Voluntary Departmental Review (VDR) of SDGs

In Atomic Energy Council, Executive Yuan, R.O.C. (Taiwan)

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Chapter 1. Introduction

During the 12-day-long 26th United Nations (UN) Climate Change Conference (COP26) held in November 2021, the UN promised to achieve net zero carbon emissions by 2050, and focused on planning several carbon reduction endeavors to meet various environmental sustainability goals, including temperature rise control and reduced carbon emissions. The UN presented environment, economy, and energy (the three E's) in the form of main trend images and indicated that the three E's were the solutions to global climate change. At the conference, the UN set wind power and photovoltaics as the keys to achieving net zero carbon emissions by 2050, and set energy storage and flexible scheduling as the key supporting methods. Concerning nuclear energy, it rarely receives the support of local communities due to its high early-stage investment costs and fluctuating nuclear waste disposal risks and costs. Thus, nuclear energy investments are no longer investments welcomed by the international financial industry. Additionally, countries such as Germany have issued joint statements prohibiting nuclear energy to be included in EU's sustainable energy development targets.

We, the Atomic Energy Council (AEC), are an atomic energy regulatory agency responsible for supervising Taiwan's nuclear energy safety, radiation protection, emergency responses, and radioactive waste safety, as well as researching and developing the application of atomic energy technology in people's daily lives. Our main goal is to decommission and terminate nuclear power plants (NPPs). Regarding existing NPPs, the Chinshan NPP is currently being decommissioned, the Kuosheng NPP has had its decommissioning plan reviewed, and the Maanshan NPP has submitted its decommissioning plan to AEC for a review as of 2021. These efforts illustrate the major progress made by Taiwan in decommissioning its NPPs. Concurrently, we urge Lanyu to properly implement its repacking safety control measures in preparation for its relocation. We mandate that the competent authority in charge to dispose of nuclear waste in accordance with the planned disposal process.

To actively fulfill the Sustainable Development Goals, we engage in Voluntary Departmental Reviews to determine our self-positioning and existing achievements during the Taiwan Sustainable Development Goals promotional process. These efforts allow us to think thoroughly and communicate with the public. With respect to this report, we start off by introducing Taiwan's national policies and our internal operations. Next, we explain how our operations contribute to Taiwan Sustainable Development Goals, highlight our promotional achievements, and have a look back at our indicator progress. In the meantime, we would like to thank everyone who has paid attention to and addressed sustainable development issues, and hope that we can all work together to achieve Taiwan's sustainable development.

Chapter 2. Blueprint for Sustainable Development

To elevate resource allocation effectiveness and efficiency, we must take into account our core business operations and concerns, and use them to create our key goals and build our sustainable development. The blueprint can be employed to systematically develop our goals.

(1) Create a corresponding checklist for key goals

During the National Council for Sustainable Development's 29th committee meeting in November 2016, the council referenced the United Nations Sustainable Development Goals to formulate the Taiwan Sustainable Development Goals. Relevant citizen participation and discussions as well as expert consultations ensued, on the basis of which 18 goals, 143 specific targets, and corresponding indicators were introduced.

Table 1. Taiwan Sustainable Development Goals

Goal no. & content	
Goal 01	Strengthen social and economic security-related care services provided to disadvantaged groups
Goal 02	Achieve food security, end hunger, and promote sustainable agriculture
Goal 03	Ensure healthy lives and promote well-being for all at all ages
Goal 04	Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all
Goal 05	Achieve gender equality and empower all women and girls
Goal 06	Ensure environmental quality and sustainable resource management
Goal 07	Ensure access to affordable, reliable, sustainable and modern energy for all
Goal 08	Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all
Goal 09	Build affordable, safe, environmentally friendly, resilient and sustainable transportation
Goal 10	Reduce income inequality within and among countries
Goal 11	Make cities and human settlements inclusive, safe, resilient, and sustainable
Goal 12	Ensure sustainable consumption and production patterns

Goal no. & content	
Goal 13	Complete mitigation and adaptation actions to address climate change and its impacts
Goal 14	Conserve and sustainably use marine ecosystems to ensure biodiversity and prevent marine environment deterioration
Goal 15	Protect and sustainably use terrestrial ecosystems to ensure biodiversity and prevent land degradation
Goal 16	Promote peaceful and inclusive societies, ensure judicial equality, and build credible and inclusive systems
Goal 17	Establish partnership with various domains and work together with them to realize the goal of sustainable development
Goal 18	Achieve the goal of creating a nuclear-free homeland as stipulated in the Basic Environment Act

All of these goals were formulated after referencing the United Nations Sustainable Development Goals. However, Taiwan added an additional goal (i.e., Goal 18) that focuses on creating a nuclear-free homeland by 2025. Specific targets of Goal 18 include specific target 18.1: promote the decommissioning of NPPs in compliance with the law; specific target 18.2: continue to promote the selections of sites for establishment of low level radioactive waste final disposal facilities, allowing the Lanyu Storage Site to relocate quickly and smoothly; specific target 18.3: promote high level radioactive waste final disposal facility site establishment-related legal operations, assisting the decommissioning of NPPs; specific target 18.4: enhance the safety protection of nuclear energy facilities; and specific target 18.5: promote nuclear waste disposal-related social communication and improve the education on and promotion of creating a nuclear-free homeland.

(2) Create key goals

To choose sustainable development goals that echo our operations, that should be met first, and that are closely tied to relevant future development, we reviewed and determined NPP decommissioning and terminations to be our current key tasks, and selected the various targets of Goal 18 as our key goals.

(3) Build a sustainable development blueprint

On the basis of our key goals, we built a sustainable development blueprint to showcase our commitment to promoting sustainable development and pursuing continuous improvement. Said blueprint serves as the basis when we formulate and promote relevant policies.

Table 2. Our sustainable development blueprint

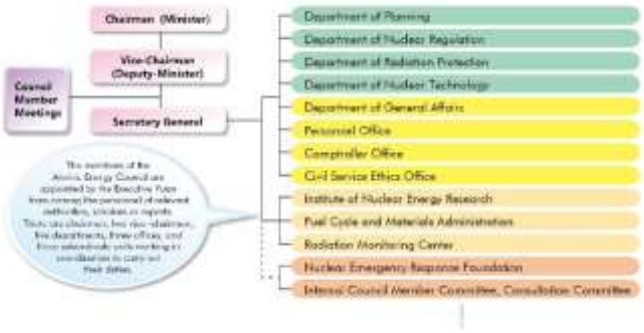
Specific target	Policy guidelines
Promote the decommissioning of NPPs in compliance with the law	■ Improve NPP decommissioning control laws and perfect control laws and systems ■ Strictly review NPP decommissioning permit applications and ensure that the Taiwan Power Company (hereafter "Taipower") has properly planned relevant operations ■ Stringently supervise the implementation of NPP decommissioning operations to ensure that Taipower has performed NPP decommissioning operations in favorable quality and as scheduled ■ Be fully updated about international NPP decommissioning experiences, promote the transmission of relevant experiences and personnel training, strengthen NPP decommissioning execution and control knowledge and skills, and facilitate the safe implementation of NPP decommissioning operations ■ Reinforce the disclosure of NPP decommissioning operation control information and related public information
Continue to promote the selections of sites for establishment of low level radioactive waste final disposal facilities, allowing the Lanyu Storage Site to relocate quickly and smoothly	■ Pursuant to the decision made by the Presidential Office Indigenous Historical Justice and Transitional Justice Committee at the fifth committee meeting in March 2018, we and the Ministry of Economic Affairs are to monitor and guide Taipower in planning and organizing the relocation of the Lanyu Storage Site as soon as possible, with the Nuclear-free Homeland Task Force to oversee the project implementation progress. ■ During the 15th committee meeting in April 2021, the Presidential Office Indigenous Historical Justice and Transitional Justice Committee indicated that the final nuclear waste storage location is a major national issue that should continue to be addressed in the future. ■ We demand that Taipower relocate Lanyu nuclear waste to a centralized storage facility for storage and management by 2029 at the latest, and continue to handle NPP decommissioning and environmental restoration matters. ■ We have asked Taipower to conscientiously promote and revise the low level radioactive waste final disposal plan. Currently, Taipower has already submitted a plan presenting a centralized storage facility. We have approved said plan and demanded that Taipower launch the storage facility by the end of March 2025.

Specific target	Policy guidelines
Promote high level radioactive waste final disposal facility site establishment-related legal operations, assisting the decommissioning of NPPs	■ We approved the Final Disposal Plan for Spent Nuclear Fuel carried out by Taipower. The disposal facilities are scheduled to begin operation in 2055. ■ We plan to develop and promote guidelines for preparing safety analysis reports on spent nuclear fuel final disposal facilities between 2020 and 2025 in order to improve Taiwan's spent nuclear fuel safe disposal capabilities. ■ We are to establish and announce the guidelines for preparing safety analysis reports on spent nuclear fuel final disposal facilities prior to applying for a disposal site license. This allows disposal facility operators to have guidelines to refer to when attaching safety analysis reports in their construction license applications.
Enhance the safety protection of nuclear energy facilities	Nuclear facility operational safety ■ Strictly execute NPP safety review and inspection control operations ■ Demand that NPPs strengthen their natural disaster protection capabilities ■ Ensure that control information is open and transparent ■ Organize international exchanges and connect us to the world Environmental radiation monitoring ■ Introduce national environmental radiation monitoring plans and enhance nuclear facility environmental monitoring mechanisms ■ Carry out automatic national environmental radiation monitoring in real time, integrate wireless communication network technology, and complete radiation safety early warning and monitoring networks and databases Protection enhancement and contingency drills ■ Enhance the protection of crucial infrastructure ■ Central government, local governments, and Taipower jointly hold nuclear emergency exercises ■ NPP emergency planning drills
Promote nuclear waste disposal-related social communication and improve the education on and promotion of creating a nuclear-free homeland	■ Elevate public participation effectiveness via the Committee on Public Participation ■ Expand the means of communication with the public through atomic energy popular science activities ■ Communicate with the residents of the Lanyu area and those living in the vicinity of dry storage facilities

Chapter 3. Organizational Structure and Promotional Mechanisms

1. Organizational Structure

We have one chairman, two vice chairmen, and one secretary general, and our members comprise personnel, scholars, or experts from relevant agencies appointed or hired by the Executive Yuan. We have five departments, three offices, three subsidiary organs (i.e., the Institute of Nuclear Energy Research, Fuel Cycle and Materials Administration, and Radiation Monitoring Center), a Nuclear Emergency Response Foundation, and several task committees (established according to our business needs) that are responsible for jointly promoting our businesses.



