.b	completed	completed	completed
13	XX-JLD-10113	equipment SBO (NTTF 4.2)	completed AEC's RAIs	completed AEC's RAIs	completed AEC's RAIs
14	XX-JLD-10114	hardened vent + filtered venting (NTTF 5.1)	completed	in progress	completed
15	XX-JLD-10115	SFP instrumentation (NTTF 7.1)	completed	completed	completed
16	XX-JLD-10116	procedures incl. SMI (NTTF 8)	in progress	in progress	in progress
17	XX-JLD-10117	volcanic PRA	completed AEC's RAIs	completed AEC's RAIs	completed
18	XX-JLD-10118	water-tight fire doors for essential equip.	completed	completed	completed
19	XX-JLD-10119	BDBE resistance fire brigade bldg	completed	in progress	in progress
20	XX-JLD-10120	reliability offsite power	completed	completed	completed
21	XX-JLD-10121	Seismic raw water res. +impermeable liner	completed	in progress	in progress
22	XX-JLD-10122	PARs	completed	completed AEC's RAIs	completed AEC's RAIs
23	CS-JLD-101101	equal to 0.4g	completed	-	-
24	MS-JLD-101301	RCP seal LOCA	-	-	completed
25	XX-JLD-10201	fault displacement analysis	completed	completed AEC's RAIs	completed
26	XX-JLD-10202	interface post-earthquake and post-tsunami proc.	completed	completed	completed
27	XX-JLD-10203	event combination flooding and natural EE	completed	completed	completed

#	Name	Keywords	Current Status		
			CS[1]	KS	MS
28	XX-JLD-10204	PMP with topo. maps	completed	completed	completed
29	XX-JLD-10301	landslides assessment	completed AEC's RAIs	completed AEC's RAIs	completed AEC's RAIs
30	XX-JLD-10302	post-seismic inspection on non-seismic category I SSCs	completed	completed	completed
31	XX-JLD-10303	installation of closed cooling water loops	completed	in progress	completed
32	XX-JLD-10304	BWR RPV depressurization	completed	in progress	-
33	XX-JLD-10305	habitability MCR	completed	completed	completed
34	XX-JLD-10306	multi-unit and multi-site accidents	completed	completed	completed
35	XX-JLD-10307	resistance of the plant site infrastructure	completed	in progress	completed
36	HQ-JLD-10201	local seismic network small earthquakes	completed	completed	completed
37	HQ-JLD-1013001	EPZ	completed	completed	completed
38	HQ-JLD-1013002	communication for EP (NTTF 9.3)	completed	completed	completed
39	XX-JLD-10104 (DNT)	seismic reinforced TSC	completed	completed	completed
40	XX-JLD-1013003	new seismically isolated TSC	completed	in progress	in progress
41	XX-JLD-1013004	staffing for EP (NTTF 9.3)	completed	completed	completed
42	RL-JLD-1012042	40 mobile detection equipment	completed	completed	completed
43	RL-JLD-1012043	13 radiation monitor, stations in EPZ	completed	completed	completed
44	RL-JLD- 1012044	4 vehicles for mobile detection equipment	completed	completed	completed

[1] NTTF is the regulatory action proposed by the U.S. NRC (Near Term Task Force) in response to the Fukushima accident in Japan.

[2] AEC's RAIs: TPC has completed safety enhancement, but some requests for additional information (RAIs) issued by AEC have not been resolved.

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ARTICLE 15. RADIATION PROTECTION

Each Contracting Party shall take the appropriate steps to ensure that, in all operational states, the radiation exposure to the workers and to the public caused by a nuclear installation shall be kept as low as reasonably achievable, and that no individual shall be exposed to radiation doses that exceed the prescribed national dose limits.

15.1 Regulatory Framework and Protection of Radiation Workers

15.1.1 Laws, Enforcement Rules, and Regulations for Radiation Protection

The Ionizing Radiation Protection Act (IRPA) was enacted in 2002 and came into effect on February 1, 2003. This Act consists of 5 chapters and 57 Articles. Simultaneously 23 regulations took effect for the implementation of the IRPA.

The purpose of the IRPA is to properly manage radioactive material, equipment capable of producing ionizing radiation, and radiation practices, so as to prevent harm to radiation workers and the public from the detrimental effects of radiation.

The IRPA prescribes the basic radiation protection principles and the following nuclear power plant related topics are emphasized in it:

- Provisions for protective measures against radiation hazards that keep the radioactive material release and the occupational radiation exposure as low as reasonably achievable (ALARA),
- Provisions for safety measures related to operations stipulating the necessary actions for protecting human bodies, the public, and the environment from radiation hazards which may accompany the operations of nuclear power stations,
- Performance criteria for the personnel dosimetry service for radiation workers or persons having access to nuclear installations, and
- Training requirements for the persons working in radiation environment.

The Enforcement Rules of the IRPA consists of 25 Articles, to address the details and necessary supplement of the Act. The provisions related to nuclear power stations are the content of the radiation protection plan, the requirement for the monitoring of the radiation worker's dose, the content of the safety assessment report for discharge of the gaseous and liquid effluents, the requirement to conduct the radiation training for the radiation workers and the content of the evaluation report for a possible accident.

There are 23 Regulations prescribing the technical requirements on radiation protection, and the following topics are emphasized for the nuclear power stations:

- Detailed provisions of the safety standards to protect the radiation worker and the public against the radiation,
- Detailed provisions for the safe transport of radioactive materials,
- Detailed provisions for the establishment of radiation protection organization in the nuclear power station,

- Detailed provisions for the radioactive materials and associated practices, such as designation of a controlled area,
- Detailed provisions for the monitoring of the radiation work places and the environment,
- Detailed provisions for the radiation protection personnel, and
- Detailed provisions for the personnel dosimetry service.

15.1.2 ALARA for Occupational Exposure

Implementation of ALARA in the Design and Construction of Nuclear Power Plants

The TPC incorporates the following radiation protection principles in the design and construction of nuclear power stations, for assuring the criterion of ALARA and maintaining the radiation doses to workers and the general public within the applicable limits:

- The high radiation dose equipments are separately in shielded rooms with partition,
- Installation of shields to fully attenuate radiation from pipes and equipment containing large amounts of radioactivity,
- Use of remotely controlled equipment and automatic equipment in radiation controlled area,
- Installation of ventilation facility in areas of potential air contamination,
- Installation of a continuously radiation monitoring system in nuclear power station, and
- Establishment of the appropriate radiation zone classification and access control.

Criteria for Radiation Exposure Control

In practice, the TPC establishes a target dose limit for radiation workers at 90% of the official limits, as depicted in Table 15.1 and it actively manages radiation doses to ensure they remain within this target dose limit. Procedures dictate that individuals whose annual dose approaches the target value will undergo close daily monitoring. Furthermore, individuals whose annual dose reaches 80% of the official limit are not permitted to work in high radiation areas unless granted approval by the plant general manager, and appropriate measures are put in place.

Management of Radiation Work

The TPC's procedures stipulate that any person intending to access controlled areas for radiation work must obtain a radiation work permit in advance. This permit is prepared separately, considering the type of work, radiation levels, and working conditions. To issue this permit, the Health Physics Section's radiation protection personnel must evaluate the anticipated dose and, if necessary, impose additional special conditions on the worker.

Table 15.1 Currently Applicable Dose Limits

Category	Radiation Worker	General Public (Critical Group)
Effective Dose	50 mSv (any single year) 100 mSv (5 continuous years)	1 mSv per year
Annual Equivalent Dose in - Lens of the Eye - Skin, Hands, and Feet	 150 mSv 500 mSv	 15 mSv 50 mSv

Table 15.2 Collective Dose in Each NPP of the TPC

Unit: Man-Sievert

Year	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Chinshan	2.885	1.966	1.937	3.187	2.845	1.394	1.036	0.525	0.469	0.501	0.189
Kuosheng	2.294	2.599	3.632	2.562	2.389	3.035	2.188	2.054	2.089	3.516	0.976
Maanshan	1.096	1.741	0.802	0.937	1.467	1.156	0.853	1.500	1.109	0.908	1.456
Total	6.275	6.306	6.371	6.686	6.701	5.585	4.077	4.079	3.667	4.925	2.621

Reduction of Occupational Radiation Exposure

The TPC has established and implemented specific targets to reduce the occupational radiation exposure, including the annual collective dose, collective dose during planned refueling outage period or preventive maintenance periods, and the job-specific collective dose. According to the procedures set by the TPC, all radiation work must adhere to a pre-established plan. It is also mandated that an ALARA Committee meeting be convened during the planning stage to estimate and evaluate radiation levels and the expected collective dose. Furthermore, the TPC will evaluate the ALARA performance more than once a year for major maintenance work, design modification and equipment replacement. When carrying out radiation work, the technique of dose reduction shall be described in the radiation work procedure or the radiation work permit. Radiation workers are required to utilize proven ALARA techniques based on past experiences with similar work

The collective doses for the employees in three NPPs from 2011 to 2021 are presented in Tables 15.2. The collective doses will be reduced significantly when NPPs enter decommissioning.

Personnel Dosimetry Service and Its Verification

Every year, there are approximately 50,000 workers associated with the occupational radiation exposure in Taiwan. The Atomic Energy Council has established the National Database Center of Occupational Radiation Exposures (NDCORE) to oversee and manage the exposure of radiation workers

All organizations providing personnel dosimetry service, including the TPC, are required to obtain approval from the AEC before they conduct the service. The TPC distributes, collects and reads monthly the thermo-luminescent dosimeters (TLD) carried by its employees and informs relevant personnel of the results. These results are also reported to the AEC on a monthly basis. INER holds the performance test of the laboratories every three years and the accuracy of the reading is maintained by laboratory accreditation from the TAF Program of the Bureau of Standards, Metrology and Inspection.

Radiation Protection Training

The TPC's procedures stipulate that radiation workers and any personnel with access to nuclear power stations, having access to the nuclear power stations and radioactive waste treatment or storage facilities are required to take appropriate radiation protection training courses. Workers acquire fundamental knowledge and necessary skills for safely conducting radiation-related tasks through this training. The curriculum is categorized into the following courses:

- Course for personnel with temporary access.
- Course for personnel with occasional access.
- Course for radiation workers.
- Refreshing course.
- Course for managers.

The specific training duration is assigned for each course. The basic subjects include fundamentals of radiation protection, health effects of radiation, access procedures to the controlled area, and emergency preparedness. Additional subjects include radiation exposure control, contamination control, waste management, and the use of instruments and protective equipment. Those who have taken the training courses shall be evaluated by a written examination. After passing the evaluation, the trainee is then qualified to have access to or conduct work in the controlled areas.

15.1.3 Activities to Enhance the Regulation

The AEC had conducted a series of projects since July 1996 to incorporate the ICRP-60 recommendations into the relevant Acts and regulations. The Ionizing Radiation Protection Act was enacted in January 2002, in which some of the radiation protection concept of ICRP-60 was incorporated. Major contents of the Regulation, “Safety Standards for Protection against Ionizing Radiation,” promulgated in January 2003 and revised in December 2005 are the reduction of the dose limits and the introduction of an internal exposure assessment system following the abolishment of the maximum permissible dose concept.

Safety Standards for Protection against Ionizing Radiation

The Safety Standards for Protection against the Ionizing Radiation were updated in accordance with ICRP-60 on December 30, 2005. This update included the adoption of the term "effective dose" to replace "effective dose equivalent" used in the previous version. According to these standards, the personal occupational dose for radiation workers shall not exceed 100 milli-sievert (mSv) over five consecutive years as defined by the AEC. The first five-year cycle was from 2003 through 2007, and the current cycle (fourth) is 2018 through 2022. This version of the Standards incorporates the radiation weighting factor and dose conversion coefficients as recommended by ICRP-60. The effective dose for the general public shall not exceed 1 mSv in one year. To evaluate internal doses for different age groups of the public, six groups of inhalation and ingestion dose coefficients have been adopted.

15.2 Protection of Radiation Exposure for Members of the Public

15.2.1 Dose Constraints on Radioactive Effluents

The AEC refers the Appendix I to US 10 CFR Part 50, "Numerical Guides for Design Objectives and Limiting Conditions for Operation to Meet the Criterion 'As Low as Reasonably Achievable' for Radioactive Material in Light-Water-Cooled Nuclear Power Reactor Effluents" to establish the maximum allowable concentration of gaseous and liquid effluents to be released into the environment from NPPs and the relevant dose constraints. According to the regulations, each NPP is allowed to discharge the gaseous or liquid effluent into the environment after confirming that their concentration is within the allowable limit.

Based on "Regulations on the Design of the Environmental Radiation Dose of a Nuclear Power Plant" (promulgated on January 8, 1990), the dose constraints to members of the public for gaseous effluents are as follows:

(1) Radioactive Inert Gas

- Effective dose from external exposure: 0.05 mSv/yr-unit,
- Equivalent dose in skin from external exposure: 0.15 mSv/yr-unit,
- Air absorbed dose from gamma rays: 0.1 mGy/yr-unit,
- Air absorbed dose from beta rays: 0.2 mGy/yr-unit,

(2) Radioactive Iodine, Tritium and Particulates (half-life > 8 days)

- Equivalent dose in organ from radioactive iodine, tritium and particulates: 0.15 mSv/yr-unit

The dose constraints for members of the public regarding liquid effluents are as follows:

- Effective dose: 0.03 mSv/yr-unit, and
- Equivalent dose in organ: 0.1 mSv/yr-unit.

15.2.2 Assessment of Radiation Doses to the Population around NPPs

IRPA require TPC to implement the safety assessment for the radiation dose effect to the population around the NPPs (critical group) resulting from the released radioactive material. This is done to confirm compliance with regulatory dose limits. The safety assessments model is based on factors such as the radioactivity of liquid and gaseous effluents, the atmospheric conditions, dose conversion factors, and social data including agricultural and marine products of the local community within a 50 km radius.

The dose received by the critical group includes the exposures from the radionuclides in the gaseous and liquid effluent. The exposure pathways considered in the gaseous release situation include plume exposure, ground exposure, inhalation, and ingestion of contaminated vegetables, meat and milk. Using the hourly meteorological data from the site area which include wind direction and speed as well as the atmospheric stability class recorded on the on-site monitoring station, the relative atmospheric dispersion factor

(χ/Q) and deposition factor (D/Q) are initially calculated at the designated position points of interest for the critical group within a 50-kilometer radius of the NPP. Then those individual doses of the critical group resulted from gaseous effluent are evaluated. The exposure pathways considered in a case of liquid releases include the ingestion of fish and invertebrates, as well as participation in swimming and shoreline recreational activities. At the same time based on the effects of exposure pathway, individual doses of the critical group resulting from liquid effluents are also evaluated.

The TPC uses NRC-approved computer programs such as XOQDOQ-82 (Radiological Assessment Code System - Meteorological Evaluation of Routine Effluent Releases at Nuclear Power Stations), GASPAR (Calculates Radiation Exposure to Man from Routine Air Releases of Nuclear Reactor Effluents), and LADTAP-II (Code System for Calculating Radiation Exposure to Man from Routine Release of Nuclear Reactor Liquid Effluents) for the safety evaluation of radiation doses to the population around NPPs. The dose conversion coefficients in the computer programs are replaced with the ICRP-60 recommended values to align with the current requirements of the Regulation, "Safety Standards for Protection against Ionizing Radiation". The actual gas and liquid emissions from the three nuclear power plants did not cause abnormal radiation doses to the surrounding population. The effective dose and organ equivalent dose from the gaseous and liquid effluents from the NPPs for the years from 2011 to 2021 meet the "Regulations on the Design of the Environmental Radiation Dose of a Nuclear Power Plant" and regulatory dose limits, too.

15.2.3 Environmental Radiation Monitoring by the Licensee

Every year, the TPC files the Environmental Radiation Monitoring Plan for the next year. Based on the plan authorized by the AEC, the TPC conducts environmental radiation monitoring activities, including the installation and operation of TLD posts and environmental radiation monitors, as well as the analysis of the radioactivity of environmental samples. This is done in accordance with the regulation entitled "Criteria for Management of Radiation Workplaces and Environmental Radiation Monitoring outside Them".

There are a total of 17 environmental radiation monitors installed within the radius of 2.0 km of the three NPPs in Taiwan. Among these monitors, 7 are for Chinshan NPP, 7 for Kuosheng NPP, 5 for Maanshan NPP, with 2 of them being shared by both Chinshan and Kuosheng NPPs according to the latest approved **Environmental Radiation Monitoring Plan**.

All the monitors are installed in consideration of topography, population distribution, and atmospheric dispersion factors. They monitor the gamma dose rate continuously at 1 m above the ground. The status of the monitoring system and the radiation dose levels can be confirmed in real-time at the Radiation Laboratory of the TPC and the Health Physics Station of the nuclear power unit, where the monitors are connected online. TLDs (Thermoluminescent Dosimeters) are installed at a height of one meter on the posts after the posts are securely installed in the ground. They are used to assess the cumulative quarterly gamma radiation dose within a 50 km radius around the nuclear power station. The number of TLDs installed is 45 for the Chinshan, 36 for the Kuosheng, and 32 for the Maanshan nuclear power plant.

The environmental samples are air samples, waterborne samples (seawater, drinking water, ground water, underground water, precipitation), seabed samples (sediment, shore line sand), and food products (milk, vegetables, fruits, sweet potato, fishes, shellfish, seaweed). Different types of samples are measured at different periods as shown in Table 15.3.

Table 15.3 Environmental Radiation Monitoring in the Vicinity of NPPs

Unit: Number of Samples

Sample Items	NPP			Analysis Items/Analysis Frequency
	Chinshan	Kuosheng	Maanshan	
Direct Radiation:				
TLD Stations	45	36	32	Gamma Dose Rate/ Quarterly
HPIC Stations	7	7	5	Gamma Dose Rate /hr
Air:				
Particulates Stations	16	11	16	Gross β, γ Spectrum[1]/ Weekly, γ Spectrum/Quarterly, Sr-89,90[2]
Iodine Stations	16	11	16	I-131/Weekly
Fallout	1	1	1	γ Spectrum / Monthly
Water:				
Sea Water	9	9	10	γ Spectrum[3], H-3[3]/ Monthly, Sr-89,90[2]
Drinking Water	7	11	7	γ Spectrum, H-3/ Quarterly, Sr-89,90[2], I-131[4]
River Water	2	4	2	γ Spectrum, H-3/ Quarterly, Sr-89,90[2]
Pond Water	5	3	3	γ Spectrum, H-3/ Quarterly, Sr-89,90[2]
Ground Water	2	3	2	γ Spectrum, H-3/ Quarterly, Sr-89,90[2]
Regular Precipitation	2	2	3	γ Spectrum / Monthly, H-3/ Quarterly, Sr-89,90[2]
Fixed Amount of Precipitation	2	2	3	γ Spectrum, H-3
Agriculture & Marine Products:				
Milk: Cow/Goat	—	—	1	I-131, γ Spectrum / Quarterly, Sr-89,90[2]
Rice	2	3	3	γ Spectrum / Semiannually, Sr-89,90[2]
Vegetables	5	5	5	I-131, γ Spectrum / Semiannually, Sr-89,90[2]
Tea	5	—	—	γ Spectrum / Semiannually, Sr-89,90[2]

Sample Items	NPP			Analysis Items/Analysis Frequency
	Chinshan	Kuosheng	Maanshan	
Fruits	2	2	1	γ Spectrum / Annually, Sr-89,90[2]
Vegetables (Root)	3	3	2	γ Spectrum / Annually, Sr-89,90[2]
Sweet Potato	1	1	—	γ Spectrum / Annually, Sr-89,90[2]
Vegetable Stem[5]	1	1	1	γ Spectrum / Annually, Sr-89,90[2]
Poultry	3	3	3	γ Spectrum / Semiannually, Sr-89,90[2]
Seaweed	2	2	2	γ Spectrum / Annually, Sr-89,90[2]
Sea Fish & hellfish	5	5	6	γ Spectrum / Quarterly, Sr-89,90[2]
Index Organism:				
Acacia (Land)	1	1	1	γ Spectrum / Monthly
Algae (Sea)	1	1	1	γ Spectrum / Annually, Sr-89,90[2]
Land & Coast:				
Beach Sand	9	12	10	γ Spectrum / Quarterly
Soil	15	15	11	γ Spectrum / Semiannually
Sea Sediment	4	4	4	γ Spectrum / Semiannually

Note: 1. Conduct γ Spectrum analysis if weekly Gross β > 4 Bq/m^3.
2. Conduct Sr-89,90 analysis if Cs-137 exceeds limit set by AEC.
3. Conduct γ Spectrum and tritium analysis in all stations if monthly results from inlet, outlet and counterpart stations exceed the limit set by AEC.
4. Conduct I-131 analysis if I-131 is found in air.
5. First NPS: bamboo shoot; Third NPS: onion.