Our chairman is responsible for managing council affairs and directing and supervising subordinate units, whereas our vice chairmen and secretary general are responsible for helping the chairmen in handling council affairs. Our departments and offices are roughly divided into business and administrative departments, where the business departments include the Department of Planning, Department of Nuclear Regulation, Department of Radiation Protection, and Department of Nuclear Technology, and the administrative departments include the Secretariat, Personnel Office, Accounting Office, and Government Ethics Office. We have also established the following task committees based on our business needs: the Evaluation Committee on Research and Development Achievements, Advisory Committee on Nuclear Facility Safety, Supervising Committee on Nuclear Safety of the Lungmen Station, Advisory Committee on Ionizing Radiation Safety, Advisory Committee on Radioactive Materials Safety, Advisory Committee on Handling of State Compensation Cases, Advisory Committee on Nuclear Legislation,

Gender Equality Committee, and
Complaints Committee against
Sexual Harassment.

2. Promotional Structure of Our Voluntary Departmental Reviews

To help our internal units compile and combine the resources and results needed to promote public sector voluntary reviews, we use our existing organizational structure to establish the primary responsible units, engage in relevant coordination, integrate overall sustainable development promotion, perform assessment, and compile reports.

We form our promotional mechanisms through the following steps:

(1) Verify the purposes and functions of sustainable groups

To create our Voluntary Departmental Reviews and promote our sustainable development-related endeavors, we formulated the Guidelines for Establishing the Taiwan Sustainable Development Goal Promotional Group. Group operation-related documents were created to achieve our promotional endeavors. The guidelines were discussed and passed during the first promotional group meeting held on April 6, 2021, and were announced via Huizongzi letter No. 1100004411 on April 8, 2021. Guideline details are listed in Table 3.

(2) Establish a clear division of labor and responsibilities within the organization

To implement the aforementioned guidelines, our vice chairman serves as the convener and the supervisors of our departments and offices (including our subordinate units), as well as their proxies, comprise the "promotional group." The promotional group issues work-related commands and unites business and administrative functions together.

Concurrently, we have set up a secretarial unit to assist in preparing agendas, sending out meeting notifications, hosting meetings, recording meeting minutes, and handling other administrative matters; establishing relevant information organization channels and necessary procedures; being fully informed about resolution implementation progress; and compiling ministry-based Voluntary Departmental Reviews.

(3) Practice documentation

We have established regulations to ensure that the aforementioned promotional mechanisms and operations are standardized, and that the promotional results of the various stages are documented and made available to the public.

To make the documents reader-friendly for the target audience, we have created an editorial group. The editorial group contains editors and proofreaders from each administrative unit; each administrative unit sends one to two of its members to serve as editors and proofreaders, ensuring that the documents are concise and easy-to-read.

Table 3. Our Guidelines for Establishing the Taiwan Sustainable Development Goal Promotional Group

Regulation	Description	Special notes
1. To collaborate with the National Council for Sustainable Development in order to promote Taiwan Sustainable Development Goals, we, the Atomic Energy Council (AEC), have formulated the following guidelines.	To formulate the objectives of the guidelines.	The objectives may be adjusted according to the internal needs of the organization.
2. The AEC Taiwan Sustainable Development Goal Promotional Group (hereafter the "promotional group") contains one convener selected from one of our vice chairmen. The promotional group consists of 12-15 members who serve as executive representatives. The members are appointed and recruited from the following units: (1) The executive representatives are the supervisors of our departments and offices (including subordinate units but not our headquarters). (2) When an executive representative is unable to fulfill his/her duties, one of the supervisors from the departments and offices described in the preceding subparagraph will be appointed as an acting executive representative. Promotional group members who are unable to fulfill their duties should be replaced. A list of the promotional group members should be published on the unit's website.	To define the members and number of members of the promotional group.	1. The convener should be the chairman or a vice chairman authorized by the chairman. 2. The number of members in a promotional group may be determined according to the size of the organization. The members should include the departments with authorities over each business operation, and the supervisors of said departments should serve as the executive representatives. 3. The departments included may be listed in Subparagraph 1, Paragraph 1 of this article. 4. The number of people appointed as stipulated in Subparagraph 2, Paragraph 1 of this article may be adjusted according to the sizes of the departments. 5. Paragraph 2 of this article is determined pursuant to the internal sign-off procedure of the organization. 6. The agency can decide whether to publicize Paragraph 3 of this article.

Regulation	Description	Special notes
3. The secretarial unit of this promotional group is the Department of Planning, which is guided and supervised by the convener. The secretarial unit is responsible for the following: (1) Assist in preparing agendas, sending out meeting notifications, hosting meetings, recording meeting minutes, and handling other administrative matters. (2) Compile sustainability-related information. (3) Assist in establishing relevant information organization channels and necessary procedures. (4) Have full knowledge about resolution implementation progress. (5) Compile ministry-based Voluntary Departmental Reviews.	To explain the need to establish a secretarial unit as well as its tasks.	1. The organization appoints one of its departments to serve as the secretarial unit to assist in handling various matters. 2. The tasks of the secretarial unit may be adjusted according to the needs of the organization.
4. The promotional group is responsible for the following tasks: (1) Formulate our blueprint for sustainable development. (2) Compile the organization's internal policies for promoting the Taiwan Sustainable Development Goals. (3) Coordinate and confirm the division of labor concerning the organization's promotion of the Taiwan Sustainable Development Goals. (4) Be fully informed about the progress and results of the organization's promotion of the Taiwan Sustainable Development Goals. (5) Create a culture of organizational sustainability. (6) Cooperate with the National Council for Sustainable Development to promote various sustainable development endeavors.	To define the scope of responsibilities of the promotional group.	1. The name of the organization's blueprint for sustainable development may be customized. 2. The scope of responsibilities may be adjusted according to the needs of the organization.

Regulation	Description	Special notes
5. The different types of meetings convened by the promotional group are explained as follows: (1) Work meetings: Two work meetings are convened per year in principle. Extraordinary meetings may be held when necessary. (2) Coordination meetings: Coordination meetings may be held regularly or irregularly according to the needs of the organization when promoting sustainable development. (3) Meetings listed in Subparagraphs 1 and 2: The meetings are hosted by the convener, who discusses and makes decisions pertaining to the issues addressed in the meetings. When the convener is unable to attend a meeting, a member from the group may be appointed as the acting convener. (4) Meetings listed in Subparagraphs 1 and 2: Related personnel may be invited to attend meetings to offer their opinions, report, or make explanations. (5) Group members should attend meetings in person. When they are unable to do so, they may appoint representatives to attend the meetings, voice opinions, and vote on behalf of the group members.	To stipulate the meeting frequencies and methods.	Meeting frequencies and methods may be adjusted according to the needs of the organization.
6. The members of this promotional group are not compensated. However, experts and scholars invited to meetings may be compensated for traveling and attendance payments pursuant to relevant meeting regulations.	To formulate relevant payment regulations.	Payment regulations may be adjusted according to the agency's regulations.
7. These guidelines shall be promulgated and become effective after being approved by the promotional group at a meeting and submitted to the chairman for ratification. Revisions made to the guidelines shall follow the same procedure.	To establish the guideline implementation and revision procedure.	Guideline formulation and implementation procedure may be adjusted according to the agency's regulations.

Chapter 4: Policy Guidelines and Highlights

A. Policy guidelines

To foster a higher level of voluntary review from the public sector, the Atomic Energy Council (AEC) has been striving to contribute to the Taiwan Sustainable Development Goals. Upon reviewing the status of our engagement in sustainable development, we provide an account of our efforts and results, as well as highlights from promoting sustainability.

As the competent authority for atomic energy safety in Taiwan, we exercise stringent regulatory control over nuclear safety and radiation safety, implement emergency response mechanisms, and carry out environmental monitoring. We also devise appropriate radioactive waste management and actively address safety issues concerning nuclear power plant decommissioning and radioactive waste management. In addition, we also strive to promote technological research and innovation to enhance the well-being of people.

"Nuclear safety and security" and "nuclear waste disposal" are not only our key focuses but also the endeavor and responsibilities across generations. Our chief contribution to the Taiwan Sustainable Development Goals lies in Goal 18: "Building a nuclear-free homeland." The following is an account of our engagement, as well as highlights from our undertaking in achieving each of the five specific objectives under the core goal.

B. Promoting the decommissioning of nuclear power plants

(1) Challenges and opportunities

Taiwan's Basic Environment Act that came into force in 2002 sets the policy goal of achieving a nuclear-free homeland in a progressive manner. In addition, the Nuclear Reactor Facilities Regulation Act stipulates that nuclear power plants shall cease operation upon the expiration of their operating licenses. Therefore, when their respective operating licenses expire, Chinshan, Kuosheng, and Maanshan Nuclear Power Plants (NPPs) will cease operation and enter the decommissioning stage in accordance with the law. Facing the decommissioning of nuclear power plants for the first time, our chief mission at this stage, as well as our main policy direction going forward, is to carry out decommissioning projects in a progressive and safe manner in accordance with decommissioning plans, so as to achieve the goal of a nuclear-free homeland, ensure environmental sustainability, and, ultimately, protect public health and environmental safety.

(2) Policy guidelines and objectives

To foster the gradual completion of nuclear power plant decommissioning and ensure the safety of decommissioning projects, as the competent authority for regulatory control over nuclear safety, we will rigorously review Taipower's nuclear power plant decommissioning plans to ensure that the planning for

decommissioning has been appropriately devised. We will also perform various radiation surveys during the decommissioning phase, review operational plans for decontamination and dismantling, and carry out on-site inspections. These efforts are made to ensure that Taipower has drawn up execution plans for, and carried out, all relevant decommissioning operations in accordance with the decommissioning plans and their timelines, and that Taipower has properly carried out radiation protection measures, spent nuclear fuel and radioactive waste management, environmental radiation monitoring, and project management during decommissioning, so as to safeguard the health of the public and protect the environment.

The following is a summary of our objectives and actions in terms of safety regulatory control, supervision and monitoring, technical competency, and information disclosure and public participation:

1/ Improving nuclear power plant decommissioning regulations and refining regulatory control systems

Taiwan has established a comprehensive regulatory control system for the safety of decommissioning nuclear power plants. The regulatory basis for the safety control of decommissioning consists of our Nuclear Reactor Facilities Regulation Act, Ionizing Radiation Protection Act, and Nuclear Materials and Radioactive Waste Management Act, as well as the Basic Environment Act under the Environmental Protection Administration (EPA). In addition, the transportation and disposal of industrial waste and the radiation safety and industrial safety concerning dismantling personnel during decommissioning must also be conducted following the relevant laws and regulations of respective competent authorities. The following is a summary of laws and regulations, enforcement rules, sub-laws, and administrative rules for implementation under the AEC:

a/ Article 23 of the Nuclear Reactor Facilities Regulation Act, the main statute governing decommissioning safety, stipulates that decommissioning nuclear power plants shall sufficiently ensure the health and safety of the public and shall comply with relevant statutory provisions in terms of environmental protection, ecological conservation, radiation protection, and radioactive materials management. Therefore, decommissioning nuclear power plants must also comply with relevant provisions under the Ionizing Radiation Protection Act, the Nuclear Materials and Radioactive Waste Management Act, and the Basic Environment Act.

b/ The Enforcement Rules for the Implementation of the Nuclear Reactor Facilities Regulation Act stipulate the manner in which decommissioning shall be executed, the requirements for the issuance of decommissioning permits, the deadline for the completion of decommissioning, and the acceptance level of radiation dose at the site after decommissioning.

c/ The Regulations on the Permit Application and the Management for Decommissioning of Nuclear Reactor Facilities, formulated under the provisions of the Nuclear Reactor Facilities Regulation Act, provide guidelines in terms of document requirements and review procedures

for applications for decommissioning permits, compliance requirements during decommissioning, including control requirements for spent nuclear fuel prior to its complete removal from the plant, and document requirements for the application for the lifting of regulatory control after the completion of decommissioning.

d/ We have also formulated administrative rules, including the Guidelines for Decommissioning Plans for Nuclear Reactor Facilities and the Guidelines for the Review of Decommissioning Plans for Nuclear Reactor Facilities, which serve as the basis for Taipower in devising decommissioning plans and for us in conducting reviews, respectively.

2/ Rigorously conducting reviews on applications for decommissioning permits to ensure appropriate planning by Taipower

According to the Nuclear Reactor Facilities Regulation Act, the operator of a nuclear reactor facility shall submit an application for a decommissioning permit three years prior to the expiration of the operating license to us by completing the application form and attaching a decommissioning plan for its review. To ensure the comprehensive review of decommissioning plans for nuclear power plants, we take the following actions:

a/ Setting up a review panel to systematically conduct professional reviews:

Experts and academics in relevant fields are recruited to form a review panel with our colleagues. From technical, safety management, and human resources aspects, the review panel conducts a rigorous review on areas of fuel safety, radiation protection and environmental safety, radioactive waste management, operational safety and emergency response, human resource and organizational management, and financial planning to ensure that all operations and key items involved in decommissioning have been appropriately planned with clear instructions.

b/ Setting up a tracking mechanism for key decommissioning activities:

Important control items related to nuclear safety, radiation safety, waste materials safety, operational safety, and personnel organization management during subsequent decommissioning and technical execution matters such as dismantling, decontamination, radiation survey, etc., as well as construction for facilities necessary for the storage of radioactive waste, are devised for tracking purposes. We will also request Taipower to submit an overall planning and manpower assessment prior to any organizational and manpower change in all phases during decommissioning.

3/ Closely supervising the implementation of decommissioning to ensure Taipower's timely and quality execution of all decommissioning operations

Upon obtaining the decommissioning permit from us, the nuclear power plant must carry out relevant operations in accordance with the decommissioning plan approved by us. We will also closely monitor all decommissioning operations during the decommissioning phase to ensure that

Taipower complies with the decommissioning plan and properly manages spent nuclear fuel safety, radiation protection, radioactive waste, environmental radiation monitoring, personnel training, and construction projects within the scheduled time frame and with expected quality results, so as to safeguard the health of the public and protect the environment. Regulatory control measures taken are summarized below:

a/ Rigorously reviewing detailed plans for decommissioning operations:

Taipower is required to submit detailed planning for decontamination, dismantling, and radiation surveys to us for our review prior to the commencement of relevant operations. We will conduct reviews on the appropriateness of measures to be adopted, operational safety, radiation protection, and radioactive waste reduction and management to ensure compliance with safety requirements.

b/ Tracking decommissioning progress and relevant control items:

Taipower is required to submit annual reports on the implementation of the decommissioning plan and half-yearly reports on the handling of important control items in the decommissioning plan. These reports will then be examined in detail by us to ensure Taipower's compliance with the decommissioning plan in carrying out dismantling and other related projects and safety management within the scheduled time frame.

c/ On-site verification conducted by our inspectors:

During the decommissioning period, we will continuously send inspectors to carry out resident inspections and project inspections. For specific decommissioning operations, project inspection teams will be sent to monitor the implementation progress on-site, as deemed necessary, to ensure compliance with the decommissioning plan and safeguard decommissioning operations.

4/ Acquiring international experience in decommissioning, promoting the passing on of experience and personnel training, and building the know-how on decommissioning implementation and control to facilitate the execution and safety of decommissioning

Like other projects, the decommissioning of nuclear power plants is a comprehensive project that involves technical expertise, planning and management, and human resources. Confronted with 20-year-long decommissioning timelines, both we and Taipower should be committed to passing on our experiences and nurturing our personnel. In this regard, we have adopted the following measures from the perspectives of external control and internal management:

a/ In the decommissioning plan, Taipower is required to provide planning specifications on professional skills, manpower qualifications and training requirements, and the corresponding organizational structure for long-term decommissioning operations. To ensure that Taipower is equipped with sound decommissioning expertise and appropriate organizational and human resource management for the safe and smooth implementation of decommissioning, we request

Taipower to actively research and understand international decommissioning experiences in terms of key technologies and the human resources required for radiation surveys and decommissioning, dismantling, and decontamination. Subsequently, Taipower is also expected to properly carry out knowledge management for decommissioning expertise, pass on experience, and implement personnel training.

b/ In addition to engaging in exchanges with the nuclear safety regulatory authorities of other countries and international nuclear energy organizations, we also actively participate in or organize international decommissioning conferences and decommissioning safety control and technical training sessions in order to extensively gather information on international experience in decommissioning, dismantling, and decontamination, radiation survey technologies, and safety planning and management, which, in turn, are used in developing and strengthening our capabilities in decommissioning safety control and quality.

5/ Enhancing information disclosure and public involvement in the regulatory control of decommissioning

Nuclear power plant decommissioning will certainly be the focus of public attention and concern; consequently, we will actively communicate with the public in the spirit of "the AEC of the people" and take the following actions:

a/ Strengthening information disclosure:

We have created a designated section on our official website for nuclear power plant decommissioning, where information on decommissioning safety and regulatory control and public participation is made available for public access.

b/ Enhancing public participation:

During the review of a decommissioning plan, letters are sent to the corresponding local administrations of the nuclear power plant for comments on the decommissioning plan, local briefing sessions and visits are organized, and local opinion leaders are called on. These efforts are made to gain access to public opinions, which will then serve as reference for regulatory control. We have also established the Committee on Public Participation, which invites experts, academics, impartial social representatives, and representatives of civil groups to give advice on matters related to our scope of operation.

(3) Rigorous review and future planning

In handling the first nuclear power plant decommissioning in Taiwan and the corresponding regulatory control for safety, we have taken relevant actions in terms of sound regulatory legislation, supervision and enforcement, and technical knowledge of personnel. However, given the long timelines for the decommissioning of nuclear power plants that will take 25 years, let alone the first decommissioning operation in Taiwan, continuous efforts will be made in learning from and advancing

with international experiences in terms of regulatory review and decommissioning practices that are subject to change due to the progress in nuclear power plant decommissioning and experiences accumulated. It is also important to be prepared for the passing on of experiences, which is necessary due to personnel retirement. We will build on the existing foundation and take the following refined measures to fully achieve effective regulatory control.

1/ Conducting rolling reviews to refine decommissioning regulations and control practices:

We will continuously research nuclear power plant decommissioning regulations, safety audit, and control experiences both from advanced countries and Taiwan, while using them as a basis for rolling reviews on regulations and control practices under our competence. For example, the experiences from reviewing the decommissioning plans of Chinshan and Kuosheng NPPs can be fed back to the review of the Maanshan NPP decommissioning plan, i.e., giving appropriate regulatory feedback in a parallel manner while taking into account the characteristics of each plant.

2/ Continuous efforts in gathering and exchanging international experiences and developing talents:

We remain committed to exchanging experiences with international nuclear safety authorities and nuclear energy organizations, gathering international experiences in decommissioning control and technologies, keeping abreast of developments, and organizing conferences and professional training sessions to strengthen and enhance the know-how of our staff in decommissioning regulatory control.

(4) Highlights from the undertaking

1/ Researching and deliberating on decommissioning safety regulations to refine our regulatory control

Taking into account the decommissioning control practices and progress of nuclear reactor facilities in advanced countries, as well as the practical experience derived from reviewing the decommissioning plan for Chinshan NPP, we conducted successive and comprehensive reviews in 2018 through to 2020 on the legislative intent of decommissioning safety regulations, application and review procedures for decommissioning permits, the transition between the expiration of operating licenses and the issuance of decommissioning permits, on-site safety control during decommissioning, and the control procedures of plant sites after the termination of decommissioning. In 2018, we completed the amendments to the Enforcement Rules for the Implementation of the Nuclear Reactor Facilities Regulation Act, the Regulations on the Permit Application for the Decommissioning of Nuclear Reactor Facilities, and Standards of Fees for Regulatory Services under the Nuclear Reactor Facilities Regulation Act, as well as renamed the Regulations on the Permit Application for the Decommissioning of Nuclear Reactor Facilities to the Regulations on the Permit Application and the Management for Decommissioning of Nuclear Reactor Facilities, making regulations and statutory provisions governing Taiwan's nuclear power

plant decommissioning safety more comprehensive and robust. Building on the experiences gained from amending the aforementioned regulations, reviewing the Chinshan NPP decommissioning plan, and the actual practices of regulatory control, we completed the revisions of the Guidelines for Decommissioning Plans for Nuclear Reactor Facilities and the Guidelines for the Review of Decommissioning Plans for Nuclear Reactor Facilities in 2019 and added provisions regarding violations during decommissioning to the Guidelines for Handling Violations at Nuclear Facilities in 2020, so as to strengthen regulatory control on nuclear facilities during decommissioning.