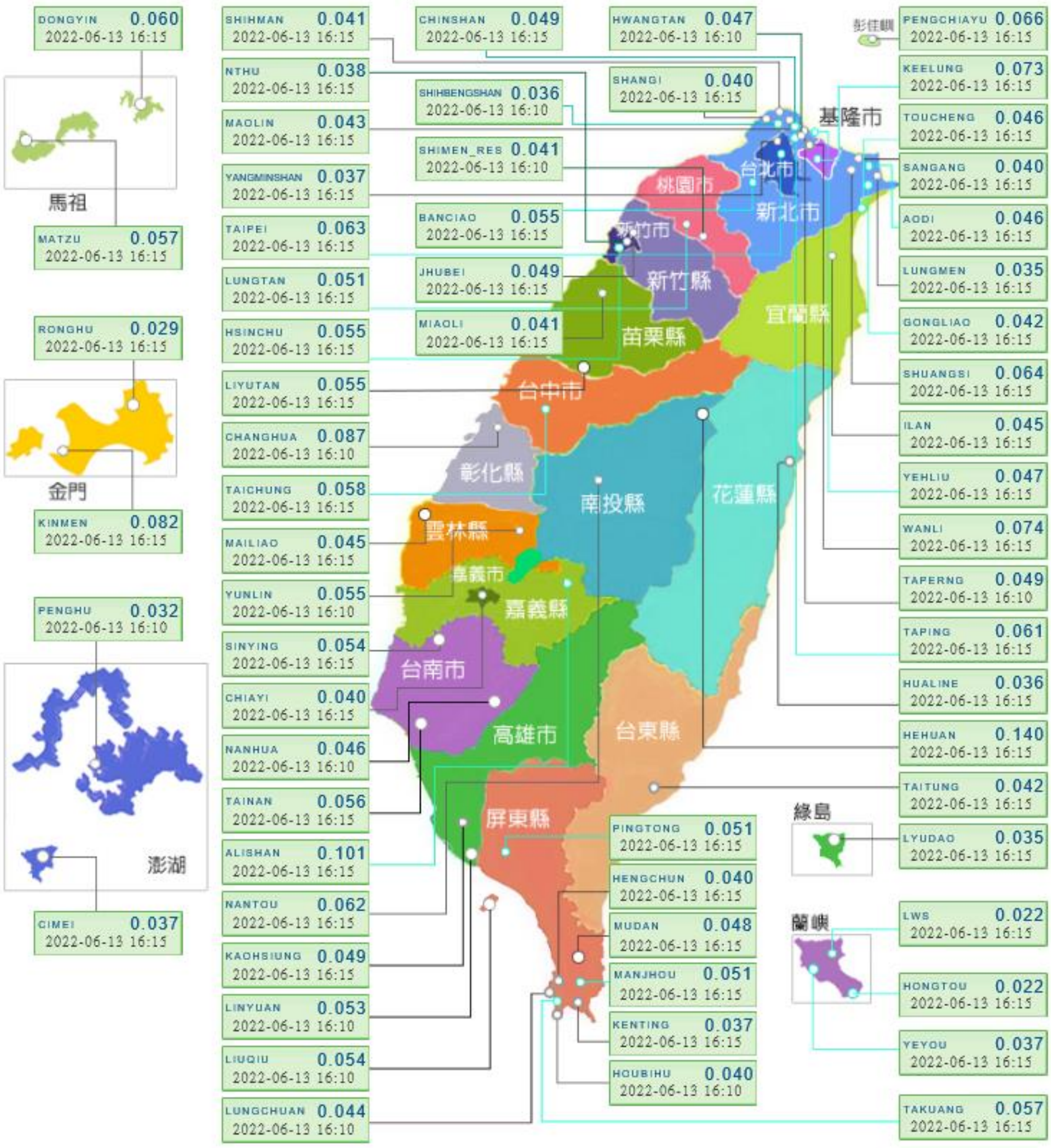
To comply with the regulatory requirements and ensure the safety of the public and the environment, TPC conducted the radiological environmental monitoring programs tailored to site characteristics. There are three exposure pathways (i.e., inhalation, ingestion, and direct radiation) that are routinely monitored. Samples of various environmental media are collected to meet these objectives. Sampling locations were selected with consideration given to site meteorology, hydrology, demography, agricultural products, lifestyle and the land-use.

Sampling locations were divided into two classes: indicator and control. Control stations were situated in locations deemed unaffected by the operations of NPPs. All other locations were designated as indicator locations and could potentially be affected by the Nuclear Power Station. The monitoring area for Chinshan and Kuosheng includes New Taipei, Keelung, and Ilan. For Mananshan Nuclear Power Station, Pingtung is considered.

15.2.4 Environmental Radiation Monitoring Network by the AEC

The Radiation Monitoring Center (RMC) of the AEC measures radioactivity in various environmental components, including airborne dust, fallout, rainwater, drinking water, underground water, livestock products, farm products, soil, and milk. Additionally, they monitor background radiation levels nationwide. The RMC also manages and operates a nation-wide Environmental Radiation Monitoring Network (ERMN). This network allows the RMC to promptly detect and respond to any abnormal environmental radioactivity situations. The nationwide ERMN, as shown in Figure 15.1, consists of the following facilities: an environmental radiation monitoring center in the RMC, local monitoring stations in five major cities with large population, the monitoring posts at three nuclear power station sites, INER and through the nation. Up to June 2022, a total of 63 Environmental Radiation Monitoring (ERM) stations have been established in Taiwan, Kinmen Island, Matzu Island, Penghu Island and Lan-yu Island. The RMC has conducted annually national and international inter-laboratory comparisons on environmental radioactivity measurements for quality control. To enhance the analysis capability of the environmental radiation detection around NPPs, the following improvements have been made: the setup of the high efficiency pure germanium multi-channel analyzer system and the wide range pure germanium energy spectrum analysis system has been completed, the capability for prompt accidental detection and analysis has been established, the environmental detection techniques and quality have been upgraded, and the induction coupled plasma mass spectrum equipment has been purchased. By the way, a wireless transmission for the emergency response environmental radiation monitoring and display network has been established, which can be installed at any chosen locations and is able to transmit real-time radiation level and meteorological information.

In the light of Japan's experience with accidents, it is crucial to have precise access to radiation detection information across land, sea, and airspace. The AEC has completed the operations of the sophisticated early warning systems and implemented the radiation monitoring project for the diffusion of fallout mutually with foreign agencies. This included the establishment of utilization of the Coast Guard ships and military helicopters to support the radiation monitoring in order to strengthen the monitoring capability in case of a nuclear accident. Furthermore, some US air and ground radiation detection equipment has been introduced to upgrade the domestic real-time detection capability during emergency response.



Frequency: 5 Minute Unit : μSv/h

Figure 15.1 Environmental Radiation Monitoring Network in the ROC

ARTICLE 16. EMERGENCY PREPAREDNESS

1. Each Contracting Party shall take the appropriate steps to ensure that there are on-site and off-site emergency plans that are routinely tested for nuclear installations and cover the activities to be carried out in the event of an emergency.

For any new nuclear installation, such plans shall be prepared and tested before it commences operation above a low power level agreed by the regulatory body.

2. Each Contracting Party shall take the appropriate steps to ensure that, insofar as they are likely to be affected by a radiological emergency, its own population and the competent authorities of the States in the vicinity of the nuclear installation are provided with appropriate information for emergency planning and response.

3. **Contracting Parties which do not have a nuclear installation on their territory, insofar as they are likely to be affected by a radiological emergency at a nuclear installation in the vicinity, shall take the appropriate steps for the preparation and testing of emergency plans for their territory that cover the activities to be carried out in the event of such an emergency.**

16.1 On-site and Off-site Emergency Preparedness

16.1.1 Laws, Regulations and Requirements

On the basis of the Nuclear Reactor Facilities Regulation Act, the safety of a nuclear installation is strictly regulated in every stage of design, construction and operation. Nevertheless, to assure the preparedness against the very unlikely occurrence of accidents with large release of radioactive materials, the "National Nuclear Accident Emergency Response Plan (NNAERP)" was promulgated in 1981 by the Executive Yuan and later revised in 1994, 1998 and 2002, respectively. The Nuclear Emergency Response Act was then promulgated by the President on December 24, 2003. In order to carry out the emergency response activities effectively for a nuclear accident, the response mechanisms have been established. The central government is responsible for the communications and decision-making for the public protection in case of a nuclear accident. The local government is responsible for the implementation of the related protective actions with the support of experts from the AEC and military units. The response organizations and their functional responsibilities are described in the following section. The nuclear reactor facility licensee shall set up a dedicated Nuclear Emergency Response Organization (NERO) in Taipower headquarters and the onsite NERO within the Facility. The responsibilities and the activation timing of the dedicated NERU and the NERO, and the relevant operational procedures are to be proposed by the nuclear reactor facility licensee and submitted to the AEC for approval.

The Nuclear Emergency Response Act, the Enforcement Rules for the Implementation of this Act, and the Nuclear Accident Emergency Response Basic Plan (NAERBP) (which was enacted in July 2005 and later amended in 2009 and 2014 by AEC to replace the previous NNAERP) cover the responsibilities of the competent organizations, accident categorizations, protective actions and recovery measures for nuclear emergency response. The major contents of the Emergency Response Basic Plan are summarized as follows:

16.1.2 Emergency Response Organizations and Their Missions

According to the Emergency Response Basic Plan (ERBP) as amended on September 24, 2014, the TPC is responsible for all the emergency response activities inside the plant in case of a nuclear accident, while the National Nuclear Emergency Response Center (NNERC) activated by the AEC is responsible to supervise the implementation of response measures, issue press release, activate public notification systems, announce orders for public protection actions and dispatch manpower and resources of the designated agencies. The NNERC consists of delegates from the following organizations assembled by AEC: Ministry of Interior, Ministry of National Defense, Ministry of Economic Affairs, Ministry of Transportation and Communications, Council of Agriculture, Ministry of Health and Welfare, National Communications Commission, Environmental Protection Administration, Ocean Affair Council (Coast Guard Administration), Office of Disaster Management, Department of Information Service, Ministry of Foreign Affairs, Ministry of Finance, Ministry of Education, and National Science and Technology Council. Under the command of the NNERC, there are three temporary emergency centers, including the Nuclear Emergency Support Center (NESC), the Regional Nuclear Emergency Response Center (RNERC) and the Radiation Monitoring and Dose Assessment Center (RMDAC). Figure 16.1 shows the response to a nuclear accident. For more detailed information about complex nuclear disasters, please see Subsection 16.3.1. Missions of the above-mentioned emergency response centers are described as follows:

<u>National Nuclear Emergency Response Center</u>

The major missions of the National Nuclear Emergency Response Center (NNERC) are: supervision of response measures; evaluation of the accident, notification of the activation of the Regional Nuclear Emergency Response Center (RNERC) and the Nuclear Emergency Support Center (NESC); announcement of the protective actions for the public; releasing information associated with accident conditions and rescue operations; correction of false messages and clarification of government announcements.

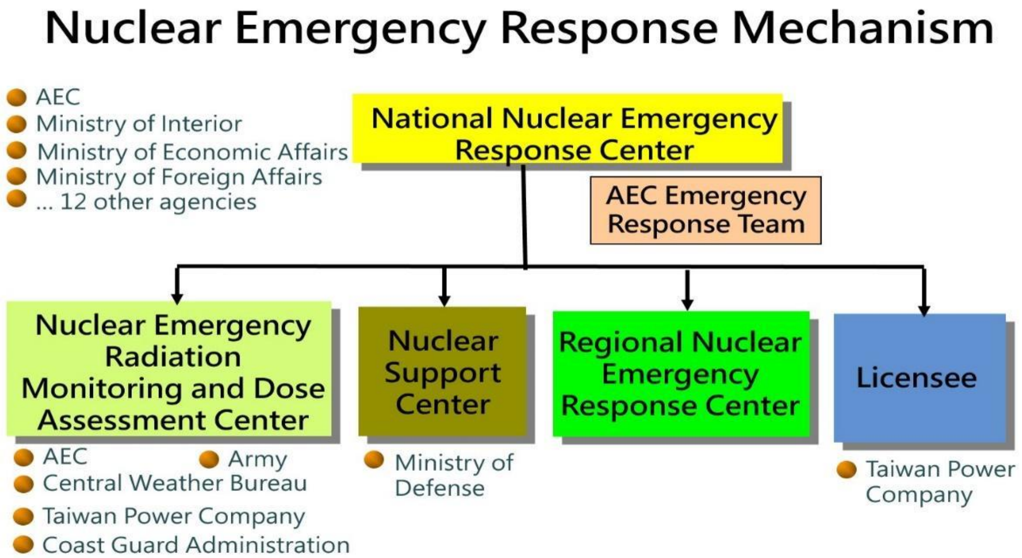


Figure 16.1 Response to a Nuclear Disaster

Radiation Monitoring and Dose Assessment Center

The Radiation Monitoring and Dose Assessment Center (RMDAC) is composed of specialists from the AEC, the Central Weather Bureau, the TPC, the Army Command Headquarters, and Ocean Affair Council (Coast Guard Administration). Its major missions are: radiation detection for personnel; vehicles and environment; siren broadcasting; accident consequence prediction; public exposure assessment; suggesting actions for public protection; and providing information and technical support to other centers.

Regional Nuclear Emergency Response Center

The Regional Nuclear Emergency Response Center (RNERC) is composed of staff from the local government. Its major missions are: caring for the affected population; the notification and implementation of protective actions for the public, including traffic control; notification of in-house shelter and evacuation plans; distribution of iodine tablets; reception, accommodation and assistance in the temporary migration of affected inhabitants; medical care for the injured; maintaining order and providing assistance with announcements, warnings and press releases.

Nuclear Emergency Support Center

The Nuclear Emergency Support Center (NESC) is composed of experts from the military corps. Its major missions are: decontamination of the public, vehicles and environment; assisting the implementation of public protective actions, including evacuation, shelter, medical care; distribution of iodine tablets; traffic control, and safeguarding the affected area. This center also provides support for radiation detection and monitoring of the affected area.

Implementation Guidelines for the Response to International Nuclear Accident

In the case of a nuclear accident occurring in a neighboring country, the AEC will take actions to protect the health and safety of the public according to the Implementation Guidelines for the Response to International Nuclear Accident (promulgated in 2014). Those actions include an emergency environmental radiation monitoring network, analysis of air samples, forecasts of dispersion pathways, and collection of international information. If the accident becomes more serious, a task force organized by multiple departments of the government will be formed to manage the emergency.

16.1.3 Emergency Response Organizations of the Licensee and Their Missions

Upon the occurrence or possible occurrence of a nuclear accident, the licensee of a nuclear reactor facility shall initiate and organize a dedicated Nuclear Emergency Response Organization at the TPC headquarters, and also, activate a Nuclear Emergency Response Organization within the facility consisting of Technical Support Center (TSC), Operation Support Center (OSC), Health Physics Center (HPC) and Emergency Public Information Center (EPIC). The Nuclear Emergency Response Organization is responsible for support and coordination of response activities inside the facility. This Response Organization is also responsible for evaluating the accident situation and the influence of possible radiation exposure, cooperating with the NNERC, RMDAC, NESC and RNERC for proceeding related emergency response measures. This Organization shall report and keep in contact with the AEC and related Centers during the emergency conditions, and request for support from possible resources outside the facility, if needed. The onsite Nuclear Emergency

Response Organization is composed of experts from the facility. The major missions of this organization are taking the compensatory measures necessary to bring the nuclear power unit under control, supervising the response measures inside the facility, detecting environmental radiation and estimating exposure levels, and also providing information regarding the accident to the offsite related organizations.

16.1.4 Categorizations of Nuclear Accidents

Not all abnormal incidents occurring in a nuclear power station require emergency response. Even if a nuclear accident does occur, there may not be a threat to the public if appropriate counter measures are taken by the plant operators. In order to effectively formulate the steps of emergency response and to determine proper protective actions for the public, nuclear accidents and the possible severity of their impact are divided into the following three categories, according to Regulations for Nuclear Emergency Classification, Notification and Response:

First Category: Alert Event (AE)

When an abnormal event in a nuclear power plant deteriorates to the extent that specific safety parameter(s) seriously exceeds the Technical Specifications limit and probably threatens the safe operation of the unit, it is defined as an Alert event (AE). A small amount of radioactive materials may be released in this kind of event, however, the safety limit associated with the protection of public health is not exceeded. Therefore, there is no need to perform any protective actions for the public. In accidents of this category, the TSC will be activated to respond to the condition. The Nuclear Emergency Response Organization of TPC headquarters will evaluate the possible impact of the accident, and prepare for necessary response activities and notify AEC and local government immediately. AEC will establish an emergency team, and notify RMDAC, RNERC and NESC to standby, based on the accident situation and its possible impact. AEC may notify RMDAC for assembly and preparedness if needed.

Second Category: Site Area Emergency Accident (SAEA)

When a nuclear power unit encounters a major accident that causes severe damage to the safety systems and endangers the safety of the unit, a declaration of “Site Area Emergency accident (SAEA)” will be needed. In case of this accident, the TPC has to activate its whole in-house emergency response structure to perform the necessary response and immediately notify NNERC and RNERC, then regularly report to them. The AEC will establish NNERC and inform the RMDAC to activate. The AEC may also notify the RNERC and the NESC to activate. Protective actions for offsite residents may be needed during this category of accident.

Third Category: General Emergency Accident (GEA)

When a nuclear power unit encounters a major accident that may cause damage of the reactor core and failure of the containment integrity, a “general emergency accident (GEA)” will be declared. In this kind of accident, all the emergency response organizations need to be activated, and in addition, the correct protective action for the offsite residents needs to be performed immediately.

16.1.5 Emergency Planning Zone (EPZ)

In case of a nuclear accident for which the preliminary protective measures or evacuation of the local residents are required, the size of the affected area needs to be evaluated. Besides the public safety consideration, cost-effectiveness should be another vital factor. An Emergency Planning Zone for the preparation of emergency responses for all nuclear accidents has been determined for each of the existing nuclear power plants. The size of the EPZ is closely related to the type of the reactor, the population density around the plant, the local topography, the local weather conditions, and the calculation of the potential severity of the accident. Identified in the "Enforcement Rules for the Implementation of the Nuclear Emergency Response Act", the guidelines to determine the EPZ boundary are as follows:

- The predicted radiation dose outside EPZ resulting from design basis accidents shall not exceed the evacuation intervention criteria stipulated in the Nuclear Emergency Public Protective Action Guides of AEC.
- The annual probability of the predicted radiation dose outside the EPZ resulting from a core meltdown accident exceeding evacuation intervention criteria stipulated in the Nuclear Emergency Public Protective Action Guides of AEC shall be less than three in 100,000.
- The annual probability of the predicted radiation dose outside the EPZ resulting from a core meltdown accident exceeding 2 Sv shall be less than three in 1,000,000.

The re-analysis of the accident dose and risk distribution for the current EPZ after the Fukushima accident in 2011 was made by applying the computer code MACCS2 with the following input information:

- Assumption of source terms resulted from simultaneous failure of multiple units induced by composite natural disasters,
- Updated meteorological data,
- Possibility of radiation release,
- Weather conditions,
- Population distribution around the plant, and
- Other related parameters.

Based on the above-mentioned guidelines, methods and analysis results, and the dose limits of the "Nuclear Emergency Public Protective Action Guides" as well as following a detailed analysis with social and economic considerations after the Fukushima accident in 2011, the EPZs for the operating NPPs were all set as a circle with the radius being extended from 5 to 8 kilometers from the center of the nuclear power station. The boundary of EPZ of each NPP will be re-evaluated by TPC every 3 years. The population and meteorological data will be updated in the re-evaluation.

Within the EPZ, all the preparedness must be ready at all times, including the public alert systems, rendezvous points, evacuation routes, distribution of iodine tablets, the reception and accommodation centers, etc. Drills should be conducted periodically to evaluate the feasibility of the preparedness and response arrangements, to see whether the staff act according to the emergency plan implementing procedures, to check the functions of relevant hardware and software, and finally to find out whether the nearby residents are familiar with the practice so as to enhance the efficiency and effectiveness of the emergency response plan.

16.1.6 Planning and Training

Based on the Nuclear Emergency Response Act, the AEC shall consult all designated agencies to lay down the Nuclear Accident Emergency Response Basic Plan (NAERBP) and the Nuclear Emergency Public Protection Action Guides (NEPPAG). The contents of the Nuclear Accident Emergency Response Basic Plan include the missions of the response organizations, their routine preparedness measures, the exercise of the emergency response plan, notification and activation of each response organization, and the recovery measures after the nuclear accident. This basic plan provides the basic guides for the AEC, the NNERC, the RMDAC, the NESC and the RNERC for their detailed planning to enhance their capability for emergency response.

The local government shall lay down the Public Protection Plan based on the Nuclear Accident Emergency Response Basic Plan (NAERBP) and the Nuclear Emergency Public Protection Action Guides (NEPPAG). The contents of this Plan shall include categorization of the nuclear accident, mission of the organization, facility layout of the response center, notification of the accident and activation of the organization, routine preparedness measures, emergency response measures, and recovery measures after the accident.

The nuclear reactor facility licensee shall follow the provisions laid down by AEC to define the EPZ in the surrounding area of the nuclear reactor facility. The area of the EPZ should be reviewed and revised every three years. The licensee shall periodically submit the analysis and planning of the public protective measures within the EPZ to the AEC for approval. The analysis and planning of the public protective measures within the EPZ includes the population distribution, radiation monitoring program, public siren system, and the assembly, evacuation and accommodation of the public. The licensee shall set up necessary places and equipment according to the approved analysis and planning of the public protective measures within the EPZ. The licensee shall also draw up the Emergency Response Plan for the nuclear reactor facility. The contents of the plan include categorization of the nuclear accident with its justification procedure and method, the mission of the emergency response organization, the related routine preparedness measures, the emergency response measures, and recovery measures after the accident. A newly constructed nuclear reactor facility shall define the EPZ, the proposed public protective plan within the EPZ and the emergency response plan for the facility to be submitted to the AEC for approval before initial fuel loading.

To assure the knowledge and skill of the emergency response for the personnel involved in the response actions, periodic training courses together with the equipment test and maintenance are held in each nuclear power station and the designated agencies. The scope of training includes emergency response implementing procedures, rescue of injured persons, and emergency repair of damaged equipment. Inspectors from AEC are responsible for auditing the effectiveness of these courses. As for those from the central government, local government and military agency who are responsible for the emergency response, regular training courses in the areas of nuclear accident basics, emergency communication, radiation protection, disaster countermeasures, sheltering and evacuation, etc., are held by AEC. Special training on decontamination of personnel, vehicles and roads are performed by the relevant military agency on a regular basis. In addition, introductory lectures for the nuclear emergency response are given to the local residents living within the EPZ every time before an off-site drill is conducted. Primary and high school teachers in this area are trained to instruct their students about the knowledge of protective actions in case of a nuclear accident. Brochures, as well as the audio and video compact discs (or

USBs), about nuclear emergency response are distributed in the EPZ area associated with each nuclear power station every year.

In order to ensure all the facilities and equipment are in normal operating condition, the nuclear reactor facility licensee and the emergency response organizations shall perform the maintenance and functional testing according to the pre-approved maintenance program. Testing and maintenance of the emergency communication equipment is the important portion of the program.

16.1.7 Nuclear Safety Duty Center

A 24/7 (24 hours a day, 7 days a week) operation center, the Nuclear Safety Duty Center (NSDC) established in the AEC, provides the single point-of-contact for receiving emergency notifications whenever needed. It performs initial notifications, and coordinates management, logistics and mobilization actions during periods of national emergencies, natural and man-made disasters, or other extraordinary situations requiring centralized management notification and response. The main functions and capability of this NSDC center are illustrated as follows:

Safety Parameter Display System:

This system provides the NPPs' safety parameters on a real time basis to know the whole situation well. When an emergency occurs, these parameters will provide the vital first-hand information for event analysis and reference for the following response measures.