We remain committed to paying close attention to the development of international regulatory control of decommissioning and gathering experiences from regulatory control practices for future reference in refining regulatory frameworks.

2/ Conducting rigorous reviews on nuclear power plant decommissioning plans: issuing a decommissioning permit for the Chinshan NPP and reviewing the Kuosheng NPP and Maanshan NPP decommissioning plans to move forward towards a nuclear-free homeland

Upon receiving Taipower's decommissioning permit applications and the decommissioning plans for Chinshan and Kuosheng NPPs in November 2015 and December 2018, respectively, we set up review panels consisting of our specialists, experts, and academics in related fields of nuclear safety, radiation protection, radioactive waste management, emergency response, and quality assurance. The review panels, divided into different groups on the basis of the chapter divisions of the decommissioning plans and the expertise of the members of the panels, conducted rigorous reviews on the Chinshan and Kuosheng NPP decommissioning plans and carried out on-site surveys; after three rounds of group review meetings and joint, comprehensive review meetings, conclusions from the reviews were made.

The decommissioning plan for Chinshan NPP was approved in June 2017 upon confirmation that appropriate planning for decommissioning had been proposed. On July 4, 2019, Taipower submitted the environmental impact assessment and related information approved by the EPA for our review. Upon confirming that the decommissioning planning for Chinshan NPP complied with the provisions of Article 23 of the Nuclear Reactor Facilities Regulation Act, we issued a decommissioning permit for Chinshan NPP on July 12, 2019, which came into effect on July 16th of the same year. Taipower is required to complete the decommissioning operations within 25 years from the effective date of the decommissioning permit so that the plant site can be restored and reused. On October 20, 2020, we also approved the decommissioning plan for Kuosheng NPP. Subsequently, Taipower is to submit an environmental impact assessment and related information when it is approved by the EPA. Upon confirming its compliance with the provisions of Article 23 of the Nuclear Reactor Facilities Regulation Act, we will proceed with the issuance of a decommissioning permit. Figure 1 below is the closing meeting for the review of the Kuosheng NPP decommissioning plan convened by us; Figure 2 is an on-site visit by the review committee for the Kuosheng NPP decommissioning plan.

The operating licenses of Units 1 and 2 in the Maanshan NPP will expire on July 27, 2024 and May 17, 2025, respectively. Pursuant to the Nuclear Reactor Facilities Regulation Act, Taipower is to submit decommissioning permit applications three months prior to the units' scheduled permanent operation terminations. We have received the Maanshan NPP's decommissioning permit application on July 26, 2021, and reviewed such application on August 23 of the same year. Our review results showed that Taipower has submitted the application documents in full and met the application requirements. Hence, our substantive reviews officially began.

Prior to our substantive reviews, we convened a preparatory meeting for the Maanshan NPP decommissioning plan substantive review via video conferencing on August 18, 2021, where we invited the reviewers of this plan and internal review personnel to discuss Maanshan NPP decommissioning plan substantive review-related planning and issues.

The review team conducting the substantive reviews comprised our employees as well as external scholars and experts, who reviewed key project items such as decontamination and dismantling methods adopted, radiation protection and environmental radiation monitoring, waste management, organizational and personnel training, emergency responses, and fuel safety. The reviews will take approximately 18 months and are scheduled to be completed by the end of February 2023. However, actual review duration may change according to Taipower's responses to our review opinions and the quality of its responses.

The substantive reviews consist of three review rounds and a summary of the three review rounds. The first round of review is scheduled to take place from August 23, 2021 to January 22, 2022. On November 15, we held a joint review meeting, explaining to the review team and committee members major review findings from the various chapters of the Maanshan NPP decommissioning plan. On November 25, we issued a formal letter to Taipower requesting for its replies.

Figures 3 and 4 show the preparatory meeting held by us for the Maanshan NPP decommissioning plan (committee members participated in the meeting via video conferencing).

Figure 1: The closing meeting for the review of the Kuosheng NPP decommissioning plan convened on September 8, 2020

Figure 2: An on-site visit by our review committee for the Kuosheng NPP decommissioning plan on September 7, 2020

Figure 3. On August 18, 2021, we held the preparatory meeting for the Maanshan NPP decommissioning plan substantive review (1).

Figure 4. On August 18, 2021, we held the preparatory meeting for the Maanshan NPP decommissioning plan substantive review (2).

3/ Feedback on the review experience of decommissioning plans

When we received Taipower's decommissioning permit application and decommissioning plan for Kuosheng NPP in 2018, we were able to apply our experience gained from reviewing the Chinshan NPP decommissioning application to the preparation and actual review of the Kuosheng NPP decommissioning plan, including:

a/ Conducting preliminary planning prior to the review on the Kuosheng and Maanshan NPP decommissioning plans:

To enhance the quality and efficiency of the review process for nuclear power plant decommissioning plans so that the review may be completed following timeline and quality requirements, we took the initiative of conducting preliminary work prior to Taipower's formal

submission of the Kuosheng and Maanshan NPP decommissioning plans, including setting up review panels, conducting preparatory investigations on the basis of the draft of the decommissioning plans, and organizing training sessions for internal staff to ensure the smooth completion of the review on the decommissioning plans.

b/ When we completed our review on the Kuosheng NPP decommissioning plan in October 2020, we requested Taipower to examine the 33 important control items on the basis of their applicability and provide feedback to the Chinshan NPP decommissioning plan, as well as to the Maanshan NPP decommissioning plan scheduled for submission in July 2021.

4/ Strictly conducting the review on the dismantling plan for Chinshan NPP and on-site verifications

The decommissioning permit for Taipower's Chinshan NPP came into effect on July 16, 2019. At the beginning of the decommissioning phase, spent fuel still had to be temporarily stored in the reactor since the dry storage facilities were not yet operational. Consequently, the decommissioning work was performed by focusing on the areas of the decommissioning plan that do not involve the safety of fuel storage in the core. In October 2019, Taipower started to submit dismantling plans for the contact tower, which only has power output functions, the gas turbine plant, which is the intended site for indoor dry storage facilities, and the main steam engine and other equipment. Depending on the scale of dismantling and issues involved, we also recruited external experts and academics to form a task force with our specialists to rigorously review the dismantling plans proposed by Taipower. To date, we have reviewed and approved the detailed plans for the dismantling of the contact tower, gas turbine plant, and main turbine equipment. The contact tower was dismantled in January 2020, whereas the gas turbine plant and equipment were dismantled in early October 2020 following our review and approval. The overall dismantling operations are scheduled to be completed in early 2022. As for the review of the main turbine equipment dismantling plan, we completed it in late September 2021, and Taipower is currently doing the dismantling-related preliminary work in accordance with the plan.

To ensure Taipower's compliance with the plans in performing the dismantling projects, we also sent inspectors to perform on-site inspections and supervise operational safety. Figures 5 to 9 show the review meeting (via video conferencing) for the Chinshan NPP turbine plant equipment dismantling plan and our inspectors verifying the dismantling work of the gas turbine plant at Chinshan NPP.

Figure 5. Our review team performing an on-site inspection at the Chinshan NPP turbine plant and equipment dismantling site on March 12, 2021 (a)

Figure 6. Our review team performing an on-site inspection at the Chinshan NPP turbine plant and equipment dismantling site on March 12, 2021 (b)

Figure 7. Our review team convening a review meeting (via video conferencing) for the Chinshan NPP turbine plant and equipment dismantling plan on August 12, 2021

Figure 8. Our inspectors verifying the dismantling work of the gas turbine plant at Chinshan NPP on October 18, 2021

Figure 9. Our inspectors verifying the waste radiation measurement operations performed for the dismantling of the Chinshan NPP gas turbine plant on October 18, 2021

5/ Engaging in international exchanges, drawing on decommissioning experiences, and strengthening the know-how of decommissioning safety control

To ensure that Taiwan's regulatory control technologies, expertise, and capabilities regarding decommissioning safety are in line with international standards and to facilitate the smooth promotion and implementation of the nuclear-free homeland policy through proper decommissioning safety control, we have continuously engaged in collaboration and exchanges with international nuclear regulatory authorities and nuclear energy organizations, actively participated in or held conferences on international decommissioning technologies, and sent our staff to participate in professional programs offered by international organizations or conducted decommissioning courses, so as to learn from international experiences and to strengthen our know-how in decommissioning technologies and regulatory control.

We have signed the Agreement on TECRO-AIT Joint Standing Committee Meeting on Civil Nuclear Cooperation with the U.S. and the Taiwan-Japan Memorandum of Understanding for the Exchange of Regulatory Information on Nuclear Safety with Japan, while regularly holding the Taiwan-U.S. Bilateral Technical Meetings and the AEC-NRA Nuclear Regulatory Information Exchange Meetings to exchange and share experiences on the regulatory control of decommissioning safety. In recent years, we also attended the international conferences on nuclear decommissioning hosted by the Nuclear Energy Agency of the Organisation for Economic Co-operation and Development (OECD/NEA) and meetings held by the Working Party on Management of Materials from Decommissioning and Dismantling (WPDD). In addition, we also held decommissioning conferences, such as Taiwan-U.S. Conference on Nuclear Power Plant Decommissioning Review and Regulations, Taiwan-Japan Conference on the Exchange of Nuclear Power Plant Decommissioning Technology, and exchange forums on nuclear power plant decommissioning technology, inviting international experts to Taiwan to share their experiences, as

well as making them accessible for the participation of the private, public, and academic sectors, and the public, so as to strengthen Taiwan's regulatory and technical capabilities in decommissioning safety. We also sent staff to the U.S. and Japan to partake in courses and practical training sessions on decommissioning radiation surveys and decommissioning, dismantling, and decontamination techniques offered by professional institutes and to visit decommissioning nuclear power plants to learn about decommissioning activities on-site. At the same time, we also held training courses on post-decommissioning site radiation dose assessment, radiation characteristics investigation, and radiation detection. We have been striving to learn from the experiences of countries around the world in decommissioning technologies and regulatory practices to improve our technical and regulatory capabilities in decommissioning safety. In 2021, because of COVID-19, live international exchanges decreased in number. However, related information was still exchanged online and via video conferencing.

Figures 10 to 13 are photos taken from exchange meetings with international regulatory bodies, an expert keynote speech, and an on-site visit to a decommissioning nuclear power plant.

Figure 10: A Taiwan-U.S. Bilateral Technical Meeting

Figure 11: An AEC-NRA Nuclear Regulatory Information Exchange Meeting

Figure 12: A keynote speech on radiation dose assessment

Figure 13: An on-site visit to a decommissioning nuclear power plant in Japan

6/ Fostering public participation and information disclosure for regulatory control during decommissioning

We have continued to promote public participation. After receiving Maanshan NPP's decommissioning plan, we referenced our previous experiences in reviewing the Chinshan and Kuosheng NPP decommissioning plans, and sent letters to local governments and relevant agencies to collect their opinions. We also visited local township offices, village heads, and local residents to explain the decommissioning plan review situations. Concurrently, we invited legislators, civic groups, and local residents to participate in our local briefing sessions held in Hengchun Township, Pingtung County. The goals were to, through mutual opinion exchanges, allow local villagers to fully understand Taipower's Maanshan NPP decommissioning plan and our review operations; allow us to actively solicit/listen to the opinions and suggestions of the public/local residents, and incorporate these opinions and suggestions into our reviews; and enable local villagers to participate in the decommissioning plan review process, and us to provide a more diverse and complete review process. Concerning matters involving other units, they are forwarded to relevant units to be handled, so as to achieve the goals of collecting public opinions and realizing public participation. Additionally, we built an NPP decommissioning section on our external website, disclosing information such as the Maanshan NPP decommissioning plan and related public participation to the world, thereby realizing information disclosure.

Figures 14 and 15 show us visiting the Hengchun Township Office and hosting the decommissioning plan local briefing session, respectively. Figures 16 and 17 are the public webpage disclosing decommissioning information.

Figure 14. We visiting the Hengchun Township Office director on October 12, 2021

Figure 15. We hosting the Maanshan NPP decommissioning plan local briefing session on November 3, 2021

Figure 16. NPP decommissioning control section on our official website

Figure 17. NPP decommissioning permit application review page on our official website

7/ Strengthening regulatory control on nuclear power plant dry storage plans

According to Taipower's Program Plan for the Final Disposal of Spent Nuclear Fuel (2018 Revision), the three nuclear power plants are estimated to be generating about 22,210 bundles of spent nuclear fuel, totaling about 4,997 metric tons of uranium, over 40 years of operation.

Taiwan has adopted "spent fuel pool storage for the near term, dry storage on-site for the medium term, and final deep geological disposal for the long term" as its management strategy for spent nuclear fuel. With Taiwan's three nuclear power plants entering the decommissioning phase successively, the primary task for nuclear power plant decommissioning is to transfer spent nuclear fuel in nuclear reactors and spent fuel pools to dry storage facilities, following which subsequent decommissioning and dismantling of the plants may proceed. Therefore, dry storage facilities are

fundamental for the decommissioning of nuclear power plants.

Taiwan's Nuclear Materials and Radioactive Waste Management Act imposes strict safety requirements for dry storage facilities, including conformity with international conventions, adequate equipment and facilities to safeguard the health and safety of the public, compliance with related statutory provisions in terms of environmental and ecological impact, and sufficient technical and management capabilities and financial base of the applicant for the competent operation of its facilities; only when the aforementioned criteria are met can the construction and operation of the facilities be allowed to proceed. We adopt a strict, two-stage review system for the construction license and operating license of dry storage facilities (Figure 18) and perform safety and quality inspections during the construction, commissioning, and operation of the facilities to ensure the safety of spent nuclear fuel storage. During the application stage of a construction license, we hold public hearings to listen to the opinions and suggestions from various sectors and parties. Moreover, to enhance the openness and transparency in regulatory control, we invite the public to participate in regular visits during the construction and commissioning phases of the facilities, so that the public can gain a clear understanding of facility safety. The radiation dose limit at the plant boundaries of dry storage facilities is designed at no greater than 0.05 mSv per year, which is one-twentieth of the annual dose limit for the general public, to ensure public safety and environmental quality (Figure 19).

In September 2013, we approved Taipower's application to perform the thermal testing of Phase I dry storage facility at Chinshan NPP; the thermal testing, however, has not been carried out due to the lack of a certificate of completion of soil and water conservation yet to be issued by New Taipei City Government. As for the Phase I dry storage facility at Kuosheng NPP, we issued our construction license in August 2015; the construction for the facility, however, has not commenced yet due to the absence of approval for the construction site's water pollution abatement plan by New Taipei City Government. The commissioning of Phase I dry storage facilities will facilitate the removal of spent nuclear fuel from nuclear reactors. We have requested that Taipower strengthen its communication with local governments for the earliest commissioning of Phase I dry storage facilities.

Indoor storage has become the consensus of the society. Consequently, we have requested Taipower to adopt indoor storage for Phase II dry storage facilities at the Chinshan and Kuosheng NPPs, and to adopt indoor storage for storage facilities at the Maanshan NPP. Relevant facility construction projects for the Chinshan, Kuosheng, and Maanshan NPPs have been approved by the Executive Yuan in August 2019, April 2021, and October 2021, respectively. We will continue to supervise Taipower to actively push forward facility construction, complete and adopt indoor dry storage at the Chinshan, Kuosheng, and Maanshan NPPs during the decommissioning plan downtime, strengthen public communication, and facilitate information disclosure so as to smoothly implement NPP decommissioning.

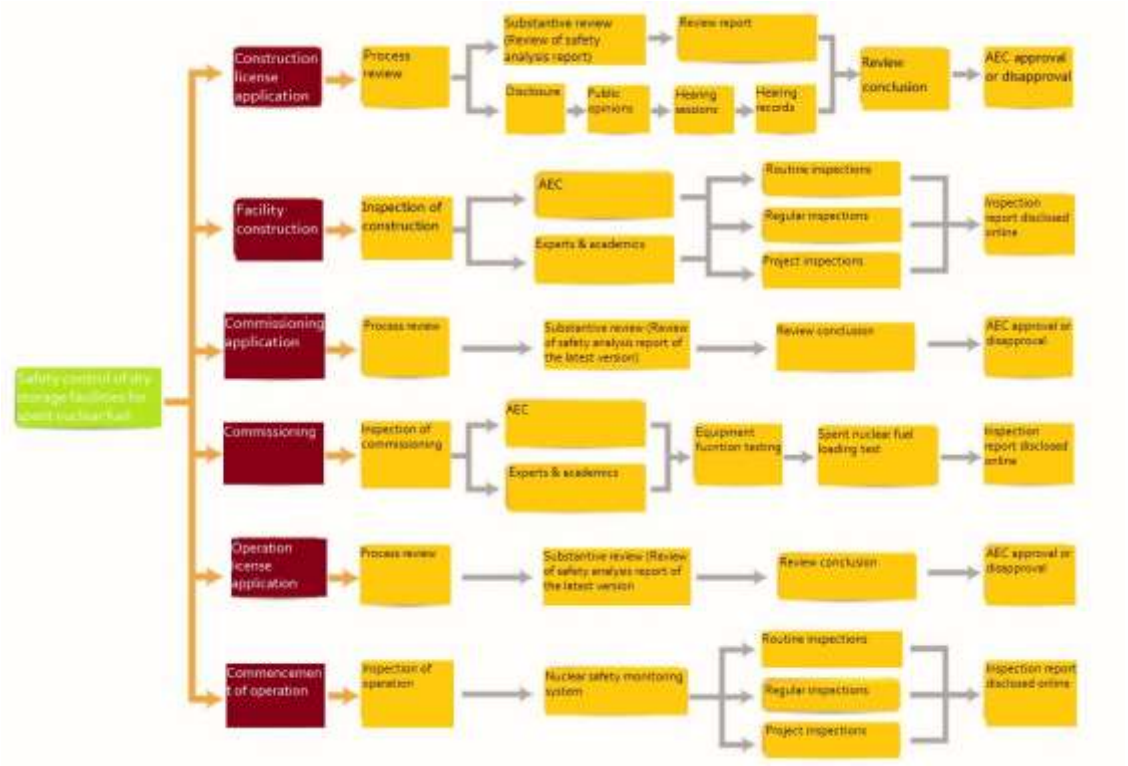


Figure 18: Safety control procedures of dry storage facilities for spent nuclear fuel

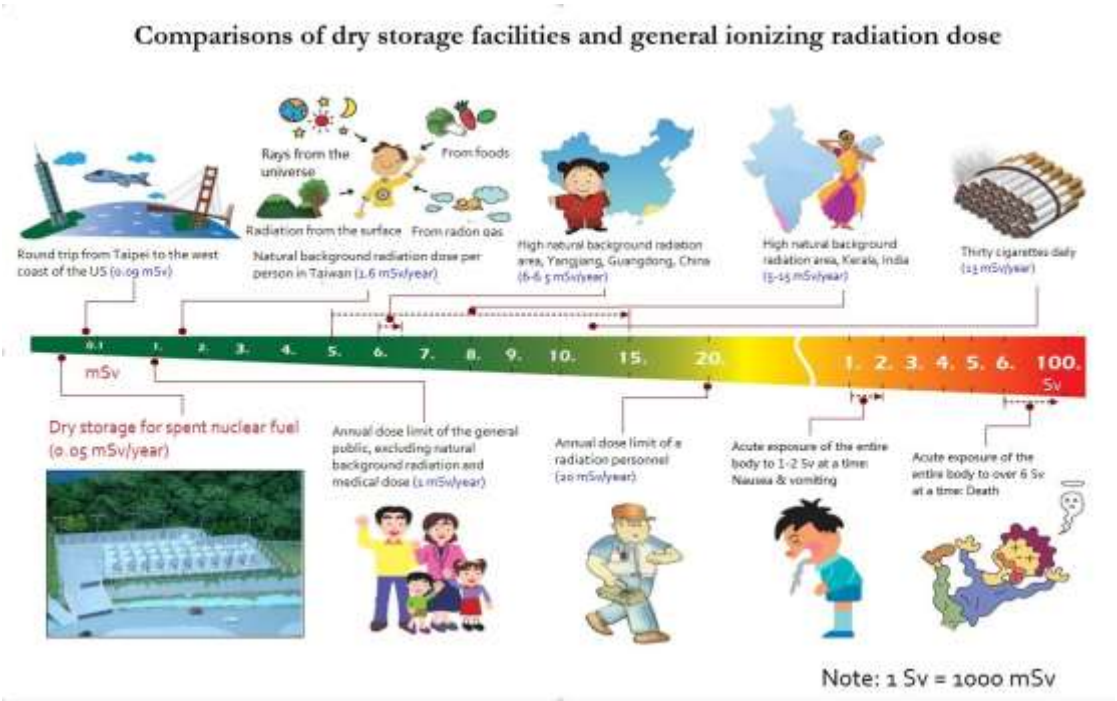


Figure 19: Comparisons of dry storage facilities and general ionizing radiation dose