Environmental Radiation Monitoring System (ERMS):

Before 2011, there were a total of 30 radiation monitoring stations around this country, providing 24/7 real time environmental radiation (mainly γ-ray) information nationwide. After the Fukushima accident in 2011, an additional 33 stations were installed to broaden the monitored region.

Video Conference System:

This is an integrated system serving as a remote control channel during accident or abnormal conditions. Normally, a video conference test among AEC, TPC Headquarters and the operating NPPs will be performed on a regular time schedule to maintain the unimpeded emergency communication.

NPP Site Boundary Radiation Monitoring System:

There are multiple radiation stations at each NPP to monitor the radiation level (mainly γ-ray) at the plant site boundary area. All of the information is displayed 24/7, in real-time, at this center.

Cable TV News Channel:

Monitoring news channels and the acquisition of domestic and foreign reporting enable any worldwide nuclear event to be reported in its early stages.

Satellite Communication System:

In case of a total breakdown of all communication mechanisms, the satellite telephone can be used as an important backup for the AEC to communicate with other organizations.

Dedicated Hot Line Phone:

Dedicated hot lines have been installed for immediate and direct contact with each nuclear power plant and the Taipower headquarters during an emergency. The lines are tested everyday by the on-duty staff.

16.2 Notification and Protection of the Public

16.2.1 Implementation of Emergency Preparedness

Notification and Activation of Emergency Response Organizations

In case an "Alert Event (AE)" occurs, the licensee must mobilize all personnel of the Nuclear Emergency Response Organization and the Nuclear Emergency Response Unit of the nuclear facility to respond to the event and immediately notify the AEC and the local government. The AEC will then mobilize the Emergency Response Team as well as technical groups as the sub-teams, and complete a second level activation of the National Nuclear Emergency Response Center (NNERC). In the meantime, the AEC will notify related organizations to set up the Radiation Monitoring and Dose Assessment Center (RMDAC) as well as to complete a second level activation of the Regional Nuclear Emergency Response Center (RNERC) and the Nuclear Emergency Support Center (NESC). If the situation worsens to become a "Site Area Emergency Accident (SAEA)" accident or even a "General Emergency Accident (GEA)" accident, besides conducting his emergency response actions continuously, the licensee must regularly report to the NNERC and the RNERC. After receiving notification of a deteriorating situation, the NNERC must achieve its first level activation and notify the local government and all the response organizations to accomplish a first level activation of the RNERC, RMDAC and the NESC, respectively.

Notification of the General Public

In case of a severe nuclear accident, that may affect the residents in the EPZ, the NNERC is responsible for providing the public with the correct and complete information.

In general, the ways of notifying the public nearby the NPP include radio, TV, broadcasting vehicles and emergency siren systems set up at police stations by TPC in the EPZ, etc.

Protective Actions for the General Public

In case of a severe nuclear accident that may affect the offsite environment, the protective actions for the residents in the EPZ will include sheltering, evacuation, iodine thyroid blocking and relocation. These actions are performed according to the criteria of the "Nuclear Emergency Public Protection Action Guides" and described in Table 16.1. Iodine Tablets for radiation dose reduction (iodine thyroid blocking) are prepared for all the evacuees. Accommodation centers will be established at some appropriate places outside the EPZ to accommodate the personnel evacuated from the EPZ. Personnel and vehicles need to be checked for radiation contamination before entering these centers. De-contamination processes will be executed wherever necessary. RNERC is responsible for providing the evacuees water, food, medicines and other necessary assistance and NESC will provide decontamination of the personnel, vehicles and road as well as the traffic control, relocation of the personnel, emergency medical care, and Iodine Tablet distribution.

Protective Action Guides

In case of a radioactive material release to the offsite areas of a nuclear power plant, the decision on whether the offsite residents need to take shelter, evacuate or other protective actions is based on the predicted radiation exposure as listed in Table 16.1, which forms the Protective Action Guides (PAGs) used by AEC. As suggested in ICRP-63 and IAEA-115 reports, the projected dose and the avertable dose are used to define the dose limit for the intervention level for protective actions. The projected dose means the evaluated dose when no protective action is taken, while the avertable dose is the dose that could be cut back on when protective actions are taken as compared with the projected dose. On the other hand, the decision of food edibility in the contaminated area is based on the control standards of the equivalent concentrations of radionuclides in milk, infant foodstuffs or drinking water and the ordinary food as listed in Table 16.2.

Table 16.1 Intervention Levels for Protective Actions

Protective Action	Intervention Level
All residents need to take sheltering inside the house	Avertable Dose of 10 mSv in 2 days
Residents to be evacuated from EPZ	Avertable Dose of 50 to 100 mSv in 7 days
Take Iodine Tablet	Avertable Thyroid Equivalent Dose of 100 mSv
Temporary relocation (To be terminated when Projected Dose below 10 mSv in 30 days)	Projected Dose of 30 mSv in 30 days
Permanent Relocation	Expected Lifetime Dose Greater than 1 Sv, or Temporary Relocation over 1 Year

Table 16.2 Food and Drinking Water Control Standards

Radionuclide	Action Level (kBq/kg)	
	Food	Milk, Infant Foodstuffs, Drinking Water
Cs-134,Cs-137,Ru-103,Ru-106,Sr-89	≧ 1	≧ 1
I-131	−	≧ 0.1
Sr-90	≧ 0.1	−
Am-241,Pu-238,Pu-239	≧ 0.01	≧ 0.001

In addition, the "Reference Guidelines for Decision Making on Public Protective Actions in a Nuclear Accident" was created by AEC on May 2018. The Reference Guidelines adopted the latest ideas from the "Criteria for use in preparedness and response for a nuclear or radiological emergency (No. GSG-2)"; "Actions to protect the public in an emergency due to severe conditions at a light water reactor (EPR-NPP Public Protective Actions)" and "Operational interventional levels for reactor emergencies and methodology for their derivation (EPR-NPP OILs) " issued by the International Atomic Energy Agency in 2011, 2013 and 2017 respectively. It will help the Central Emergency Operation Center to make a more comprehensive decision on public protective actions during nuclear accidents. The guidelines include “Recommendations for Public Protection Actions in the Emergency Planning Zone (shown in Table 16.3)” and “Recommendations for Public Protective Action in the affected areas (shown in Table 16.4)”. “Recommendations for Public Protection Actions in the Emergency Planning Zone" is the decision-making reference of the public protection actions that can be adopted immediately by the government in the very beginning stage of nuclear accidents. "Recommendations for Public Protective Action in the affected areas" is used on the following stages of nuclear accidents. The Operational Intervention Level (OIL) is the criteria of the civil protection actions and considered the realistic radioactive materials distribution and effects through radiation detection and monitoring.

Table 16.3 Recommendations for Public Protection Actions in the Emergency Planning Zone

	classification of nuclear emergency		
	Alert Event	Site Area Emergency Accident	General Emergency Accident
Public protective actions	Close public recreation area		
		1. Issue nuclear emergency siren. 2. Evacuate vulnerable populations within the EPZ 3. Instruct the general public within EPZ to shelter at home	
			Evacuate general population within 3 km

Table 16.4 Recommendations for Public Protective Action in the affected areas

		Operational Intervention Level (OIL)	Intervention Level
Timing		After radionuclide released	Before and After radionuclide released
Mea	shelter		Avertable dose ≧ 10 mSv in 2 days
	Iodine Tablet Administration		Avertable dose ≧ 100 mSv of $H_{T(thyroid)}$

s u r e s	Evacuation	OIL1	Dose rate at 1m above ground level > 500μSv/hr	Avertable dose 50-100 mSv in 7 days
	Temporary Relocation	OIL2	Dose rate at 1m above ground level > 20μSv/hr	
	Food and Water Restrictions	OIL3	Dose rate at 1m above ground level > 0.5μSv/hr	
	Decontaminatio n of Individuals	OIL4	Dose rate at 10cm from skin > 1μSv/hr	

16.2.2 Exercise

To assure the effectiveness of the emergency response actions, both on-site and off-site emergency response exercises are held periodically. For the on-site exercise, once a year is required for each nuclear power plant. The items of the on-site exercise include notification and information transmission, activation and response of the emergency organization, rescue of the accident condition, accident impact evaluation, nuclear security, radiation monitoring, and dose evaluation. The scenario of each exercise is planned in the TPC Headquarters and kept confidential beforehand. An evaluation group, consisting of scholars, government officials and civilian representatives, is organized to oversee the performance of the exercise. Critics and recommendations from this group are documented for TPC's improvement.

For the off-site emergency response, a full-scale exercise was held in this country every two years before 2001. However, the frequency has been changed to once a year since 2002 as required by the government. Currently, the Maanshan, Kuosheng and Chinshan plants hold the exercise in turn. The items of the off-site exercise in recent years include notification and information transmission, activation and response of the emergency organization, accident impact evaluation, protective actions for the public, area control, radiation monitoring and dose evaluation, radiation decontamination, and related recovery measures. The participating organizations include all Ministries involved in the NNERC, the RNERC, the RMDAC, the NESC, and the TPC. In addition, some of the residents in the area of the EPZ are invited to participate in the evacuation practice of each exercise. The performance of each exercise is evaluated by a group of experts similar to the evaluation group for the on-site exercise. The recommendations on further improvements will be followed up by the participating organizations.

16.2.3 Recovery Measures

In order to allow the affected regions to recover promptly to normal conditions, the AEC shall call upon relevant government agencies of various levels and the nuclear reactor facility licensee to activate the Nuclear Emergency Recovery Committee to take recovery measures. The Committee consists of 19 to 23 members from the AEC, relevant government agencies, the nuclear reactor facility licensee and the public representatives from the affected regions. The responsibility of this committee includes: determining recovery measures, supervising the implementation of these measures; notifying relevant government agencies of various levels and the nuclear reactor facility licensee to implement relevant recovery measures; coordinating the dispatched manpower and resources for recovery; announcing orders for public protective actions during the recovery period; issuing press releases to aid recovery, and the carrying out of any other recovery measures. The missions of the relevant organizations are as follows:

Ministry of Interior (MOI)

The Ministry of Interior is responsible for: (a) supervising the local government to assist the public in the affected regions for temporary relocation or permanent accommodation, reconstructing the community, and searching the missing personnel; (b) supervising the supply and storage of necessary daily stuffs for the public in affected regions, and maintaining the necessary police and fire protection force for the affected regions; and (c) planning and conducting the recovery of the contaminated national park near the affected regions.

Ministry of National Defense (MOND)

The Ministry of National Defense supervises the military force to support radiation monitoring, to support local government for area control and transportation of the public, to conduct the decontamination of personnel, vehicle and road in affected regions, and to arrange vehicles for recovery related measures.

Ministry of Finance (MOF)

The Ministry of Finance is responsible for reduction or deferring of the land tax and customs duties in affected regions and adjusting the rate of the import tax or the amount of the quota as needed by the condition of the disaster.

Ministry of Economic Affairs (MOEA)

The Ministry of Economic Affairs supervises the nuclear reactor facility licensee to perform the recovery measures, and the affiliated organizations to control the contaminated water resources and adjust the water supply, and to regulate the electricity and the necessary stuffs for the public's livelihood.

Ministry of Transportation and Communication (MOTC)

The Ministry of Transportation and Communication supports the evaluation and planning of the road required for the recovery measures and acquisition of vehicles required for the recovery measures, and planning and conducting the recovery of contaminated national scenic spots near the affected regions.

Directorate-General of Budget Accounting and Statistics (DGBAS)

The Directorate-General of Budget Accounting and Statistics provides the local government of the affected regions with the financial support required to perform the recovery measures.

Ministry of Health and Welfare (MOHW)

The Ministry of Health and Welfare supervises the medical care for the public in affected regions, planning and dispatching medical supplies for the recovery measures, and evaluating the radiation injuries. It is also responsible for the health insurance and medical care related items for the affected public.

Environmental Protection Administration (EPA)

The Environmental Protection Administration evaluates the non-radiological environmental impact and environment protection, supports for the recovery of the contaminated environment, and make the recommendation for the transport, processing, and disposal of the contaminated waste. (The EPA was reconstructed into Ministry of Environment on August 22, 2023.)

Financial Supervisory Commission (FSC)

The Financial Supervisory Commission coordinates the deferring or reduction of the insurance fee for the affected public and provides assistance through insurance compensation or preferential financial measures for the public.

Atomic Energy Council (AEC)

The Atomic Energy Council provides the technical consultation for the recovery measures and supervises the licensee for the radiation detection and protection, radiation dose and contamination evaluation, etc., as needed in the recovery measures. The AEC shall also plan the decontamination measures, including transportation, processing and disposal of the contaminated waste, coordinate the technical support from foreign countries, identify the radiation affected regions based on actual radiation detection, assist the public for the nuclear damage compensation related cases, summarize the damage situation, and issue the contamination certificate.

Council of Agriculture

The Council of Agriculture coordinates the supply of agricultural produces in affected regions, summarizes and reports their damage situation, supports the control and recovery of the agriculture in the affected regions, coordinates the organizations of financial support for the recovery measures, supports for the recovery measures to deal with the contaminated agricultural produces, and plans for their protection afterwards.

National Communications Commission (NCC)

The National Communications Commission coordinates the communication organizations for normal communication in the affected regions and provides the emergency communication measures as needed.

Local Government

The local government compiles the recovery plan to coordinate and assist the re-construction and notification of the affected public, to conduct temporary relocation and permanent accommodation for the affected public, to handle the non-radiological waste to protect the public, and to enhance the public security and traffic control.

Nuclear Reactor Licensee

The nuclear reactor licensee shall recover the damaged nuclear facility, perform radiation monitoring, dose assessment, and protective measures needed in affected regions, and assist decontamination and transport, processing and disposal of contaminated waste.

16.2.4 Compensation for Nuclear Damage

The financial compensation program for the liability claims arising from nuclear accidents is described in Subsection 11.1.4 of Article 11 of this report. However, some important requirements associated with the compensation for nuclear damage are emphasized in this section. The Current Nuclear Damage Compensation Law with the latest version promulgated on May 14, 1997, was enacted according to Article 29 of the Atomic Energy Act (amended in 1971). This Law applies to compensation for nuclear damage resulting from the peaceful use of atomic energy. When a nuclear incident occurs in a nuclear installation or during the transport of nuclear materials belonging to the installation, the operator of the installation thereof shall be liable for the compensation of the resulting damage. This liability is regardless of whether the incident is caused through intention or negligence, except when it is caused directly by international armed conflicts, hostilities, domestic rebellion, or grave natural calamity. In case the operator can prove that the occurrence or expansion of nuclear damage was caused by the victim's intentional action or negligence, the court may reduce or dispense with the compensation.

The liability of a nuclear installation operator for nuclear damages arising out of each single nuclear incident shall be limited to four billion two hundred million NT Dollars (4.2 billion NT Dollars). A nuclear installation operator shall maintain liability insurance or financial guarantee sufficient to cover the maximum amount of nuclear damage compensation liability. However, this stipulation is not applicable to the nuclear installations of the central or local government and their research organizations. In respect of operation of a nuclear installation or transport of nuclear material, applications may be filed with the AEC for the reduction of the amount of liability insurance or financial guarantee within a certain limit. Should the amount received from the liability insurance or financial guarantee not sufficient to cover the finalized nuclear damage compensation, the government shall loan the balance to the nuclear installation operator to cover its complete liability; but only to the maximum amount that the operator is liable.

According to the Article 28 of Nuclear Damage Compensation Law, claims of compensation for nuclear damage shall be extinguished if an action is not brought within three years after knowledge of the damage and of the nuclear installation operator liable for the damage; however, the period shall in no case exceed ten years from the date of the nuclear accident. After the occurrence of a nuclear accident, the AEC may organize an Advisory Committee on Nuclear Accident Investigation and Evaluation to perform the duties and exercise the rights as follows:

(1) Determination of the extent of a nuclear accident and investigation of the cause thereof,

(2) Investigation and evaluation of the nuclear damage,

(3) Recommendation on compensation, relief and rehabilitation measures for the nuclear accident, and

(4) Recommendations on improvements to the safety of the nuclear installation.

Reports of the aforementioned investigation, evaluation, and recommendations shall be prepared for public announcement. When the victims of a nuclear accident seek compensation by way of a judicial proceeding, the court may take into account these reports.

16.3 Fukushima Lessons Learned

16.3.1 Emergency Response Mechanism of Complex Disaster

After the Fukushima accident the AEC revised the ERBP plan to cope with complex disasters, meaning natural disaster induced nuclear accidents. When a natural disaster, such as earthquake, tsunami, extreme rainfall or mudslide, combines with a nuclear accident, the national emergency response team requires more agencies to be involved and this operation has been enhanced through central coordination of multiple agencies. The timing to activate the nuclear emergency response mechanism has been elevated to one phase earlier, meaning that the response mechanism will be activated at level of Alert Event (AE) instead of Site Area Emergency Accident (SAEA), as before the Fukushima Accident. If an AE was notified to the AEC from NPP, the AEC emergency response team will be activated immediately, and NNERC will be formed soon after approved by the AEC Chairman. After that, the following response steps remain the same as previously described, and all staff members of the National Centre will move and merge into the "Central Emergency Operation Centre" to deal with the complex disaster. The commander of the Central Emergency Operation Centre will be designated by the Premier of Executive Yuan, and the AEC chairman will be the co-commander. Figure 16.2 shows the response to a complex nuclear disaster.

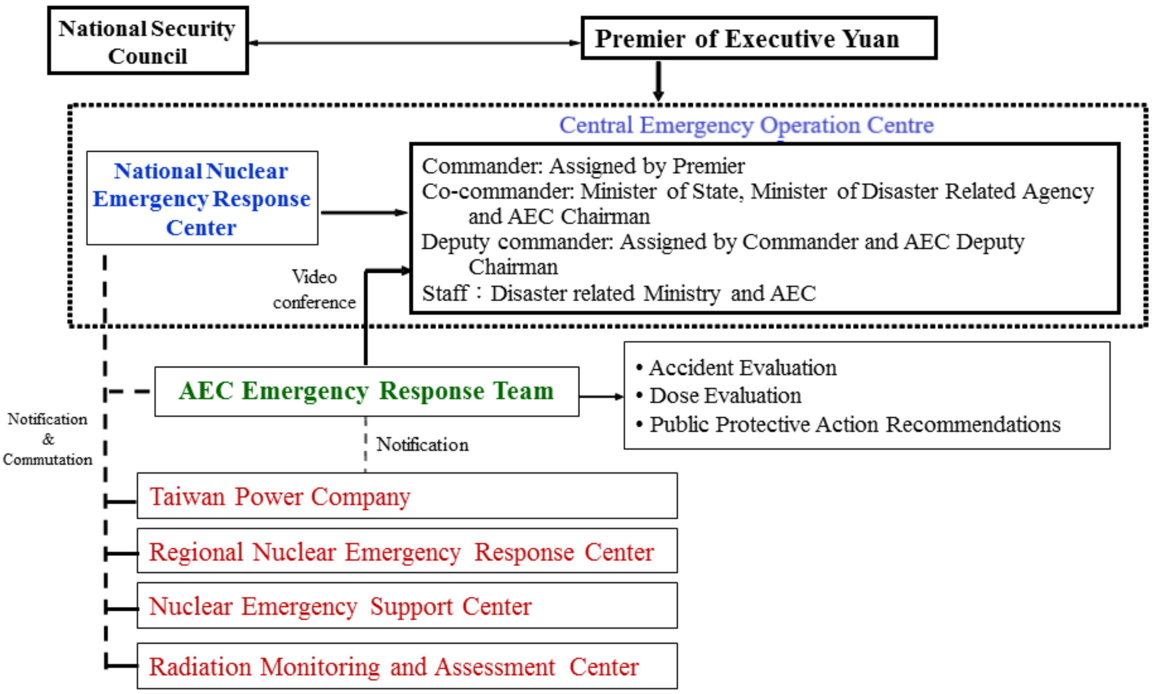


Figure 16.2 Response to a Complex Nuclear Disaster

16.3.2 Emergency Response and Preparedness

Based on the revelations of the Fukushima nuclear disaster, a reassessment of overall nuclear safety in Taiwan was completed, and a number of related enhancement measures, including the expansion of the EPZ radius from 5 km to 8 km, were carried out.

Application of Atmospheric Dispersion Model:

In the past, the research had been focused on the atmospheric dispersion assessment near the

NPP area, leading to the establishment of the so-called "two or three dimensional atmospheric dispersion model". After Japan's Fukushima accident, the focus of research shifted to long-range atmospheric dispersion. It is important to know how to integrate these different models and to engage a recognized model in the international community. The cooperation with the US National Nuclear Security Administration of the Department of Energy (USDOE/NNSA) could benefit the ongoing model (XOQDOQ) development in Taiwan.

A severe accident caused by an extreme tsunami occurred in Japan's Fukushima Daiichi Nuclear Power Plant on March 11, 2011. Large amounts of radioactive material were released into the atmosphere and widely dispersed. The government, mass media, and the public in Taiwan paid much attention to the radiation effect of the Fukushima event. The Atomic Energy Council (AEC) re-evaluated and strengthened the capabilities and requirements for emergency response to nuclear accidents in domestic nuclear power plants.

The first priority is to combine the dedicated technologies of Institute of Nuclear Energy Research (INER) and Central Weather Bureau (CWB) to develop a nation-level system for radiation evaluation and forecasting in response to nuclear accidents occurring abroad. An evaluated forecast of the radiation fallout impact can provide the government with powerful information to support responses to the occurrence of foreign nuclear accidents. This Radiation Assessment Network system, will be helpful for strengthening the basis of decision making and for enabling authorities to take more effective action during emergency response periods.

The dose evaluation system for domestic NPP is based on an extension of the emergency response region. Development of the ability to assess the entire Taiwan area with a 2.5 km spatial resolution, simulation for multiple release points, and the reverse estimate of release source terms were included in the dose evaluation system.

A nation-wide system in response to nuclear accidents occurring abroad, and the dose evaluation system for domestic NPPs, are being developed for integration as an unique system, making the spatial resolution for weather forecast higher.

16.3.3 Marine and Airborne Radiation Monitoring

Marine monitoring:

The purpose of marine monitoring is to assess the radiation contamination level to the biota in the nearby sea of the NPP due to the release of the radioactive liquid, and to confirm the impact on sea ecology after radiation dispersion affects areas outside of the EPZ.