8/ Conducting strict regulatory control on decommissioning plans for radioactive materials facilities at Chinshan NPP

Chinshan NPP has entered the decommissioning phase, and decommissioning planning for related radioactive materials facilities has also started. Upon our approval of the waste removal and trench cleanup plan for Chinshan NPP in March 2019, Taipower began the cleanup operation immediately. We also sent inspectors to conduct timely audits of the cleanup operation at Taipower facilities to ensure compliance of the processes with the plan. As of March 2021, relevant operations at Chinshan NPP were completed, and the Report on the Completion of Waste Trench Decommissioning at Chinshan NPP was submitted in accordance with the law. To confirm Taipower's compliance with statutory provisions in the cleanup operation, we conducted several on-site audits of the decommissioning results and took samples for comparisons to ensure that the operation met the requirements of zero accidents and zero radiation incidents during the entire process and that the operation was completed within the timeline and quality framework. The completion report on the decommissioning is still under review. After its approval, the waste trenches (Figure 20) at Chinshan NPP will be used as the planned site for the Phase II indoor dry storage facility to facilitate the implementation of the decommissioning plan for Chinshan NPP.

Figure 20: Waste trenches at Chinshan NPP

Since Chinshan NPP has entered the decommissioning phase, its nuclear fuel storage facilities are no longer in use. For better flexibility in utilizing the plant space, Taipower formulated a decommissioning plan for nuclear fuel storage facilities at Chinshan NPP, which was approved by us in January 2021. During the decommissioning of the facilities, we conducted strict inspections to ensure that the requirements of the decommissioning plan were met. The decommissioning of the facilities at Chinshan NPP was completed in March 2021, following which a report on the completion of decommissioning was submitted. Upon the completion of the decommissioning, we performed on-site inspections of the facilities and took samples for comparisons to ensure Taipower's compliance with statutory provisions in carrying out the decommissioning operation. The report on the completion of decommissioning is currently under review. After the lifting of regulatory control, the nuclear fuel storage facilities at Chinshan NPP will be converted to general warehouse use. Such a method makes use of decommissioned NPPs, adding more flexibility to

decommissioning plans.

C/ Continuous endeavor in conducting site selection for the Final Disposal Facility for Low-Level Radioactive Waste to ensure the smooth and timely relocation of the Lanyu Storage Site

(1) Challenges and opportunities

1/ In compliance with the instructions from the Executive Yuan, we initiated the Lanyu Storage Site Construction Project in 1978, entrusting Taipower to take over all subsequent construction responsibilities. Phase I of the project was completed in 1982, after which the Lanyu Storage Site began collecting waste drums from the Chinshan NPP. The storage site contains 23 storage trenches and has received 97,672 drums of low-level radioactive solidified waste between 1982 and 1996. To ensure safe waste storage, Taipower performed waste drum inspections from 2007 to 2011, increasing the number of storage drums slightly to 100,277 after the inspections.

2/ Taipower began the planning for low-level radioactive waste disposal facilities in July 1990; it set up the Candidate Site Selection Committee in February 1993 and completed "area screening" in May 1993. In August 1996, it issued a call for candidate sites following a voluntary approach. Starting from February 1998, Taipower has carried out evaluation and selection processes through the Candidate Site Selection Committee and the Site Evaluation Task Force; however, no suitable site has been selected.

3/In June 2006, based on the Act on Sites for Establishment of Low-Level Radioactive Waste Final Disposal Facility, the Ministry of Economic Affairs (MOEA) designated Taipower as the site selecting operator to conduct site selection. According to the plan for low-level radioactive waste disposal facilities currently in effect, Taipower should complete the site selection process for low-level radioactive waste disposal facilities by March 2016; however, this task was not completed in accordance with the timeline. In response to the failure to select a candidate site for low-level radioactive waste disposal facilities within the timeframe, Taipower submitted a contingency plan for a centralized storage facility, which was approved by us. The centralized storage facility is required to be operational by the end of March 2025 to solve the issue of radioactive waste.

4/ To promote the relocation of the Lanyu Storage Site, the Executive Yuan set up the Executive Yuan Committee for the Promotion of the Relocation of the Lanyu Storage Site as early as May 2002. In a Committee meeting in December 2005, Taipower proposed an 18-year relocation timeline plan that is further divided into two five-year and two four-year time frames, specifying that when the final disposal facility is completed, the relocation of the Lanyu Storage Site will commence.

5/ Taipower was unable to select a site before March 2016. To foster the relocation of the site, we approved Taipower's Planning Report on the Relocation of the Lanyu Storage Site in February 2017 and requested that the nuclear waste at Lanyu be relocated to a centralized storage and management facility by 2029 at the latest, following which the decommissioning and environmental restoration of the site should be carried out.

6/ The Executive Yuan Nuclear-Free Homeland Task Force Committee has requested Taipower to promote the construction of a medium-term temporary storage facility for radioactive waste and asked the MOEA and Taipower to actively review the communication mechanisms with the public for the selection of nuclear waste facilities, strengthen consultation with local governments, and communicate with local residents.

(2) Policy guidelines and objectives

1/ At the fifth meeting of the Presidential Office Indigenous Historical Justice and Transitional Justice Committee held in March 2018, it was decided that we and the MOEA should jointly supervise Taipower to plan and handle the relocation of the Lanyu Storage Site as soon as possible and that the Nuclear-Free Homeland Task Force should manage the progress.

2/ During the 15th meeting held in April 2021, the Presidential Office Indigenous Historical Justice and Transitional Justice Committee indicated that the final nuclear waste storage location is a major national issue that should continue to be addressed in the future, and that the Ministry of Economic Affairs should invite Tao people to participate when hosting relevant discussions.

3/ In February 2017, we approved Taipower's Planning Report on the Relocation of the Lanyu Storage Site and requested that the nuclear waste at Lanyu be relocated to a centralized storage and management facility by 2029 at the latest, following which the decommissioning and environmental restoration of the site should be carried out.

4/ We have requested Taipower to revise the Plan for the Final Disposal of Low-Level Radioactive Waste and to closely follow the timeline of the plan to properly dispose of nuclear waste. Following its failure to select a candidate site for a low-level radioactive waste disposal facility within the time frame, Taipower submitted a contingency plan for a centralized storage facility, which was approved by us. The centralized storage facility is required to commence operation by the end of March 2025 to solve the predicament of nuclear power plant decommissioning and nuclear waste disposal.

(3) Rigorous review and future planning

1/ The predicament Taiwan is facing regarding nuclear waste disposal lies in the difficulties in communicating with the public and selecting a site for nuclear waste disposal. Intransigent attitudes

and strong reactions of local governments and residents resulted in the failure in finding a location, where its residents are willing to accept nuclear waste, hence the dilemma for the disposal of nuclear waste. We have requested Taipower to conduct the selection for a disposal facility site based on three principles: an impartial organization, an open and participatory process, and objective criteria.

2/ The Executive Yuan Nuclear-Free Homeland Task Force has requested Taipower to promote the construction of a medium-term temporary storage facility for radioactive waste and asked the MOEA and Taipower to actively review the communication mechanisms with the public for the selection of nuclear waste facilities, strengthen consultation with local governments, and communicate with local residents. Additionally, we requested that Taipower draft contingency plans for challenges that may occur during the implementation of medium-term temporary storage facility, as well as establish guidelines for site selection.

3/ To ensure storage safety at the Lanyu Storage Site before the relocation of its nuclear waste, in accordance with the Regulations on Treatment and Storage of Radioactive Waste and Safety Management of the Facilities, we have requested Taipower to conduct re-evaluations of storage facilities every ten years, carry out testing and monitoring on the structural integrity of storage trenches, and manage seismic and aging threats to the structure of processing centers and steel plants.

4/ To safeguard public safety and environmental quality, we have requested Taipower to strive to advance its disposal technologies and submit periodic reports on the progress, so as to ensure that its disposal technologies are the best available technologies and in line with international standards. In addition, Taipower is also required to submit, by the end of June 2021, the Report on the Evaluation of Low-Level Radioactive Waste Final Disposal Technology (2020 edition) that has been peer-reviewed domestically and internationally. Taipower has submitted said report, which is currently being reviewed by us.

(4) Highlights from the undertaking

1/ Actively pushing forward waste reduction and alleviating the load on disposal facilities

To relieve the load on disposal facilities, we have actively pushed forward waste reduction and urged nuclear power plants to reduce their output of radioactive waste. Since 1990, we have formulated reduction strategies for low-level radioactive waste; based on the actual output and treatment status of solidified waste at each nuclear power plant, reduction targets for waste output that could clearly be controlled have been set for each nuclear power plant to achieve in stages. In December 1998, Maanshan NPP adopted high-efficiency solidification technology to reduce the volume of its solidified waste to less than one-fifth of its original volume. In May 2006, Kuosheng NPP also adopted high-efficiency solidification technology to reduce its waste output. Thanks to

the adoption of reduction measures, the output of low-level radioactive solidified waste at each nuclear power plant has gradually decreased over the years from a maximum of 12,258 drums in 1983 to less than 200 drums per year since 2011. The output of solidified waste went down to only 172 drums in 2020 (Figure 21).

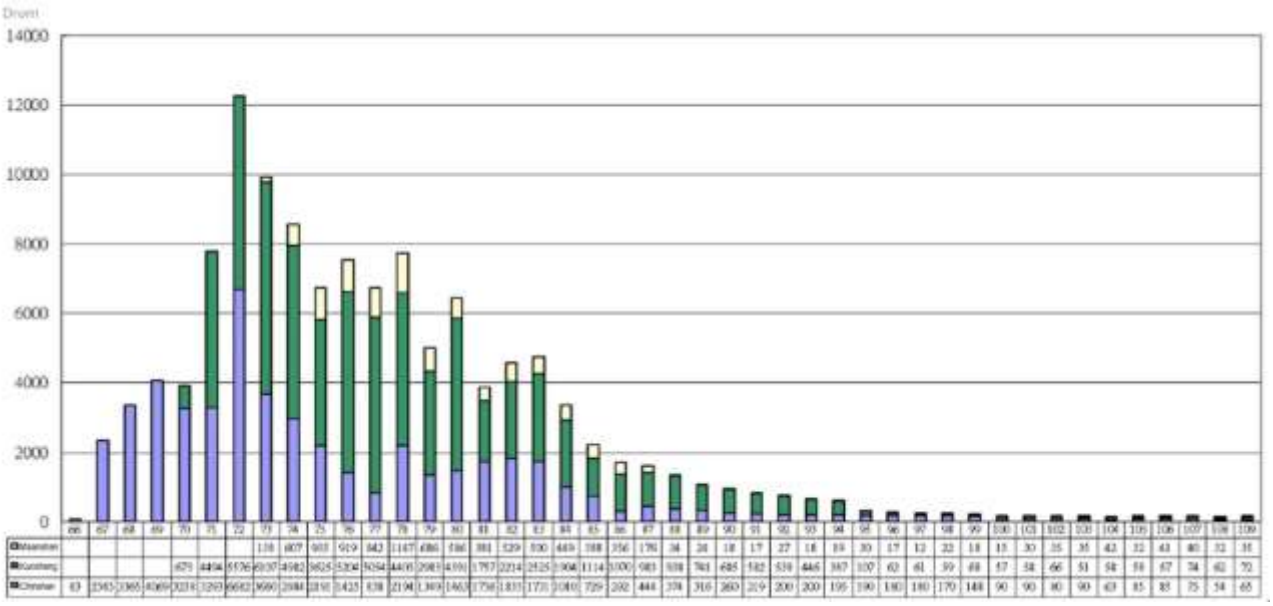


Figure 21: Historical output of solidified waste drums at each nuclear power plant

2/ Strengthening regulatory control on the final disposal of low-level radioactive waste

Countries around the world have adopted the multi-barrier system (Figure 22) in designing final disposal sites for low-level radioactive waste. Approved and recommended by the International Atomic Energy Agency (IAEA), this disposal approach prescribes protective measures, including containers for the packaging of solidified radioactive waste, buffer and backfill materials, and other engineering and natural barriers to isolate radioactive waste from the human living environment.

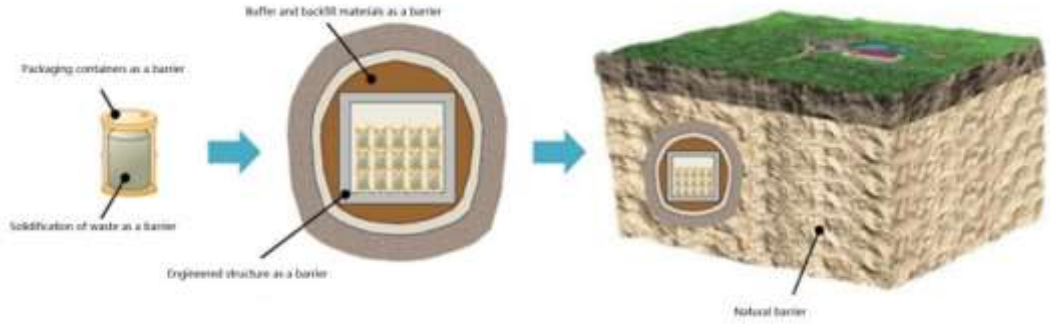


Figure 22: The concept of multi-barrier for the final disposal of low-level radioactive waste

Taiwan's regulatory provisions stipulate that the maximum annual effective dose caused to an individual by low-level radioactive waste final disposal facilities shall not exceed 0.25 mSv, which is a quarter of the annual dose limit for the general public. Control measures covering regulatory framework and facilities of all stages have been progressively implemented in an open and transparent manner and under safe conditions to ensure the safety of the final disposal of low-level radioactive waste.

In terms of site selection, according to the Act on Sites for Establishment of Low-Level Radioactive Waste Final Disposal Facility, the MOEA is in charge of the site selection process, and Taipower has been designated to handle matters regarding site investigation, safety analysis, and public communication. The selected site will still need to pass local referendum and environmental impact assessment review before it is approved as a disposal facility site. On July 3, 2012, the MOEA selected Daren Township in Taitung County and Wuqiu Township in Kinmen County as the two proposed candidate sites; a local referendum is needed to determine the candidacy of the sites. However, the MOEA and Taipower failed to establish a consensus with the local governments and residents, leading to an extended delay in local referendums and, in turn, the overall delay in meeting the timelines of the disposal plan (Figure 23).

The final disposal of radioactive waste involves environmental and generational justice and is an issue that must be properly addressed by the present generation. In response to Taipower's delay in implementing the low-level radioactive waste disposal plan, we have imposed fines on Taipower since August 2016 on the basis of the Nuclear Materials and Radioactive Waste Management Act; we also requested Taipower to initiate the contingency plan for a centralized storage facility at the end of 2016. In addition, since the nuclear power plants are still in operation, many disposal technologies, such as waste characteristics and site characteristics investigation, disposal facility design and operation, and safety assessment, still need to be developed and strengthened. We have requested Taipower to keep up with international developments, strive to advance its disposal technologies in accordance with IAEA provisions, and submit an updated version of the Report on the Evaluation of Low-Level Radioactive Waste Final Disposal Technology following domestic and international peer reviews every four years to ensure that Taipower's disposal technologies are up to the best available technologies and in line with international standards for the safety of disposal facilities, the safety of the public, and the quality of the environment.

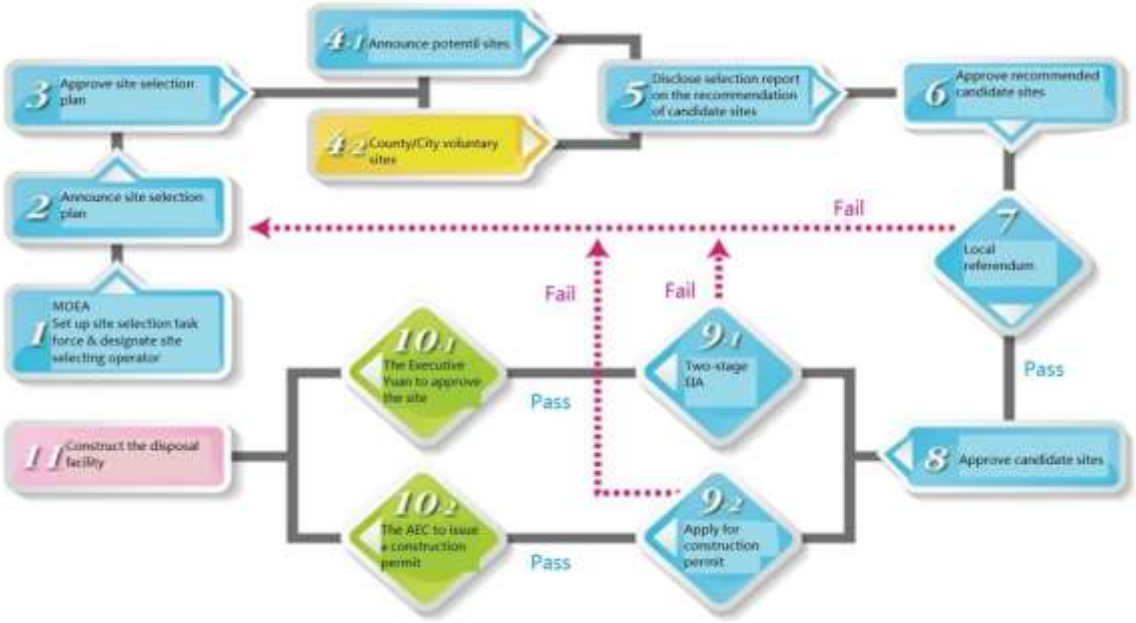


Figure 23: Site selection process for low-level radioactive waste final disposal facilities

3/ Supervising the implementation of the contingency plan for a centralized storage facility

Given the uncertainty of site selection for proposed disposal facilities, the imminent decommissioning of nuclear power plants following the end of their respective operational life, and the future demand for the relocation of the Lanyu Storage Site, Taipower has planned and promoted an alternative, contingency plan for the final disposal of low-level radioactive waste. Two contingency plans have been submitted by Taipower: one is temporary storage at each nuclear power plant while the other is the construction of a centralized storage facility, the latter of which has been adopted by Canada, the Netherlands, Belgium, Switzerland, and other countries around the world.

According to the Plan for the Final Disposal of Low-Level Radioactive Waste submitted by Taipower, if a candidate site for a final disposal facility for low-level radioactive waste cannot be selected by March 2016, the centralized storage contingency plan for low-level radioactive waste should be initiated at the end of 2016. Taipower submitted the Specific Implementation Plan for the Alternative/Contingency Plan for the Final Disposal of Low-Level Radioactive Waste to us at the end of 2016; we completed our review in February 2017. Taipower is required to complete the construction and commissioning of the centralized storage facility within eight years from March 2017. In addition, at the fourth meeting of the Executive Yuan Nuclear-Free Homeland Task Force on March 15, 2019, it was resolved that Taipower should actively promote the construction of a medium-term temporary storage facility and initiate communication with society. In December 2020, the fifth meeting was held and resolved that Taipower draft contingency plans for challenges that may occur during the implementation of medium-term temporary storage facility, as well as establish guidelines for site selection.