The plan of marine monitoring is based on "The Marine Monitoring Equipment and Sampling Operation Procedure" of the RMDAC. The plan for marine monitoring and sampling sea surface water will be established by considering the following factors: the radiation release conditions, the sea state, and the radiation detection results close to the NPP. After the director of RMDAC approves the monitoring plan and notifies NNERC, the delegates of the Coast Guard Administration in RMDAC will make contact with the Coast Guard Administration to coordinate the corresponding team to assist the detection operation of the RMDAC personnel.

Airborne monitoring technique:

Airborne monitoring is an effective way to monitor the radiation level on the ground in an effort to judge its possible radiological impact to the environment and the public. Meanwhile, the government can use this information to guide the public to take early evacuation or sheltering measures. In Taiwan, downsized drone were developed mainly for meteorological studies. The hardware and software for the airborne radiation monitoring technique will be developed with the assistance of the USDOE/NNSA.

The plan of the airborne radiation monitoring operation is based on “The Airborne Radiation Monitoring Operation Procedure” of the RMDAC. The airborne radiation monitoring plan will be established by considering the following factors: the nearby terrain of the NPP, the meteorology conditions, the radioactive material released, and the assessment of the direction and range of the radioactive plume. After the director of RMDAC approves the monitoring plan and notifies NNERC, the delegates of Ministry of National Defense in RMDAC will make contact with the Ministry of National Defense to coordinate the corresponding team to assist the detection operation of the RMDAC personnel.

The domestic joint team including INER, RMC, Military and National Airborne Service Corps established the aerial measurement technology with support from US DOE/NNSA. Collaborating with the Aviation and Special Forces Command (ROC Army), the aerial measurement was a major item in the annual NPP drill.

Considering that, after a nuclear accident, access to a high exposure area is difficult for manned aircraft, a lightweight radiation detector, carried by unmanned aerial vehicle (UAV), was developed and tested to reduce exposure levels for responders.

16.3.4 Review of Radiation Detection Plan

Additional establishment of real-time environmental radiation monitoring stations and monitoring routes was planned in the radiation detection plan. Each NPP is required to be equipped with a sufficient amount of radiation detection vehicles for necessary emergency detection.

The Radiation Monitoring Center (RMC) of the AEC installs and operates a nationwide Environmental Radiation Monitoring Network (ERMN). Five Automatic Continuous Environmental Direct Radiation Monitoring stations have been established within each EPZ of the three NPPs. Every station operates 24 hours per day to monitor the environmental radiation and transport the result to the internet immediately.

After the Fukushima nuclear accident, the monitoring routes in the EPZs have been reviewed. Based on the recorded data of the wind velocity and direction, and the average precipitation surrounding NPP during 2013 and 2016, the number of the monitoring routes has been increased for the high population area. For example, the number of NPP1 has been changed from 10 to 11, the number of NPP2 has been changed from 9 to 11 and the number of NPP3 has been changed from 6 to 7.

16.3.5 Precautionary Evacuation and Nuclear Accident Response Measures

After the Fukushima nuclear accident, AEC conducted analysis and study for the evacuation operation, which resulted in the following recommendations:

Preventive Evacuation

- Evacuation Plan of the General Public

  The basic concept of risk is that the closer people live to the NPP, the higher the risk they face in the event of a nuclear accident. Additionally, the diversity of protection measures for different groups must be considered. Therefore, the first priority is to evacuate people living within 3 km of the NPP, as well as vulnerable populations and particular groups (such as those in hospitals, schools, nursing homes, and elderly care centers) within the EPZ using preventive measures.

  As for the tourists and people participating in large-scale activities, they will be notified to leave in advance, at the initial stage of the accident. Also, the entering of vehicles into the EPZ will be under control.

- Emergence Response of the Primary and Junior High School Students

  Every primary or junior high school inside the EPZ has already pre-planned its emergency response plan. In order that the curriculum of the primary or junior high school students will continue without interruption after they are relocated and to reduce the impact to the camp from the nuclear accident, local governments could issue the order to suspend the school curriculum according to the development of the nuclear accident in AE and SAEA. The students could be evacuated with their parents so that the panic of the students and the parents could be reduced. The schools near the accommodation shelters will become the “host school” to restore the curriculum.

Downwind First for the Evacuation

The evolution of a nuclear accident and the risks are gradual. The basic principle for evacuation measures during a nuclear accident is “from the inside out” and “downwind first”.

Indoor Sheltering

For the emergency response to a nuclear accident, taking shelter indoors is another effective radiation protection measure in addition to the evacuation of the local residents. Reinforced concrete is an effective shielding material. The radiation protection effect of taking shelter inside reinforced concrete houses can be high. Thus, in regions where the government has not given instructions to evacuate, the major emergency response is to shelter indoors, avoiding any unnecessary loss of life and property due to a hasty and confusing evacuation. When the government gives the instruction asking local residents to shelter indoors, it will mean that at this time the radiation protection effect of taking shelter indoors is better than that of evacuation.

Update of the TPC’s Public Protection Measures

As mentioned in Subsection 16.1.5, after the Fukushima nuclear accident in Japan, the emergency planning zones (EPZ) of the Chinshan, Kuosheng and Maanshan NPPs in Taiwan were expanded from 5 km to 8 km radius. TPC has completed a latest report on “The Review and Revision of the Analysis and Planning of the Public Protective Measures in the Emergency Planning Zones for Nuclear Power Plants in Taiwan” and the report was approved by AEC in August 2018. The contents of this report consist of the population distribution, radiation detection program, public warning system, public assembling, evacuation and relocation, etc.

Based on this report, the local governments revised their response plans for the protection of the public within the EPZ. The contents of these plans consist of emergency response organization, sites, equipment, and the usual preparedness and response measures to ensure the safety of the people, such as various ways of warning alert notification, implementation of sheltering, notification of distribution and taking of the iodine tablets, implementation of evacuation, etc.

AEC also planned the response mechanism against the complex disaster resulting from a nuclear accident concurrent with the occurrence of major natural disasters. This has been incorporated into the regulation "Directions on the Operations of National Nuclear Emergency Response Center" in February 2012. In addition, in the amendment of "National Disaster Prevention and Relief Act" promulgated by the President on April 13, 2016, the radiological disaster was formally included as one of the official disasters in this Act. It follows that, in the future, the prevention, preparedness, response and recovery operations for a domestic nuclear disaster by the central and local governments will be integrated to effectively utilize the national resources for rescue.

Nuclear Emergency Exercises

Each nuclear power plant is required by the AEC to conduct an onsite emergency exercise at least once a year. Together with various ministries and local governments, the AEC also conducts a national nuclear emergency exercise (NEE) in one selected EPZ at least once per three years.

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ARTICLE 17. SITING

Each Contracting Party shall take the appropriate steps to ensure that appropriate procedures are established and implemented for

(i) evaluating all relevant site-related factors that are likely to affect the safety of a nuclear installation for its projected lifetime

(ii) evaluating the likely safety impact of a proposed nuclear installation on individuals, society, and the environment

(iii) Re-evaluating, as necessary, all relevant factors referred to in sub-paragraphs (i)and (ii) so as to ensure the continued safety acceptability of the nuclear installation

(iv) consulting Contracting Parties in the vicinity of a proposed nuclear installation, insofar as they are likely to be affected by that installation and, upon request, providing the necessary information to such Contracting Parties, in order to enable them to evaluate and make their own assessment of the likely safety impact on their own territory of the nuclear installation

17.1 Evaluation of Site-related Factors

The siting requirements are mainly contained in the Enforcement Rules of the Nuclear Reactor Facilities Regulation Act. Other major codes and Standards for the site selections required by the country of origin (here referred to USA) are listed as follows:

- 10 CFR Part 100 -- Reactor Site Criteria
- USNRC Regulatory Guide 4.7 -- General Site Suitability Criteria for Nuclear Power Stations
- USNRC Standard Review Plan 2.5.1 -- Basic Geologic and Seismic Information.

These codes and Standards required by the country of origin are considered by the AEC as important reference documents. In order to fulfill the regulatory siting requirements, the evaluations of site-related factors that are likely to affect the safety of the plant are documented in the PSARs and FSARs of the existing domestic NPPs. The important considerations of these evaluations are described in the following sections.

17.1.1 Nearby Industrial and Military Facilities and Transportation

According to the relevant regulatory requirements, the applicant for a new reactor site should provide information for the nearby industrial and military facilities, as well as t transportation routes, and evaluate the potential external hazards. The applicant should also identify any situations in the vicinity of the plant that have potential for accidents, such as explosions of hazardous materials, delayed ignition of flammable vapor clouds, liquid spills, and release of toxic vapors, fires, accidents at sea, etc., and assess the potential effects of these situations on the safe operation of the nuclear facility. To fulfill these requirements, important and relevant evaluations performed by the licensee of the existing domestic NPPs include river traffic accidents, explosions, fires, accidental releases of toxic gases, airplane crashes, airborne pollutants, and so on. Generally speaking, the potential hazards caused by the nearby industrial and military facilities and transportation means are negligible for these NPPs.

17.1.2 Meteorology

The evaluations of site-related factors associated with meteorology include heavy precipitation, typhoons, thunderstorms, tornadoes, strong winds, and tsunami. In order to collect data for meteorological evaluation, each NPP performs an 'Onsite Meteorological Measurement Program' before and after the commercial operation. In this program, the meteorological variables under observation before operation include wind, temperature, precipitation, sunshine rate, elevation of sun, insolation, evaporation, cloud conditions, atmospheric pressure, humidity, wind aloft, and temperature gradient. After operation, the meteorological monitoring system to be maintained includes wind speed and direction, temperature gradient, and humidity (or dew point).

17.1.3 Hydrology

The site-related factors to be evaluated in association with hydrology include probable maximum flood, probable maximum precipitation, precipitation losses, coincident wind-wave activity, the combination of natural events, probable maximum tsunami flooding, and so on.

17.1.4 Geology and Seismology

The evaluations associated with geology and seismology are required to determine site suitability and to provide reasonable assurance that a nuclear power station can be constructed and operated at a proposed site. The structures, systems and components (SSCs) of safety systems shall be designed to withstand appropriate seismic forces. The major considerations for these evaluations include:

(1) Basic Geology and Seismic Data

The data associated with regional and site physiography, regional geology and tectonic, site geology, structural geologic map, geologic profiles (presenting the relationship of the foundations of the nuclear power plant to subsurface materials), history of groundwater fluctuations, subsurface investigation, seismic and velocity surveys, static and dynamic rock properties, and excavation and backfill are collected and analyzed for geology and seismology evaluations.

(2) Vibratory Ground Motion

The analyses associated with the vibratory ground motion include those on: regional and site tectonic structures, prior earthquake behavior of surficial and subsurface materials, static and dynamic soil properties, previous regional earthquake data, correlation of epicenters with tectonic divisions, active faults, vibratory ground motion at the site for structure-related earthquakes, vibratory ground motion at the site for site tectonic province-related earthquakes, maximum ground acceleration at the site and design basis earthquake, operating basis earthquake, etc. The design for the Design Basis Earthquake is intended to assure that:

- The integrity of the reactor coolant pressure boundary is not compromised.

- The capability to shut down the reactor and maintain it in a safe condition is not compromised.

- The capability to prevent or mitigate the consequences of accidents, which could otherwise result in potential offsite exposures comparable to the limiting exposures of the Enforcement Rules for the Implementation of the Nuclear Reactor Facilities Regulation Act, is not compromised.

(3) Probabilistic Seismic Hazard Analysis (PSHA)

After the Fukushima accident in Japan, the TPC has accomplished the PSHA Hazard Input Document (HID) in June 2019 according to the SSHAC Level 3 procedure and completed the built-up of site-specific hazard-consistent GMRS for each NPP in December 2020 (Note for 2022: the TPC has submitted the SPID (Screening, Prioritization and Implementation Details) report in February 2021, whereas the AEC has agreed all the review comments in July 2022.

17.2 Evaluation of Safety Impact on Individuals, Society, and the Environment

17.2.1 Regulatory Requirements for Environmental Impact Assessment

According to item 10, Article 5 of the Environmental Impact Assessment Act, for the development of nuclear energy or other energy or the construction of radioactive waste storage or treatment facilities, and when there is a concern of adverse impact on the environment, the environmental impact assessments shall be conducted. The competent authority of the environmental impact assessment is the Environmental Protection Administration (EPA) of the Executive Yuan.

17.2.2 Evaluation of Radiological Consequences

According to Article 3 of the Enforcement Rules for the Implementation of Nuclear Reactor Facilities Regulation Act, the area surrounding the nuclear facility shall be divided into the two following regions based on the possible damage resulting from the design-basis nuclear accidents:

(1) Exclusion area: An exclusion area (EA) is the area surrounding the reactor, that an individual at its boundary for two hours immediately after the onset of a postulated fission product release would not receive a total radiation dose to the whole body in excess of 250 mSv (25 rem) or a total radiation dose in excess of 3 Sv (300 rem) to the thyroid from iodine exposure.

(2) Low population zone: A low population zone (LPZ) is the area surrounding the exclusion area that an individual at its outer boundary who is exposed to the radioactive cloud during the entire period of its passage would not receive a total radiation dose to the whole body in excess of 250 mSv (25 rem) or a total radiation dose in excess of 3 Sv (300 rem) to the thyroid from iodine exposure.

In addition to the dose criteria, Article 4 of the Nuclear Reactor Facilities Regulation Act requires that the distance from the nuclear facility to the nearest boundary of a densely populated center with 25,000 or more residents must be at least one and one-third times the radius of the low population zone. Furthermore, except for highway, railroad, or waterway, the licensee shall obtain the full right of land use within the exclusion boundary during the intended utilization period. Every site must have a designated low population zone immediately surrounding the exclusion area boundary so that there is a reasonable probability that appropriate protective measures could be taken in a serious accident. According to Article 4 of the Act, residence within the low population zone is generally permitted. However, for a newly established school, workplaces, jail, hospital, long-term nursing institute, or recuperation and convalescent institute (charity) for the aged, protective measures shall be provided, with reference to the response plan of civil security and protection of that local area, and submitted to the AEC. After the AEC invites the government of the municipality under the direct jurisdiction of the Executive Yuan and the county (city) government to review and approve those protective measures, these facilities can then be constructed and operated in accordance with the relevant laws and decrees.

In accordance with the previous requirements, data about the population within 10 km from the reactor, population between 10 and 40 km, transient population (mainly resulted from both seasonal variations in beach, park, temple, church, and fishing as well as daily workday variations), population center, and the public facilities and institutions have been collected. To evaluate the range of the exclusion area and the low population zone, domestic NPPs adopt justifiable parameters for the following: Fission product release fraction from the core, expected leak rate from the containment, and the meteorological conditions for the site. In addition, an investigation of the atmospheric diffusion characteristics and provision of the bounding relative atmospheric dispersion factor (χ/Q) were also performed to evaluate the radiological consequences of the postulated design-basis accident, to ensure that the safety limits are not exceeded.

Besides the dose analyses necessary to support reactor siting, all domestic NPPs have also performed evaluation of the potential increase in the consequences of accidents and radiological release that might result from the modification of the systems, structures, and components of the facility after construction. As part of the accident analysis in the FSAR, the changes in dose resulting from the design basis accidents such as large break LOCA, small break LOCA, fuel handling accidents, etc. were also performed to ensure that these changes will still comply with the dose criteria.

ARTICLE 18. DESIGN AND CONSTRUCTION

Each Contracting Party shall take the appropriate steps to ensure that:

(i) the design and construction of a nuclear installation provides for several reliable levels and methods of protection (defense in depth) against the release of radioactive material, with a view to preventing the occurrence of accidents and to mitigating their radiological consequences should they occur;

(ii) the technologies incorporated in the design and construction of a nuclear installation are proven by experience or qualified by testing or analysis;

(iii) the design of a nuclear installation allows for reliable, stable, and easily manageable operation, with specific consideration of human factors and the man-machine interface.

18.1 Protection against the Release of Radioactive Materials

18.1.1 Licensing Process and Regulatory Requirements

The following are the important processes for constructing a nuclear power plant as per the regulatory requirements related to the Nuclear Reactor Facilities Regulation Act and the Nuclear Emergency Response Act:

(1) To define an Exclusion Area Boundary(EAB) and a Low Population Zone (LPZ),

(2) To submit the PSAR to get a Construction License,

(3) To submit the FSAR to get an initial fuel loading permit and then Operating License, and

(4) To define an Emergency Planning Zone (EPZ) before the initial fuel loading.

The following are the important requirements related to the statement of “protection against the release of radioactive material” in these processes:

(1) In case of a postulated nuclear accident in the plant, the whole-body dose and thyroid dose for a person at the boundary of the EAB shall be less than 250 mSv and 3 Sv, respectively, within 2 hours. The owner of the plant has to purchase all land inside the EA.

(2) In case of a postulated nuclear accident in the plant, the whole-body dose and thyroid dose for a person at the boundary of the LPZ shall be less than 250 mSv and 3 Sv, respectively, within 30 days.

(3) The Measures of protection against the release of radioactive material shall be described in the PSAR and FSAR clearly for review. Important chapters of the PSAR and FSAR associated with this topic include:

- Chapter 11 Radioactive Waste Management,
- Chapter 12 Radiation Protection,
- Chapter 15 Accident Analysis,
- Chapter 19 Severe Accident Analysis,

- App. A Probabilistic Risk Assessment (PRA), and
- App. C Emergency Plan.

(4) The EPZ assessment criteria as per the Nuclear Emergency Response Act and its Enforcement Rules are:

- The design basis accidents shall not cause the predicted radiation dose outside the EPZ to exceed the evacuation criteria stipulated in the Nuclear Emergency Public Protective Action Guide.
- The core melt accident shall have an annual probability of less than three in 100,000 of causing the predicted radiation dose outside the EPZ to exceed the evacuation intervention criteria stipulated in the Nuclear Emergency Public Protective Action Guide.
- The core melt accident shall have an annual probability of less than three in 1,000,000 of causing the predicted radiation dose outside the EPZ to exceed 2 Sv.

The evacuation intervention level is when the averted dose for a person near an NPP ranges from 50 mSv to 100 mSv within the first 7 days of an accident.

The "Regulations on the Review and Approval of Applications for Construction License of Nuclear Reactor Facilities" and the "Regulations on the Review and Approval of Applications for Operating License of Nuclear Reactor Facilities" describe the requirements for the construction and operating licenses in detail.

18.1.2 Implementation of Defense-in-Depth Concept

The design of all SSCs of a nuclear power plant, regardless of reactor types, should consider the following internal and external events, as specified by the Nuclear Reactor Facilities Regulation Act, its Enforcement Rules, General Design Criteria (GDC) for Nuclear Reactor Facilities, and the related Regulations:

- Internal events: loss of coolant accident, main steam and high-energy line breaks, internal missiles from a turbine rotor, fire, flooding, etc.
- External events: earthquakes, floods, typhoons, flammable substances, poisonous gas, explosions, and other potential man-made disasters, etc.

The defense-in-depth principle, a safety design concept against the internal and external events mentioned above, guides the design of a nuclear power plant. This principle consists of the following major elements:

- The design secures sufficient safety margin to minimize the probability of any design basis accident. Safety systems are designed with independency, redundancy, and diversity so that the consequences of accidents are minimized.
- The design ensures that the reactor protection system operates automatically after detecting any abnormal condition caused by equipment failures, operator errors or combination thereof, and initiates the reactor trip system to prevent the abnormal condition from escalating into a severe accident.

- The design employs multiple barriers to guarantee nuclear power generation safety. The logic is as follows:

  Each layer of defense offers adequate safety and protective functions in case the previous layer fails for any reason. Even if the first and second layers of defense fail, the third or fourth layer of defense will still ensure safety and protection.

  The objective of setting up multiple layers of defense is to reduce the possibility of a nuclear power accident and minimize its impact. The layers of defense-in-depth aim to prevent the release of nuclear fission products and they include: fuel pellet, fuel rod, the connection between the reactor pressure vessel and the closed coolant system, and containment building. The containment building ensures that all radioactive substances from the reactor or cooling system are confined from the outside environment.

In order to ensure the safety of the nuclear power plants, the TPC applies the defense-in-depth principle to the design, construction and operation of the nuclear power plants. The following basic concepts are taken into account for the implementation of the defense-in-depth principle into all safety related systems:

- Securing sufficient design safety margins,
- Fail-safe concept,
- Interlock concept,
- Securing independency, redundancy, and diversity,
- Multiple barriers concept, and
- In-service testability.

18.1.3 Prevention and Mitigation of Accidents

The requirements for the prevention and mitigation of accidents are specified in the Nuclear Reactor Facilities Regulation Act, its Enforcement rules, General Design Criteria for Nuclear Reactor Facilities, and the related Regulations. In accordance with these requirements, the following practices are implemented in the design of the TPC’s nuclear power stations.

- The reactor core is designed in such a way that in the power operating range, the prompt inherent nuclear reactivity characteristics tend to compensate for a rapid increase in power (i.e. negative power coefficient). The reactor core is also designed to ensure that power oscillations, which can result in conditions exceeding specified design limits, are not possible or can be easily suppressed.

- The reactor coolant pressure boundary is designed to have an extremely low probability of abnormal leakage and gross rupture. If any leakage of the reactor coolant system (RCS) occurs, it is promptly detected to prevent the event from proceeding to a severe accident. It is also designed to allow periodic inspection and testing of the system to assess the structural integrity and leak-tightness.

- The Emergency Core cooling system (ECCS) is designed for automatic core cooling following any loss of reactor coolant at a rate such that any fuel damage that could interfere with continued effective core cooling is prevented. Even if the off-site power is lost, the necessary power of the ECCS system is guaranteed to be supplied from emergency diesel generators installed in the nuclear power plant. The residual heat removal (RHR) system is designed to remove the core decay heat.

The reactor protection system (RPS) is installed to detect accident conditions and to ensure the reactor remains at a safe state by automatically initiating the reactor shutdown system and the engineered safety features (ESFs). The RPS is designed with redundancy, diversity, and independence to guarantee that no single failure of any equipment or channel of the system results in the loss of the intended safety functions.

The following practices are incorporated into the design of NPPs to mitigate any accidents including a severe accident:

- The reactor containment is designed in such a way that if any accident occurs, the radioactive material released from the reactor coolant pressure boundary is confined and reduced over a long period. A system is installed in the containment to control the concentration of any combustible gas as it accumulates inside. The engineered safety features including the containment spray system and fan coolers which are designed to lower the pressure inside the containment and to minimize radioactivity release.

- The emergency response facility (ERF) is installed to ensure that if any radioactive material is accidentally released outside the nuclear power plant, the radiological effects on nearby inhabitants and the contamination to the environment are minimized. The ERF consists of the technical support center (TSC) and the operating support center (OSC). The safety parameter display system (SPDS) is installed in the following locations: main control room (MCR) of the plant, the TSC, and the TPC Headquarters, so that the major safety parameters are immediately recognized.

The MCR is designed in such a way that even if an severe accident occurs, the operators can still stay safely inside the MCR to take the necessary post-accident actions. It is possible in the MCR to monitor the operating parameters, the radioactivity inside and outside the reactor containment, the radioactive material release passage, and the radioactivity around the NPP in order to gain control of the accident conditions and to take appropriate actions.

18.2 Application of Proven Technologies

In order to ensure the safety of nuclear reactor facilities, the TPC required that the design and construction of a nuclear power plant should use the proven engineering technologies. The essential elements in the proven technologies include:

- All technologies are proved by testing and experience.

- All processes of the design, construction, and operation follow approved codes and standards.

- All design and construction are performed by qualified manufacturers and constructors under their QA Program approved by TPC.

Since all nuclear reactors in this nation were imported from foreign countries, proven technologies are always the top tier requirements in the bidding processes performed by the TPC. The bid specifications stipulate that all nuclear power reactors imported to Taiwan must be designed using technologies proven by operating experiences either inside or outside this country. Additionally, these reactors must be licensable in the exporting country. These requirements are usually important for the applications for construction and operating licenses of the new NPPs.

Regarding the codes and standards, the Nuclear Reactor Facilities Regulation Act, its Enforcement rules, General Design Criteria for Nuclear Reactor Facilities, and related domestic regulations are the basic regulations and criteria that the TPC must follow for the design and construction of nuclear reactor facilities. Moreover, codes and standards of the exporting country such as the USNRC regulations, ASME and IEEE standards are also crucial references for domestic regulators and utilities to follow. Finally, for the qualifications of manufacturers and constructors, the TPC set up stringent criteria in the bid specifications for nuclear reactor procurement. The AEC will audit the TPC's quality of design and construction through safety review and inspections.

18.3 Consideration of Human Factors and Man-Machine Interface

The Nuclear Reactor Facilities Regulation Act and its Enforcement Rules and Regulations stipulate that the MCR, SPDS, and the remote shutdown panel must be designed to reflect the results of analyzing and evaluating the human factors in order to enhance the safety of the nuclear power plants. According to this provision, the analysis for the feasibility and suitability of the human engineering design is included in the PSAR and FSAR. The major contents of the analysis are as follows:

- The MCR design takes into account human factors to ensure that the man-machine interface (MMI) is suitable for the safe operation of the nuclear power plants. The major factors are: the working space and its environment, the alarm and control facility, the visual indicating facility, the auditory signal facility, the nameplates and their positioning, and the layout of distributing boards.

- The SPDS design follows the human factors engineering principle to ensure that the system continually provides important safety information and that the reactor operators can easily identify them from the designated location.

- The remote shutdown panel design takes into account human factors to ensure that the reactor can be safely shut down.

The TMI accident demonstrated that operator performance is crucial to safety. Human error is one of the factors that influence the human performance. To mitigate human error, the design of the Human System Interface (HSI) of the MCR for an NPP incorporates the following considerations:

- Eliminating affordability of errors in the design phase,

- Including the training program improvement in the intelligent decision support systems,
- Providing memory aids for the operator, e.g., portable interactive maintenance assistant,
- Training for error management, and
- Using ecological interface design.

18.4 Fukushima Lessons Learned

Before the nuclear accident at Fukushima, Tokyo Electric Power Company Holdings, Inc. of Japan had been continuously reassessing the tsunami hazard, and the evaluation results had not been reviewed by the regulatory authority. The company ran out of time to strengthen and improve the safety measures in accordance with the revised tsunami hazard results, and then a magnitude 9.0 earthquake hit, resulting in an over 14 meters high tsunami which led to the core melt accident. Although there have been huge tsunamis attacking the east coast of the northern area in the main island of Japan, the 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 AEC required all the NPPs in Taiwan, operating and under construction (Note in 2021: There is no nuclear power plants under construction in Taiwan), to follow the lessons learned from the Fukushima Daiichi accident, to re-visit the design basis and this resulted in the implementation of the following safety enhancement measures.

(A) 11 Technical Areas for Safety Reassessment of Taiwanese NPPs

By referring to measures recommended by various major nuclear authorities or international organizations, such as US Nuclear Regulatory Commission (USNRC), Nuclear Energy Institute (NEI), European Nuclear Safety Regulators Group (ENSREG), World Association of Nuclear Operators (WANO) and Japanese Nuclear and Industrial Safety Agency (NISA), the TPC conducted the Safety Reassessment Program in Taiwan right after the Fukushima accident. AEC required TPC to verify the capability of NPPs in response to both the DBA and beyond DBA based on 11 technical areas. A verification report was submitted by the TPC and reviewed by the AEC. The 11 technical areas are as follows:

(1) Capability of protection against loss of all AC power (SBO)

(2) Capability of protection against flooding and tsunami

(3) Integrity and cooling capability of spent fuel pool

(4) Capability of heat removal and ultimate heat sink (UHS)

(5) EOP and training

(6) Establishment of plant Specific Major Incident guidelines (SMI)

(7) Mutual support between units 1 and 2 of the same NPP

(8) Consideration of compound accidents

(9) Mitigation of the beyond DBA

(10) Preparedness of facilities, equipment and backup spare parts

(11) Manpower, organization, and safety culture.

(B) Additional Areas of Improvement Requirements

Although the results of this reassessment showed neither immediate nuclear safety concern nor threat to the public health and safety, the AEC still requested that the TPC focus on strengthening its reevaluation 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 requirements have been identified as follows:

(1)SBO

- Reanalysis for 24-hr SBO capability
- Enhancing the battery capacity in response to requirement to extend SBO coping time from 8 to 24 hours.
- Load distribution planning of air-cooled swing EDG for both units of the same NPP

(2)Flooding Protection

- Enhancement of flooding protection and water tight design for emergency service water room and other supporting facilities
- Additional spare parts for the emergency service water (ESW) and emergency core cooling system (ECCS) pumps, and storage of them at higher ground
- Reevaluation of the design basis tsunami heights
- Physical separation of service water systems for different units

(3)Spent Fuel Pool

- Safety-related instrumentation for monitoring water level, temperature, etc. and the equipment setup for Chinshan, Kuosheng and Maanshan NPPs
- Safety-related power supply for SFP makeup
- On-site emergency power to pumps and instrumentation
- Seismic resistant spray to the spent fuel pool

(4)Containment Vent and Hydrogen Exhaustion

- Mobile air compressor for air-operated valves
- Re-examining the vent route for hydrogen
- Prevention of H_2 accumulation in the buildings

(5)Severe Accident Management

- Establishing the SMI procedure to prevent an event from escalating into an accident or severe accident, or to sacrifice future operation and electricity generation from the affected NPP should it become necessary to inject sea water into the reactor in order to prevent the core from melting.
- Procurement of more natural boric acid

- Building a seismic-resistant technical support center
- Simulation of the severe accident scenario of Fukushima-like case for NPPs

(6)Seismic Enhancement

- Strengthening the robustness of raw water reservoir and its piping
- Reevaluating the seismic hazard analysis

(7)Infrastructure

- Coordination with outside supports (military, fire department)
- Examination of internal capability and training in response to extended accident sequence

(8)Safety Culture

- IAEA safety principle (SF-1) implementation
- NRC safety culture statement and ROP inspection for cross-cutting issues

(C) Reinforcement for BDBA

The robustness of the NPPs was examined by the EU stress tests performed in Taiwan taking into account beyond design basis events caused by earthquakes, external flooding and extreme weather conditions, as well as loss of the power supply and loss of the heat sink. The AEC requested the TPC to implement more countermeasures to further enhance the capability to cope with extreme natural disasters. The reinforcements for BDBA includes:

(1) Safety Enhancement for Core Cooling (see Figure 18.1)

- Capacity of all water resources: on-site and off-site, and transfer and injection procedures developed.
- Fire engine resources: quantity, capacity, discharge pressure, and redundancy developed.
- Scheme for alternative reactor coolant injection (various paths) developed.
- Alternative UHS developed.
- Scheme for recovery of UHS developed.
- Procurement of portable air compressors and spare nitrogen bottles for SRVs and air-operated valves.

(2) Spent Fuel Pool Emergency Makeup (see Figure 18.2)

- Various SFP make up strategies developed.
- Extra makeup and spray flow paths installed according to NEI 06-12.
- SFP instrumentation enhanced, per NTTF 7.1, including upgrading the instruments for monitoring water level and temperature to safety grade equivalent.

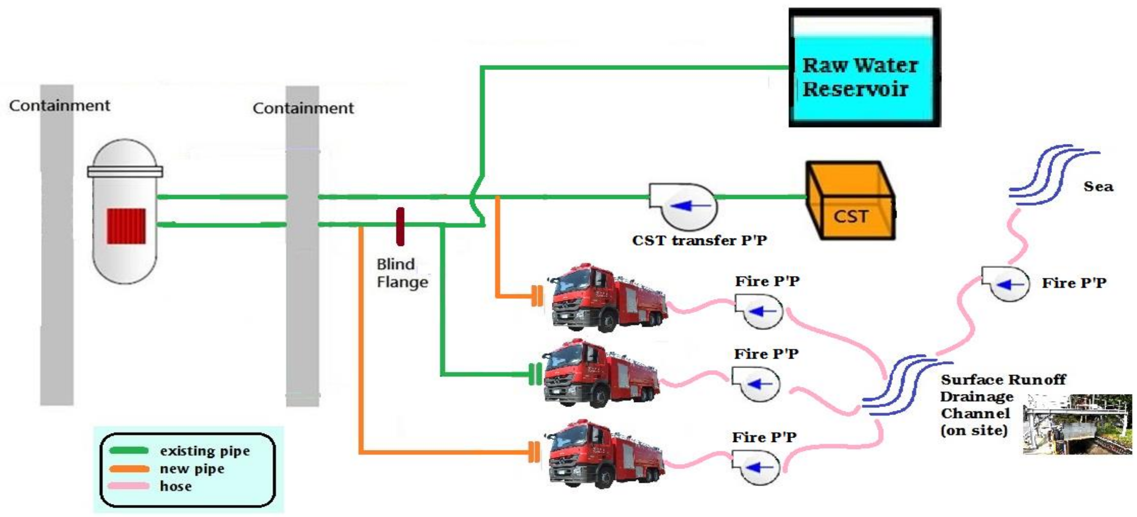

Figure 18.1 Safety Enhancement for Core Cooling

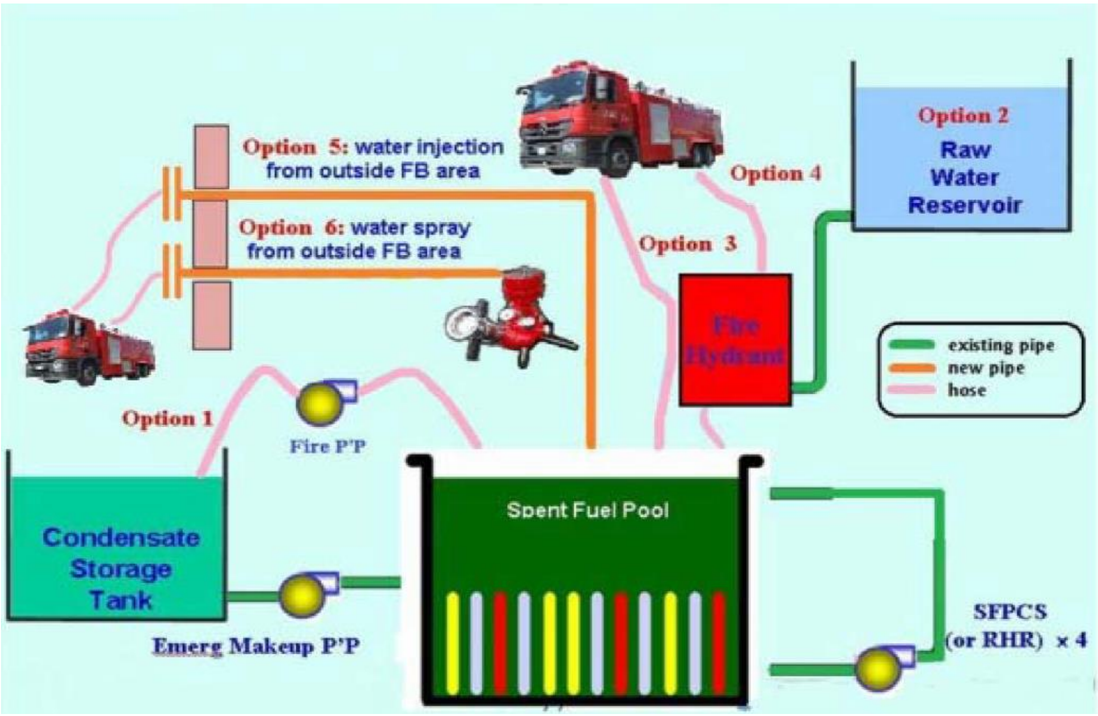

Figure 18.2 Emergency Makeup for Spent Fuel Pool

(3) Containment Integrity and Hydrogen Control

- Addition of a robust and reliable containment filter venting system for MSNPP (PWR) per EU's experience.
- Addition of passive autocatalytic recombiners (PARs) for MSNPP (PWR) per EU's experience.
- Development of containment early venting strategy
  - To reduce the temperature and pressure rises in the torus, and

- To lengthen the injection time for RCIC and enhance the availability of RPV injection

(4) Electrical Power Source (see Figure 18.3)

- The 5th standby EDG can now supply emergency loads for both units simultaneously.
- The black-start D/G used to start G/T can now supply emergency loads for both units simultaneously
- Improving the flood resistance capabilities of the air-cooled swing EDG for the Chinshan, Kuosheng and Maanshan NPPs.
- Six sets of 4.16 kV power vehicles and 26 sets of 480 V portable D/Gs procured for Chinshan, Kuosheng and Maanshan NPPs.
- Capacity of DC power extended in response to the requirement to extend SBO coping time from 8 to 24 hours.
- Portable generators and batteries for control power and supervisory instruments prepared.

(5) Development of Specific Major Incident Guidelines (SMI)

The development background and main features of the SMI are as follows:

- In the light of lessons learned from the Fukushima accident, a timely disposition in the MCR is the key to preventing an event from escalating into an accident.
- The current EOPs may not be effective for coping with complex external disasters.
- SMI is specifically designed to cut off event evolution and take immediate actions to prevent core damage.
- SMI will be considered for making an interface integration with EOPs, severe accident management guidelines (SAMG), and extensive damage mitigation guidelines (EDMG).
- The reactor core will be secured by emergency depressurization, containment venting and injection of any available water (even seawater) through any available injection path if any of the following three conditions is reached:
  - Plant suffered from larger than SSE earthquake and tsunami
  - SBO
  - Loss of UHS

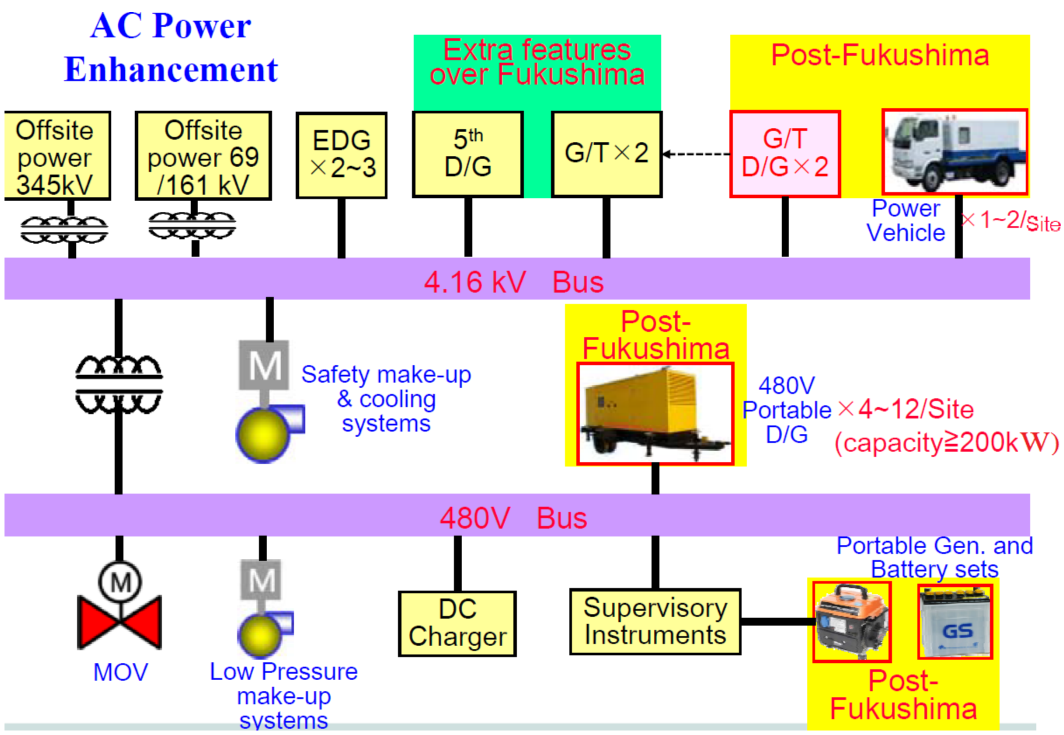

Figure 18.3 Safety Enhancement for AC Power Source

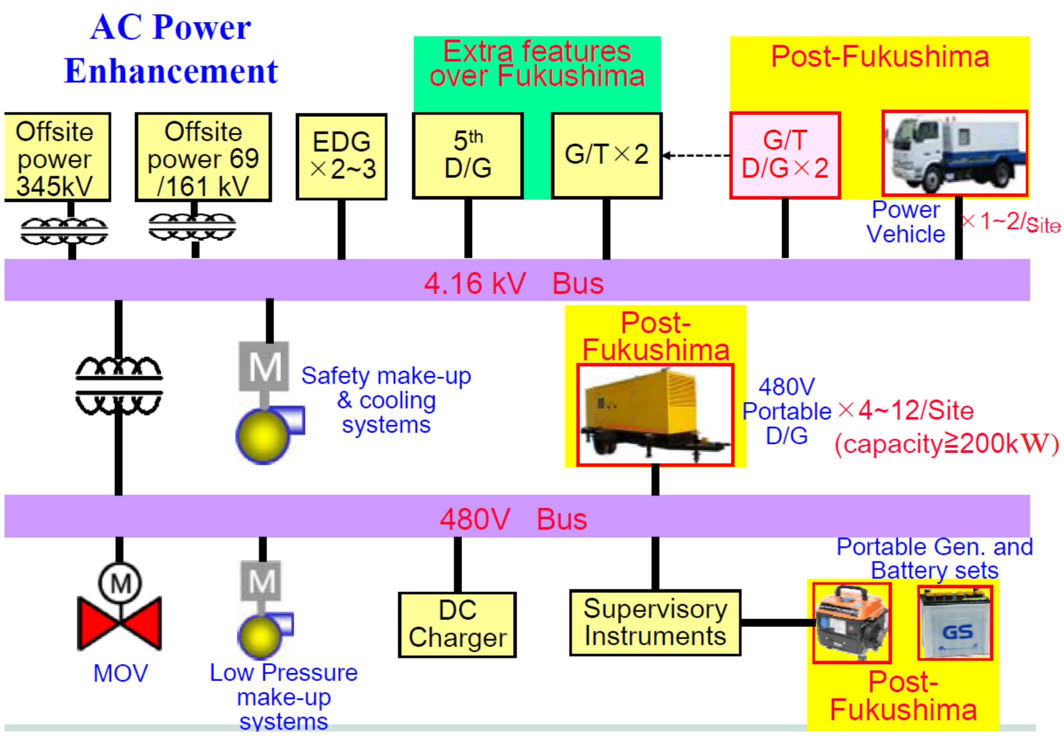

Figure 18.4 Safety Enhancement for AC Power Source

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ARTICLE 19. OPERATION

Each Contracting Party shall take appropriate steps to ensure that:

(i) the initial authorization to operate a nuclear installation is based upon an appropriate safety analysis and a commissioning program demonstrating that the installation, as constructed, is consistent with design and safety requirements

(ii) operational limits and conditions derived from the safety analysis, test, and operational experience are defined and revised as necessary for identifying safe boundaries for operation

(iii) operation, maintenance, inspection, and testing of a nuclear installation are conducted in accordance with approved procedures

(iv) procedures are established for responding to anticipated operational occurrences and to accidents

(v) necessary engineering and technical support in all safety related fields is available throughout the lifetime of a nuclear installation

(vi) incidents significant to safety are reported in a timely manner by the holder of the relevant license to the regulatory body

(vii) programs to collect and analyze operating experience are established, the results obtained and the conclusions drawn are acted upon and that existing mechanisms are used to share important experience with international bodies and with other operating organizations and regulatory bodies

(viii) the generation of radioactive waste resulting from the operation of a nuclear installation is kept to the minimum practicable for the process concerned, both in activity and in volume, and any necessary treatment and storage of spent fuel and waste directly related to the operation and on the same site as that of the nuclear installation take into consideration conditioning and disposal

19.1 Initial Authorization to Operate a Nuclear Installation

In order to obtain a construction license (CL) of a nuclear reactor installation, an applicant must submit the following documents to the regulatory bodies, as required by Article 3 of “Regulations on the Review and Approval of Applications for Construction License of Nuclear Reactor Facilities” of 2004:

(1) Preliminary safety analysis report (PSAR),

(2) Environmental impact assessment (EIA) approved by EPA,

(3) Applicant’s financial capability, and

(4) Others as required and published by the regulatory body.

After the construction work is completed, in order to obtain an approval for loading fuel into a newly constructed reactor for the first time, the holder of the CL must submit the following documents within the required periods for review and approval, as stipulated by "Regulations on the Review and Approval of Applications for Operating License of Nuclear Reactor Facilities" of 2004 as amended in 2005 (Article 2):

(1) Application for initial fuel loading – 14 months before scheduled initial fuel loading,

(2) Final safety analysis report (FSAR) – 14 months before scheduled initial fuel loading,

(3) A plan, based on the level of radiation dose received by the public after a nuclear accident occurs, submitted to the Regulatory Body for demarcating the exclusion area and the low population zone of the NPP in consultation with the Ministry of Interior, the government of municipality under the direct jurisdiction of the Executive Yuan, the county (city) government, and the relevant authorities – 14 months before scheduled initial fuel loading,

(4) Summary report on the corrective actions based on the inspection findings during the construction stage – 3 months before scheduled initial fuel loading,

(5) List of operating procedures – 2 months before scheduled initial fuel loading,

(6) Fuel loading plan – 2 months before scheduled initial fuel loading,

(7) Startup test plan – 2 months before scheduled initial fuel loading, and

(8) Reports on the systems' functional tests (or preoperational tests) – before scheduled initial fuel loading.

If an approval of initial fuel loading (IFL) is granted, then loading fuel into the newly constructed reactor can be performed for the first time. To comply with the regulatory requirements stated in Articles 13 and 14 of "Regulations on the Review and Approval of Applications for Operating License of Nuclear Reactor Facilities" as amended in 2005, it is required that the application for an operating license (OL) has to be submitted within 18 months after the initial fuel loading was approved. In addition, the applicant needs to submit the approved EIA at least one year prior to the scheduled date of operation and an application form for OL as well as the following documents after the completion of the power tests (or startup tests) for review and approval:

- Updated FSAR,
- Summary report on results of the power tests, and
- Financial capability.

19.2 Operational Limits and Conditions

The technical specifications (TS), which are part of the PSAR and FSAR as required by Article 4 of "Regulations on the Review and Approval of Applications for Construction License of Nuclear Reactor Facilities" and Article 3 and 16 of "Regulations on the Review and Approval of Applications for Operating License of Nuclear Reactor Facilities," respectively, are established by the licensee to ensure the safe operation of a nuclear power plant.

The technical specifications mainly include:

- Safety limits;
- Limiting safety system setting (LSSS);
- Limiting conditions for operation (LCO);
- Surveillance requirements;
- Design features; and
- Administrative control.

19.3 Operation, Maintenance, Inspection, and Testing Conducted in Accordance with Approved Procedures

Listed in the FSAR of each operating NPP are the plant operating procedures including the administrative procedures, the operating and maintenance procedures, and other procedures. The administrative procedures are further divided into the following categories:

- Procedures for the shift leaders (SL) and reactor operators (including RO and SRO),
- Special procedures,
- Equipment control procedures,
- Control of the maintenance and modification procedures,
- Master surveillance testing schedule,
- Log book usage and control procedures, and
- Temporary procedures.

19.4 Procedures for Responding to Anticipated Operational Occurrences (AOO) and Specific Major Accident Strategy Guidelines (SMI)

19.4.1 Emergency Operating Procedures (EOPs)

In the FSAR of a nuclear power plant, transients and accidents are analyzed based on the single-failure criterion. However, when considering multiple failure events, the single-failure criterion is not appropriate for the emergency operating procedures (EOPs). Therefore, the licensee is required to develop procedures to cope with accidents and transients that are caused by initiating events with multiple system or component failures or operator errors. Examples of multiple failure events are:

- Multiple tube ruptures in a single steam generator (SG) and/or tube ruptures in more than one steam generator,
- Failure of both main and auxiliary feedwater systems,
- Failure of high pressure reactor coolant makeup system,
- An anticipated transient without scram (ATWS) event following a loss of offsite power (LOOP), a stuck-open PORV or safety valve (SV), or a loss of main feedwater, and
- Operator errors of negligence.

On the other hand, the operating and maintenance procedures consist of two parts: the control room operating procedures and the other procedures. The control room operating procedures are further divided into the following categories:

- General Plant Operating Procedures,
- System Operating Procedures,
- Instrumentation Procedures,
- System's Abnormal Procedures,
- Alarm Procedures,
- Emergency Operating Procedures, and
- Temporary Procedures.

In addition to the above-mentioned procedures, there are other procedures including:

- Plant radiation protection procedures,
- Emergency preparedness procedures,
- Instrument calibration and test procedures,
- Chemical-radiochemical control procedures,
- Radioactive waste management procedures,
- Maintenance and modification procedures,
- Material control procedures, and
- Plant security procedures.

19.4.2 Specific Major Incident Guideline (SMI)

The operating conditions of an NPP can be classified into four categories:

(1) Normal operations,

(2) Abnormal events/transients,

(3) Accidents, and

(4) Severe accidents.

Thus, the NPP has four corresponding plant operating procedures in place for operators to follow as shown in Figure 19.1:

(1) Operating procedures,

(2) Abnormal operating procedures (AOP),

(3) Emergency operating procedures (EOP), and

(4) Severe accident management guidelines (SAMG).

The purpose of SMI is to develop an effective way for alternative water injection to avoid core meltdown through control of the reactor pressure and water level. The SMI can be viewed as a defense-in-depth supplement to the EOP in order to prevent an accident from becoming a severe (core-melt) accident, similar to the concept adopted in NEI 12-06: "Diverse and Flexible Coping Strategies (FLEX) Implementation Guide." Figure 19.1

shows a comparison between FLEX and SMI. The SMI can also be viewed as an improvement to the current EOPs based on lessons learned from the Fukushima accident.

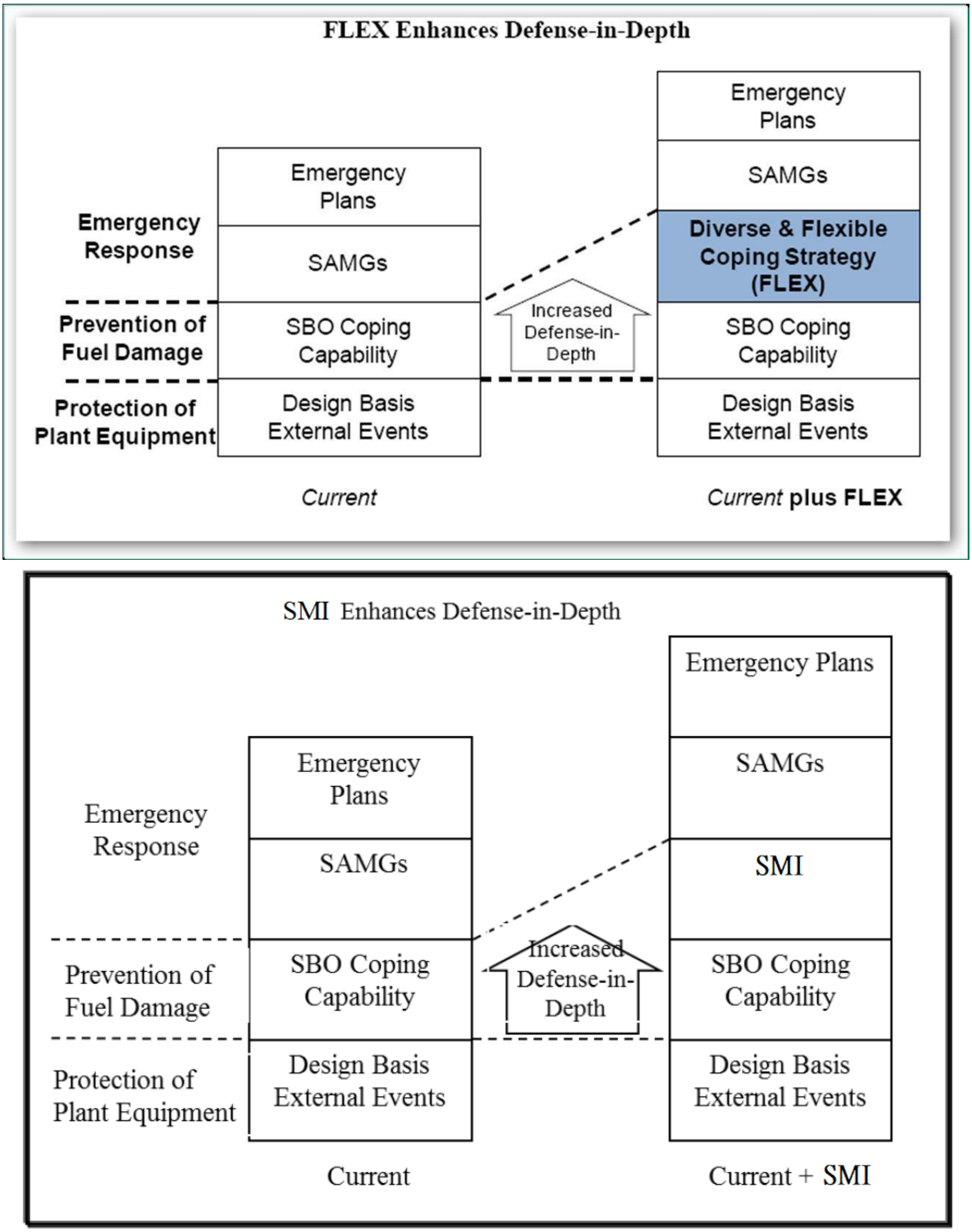

Figure 19.1 A Comparison between the FLEX and the SMI

19.5 Engineering and Technical Support

In each NPP, there is a Station Operation Review Committee (SORC) whose principal responsibility is to provide recommendations on the plant safety affairs for the plant general manager (PGM). There are 11 to 13 committee members with the PGM being the chairman of the SORC and three deputy PGMs as the official members. The SORC is responsible mainly for:

- Reviewing the plant operating procedures and their modifications or changes,
- Reviewing the proposed tests and experiments which may affect the nuclear safety,
- Reviewing the proposed modifications or changes of the technical specifications (TS),
- Reviewing the proposed design change requests (DCRs) or modifications to the system or equipment which may affect the nuclear safety,
- Investigating the TS violation event and providing recommendation to prevent such event from happening again,
- Reviewing the abnormal events required by Section 16.6.9.2 of the FSAR to report, etc.

As for the engineering and technical supports for plant operations from outside the plant, the TPC has retained various local as well as overseas consultants to provide technical assistance on subjects related to plant safety and operation as well as maintenance. However, the principal backup supports for plant operation are from various TPC departments of its headquarters (refer to Subsections 9.1.1 and 11.2.2.1 for the organizations of the TPC), other TPC's NPPs, and the Institute of Nuclear Energy Research (INER) with regard to the following special technical areas:

- Nuclear, mechanical, structural, electrical, thermal hydraulic, metallurgy and materials, instrument, and controls engineering supports were provided by the DONG, DNS, DNE, other NPPs of TPC and the INER.
- Plant chemistry and health physics supports were provided by the DONG, other NPPs of TPC and the INER.
- Fueling and refueling operation supports were provided by the DONG, other NPPs of TPC and the INER.
- Maintenance support was provided by the DOM, DONG, other NPPs of TPC and the INER.

As an illustration, the DONG provides regular support to the TPC's nuclear power plants in the following areas:

- Establishment and/or implementation of the projects for uprating the plant power or performance,
- Collection and provision of technical information, operating experiences, etc.,
- Reloading core designs and safety analysis review,
- Long-term fuel management planning,
- Safety evaluation and review of unexpected and/or important events,
- Review of the modifications of TS and/or FSAR, and
- Review of the plant design change requests (DCRs).

On the other hand, in addition to dispatching a quality assurance (QA) team to stay in each NPP, the areas regularly supported by the DNS to the NPPs are as follows:

- Projects for implementing the maintenance rule (MR), life extension, etc.,
- Establishment of the plant-specific probabilistic risk assessment (PRA) models,
- Safety evaluation and review of unexpected and/or important events,
- Review of the modifications of TS and/or FSAR, and
- Review of the safety analyses of the reloading core operation transients and/or accidents.

In addition, the Institute of Nuclear Energy Research (INER) conducts the research and development (R&D) programs in recent years in the areas of nuclear safety such as the technical support of the operating NPPs, advanced applications of probabilistic risk assessments (PRA) of the operating NPPs, source term evaluation, seismic risk re-assessment of an NPP, high efficiency solidification technology (HEST) study for the low level radioactive waste (LLRW or LLW), nuclear facility decommissioning and radioactive waste management, radiobiological medicines, the establishment of the accreditation platform for the nuclear grade industrial technologies, etc. The INER can also form a technical team or establish a project to solve a specific safety issue when requested.

19.6 Reporting of Incidents Significant to Safety

19.6.1 Regulatory Requirements for Reporting Incidents

If any abnormal or emergency events occur in any operating nuclear power plant, the TPC shall report it to the AEC as per the requirements of reporting abnormal or emergency events by the licensee in a timely manner as stipulated in Article 10 of the "Nuclear Reactor Facilities Regulation Act," Article 7 of "Enforcement Rules for the Implementation of Nuclear Reactor Facilities Regulation Act" as amended in November 2018, and "Regulations on Immediate Notification Requirements and Reportable Event Report for Nuclear Reactor Facilities" of 2004.

19.6.2 Restart of a Nuclear Power Unit after Scram

Within two hours of the occurrence of a reactor scram, the TPC must report to the Nuclear Safety Duty Center (NSDC) of the AEC, about the conditions of the plant after the scram and the probable causes. If the cause of the scram is unclear or it has possible safety concerns, the restart of the said nuclear unit will be under the AEC's rigorous regulation. The unit will be allowed to restart only after the root cause is identified or a satisfactory safety assessment is completed. The guidelines for a reactor to restart after a scram are given in Chapter 4, consisting of Articles 17 to 19 of the Regulations on the Restart of Nuclear Reactor Facilities after Operating Outage.

Table 19.1 Number of Reportable Events of the TPC's NPPs

Year	Number of Reportable Events			
	Chinshan	Kuosheng	Maanshan	Total

2012	5	2	2	9
2013	2	1	2	5
2014	2	5	1	8
2015	3	1	3	7
2016	8	3	1	12
2017	1	0	3	4
2018	3	1	2	6
2019	0	1	2	3
2020	1	3	0	5
2021	3	1	1	4
2022	0	0	2	2

19.6.3 Evaluation of the Abnormal Occurrence and Equipment Malfunctions of the Nuclear Power Plant

If there is an abnormal event occurring in a nuclear power unit, which is required to report as specified in the technical specifications, a detailed report of the situation, corrective actions and measures to prevent recurrence must be submitted to the AEC within 30 days. The detailed requirements for this report are given in "Regulations on Immediate Notification Requirements and Reportable Event Report for Nuclear Reactor Facilities" of 2004. The AEC will review this report, evaluate the corrective measures of the plant, dispatch inspectors to the plant if necessary, and monitor the corrective actions taken.

The number of reportable events (RE) for each of the TPC's operating NPPs in the past ten years until December 2022 is shown in Table 19.1.

19.7 Penalty for Violations of Regulatory Requirements

19.7.1 Violations by the Nuclear Facilities

According to "Regulations on the Penalty for Violations of Regulatory Requirements by the Nuclear Facilities" of 1988 as amended in January 2008 (Articles 5, 9 to 15), the following penalty rules related to violations of regulatory requirements by a nuclear installation are stated.

Whenever there is a violation of regulatory requirements by a nuclear power facility, the regulatory body, AEC, will issue an administrative order to rectify it. Violations of the regulatory requirements by a nuclear facility can be classified into five levels. The first degree of violation is the most serious, while the 5th degree is the least. The Appendix of the "Regulations on the Penalty for Violations of Regulatory Requirements by the Nuclear Facilities" gives the classifications of violations.

If a Level I violation or a Level II violation occurs in an NPP, which means there was a serious violation, the AEC will immediately issue a correction order and may order the plant to stop the relevant activities, to reduce power, to stop reactor operation, or to implement special corrective measures, based on the relevant atomic energy laws and/or regulations. In addition, the AEC will release news of this violation to the media immediately.

If a Level III violation occurs, the NPP must submit a corrective action plan for approval by the AEC. In the meantime, the AEC may release news to the media, if necessary.

As for a Level IV or Level V violation which is called a minor violation, the AEC may (or may not) ask the NPP to submit a corrective action plan for approval.

Table 19.2 shows the annual number of violations by all NPPs in recent years. The total number of violations has a trend of decreasing.

The descriptions of minor (Level V and Level IV) violations that occurred in the recent years (from Year 2016 to 2021) are given below.

<u>Violations occurred in 2016</u>

- Level V events
  - Due to the extended calibration interval of the radiation monitors in Maanshan NPP, there was no prior evaluation of fitness and no application for the extension of equipment preventive maintenance within the time limit

Table 19.2 Annual Number of Violations by the NPPs

year	Number of Violations*					
	Level V	Level IV	Level III	Level II	Level I	Total
2012	5	8	2	0	0	15
2013	7	4	0	0	0	11
2014	5	3	0	0	0	8
2015	2	4	0	0	0	6
2016	3	1	0	0	0	4
2017	2	0	0	0	0	2
2018	3	2	0	0	0	5
2019	1	1	0	0	0	2
2020	1	0	0	0	0	1
2021	3	1	0	0	0	4
2022	0	0	0	0	0	0
* The Level I violation is the most serious one, then the Level II violation, and so forth.						

specified in the series of the Procedure 700. The DRP gave a Level V violation on June 17, 2016 to account for the condition of Article 7 in “Other Violations that have a slight impact on safety or the environment" in the attachment, "Classification of Types of Violations", of "Guides to Handle the Violation Matters of Nuclear Facility".

- Due to the inadequacy of the detection test procedure of safety-related 125V DC power charger in Maanshan NPP, the DNR issued a Level V violation on January 26, 2017 in accordance with Article 1 of the attachment, “Classification of Types of Violations”, of “Guides to Handle the Violation Matters of Nuclear Facility”. This article states that “Failure to operate in accordance with the procedures, which may have a slight impact on safety or the environment” constitutes a Level V violation.

- Due to the failure to notify the AEC of the alarm of the process radiation monitor in Kuosheng NPP, the DRP imposed a Level V violation on June 04, 2016 in compliance with Article 7 of the attachment, “Classification of Types of Violations”, of “Guides to Handle the Violation Matters of Nuclear Facility”. This article specifies that "Any other violations that have a slight impact on safety or the environment" are classified as Level V violations.

The TPC successfully completed all the relevant improvements and the AEC concurred to close all the cases.

- Level IV events

  - The reactor scrammed due to the violation of the operation procedure of critical components in Chinshan NPP. The DNR issued a Level IV violation on April 28, 2016 to account for the condition of Article 1 in “Failed to operate in accordance with the procedures, which may have a negative impact on safety or the environment" in the attachment, "Classification of Types of Violations", of "Guides to Handle the Violation Matters of Nuclear Facility".

  The TPC had successfully completed the relevant improvements and the AEC concurred to close the case.

Violations occurred in 2017

- Level V events

  - Due to the defect in the reporting of the intrusion of foreign objects into the core during the 23rd refueling stage of Unit 2 in Maanshan NPP. The DNR imposed a Level V violation on July 19, 2017 to account for the condition of Article 7 in “Other Violations that have a slight impact on safety or the environment" in the attachment, "Classification of Types of Violations", of "Guides to Handle the Violation Matters of Nuclear Facility".
  - Due to the defect in the tagging operation, the ESF was activated unexpectedly, causing the abnormal event during the 23rd refueling stage of Unit 2 in Maanshan NPP. The DNR issued a Level V violation on July 19, 2017 to account for the condition of Article 1 in “Failed to operate in accordance with the procedures, which may have a slight impact on safety or the environment" in the attachment, "Classification of Types of Violations", of "Guides to Handle the Violation Matters of Nuclear Facility".

  The TPC had successfully completed the relevant improvements and the AEC concurred to close the case.

Violations occurred in 2018

- Level V events
  - Due to the defect in the calibration operation of radiation monitors in Chinshan NPP. The DRP imposed a Level V violation on April 30, 2018 to account for the condition of Article 7 in “Other Violations that have a slight impact on safety or the environment" in the attachment, "Classification of Types of Violations", of "Guides to Handle the Violation Matters of Nuclear Facility".
  - Due to the defect in the calibration operation of radiation monitors in Kuosheng NPP. The DRP imposed a Level V violation on April 24, 2018 to account for the condition of Article 7 in “Other Violations that have a slight impact on safety or the environment" in the attachment, "Classification of Types of Violations", of "Guides to Handle the Violation Matters of Nuclear Facility".
  - Due to the defect in the tagging operation, the ESF of Unit 2 was activated unexpectedly, causing the abnormal event during the 24th refueling stage of Unit 1 in Maanshan NPP. The DNR imposed a Level V violation on July 12, 2018 to account for the condition of Article 1 in “Failed to operate in accordance with the procedures, which may have a slight impact on safety or the environment" in the attachment, "Classification of Types of Violations", of "Guides to Handle the Violation Matters of Nuclear Facility".

  The TPC had successfully completed the relevant improvements and the AEC concurred to close the case.

- Level IV events
  - The measured specific activity of Co-60 exceeded the value of 80 Bq/Kg at the non-radioactive business waste landfill site of Maanshan NPP, which indicated the radioactive waste management and the landfill operation were inadequate. This compromised the safety of the radioactive material management at the Maanshan NPP. The DRP issued a Level IV violation on May 14, 2018 to account for the condition of Article 7 in “Other violations that adversely affect safety or the environment " in the attachment, "Classification of Types of Violations", of "Guides to Handle the Violation Matters of Nuclear Facility".
  - The calibration operation of the Steam Bypass and Pressure Regulation System did not comply with the requirements of the Nuclear Facility Quality Assurance Standard, resulting in the reactor scram in the Unit 2 of Kuosheng NPP. The DNR issued a Level IV violation on September 14, 2018 to account for the condition of Article 1 in “Failed to operate in accordance with the procedures, which may have a negative impact on safety or the environment" in the attachment, "Classification of Types of Violations", of "Guides to Handle the Violation Matters of Nuclear Facility".

  The TPC had successfully completed the relevant improvements and the AEC concurred to close the case.

Violations occurred in 2019

- Level V events
  - Due to the failure of the Maanshan NPP to adhere to the regulatory requirements

of the procedure, during the welding operation, the process radiation detector GL-RT069 was erroneously triggered in the auxiliary building of Unit 2. In accordance with "Classification of Types of Violations" of "Guides to Handle the Violation Matters of Nuclear Facility," The DNR issued a Level V violation on July 3, 2019, to account for the condition of Article 1 in "Failed to operate in accordance with the procedures, which may have a slight impact on safety or the environment" in the attachment, "Classification of Types of Violations," of "Guides to Handle the Violation Matters of Nuclear Facility."

- Level IV events

  - The TPC failed to perform the GA-0-10201 nuclear regulation case "The verification of the Boundary Integrity of the Main Control Rooms of the Chinshan, Kuosheng, and Maanshan NPPs and the establishment of the habitability plan for the main control rooms" on schedule, resulting in the delay in further confirming the control room habitability. Initially, as per the "Guides to Handle the Violation Matters of Nuclear Facility", it was a Level V violation. After several requests by the AEC to perform it as soon as possible, the TPC failed to complete the relevant process. As a result, the DNR issued a Level IV violation to account for the condition of Article 10 in "Failure to prevent defects despite notification."

The TPC had successfully completed the relevant improvements and the AEC concurred to close the case.

Violations occurred in 2020

- Level V events

  - The TPC Chinshan Nuclear Plant staff didn't review whether the hospital for physical examination of the workers is qualified by the Ministry of Labor. The Department of Radiation Protection (DRP) issued a Level V violation on November 17, 2020, to account for the condition of Article 4 in "Violations of radiation workplace that have a slight impact on safety or the environment"

The TPC had successfully completed the relevant improvements and the AEC concurred to close the case.

Violations occurred in 2021

- Level V events

  - During the refueling outage period of EOC-26 Unit 2 of the Kuosheng NPP, due to the failure to implement the refueling outage schedule management, the TPC failed to complete the work by the due date specified in the technical specifications. The DNR issued a Level V violation on May 14, 2021, to account for the condition of Article 1 in "Classification of Types of Violations" of "Guides to Handle the Violation Matters of Nuclear Facility."

  - TPC backend office staff performed well drilling at Chinshan nuclear plant and mistakenly broke the pipe of essential sea water system of Unit 1. DNR issued a Level V violation on April 20, 2021, to account for the condition of Article 7 in "Classification of Types of Violations" of "Guides to Handle the Violation Matters of Nuclear Facility."

  - TPC backend office didn't follow proper procedure regarding investigating soil and drilling and subsequently break the pipe during drilling. DNR issued a Level V violation on April 20, 2021, to account for the condition of Article 7 in "Classification of Types of Violations" of "Guides to Handle the Violation Matters of Nuclear Facility."

- Level IV events
  - The main steam isolation valve of Unit 2 of the Kuosheng NPP accidentally closed due to human error, resulting in an emergency shutdown of the unit. The DNR issued a Level IV violation on August 17, 2021, to account for the condition of Article 1 in "Classification of Types of Violations" of "Guides to Handle the Violation Matters of Nuclear Facility."

The TPC had successfully completed the relevant improvements and the AEC concurred to close the case.

19.8 Operating Experience Feedback

19.8.1 Regulatory Information Study and International Operating Experience Collections

In collaboration with the INER, the AEC has implemented a program since 1993 to regularly collect and analyze foreign countries' plant operating experiences, especially those of the USA, Japan and France. This includes the collection of the generic communications from the USNRC, such as regulatory issue summaries, generic letters, bulletins, and information notices as well as the abnormal events from both Japan and France.

The AEC also has its liaison representatives stationed in Washington DC, Vienna Paris, and Tokyo to coordinate international exchange affairs and nuclear cooperation activities with the NRC, IAEA, OECD/NEA, and NRA, respectively. In the meantime, these representatives collect the most recent nuclear-related information and operating experience there and provide feedback to the AEC.

In addition, the AEC has required the TPC to constantly collect regulatory information issued by the USNRC.

The TPC also obtains operating experiences from the General Electric Service Information Letter, Westinghouse Technical Bulletins, Boiling Water Reactors Owners Group (BWROG), Pressurized Water Reactor Owners Group (PWROG), WANO Networks and NRC bulletin. The TPC learns from foreign operating experiences such as critical reviews of relevant circumstances. The TPC is also constantly collecting additional relevant information and carrying out recommendations identified in the outside reports. Additional surveillance, testing and periodic inspections may be required by the AEC as a result of the experience feedback.

19.8.2 Establishment of a System for the Feedback of Operating and Maintenance Experiences

In order to share the important operating and maintenance experiences among different NPPs in Taiwan, the TPC developed a program, called the Operating Experience (OE) program, which can be applied to all the TPC's nuclear installations.

The standard operating procedures (SOP) of a plant have been developed to ensure that the plant operating personnel are kept informed of the pertinent improvement information of the plant operation. In addition, steps have been taken to ensure that this information is continually factored into the training programs. For example, the Maanshan's standard operating procedures (SOP 108) have been developed to ensure that the plant staff will be informed of operating experience feedback.

19.8.3 Lessons Learned from Domestic and International Operating Experiences and/or Incidents

The TPC's NPPs use a deterministic approach complemented with the probabilistic risk assessment (PRA) studies and models to assess the risks related to loss of electrical power and loss of ultimate heat sink (UHS). The PRA database is regularly updated every 3 years according to the TPC's procedure. In this update process, the operational experience feedback (OEF) is systematically analyzed and the results are used as one of the inputs for the licensee's plant enhancement measures and for improvements of the regulatory requirements/guidance. For example, at the Maanshan NPP a diesel engine driven auxiliary feedwater pump (AFP) was installed as a result of the lesson learned from the specific SBO event that occurred on March 18, 2001 at the Maanshan plant (which is locally called the "318 Event").

Another example of OEF was that the AEC required the TPC to improve the outage procedures for EDGs in accordance with lessons learned from the SBO event that occurred on April 7, 2011 at the Japanese Higashidori NPP.

19.9 Radioactive Waste Management

The Nuclear Materials and Radioactive Waste Management Act was enacted on December 25, 2002, replacing all administrative orders for the nuclear materials, nuclear fuels and radioactive waste management previously enforced upon licensees in the past decades. This Act sets the regulatory requirements for all licensing and enforcement activities on the production, treatment, storage, and final disposal of the nuclear materials, nuclear fuels and radioactive wastes as well as the construction, operation, decommissioning, closure and supervision of the facility. The AEC with its subsidiary agency, the Fuel Cycle and Materials Administration (FCMA), is the regulatory authority in Taiwan.

19.9.1 Low Level Waste Management

The AEC's low level radioactive waste (LLRW) (or simply low level waste, LLW) management strategies are to minimize the waste volume, enhance the waste treatment efficiency, ensure the safety of the storage and actively promote the final disposal program. Until the end of January 2022, a total of 131,544 drums (55-gallon each) of the LLW are stored in Taiwan (not including those stored in the offshore islet Lanyu). Among them, over 90 percent of the LLW, by volume, was generated by the operating NPPs, while the hospitals, research institutes and the industry accounted for the rest. The Lanyu storage facility, located on an offshore islet Lanyu, provides a temporary storage for the solidified LLW since 1982. This facility, designed to store 133,728 drums of the LLW in 23 semi-underground engineered trenches, stores 100,277 drums of LLW currently, and has stopped receiving LLW since 1996 due to opposition from local residents. New storage facilities have been constructed at each nuclear power plant site to accommodate the newly generated LLW.

On May 24, 2006, the “Act on Sites for Establishment of Low Level Radioactive Waste Final Disposal Facility” (hereafter referred as the “Site Selection Act”) was enacted and became effective. This Act stipulates the disposal site selection procedures and the associated measures. It designates the Ministry of Economic Affairs (MOEA), which supervises the TPC, as the implementing authority and the TPC as the site selection operator. Field investigation and public acceptance activities are being carried out for the site selection.

In August 2008, three potential sites were selected, of which two were later endorsed in March 2009 as the recommended candidate sites for local county referendum. Since one of the three sites was declared a “natural landscape protection area”, the site was rendered ineligible for hosting a disposal facility. Since at least two recommended candidate sites are required, in accordance with the Site Selection Act, for holding local county referendum, the site selection process was returned to the “potential site selection stage”.

In September 2010, the "site selection group" selected two "potential sites" once more. Later in July 2012, the Ministry of Economic Affairs announced these two sites as "recommended candidate sites." However, due to the failure of site selection, the AEC urges the MOEA and TPC to continue to strengthening communication with the two local governments and the public. If a recommended candidate site passes the local referendum, it will become a formal candidate site. After successfully passing the Environmental Impact Assessment Reviewing Process, this candidate site can then be designated as a final disposal site by the Executive Yuan.

19.9.2 Spent Nuclear Fuel Management

Regarding spent nuclear fuel (SNF) management, the on-site interim dry storage is considered as a favorable option in Taiwan before implementing the final disposal.

In the operating NPPs in Taiwan, any SNF removed from the reactor core will be initially stored in the spent fuel pools (SFPs) of each nuclear power plant. Because the original storage capacity of the SFPs of these NPPs was insufficient, the SFPs of the Chinshan and Kuosheng NPPs underwent re-racking operation twice, and the SFP of the Maanshan NPP was re-racked once. However, even after these re-racking operations, the SFPs of the Chinshan and Kuosheng NPPs will reach their full capacities in the near future. Therefore, installation of on-site spent fuel dry storage facilities for the Chinshan and Kuosheng NPPs is needed urgently in order to accommodate the SNF generated during their 40-year operation. The SFP of the Maanshan NPP is expected to be able to accommodate the SNF generated during its 40-year operation.

The national strategy for present SNF management is:

(1) Storage in SFP for the short term,

(2) Onsite dry storage for the medium term, and

(3) Final disposal for the long term.

This management strategy will be properly adjusted according to the development of international situation.

NER is the main contractor of the Chinshan Independent Spent Fuel Storage Installation (ISFSI) program for onsite dry storage of SNF. The dry storage system of Chinshan is the INER High Performance System (INER-HPS). The INER-HPS dry storage cask is a vertical concrete cask (VCC). The TPC planned to install 30 INER-HPS casks. Each cask has the capacity of storing 56 spent fuel assemblies. The total capacity of the Chinshan NPP dry storage facility is 1,680 spent fuel assemblies.

The TPC submitted an application for the construction license (CL) of the Chinshan ISFSI to the AEC on March 2, 2007 and AEC issued the CL to the TPC on December 3, 2008. The construction of Chinshan ISFSI started on October 18, 2010. The AEC then conducted the construction inspection to ensure the quality of the facility. The soil preparation (including water and soil conservation) of the Chinshan ISFSI site started in January 2011 and was completed in June 2013. Construction of the concrete base and installation of auxiliary equipment of the Chinshan ISFSI were completed in February 2013.

On May 23, 2012, the AEC approved the pre-operation plan of the Chinshan ISFSI proposed by the TPC. The first stage pre-operation (or the overall functional tests) was conducted in June 2012 and completed on November 14, 2012. The TPC submitted the overall functional tests report ("Performance Test and Verification Report") to AEC on March 8, 2013 for review. The AEC approved the second stage pre-operation (or the hot test) on September 24, 2013. However, due to the lack of the Soil and Water Conservation Facility Completion Approval issued by the local government (the New Taipei City), the hot test of the Chinshan ISFSI has been put on hold until now. Construction of all the planned 25 vertical concrete casks of the Chinshan dry storage system was completed in September 2014 with the related handling and other auxiliary equipment installed and passed the functional tests.

Due to the better public acceptance of indoor storage compared to the outdoor type, the FCMA requested TPC on September 13, 2016, to review and revise the Dry Storage Facilities in accordance with the "Indoor Storage Method" in the Decommissioning Plan. Compared to outdoor storage, indoor storage indeed reduces the safety concerns, which helps to promote the dry storage of SPF and subsequent decommissioning of NPPs. In November 2016, TPC reported to the Ministry of Economic Affairs that the originally planned outdoor dry storage facilities for the three nuclear power plants were changed to indoor dry storage. It is anticipated that the public will support the construction of the dry storage facilities. The indoor storage facility of Chinshan NPP will be completed and commence operation in accordance with the Decommissioning Plan, in order to successfully transit to the dismantling stage of the Decommissioning Plan.

On the other hand, the main contractor for the Kuosheng program is Nuclear Assurance Corporation (NAC) International, USA. The dry storage system of the Kuosheng NPP is NAC-MAGNASTOR-87 with a capacity of 87 fuel assemblies per VCC and a maximum installation number of 27 VCCs (2,349 assemblies).

The Kuosheng ISFSI program received approval from MOEA on August 10, 2009. The TPC then conducted the tender operation and initiated a contract on November 12, 2010 to entrust the CTCI Machinery Corporation (Taiwan) and NAC International (USA) to construct the facility. The MAGNASTOR cask system, which was designed by the NAC, was adopted by TPC for the Kuosheng NPP dry storage facility. The cask system had already obtained the license for spent fuel dry storage from the USNRC.

The TPC submitted to the AEC the application for the construction of the Kuosheng ISFSI on February 14, 2012. After six rounds of technical review, the AEC on September 3, 2013 held a conclusive review meeting and approved the application. The AEC issued the CL to the TPC on August 7, 2015. The Council of Agriculture approved the plan "Water and Soil Conservation Plan" on December 14, 2015, and issued the "Water and Soil Conservation Construction Permit" on February 2, 2016. The Environmental Protection Agency approved the “Environmental Impact Difference Analysis Report” for the indoor dry storage change of Kuosheng NPP on May 15, 2019, and confirmed that there were no changes in related safety requirements. However, due to the lack of a runoff wastewater reduction permit issued by the local government (the New Taipei City), the facility construction program has been put on hold till now.

A long-term investigation plan is being carried out by the TPC to select a site with suitable geological formation and characteristics for hosting a final repository of the SNF.

Since December 1983, the AEC, TPC, INER, Central Geological Survey, and Industrial Technology Research Institute (ITRI) have organized a task force to draft the “Research Plan on Disposal of Spent Nuclear Fuel” and conducted four stages of research and development (R&D) for the final disposal of high-level radioactive waste (HLRW).

The four stages of this R&D program are as follows: “preliminary research and development of the final disposal concept (1986 ~ 1988),” “initial work plan (1988 ~ 1991),” “technical preparation for site area investigation (1993 ~ 1998),” and “conductance of investigation and development of technology (1999 ~ 2005),” respectively.

The "Nuclear Materials and Radioactive Waste Management Act" was promulgated on December 25, 2002. In compliance with this newly promulgated Act, the TPC submitted a “Spent Nuclear Fuel Final Disposal Plan (abbreviated as the Disposal Plan)” in 2004, which was approved by the AEC in 2006. The Disposal Plan is divided into the following 5 stages (as shown in Figure 19.5):

Stage 1: Characterization and Evaluation of Potential Host Rocks (2005 ~ 2017),

Stage 2: Investigation and Confirmation of Candidate Sites (2018 ~ 2028),

Stage 3: Detailed Site Investigation and Testing (2029 ~ 2038),

Stage 4: Design and License Application of the Repository (2039 ~ 2044), and

Stage 5: Construction of the Repository (2045 ~ 2055)

In accordance with Article 37 of the “Enforcement Rules for the Nuclear Materials and Radioactive Waste Management Act” of 2003, the Disposal Plan shall be reviewed and amended every four years. Thus, the TPC amended the Disposal Plan three times and the amended plans were submitted in May 2010, September 2014, and August 2018, respectively and then approved by the AEC in January 2011, March 2015 and January 2020, respectively. The repository is scheduled to commence operation in 2055.

Currently, the R&D program of the Disposal Plan is in the second stage. A progress report entitled "The Technical Feasibility Assessment Report on Spent Nuclear Fuel Final Disposal (abbreviated as SNFD2017 report)" was submitted to AEC in December 2017 and approved by AEC in February 2020. This SNFD2017 report compiled the R&D results of Taiwan's spent fuel disposal programs over the past 30 years. It confirms that there are potential geological strata in certain regions of Taiwan which are worthy of further investigation.

According to the Disposal Plan, the second stage: "Investigation and Confirmation of Candidate Sites (2018 ~ 2028)" will be completed in 2028. The schedule includes the proposal of candidate sites for the final disposal of spent nuclear fuel in Taiwan by the end of 2028.

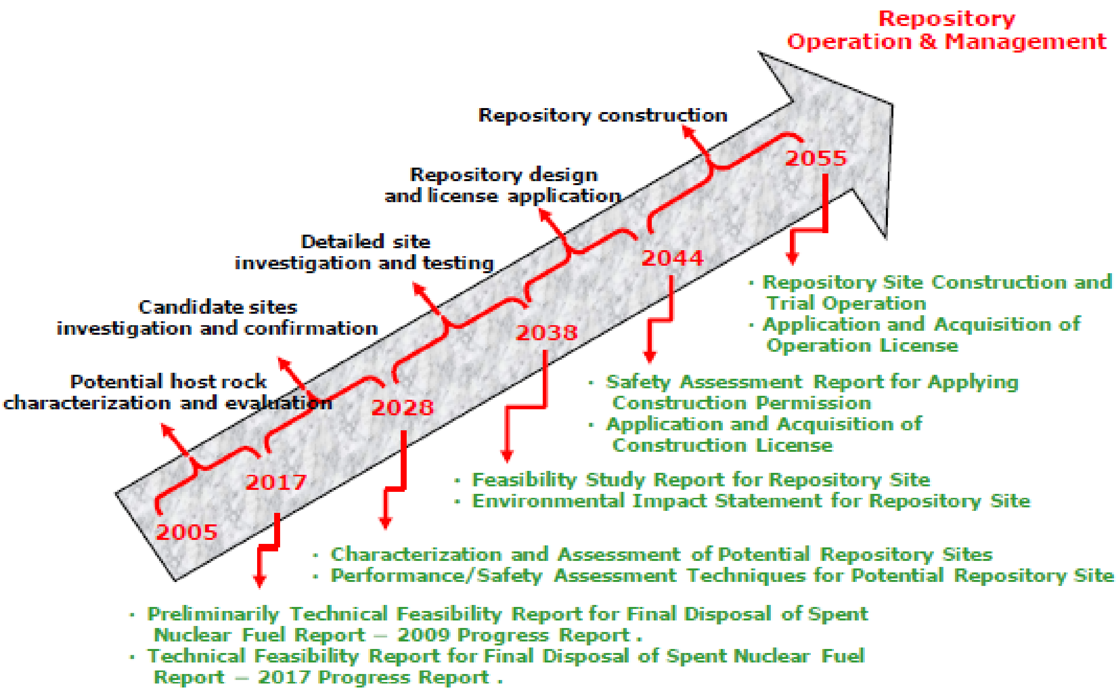

Figure 19.2 Long-Term Plan of Taiwan's SNF Final Disposal Program

APPENDIX A ACRONYMS

Abbreviation	Full Name
10 CFR	United States Title 10 of the Code of Federal Regulations
ABWR	advanced boiling water reactor
AC or ac	alternating current
AE	alert event
A/E	architect/engineer
AEC	Atomic Energy Council (Taiwan)
AFP	auxiliary feedwater pump
AIT	American Institute in Taiwan
ALARA	as low as reasonably achievable
AMT	accident management team
AOO	anticipated operational occurrence
AOP	abnormal operating procedure
ASME	American Society of Mechanical Engineers
ASTS	automatic seismic trip system
ATWS	anticipated transient without scram
BDB	beyond design basis
BDBA	beyond design basis accident
BDBE	beyond design basis earthquake
BOE	Bureau of Energy, MOEA
BWR	boiling water reactor
BWR-4	boiling water reactor of type 4
BWR-6	boiling water reactor of type 6
BWROG	BWR Owners Group
CAMP	Code Applications and Maintenance Program
CAP	corrective action program
CNS	Convention on Nuclear Safety, IAEA
CODAP	Component Operational Experience, Degradation and Ageing Program
CPD	Cooperative Program on Decommissioning
CS	Chinshan (NPP)
CSARP	Cooperative Severe Accident Research Program
CSNPP	Chinshan Nuclear Power Plant

CTCI	CTCI Corporation
CTS	customer technical specifications
DB	design basis
DBA	design basis accident
DBE	design basis earthquake
DBT	design basis threat
DC	direct current
DCR	design change request
DG or D/G	diesel generator
DGBAS	Directorate-General of Budget , Accounting and Statistics
DNBM	Department of Nuclear Backend Management, TPC
DNE	Department of Nuclear Engineering, TPC
DNR	Department of Nuclear Regulation, AEC
DNS	Department of Nuclear Safety, TPC
DNT	Department of Nuclear Technology, AEC
DOE	Department of Energy, US
DOM	Department of Maintenance, TPC
DONG	Department of Nuclear Generation, TPC
DOP	Department of Planning, AEC
DPGM	deputy plant general manager
D/Q	deposition factor
DRP (AEC)	Department of Radiation Protection, AEC
EA	exclusion area
E&C	E&C Engineering Corp
EC	European Commission
ECCS	emergency core cooling system
EC/ENSREG	ENSREG of EC
EDG	emergency diesel generator
EDMG	extensive damage mitigation guidelines
EIA	environmental impact assessment
EIS	environmental impact statement
El.	elevation
ENSREG	European Nuclear Safety Regulators Group
EOC	end of cycle
EOF	Emergency Operation Facility

EOP	emergency operating procedures
EP	emergency preparedness
EPA	Environmental Protection Administration, ROC
EPG	emergency procedure guidelines
EPIC	emergency public information center
EPRI	Electric Power Research Institute (of US)
EPU	extended power uprates
EPZ	emergency planning zone
ERBP	Emergency Response Basic Plan
ERF	Emergency Response Facility
ERM	Environmental Radiation Monitoring
ERMN	Environmental Radiation Monitoring Network
ERMS	Environmental Radiation Monitoring System
ERT	Expert Review Team (of Executive Yuan)
ESF	engineered safety features
ESW	essential service water system (Chinshan)
ESW	emergency service water system (Kuosheng)
ETA	ethanolamine (ethanol)
EU	European Union
EU-PR	European Union Peer Review
EY	Executive Yuan
FCMA	Fuel Cycle and Materials Administration
FLEX	diverse and flexible coping strategies (NEI 12-06)
FSAR	final safety analysis report
FSC	Financial Supervisory Commission
FSG	FLEX Support Guidelines
FY	fiscal year
g	standard value of the gravitational acceleration (1 g = 9.81 m/s^2)
GDC	general design criteria (10 CFR Part 50, Appendix A, “General Design Criteria for Nuclear Power Plants”)
GE	General Electric Company
GEA	general emergency accident
GIO	Government Information Office
GT or G/T	gas turbine (= gas turbine generator)

GTBSDG	gas turbine black start diesel generator
GTG	gas turbine generator (= gas turbine)
GWe	giga–watts electrical (= 10^9 watts)
h	hour
HEP	human error probabilities
HEST	high efficiency solidification technology
HLRW	high level radioactive waste
HPC	health physics center
HPES	human performance enhancement system
HPIC	high pressure ionization chamber
HPS	high performance system, ISFSI
HRA	human reliability analysis
HSI	human-system interface
HX	heat exchanger
I&C	instrumentation and control
IAEA	International Atomic Energy Agency
ICRP	International Commission on Radiological Protection
IEEE	Institute of Electrical and Electronics Engineers
IFL	initial fuel loading
IN	Information Notice (of NRC)
INER	Institute of Nuclear Energy Research, AEC
INER-HPS	INER High Performance System (dry storage cask)
INSAG	International Nuclear Safety Advisory Group
IPA	integrated plant assessment
IPP	independent power producer
IRA	integrated reliability analysis
IRPA	Ionizing Radiation Protection Act
ISA	integrated safety assessment (for PSR every 10 years)
ISAR	integrated safety assessment report
ISFSI	independent spent fuel storage installation
ISO	International Organization for Standardization
ITRI	Industrial Technology Research Institute
ITS	improved technical specifications
JLD	Japan Lessons-learned project Directorate
kg or Kg	kilogram

KLOE	kilo-liter oil equivalent
km	kilometer
KS	Kuosheng (NPP)
KSNPP	Kuosheng nuclear power plant
kV	kilovolt
kVA	kilovolt-ampere
kW	kilowatt
kWh	kilowatt-hour
L2	Level 2
L3	Level 3
LCO	limiting conditions for operation
LLW	low level waste (= LLRW)
LLRW	low level radioactive waste (= LLW)
LOCA	loss of coolant accident
LOOP	loss of offsite power
LOV	loss of voltage
LPZ	low population zone
LY	Legislative Yuan
m	meter
MAAP	Modular Accident Analysis Program
MACCS2	the computer code MACCS2
MC	main condenser
MCR	main control room
MDG	mobile diesel generator
mGy	milli-gray
mGy/yr	milli-gray per year
mGy/yr-unit	milli-gray per year per unit
MIRU	Maintenance Integrated Risk Utilities (computer program)
MMI	man-machine interface
MOE	Ministry of Education
MOEA	Ministry of Economic Affairs, Taiwan
MOF	Ministry of Finance
MOFA	Ministry of Foreign Affairs, ROC (Taiwan)
MOHW	Ministry of Health and Welfare
MOI	Ministry of Interior

MOL	Ministry of Labor
MOND	Ministry of National Defense
MOTC	Ministry of Transportation and Communication
MOV	motor-operated valve
MR	maintenance rule
MRC	Management Review Committee
MS	Maanshan (NPP)
MSL	mean sea level
MSNPP	Maanshan nuclear power plant
μSv/h	micro-sievert per hour
mSv	milli-sievert
mSv/yr	milli-sievert per year
mSv/yr-unit	milli-sievert per year per unit
M_w	moment magnitude scale (of earthquake) (The Richter scale was succeeded in the 1970s by the moment magnitude scale (MMS). This is now the scale used by the United States Geological Survey to estimate magnitudes for all modern large earthquakes.)
MW	megawatts (= 10^6 watts)
MWe	megawatts electrical (= 10^6 watts)
MWt	megawatts thermal (= 10^6 watts)
NAC	Nuclear Assurance Corporation International, USA
NCC	National Communications Commission
NCT	Nuclear Communication Team, TPC
NDCORE	National Database Center of Occupational Radiation Exposures
NDE	non-destructive examination
NEA	Nuclear Energy Agency (of OECD)
NEE	Nuclear Emergency Exercise (onsite + off-site) (= NS Drill)
NEI	Nuclear Energy Institute (formerly NUMARC and USCEA)
NEPEC	Nuclear Emergency Planning Executive Committee, TPC
NERC	National Emergency Response Center
NERF	Nuclear Emergency Response Fund
NERO	Nuclear Emergency Response Organization, TPC
NERU	Nuclear Emergency Response Unit, TPC
NESC	Nuclear Emergency Support Center

NEST	Nuclear Energy Society, Taipei
NISA	Japanese Nuclear and Industrial Safety Agency
NNAERP	National Nuclear Accident Emergency Response Plan (replaced by ERBP by AEC in July 2005)
NNERC	National Nuclear Emergency Response Center
NNSA (DOE/NNSA)	US National Nuclear Security Administration of the Department of Energy
NPP	nuclear power plant
NRA	Nuclear Regulation Authority, Japan
NRC	Nuclear Regulatory Commission, U.S.
NSA	Nuclear Safety Authority
NSC	Nuclear Safety Committee , TPC
NSDC	Nuclear Safety Duty Center, AEC
NS Drill	Nuclear Safety Drill (= NEE)
NSSS	nuclear steam supply system
NTHU	National Tsing Hua University
NT$	New Taiwan Dollar
NTTF	Near-Term Task Force (of NRC)
NUPIC	Nuclear Procurement Issues Committee, US
NUREG	nuclear regulatory
NuSTA	Nuclear Science and Technology Association, Taiwan
O&M	operation and maintenance
OBE	operating basis earthquake
OE	operating experience
OECD	Organization for Economic Cooperation and Development
OECD/NEA	Nuclear Energy Agency of OECD
OEF	operational experience feedback
OIL	Operational Intervention Level
OJT	on-the-job training or on-job training
OL	operating license
OSC	Operation Support Center (or Operating Support Center)
PAG	protective action guides
PAR	passive autocatalytic recombiner
PBNC	Pacific Basin Nuclear Conference
PECL	Pacific Engineers & Constructors, Ltd.

PGA	peak ground acceleration
PGM	plant general manager
PI	performance indicator
PMP	probable maximum precipitation
PNC	Pacific Nuclear Council
PORV	power operated relief valve
PRA	probabilistic risk assessment
PRiSE	a PRA model based Risk Significance Evaluation tool
PSAR	preliminary safety analysis report
PSR	periodic safety review
PWR	pressurized water reactor
PWROG	Pressurized Water Reactor Owners Group
Q	safety-qualified
Q1	1st quarter
Q2	2nd quarter
Q3	3rd quarter
Q4	4th quarter
QA	quality assurance
QC	quality control
R&D	research and development
RAI	required additional information
RAMP	RAdiation protection code analysis and Maintenance Program
RCIC	reactor core isolation cooling (system)
RCP	reactor coolant pump
RCS	reactor coolant system
RE	reportable event
RER	reportable event reports
RG	Regulatory Guide, NRC
RHR	residual heat removal (system)
RIS 2002-03	NRC Regulatory Issue Summary 2002-03
RL	Radiation Laboratory, TPC
RLE	review level earthquake
RMC	Radiation Monitoring Center, AEC
RMDAC	Radiation Monitoring and Dose Assessment Center
RNERC	Regional Nuclear Emergency Response Center

RO	reactor operator
ROC	Republic of China
ROP	reactor oversight process
RPCS	Radiation Protection Control System
RPS	reactor protection system
RPV	reactor pressure vessel
RS-001	Review Standard for Extended Power Uprates
RSAR	reload safety analysis report for the BWR
RSER	reload safety evaluation report for the PWR
RW	radioactive waste (or radwaste)
RWA	Radioactive Waste Administration, AEC
SAEA	site area emergency accident
S & W	Stone & Webster Construction, Inc.
SAG	severe accident guidelines
SAMG	severe accident management guidelines
SAR	safety analysis report
SAT	Systematic Approach to Training
SBO	station blackout (≡ a complete loss of normal offsite ac power and onsite backup EDGs power, not including the swing EDG and gas turbines for emergency backup) (= loss of all permanently installed AC power sources)
SC	safety culture
SDP	significance determination process
SER	safety evaluation report
SER	significant event reports (of WANO)
SFP	spent fuel pool
SG	steam generator
SL	shift leader
SM	shift manager
SMA	seismic margin assessment
SMI	specific major incident guidelines
SMS	strong-motion seismometer
SNF	spent nuclear fuel
SNFD2009	Spent Nuclear Fuel (final) Disposal report in 2009 of TPC
SOC	Station Ownership Committee

SOER	significant operating experience reports (of WANO)
SOP	standard operating procedure
SORC	station operation review committee, TPC
SPDS	safety parameter display system
SPRA	seismic probabilistic risk assessment (or Seismic PRA)
SPU	stretch power uprates
SRO	senior reactor operator
SRV	safety relief valve
SSC	structures, systems and components
SSE	safe shutdown earthquake
SSHAC	Senior Seismic Hazard Analysis Committee
SSI	soil-structure interaction
SSP	safety system performance (one of WANO's PIs)
ST	stress tests
STS	standard technical specifications
SÚ JB	State Office for Nuclear Safety of the Czech Republic.
SV	safety valve
TAF	Taiwan Accreditation Foundation
Taipower	Taiwan Power Company
TECRO	Taipei Economic and Cultural Representative Office in the US
TEPCO	Tokyo Electric Power Company
TG or T/G	turbine generator
TLD	thermo-luminescent dosimeter
TMI	Three Mile Island NPP
TMI accident	1979 accident at Three Mile Island NPP Unit 2
TPC	Taiwan Power Company
TIRM	TPC Integrated Risk Monitor
TRM	technical requirement manual
TRMS	Taiwan Radiation Monitoring Station, AEC
TS	technical specifications
TSC	technical support center
UHS	ultimate heat sink (sea water) ultimate heat sink
UK	United Kingdom
UN	United Nations

UPS	uninterruptible power supply
URG	ultimate response guidelines
US	United States
USA	United States of America
USNRC	United States Nuclear Regulatory Commission
V	volt
VAC	volt alternating current
V&V	verification and validation
VCC	vertical concrete cask, ISFSI
VDC	volt direct current
VDNS	Vienna Declaration on Nuclear Safety
W	Westinghouse Electric Corporation
WANO	World Association of Nuclear Operators
WANO-TC	World Association of Nuclear Operators – Tokyo Center
χ/Q	relative atmospheric dispersion factor

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APPENDIX B   CONTRIBUTORS TO THE ROC’S NATIONAL REPORT

The Atomic Energy Council and the Institute of Nuclear Energy Research prepared this report in consultation with:

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Kuosheng NPP (2nd NPP), TPC,

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Department of Nuclear Generation (DONG), TPC,
Department of Nuclear Engineering (DNE), TPC,
Department of Nuclear Safety (DNS), TPC,
Nuclear Emergency Planning Executive Committee, TPC,
Nuclear Emergency Response Unit, TPC,
Taiwan Power Company (TPC) Headquarters,
Department of Nuclear Regulation (DNR), AEC,
Department of Nuclear Technology (DNT), AEC,
Department of Planning, AEC,
Department of Radiation Protection, AEC,
Fuel Cycle and Materials Administration (FCMA), AEC,
Radiation Monitoring Center (RMC), AEC, and
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ANNEX 1 REGULATORY REQUIREMENTS/ORDERS IN THE AFTERMATH OF FUKUSHIMA DAIICHI NUCLEAR ACCIDENT

In general, due to the fact that all its reactors are designed and manufactured by the US, Taiwan's NPPs shall follow all applicable laws and regulations of the country of origin, i.e. the ones of the USNRC. In addition, in light of the lessons learned from Fukushima, AEC also required TPC to adopt good practices from Japan and Europe to further strengthen the robustness of its NPPs on the basis of the Nuclear Reactor Facilities Regulation Act.

Article 14 of this Act states that: "If there is anything that does not conform to the prescription or if public health/safety or environmental ecology may be endangered, the competent authorities shall order the licensee to improve the situation or take any other necessary measures within a prescribed time period. If the situation is serious, the licensee does not improve it or does not take necessary measures within the prescribed period, the competent authorities may order the licensee to cease the working on the scene, or operation thereof, or may revoke the license or permit the operation only under a limited power."

Based on the above-mentioned legal structure, AEC issued the following regulatory orders in three batches to TPC requiring implementation of enhancements on nuclear safety on 5/11/2012, 6/6/2013, and 6/3/2014, respectively:

A. Regulatory Orders Issued on November 5, 2012

Building on the results of the stress tests (STs) conducted in Taiwan and insights from the actions being taken by other regulators, the AEC issued following orders to TPC on November 5, 2012, while the TPC may propose alternatives subject to AEC approval:

<u>Orders Issued by AEC's Department of Nuclear Regulation (DNR):</u>

1. XX-JLD-10101*: Requiring seismic hazard re-evaluations implementing the recommendation from the USNRC NTTF Report Tier 1 recommendation 2.1 to conduct seismic and flood hazard re-evaluations.
2. XX-JLD-10102: Requiring flood hazard re-evaluations implementing the USNRC NTTF Report Tier 1 recommendation 2.1 to conduct seismic and flood hazard re-evaluations.
3. XX-JLD-10103: Requiring TPC to simulate the mechanism of seismic and tsunami hazards and the resulting risks based on comments from an AEC review meeting.
4. XX-JLD-10104: Requiring the enhancement of the water tightness of buildings (or build seawall, or tidal barrier) to a level of 6 meters above current licensing bases based on the actions being taken at Japanese NPPs and as referred to in the USNRC NTTF Report, to address the uncertainty from the original design basis tsunami height by adding 6 meters of protection.
5. XX-JLD-10105: Requiring seismic, flood and other external events walkdowns consistent with the USNRC NTTF Report Tier 1 recommendation 2.3 to conduct seismic and flood walkdowns.

6. XX-JLD-10106: Requiring TPC to take actions to address Station Blackout (SBO) consistent with the USNRC NTTF Report Tier 1 recommendation 4.1 on SBO regulatory actions.
7. XX-JLD-10107: Requiring at least 2 Emergency Diesel Generators (EDGs) to be in an operable state all the time even when the reactor is shut down so that if one unit is shut down with one EDG under maintenance and the swing EDG is assigned to it according to the new requirement, the capability of the swing EDG to back up the other unit is restricted.
8. XX-JLD-10108: Requiring TPC to enhance emergency DC power supply to secure the batteries storage capacity of at least 8 h without isolating the load and at least 24 h after the unnecessary loads are isolated.
9. XX-JLD-10109: Requiring TPC to extend the SBO coping time to at least 24 h based on specific issues for Taiwan's NPP in that the original requirements of USNRC Regulatory Guide (RG) 1.155 do not include the effects resulting from earthquake and tsunami.
10. XX-JLD-10110: Requiring TPC to install an extra seismic qualified gas-cooled EDG at high elevation for each NPP to address specific defense-in-depth issues with electrical power supplies for Taiwan. AEC accepts the alternatives for this order to provide the watertightness of the swing EDG building.
11. XX-JLD-10111: Requiring TPC to install an alternate UHS consistent with recommendations from the ENSREG action plan.
12. XX-JLD-10112: Requiring TPC to implement the actions of the USNRC's Post-9/11 action (B.5.b) (SBO and Advanced Accident Mitigation) to stage response equipment on or near site to respond to extreme external events (see USNRC 10 CFR 50.54(hh)(2)).
13. XX-JLD-10113: Requiring TPC to address the USNRC NTTF Report Tier 1 recommendation 4.2 on equipment covered under USNRC regulation 10 CFR 50.54(hh)(2).
14. XX-JLD-10114: Requiring TPC to install reliable hardened vents for Mark I and ABWR containments and request the installation of filtration for all different containment designs consistent with the recommendation of USNRC NTTF Report Tier 1 recommendation 5.1 on reliable hardened vents for BWR Mark I and Mark II containments.
15. XX-JLD-10115: Requiring TPC to install SFP instrumentation consistent with the recommendation of the USNRC NTTF Report Tier 1 recommendation 7.1 on SFP instrumentation.
16. XX-JLD-10116: Requiring TPC to strengthen and integrate the EOPs, SAMGs and EDMGs with the ultimate response guidelines (URGs) developed by TPC following the Fukushima accident consistent with the USNRC NTTF Report Tier 1 recommendation 8 on strengthening and integration of EOPs, SAMGs, and EDMGs. The URG is renamed as specific major incident guidelines (SMI).
17. XX-JLD-10117: Requiring TPC to perform a volcanic PRA for its NPPs and to study the impacts from ash dispersion based on comments during a high-level review meeting.
18. XX-JLD-10118: Requiring TPC to enhance the water-tightness of the fire doors

of essential electrical equipment rooms based on specific concerns with the location of the equipment at Taiwan's NPPs and recommendations from the Japanese regulatory body for NPPs in Japan.

19. XX-JLD-10119: Requiring TPC to enhance the seismic resistance for the fire brigade buildings to cope with BDBE conditions to address specific issues for Taiwan's NPPs and a good practices from EU-PRs (EC/ENSREG Peer Reviews of Taiwan STs for NPPs).
20. XX-JLD-10120: Requiring TPC to improve the reliability of off-site power supplies to address specific issues for Taiwan's NPPs and recommendations from the Japanese regulatory body for NPPs in Japan.
21. XX-JLD-10121: Requiring TPC to improve the seismic resistance of raw water reservoirs at the NPPs and to consider the installation of impermeable liners to address specific issues for Taiwan's NPPs and consistent with the measures being taken by the Tokyo Electric Power Company (TEPCO) in Japan to install impermeable liners.
22. XX-JLD-10122: Requiring TPC to install the passive autocatalytic recombiners (PARs) to prevent hydrogen explosions consistent with recommendations in the ENSREG action plan.
23. CS-JLD-101101: Requiring TPC to conduct an enhancement evaluation of safety related SSCs for the Chinshan NPP followed by the upgrading of the licensing basis SSE from 0.3g to 0.4g for specific SSCs relied upon to respond to an accident. (An order from the Executive Yuan)
24. MS-JLD-101301: Requiring TPC to address the issue with the PWR reactor coolant pump (RCP) seal loss-of-coolant-accident leakage issue for Maanshan NPP consistent with the ENSREG action plan.

Orders Issued by AEC's Department of Nuclear Technology (DNT):

1. HQ-JLD-1013001: Requiring TPC to update "radiation protection measures and planning for the residents within emergency planning zone (EPZ) of nuclear power plant" in response to the expanded EPZ from 5 km to 8 km based on the lessons learned from Fukushima for all NPPs in Taiwan.
2. XX-JLD-1013002 and 1013004: Requiring TPC to address staffing and communications issues for emergency preparedness consistent with the USNRC NTTF Report Tier 1 recommendation 9.3 on emergency preparedness regulatory actions.
3. XX-JLD-10104 (AEC's Department of Nuclear Technology): Requiring TPC to reinforce the structure of the existing nonseismically qualified Technical Support Centre (TSC) used for emergency response to address specific seismic concerns of the NPPs in Taiwan.
4. XX-JLD-1013003: Requesting TPC to consider building a seismically isolated TSC building based on the practice being implemented in Japan in light of the Fukushima accident and consistent with lessons learned provided by the IAEA.

Orders Issued by AEC's Fuel Cycle and Materials Administration (FCMA):

1. RL-JLD-1012042: Requiring TPC to procure 40 mobile detection equipment

with automatic data transmission capability for four NPPs to enhance capability of radiation fallout monitoring in a timely manner.

2. RL-JLD-1012043: Requiring TPC to install 13 radiation monitoring stations within the EPZ of NPPs to set up a radiation monitoring preparedness platform and strengthen radiation monitoring capability.
3. RL-JLD-1012044: Requiring TPC to add four radiation detection vehicles to enhance mobile radiation monitoring capability.

B. Regulatory Orders Issued on June 6, 2013

Based on the OECD/NEA peer review results of stress tests for the Taiwanese NPPs, the AEC's DNR issued the following regulatory orders on June 6, 2013:

Orders Issued by AEC's Department of Nuclear Regulation (DNR):

1. XX-JLD-10201: Requiring TPC to conduct fault displacement analysis for new evidences of Shanchiao and Hengchun Faults near the NPPs (within a radius of 8 km).
2. XX-JLD-10202: Requiring TPC to provide the interface between existing post-earthquake and post-tsunami operating procedures of NPPs.
3. XX-JLD-10203: Requiring TPC to systematically assess the combinations of events in the areas of flooding and extreme natural events at NPPs.
4. XX-JLD-10204: Requiring TPC to examine the probable maximum precipitation (PMP) with regional topographical maps of NPPs.
5. HQ-JLD-10201: Requiring TPC headquarters to deploy a local seismic network (one in the north and one in the south) to capture small earthquakes in order to understand whether or not the pattern of the epicenters indicate correlation with postulated tectonic features.

C. Regulatory Orders Issued on March 6, 2014

Based on the EC/ENSREG peer review results of stress tests for the Taiwanese NPPs, the following regulatory orders were issued on March 6, 2014 by the AEC's DNR:

Orders Issued by AEC's Department of Nuclear Regulation (DNR) :

1. XX-JLD-10301: Requiring TPC to perform a thorough geological and geomorphological assessment for plant site damage caused by dip slope sliding and landslide on a site-specific basis and to provide a continuous monitoring and early warning system for slopes susceptible to damage caused by dip slope sliding and landslide.
2. XX-JLD-10302: Requiring TPC to conduct post-seismic walkdown inspection on non-seismic category I structures, systems and components (SSCs).
3. XX-JLD-10303: Requiring TPC to consider the development of strategies to minimize the quantity of contaminated water produced during accident and to evaluate the installation of closed cooling water loops which may include the mobile heat exchangers and high pressure alternate injection equipment.
4. XX-JLD-10304**: Requiring TPC to strengthen the capability of a BWR in

depressurizing the RPV by utilizing diversified measures.

5. XX-JLD-10305: Requiring TPC to improve the habitability in the main control room (MCR) and local shutdown panel areas under accident conditions.
6. XX-JLD-10306: Requiring TPC to consider a systematic assessment of combinations of events including multi-unit and multi-site accidents (since some NPPs are located in relatively close vicinity).
7. XX-JLD-10307: Requiring TPC to improve the resistance of the plant site infrastructure against earthquakes and have heavy mechanical equipment ready for obviating the roadblocks.

The implementation status of Post-Fukushima orders in Taiwan's NPPs was listed in Table 14.1.

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* XX stands for "order applicable to all 4 NPPs of TPC";

CS, KS, or MS stands for "order applicable to Chinshan, Kuosheng, or Maanshan NPP, respectively";

HQ stands for "order issued to TPC headquarters";

RL stands for "order applicable to TPC's Radiation Laboratory"; and

JLD stands for "Japan Lessons-learned project Directorate".

** not applicable to MSNPP.

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