4/ Supervising the relocation of the storage site for low-level radioactive waste in Lanyu

The government attaches great importance to the relocation of nuclear waste in Lanyu. At a meeting held by the Presidential Office Indigenous Historical Justice and Transitional Justice Committee in March 2018, the Presidential Office requested that we and the MOEA jointly supervise Taipower to plan and handle the relocation of the Lanyu Storage Site as soon as possible and that the Nuclear-Free Homeland Task Force manage the progress. In the 15th meeting of the Presidential Office Indigenous Historical Justice and Transitional Justice Committee held in April 2021, President Tsai instructed that the final storage site for nuclear waste is a major concern of the nation and that the MOEA should participate in the discussion with the indigenous people through the platform provided by the Compensation Foundation for the Loss of the Indigenous People's Reserved Land in Lanyu Used as the Nuclear Waste Storage Site.

To ensure appropriate preparation prior to the relocation, we have requested Taipower to carry out the Implementation Plan for Enhancing the Operational Safety of the Lanyu Storage Site by repacking all 55 gallons of waste drums stored in the existing trenches with thick containers. The process of nuclear waste repackaging as a preparation for the relocation was audited by our inspectors on-site and completed in February 2021 (Figure 24).

In February 2017, we approved Taipower's Planning Report on the Relocation of the Lanyu Storage Site and requested that Taipower begin the relocation of nuclear waste from Lanyu by 2025 at the latest, so as to decouple the relocation of the Lanyu Storage Site from the selection of a disposal site. Since 2018, we have been inviting the MOEA and the Council of Indigenous Peoples to hold meetings to discuss the relocation of the Lanyu nuclear waste storage site every six months and to urge Taipower to actively plan for, and handle, the relocation of the Lanyu low-level radioactive waste storage site. In addition, Taipower is also requested to strengthen the planning and execution of nuclear waste drum repackaging, the design and construction of vessels required for transportation, dredging plans for the dock, and communication with the public prior to the relocation of the site.

Before the nuclear waste is relocated from Lanyu, we will continue to strictly monitor the operational safety of the Lanyu Storage Site and perform environmental radiation monitoring to maintain public safety and environmental quality of Lanyu.

Figure 24: Implementation Plan for Enhancing the Operational Safety of the Lanyu Storage Site

5/ Completing regulatory amendments on storage sites to protect the rights of indigenous peoples

To protect the fundamental rights of indigenous peoples, the government promulgated the Indigenous Peoples Basic Law on February 5, 2005. Article 31 of the Law stipulates that the government may not store toxic materials in indigenous peoples' regions contrary to the will of indigenous peoples.

To implement the government's policy objectives for indigenous peoples, in accordance with Article 31 of the Indigenous Peoples Basic Law, we have reviewed and amended the Scope and Criteria for Identifying the Prohibited Areas for Establishing Low-Level Radioactive Waste Final Disposal Facility Sites and the Regulations for High-Level Radioactive Waste Final Disposal Facility Sites. The amended regulations, completed and announced at the end of March 2017, stipulate that radioactive waste facility sites cannot be set up in indigenous peoples' regions contrary to the will of indigenous peoples.

6/ Important line of defense for disposal—safe and reliable disposal containers: concrete packaging containers for low-level radioactive waste developed by the Institute of Nuclear Energy Research (INER)

Radioactive waste packaging containers, having both shielding and containment functions, are the key to ensuring storage and disposal safety. The containers can reduce the potential adverse effects of radioactive waste and ensure environmental quality and public safety. Therefore, developing cost-effective packaging containers under the premise of safety is a challenging task.

Our INER has been actively developing concrete packaging containers for low-level radioactive waste that can withstand 100 years of disposal (Figure 25). The verification result of container safety has been approved and filed for reference by our Fuel Cycle and Materials Administration. The technology and developed products have been applied to the inspection of low-level radioactive waste in nuclear power plants. The core of the technology, independently developed by the INER and patented, is the mixture proportion of high-performance concrete, container quality inspection, and container structural integrity testing procedures. The physical inspection technology and manufacturing equipment have been established; with a continuous process from container design, mixing, pouring to finished product, it has a competitive edge in technology and intellectual property.

The R&D team at our INER has been dedicated to the development and verification of technologies for disposal containers that can withstand 300 years. Going forward, the INER remains committed to expanding the application of related technologies to address the safety challenges of low-level radioactive waste storage and disposal.

Figure 25: The INER's high-performance concrete disposal container with structural integrity that can withstand 100 years

D. Promoting the regulatory process for High-Level Radioactive Waste Final Disposal Facilities to assist in the decommissioning of nuclear power plants

(1) Challenges and Opportunities

1/ As the competent authority for radioactive waste safety, we have completed the formulation of regulations on safety control laws, including the Regulations on the Final Disposal of High-Level Radioactive Waste and Safety Management of the Facilities and the Regulations for High-Level Radioactive Waste Final Disposal Facility Sites.

2/ According to the Program Plan for the Final Disposal of Spent Nuclear Fuel, the evaluation and approval phase for candidate sites began in 2018. To strengthen regulatory control and reviews on the safety of the final disposal plan for spent nuclear fuel in Taiwan, we have been actively promoting the regulatory process concerning Taiwan's high-level radioactive waste final disposal by taking into account relevant regulations, guidelines, safety requirements, and review cases of countries around the world with advanced nuclear energy development.

3/ To further refine regulatory processes for the spent nuclear fuel final disposal plan, we have established guidelines for facility safety analysis reports on spent nuclear fuel final disposal plan required to be submitted by Taipower when applying for construction licenses in the future, so as to enhance the capabilities of safety control and review.

4/ The regulations on the selection of sites for establishing disposal facilities mainly regulate site selection requirements and practices, including site selection procedures, public communication on site selection, site selection feedback mechanisms and policy support measures, and site investigation and safety analysis, taking into account international site selection practices for radioactive waste final disposal facilities. Site selection is under the supervision of competent ministries and agencies responsible for the economy and energy.

(2) Policy guidelines and objectives

1/ In accordance with the Nuclear Materials and Radioactive Waste Management Act and taking international experience into account, Taipower drafted the Program Plan for the Final Disposal of Spent Nuclear Fuel in 2006. The program plan, approved by us, is divided into five phases: Potential Host Rock Characterization and Evaluation (2005-2017); Candidate Site Investigation and Confirmation (2018-2028); Detailed Site Investigation and Testing (2029-2038); Repository Design and License Application (2039-2044); and Repository Construction (2045-2055), with the disposal facilities scheduled to commence operation in 2055.

2/ To achieve this core objective, we studied and analyzed information related to international final disposal programs for high-level radioactive waste and compiled the review requirements for safety analysis reports of high-level radioactive disposal facilities from various countries. We plan to promote and develop the guidelines for safety analysis reports of spent nuclear fuel final disposal facilities from 2020 to 2025, so as to enhance the capabilities of safety control on the disposal operations in Taiwan.

3/ To coordinate the timeline of the high-level radioactive disposal program, we will complete the formulation and issuance of the guidelines for safety analysis reports on spent nuclear fuel final disposal facilities prior to the phase of repository license application for the operator of disposal facilities to comply in its compilation of safety analysis reports, which is to be submitted along with its application for a construction license.

(3) Rigorous review and future planning

1/ For the rolling review of high-level radioactive disposal technologies, we have requested Taipower to follow the safety demonstration guidelines issued by the IAEA, refer to international peer review and our review comments on the Technical Feasibility Assessment Report on Spent Nuclear Fuel Final Disposal in Taiwan (SNFD 2017), adopt advanced international disposal technologies with respect to the phases of Taiwan's disposal programs and the characteristics of the geological disposal host rock, and submit a Preliminary Safety Demonstration Report on the Final Disposal of Spent Nuclear Fuel in Taiwan by the end of 2021. In addition, Taipower is also requested to submit a Safety Demonstration Report on the Final Disposal of Spent Nuclear Fuel in Taiwan by the end of 2025 and complete international and domestic peer-review requirements to ensure that its disposal technologies are the best available technologies and in line with international standards, so as to safeguard the safety of the public and the quality of the environment.

2/ In 2020, we drafted chapters and sections related to facility design standards and construction for the guidelines for safety analysis reports as a basis for the subsequent development of the guidelines; we also proposed recommendations for the structure of safety analysis reports and review requirements. In 2021, we analyzed chapters and sections related to the description of characteristics of sites and the operation of facilities. Going forward, we will continue to conduct rolling reviews and push forward the operations stipulated in the safety analysis report guidelines.

3/ The challenge of nuclear waste disposal in Taiwan does not stem from technical development but from communication with the public and the selection of nuclear waste sites. Therefore, the Executive Yuan has requested the MOEA and Taipower to actively review the mechanism for communication with society regarding the selection of nuclear waste facilities and strengthen consultation with local governments and communication with local residents. At the same time, we will continue to push forward regulatory processes for the final disposal safety control of high-level radioactive waste, so as to make a breakthrough in the plight regarding nuclear waste in Taiwan.

(4) Highlights from the undertaking

1/ Approving the Technical Feasibility Assessment Report on Spent Nuclear Fuel Final Disposal

The final disposal of high-level radioactive waste is a key issue in the back-end operation of nuclear power generation; the most important aspect of the entire disposal process lies in how to safely dispose of nuclear waste to ensure public safety and environmental quality. To achieve the

objective of safe disposal of spent nuclear fuel and high-level radioactive waste, all advanced nuclear energy countries around the world have invested a considerable amount of human and material resources into long-term research and development for the continuous promotion of final disposal. To urge Taipower to properly implement the final disposal plan for spent nuclear fuel, we requested Taipower to submit the Technical Feasibility Assessment Report on Spent Nuclear Fuel Final Disposal in 2017 and have it reviewed by international peers after the completion of the first phase of the disposal plan: Potential Host Rock Characterization and Evaluation (2005-2017).

Taipower submitted the Technical Feasibility Assessment Report on Spent Nuclear Fuel Final Disposal in Taiwan in 2017 to verify the results of the first phase of the disposal program. We completed our review at the end of December 2018 and concluded that all technical developments were able to meet the requirements of the first phase of the disposal plan, but continuous refinement would still be needed in the subsequent phases. In addition, we have also requested Taipower to submit the Preliminary Safety Demonstration Report on the Final Disposal of Spent Nuclear Fuel in Taiwan by the end of 2021 and the Safety Demonstration Report on the Final Disposal of Spent Nuclear Fuel in Taiwan by the end of 2025 to ensure that its disposal technologies are the best available technologies and in line with international standards.

2/ Overseeing the completion of nuclear fuel outbound transportation to alleviate the need for high-level radioactive disposal

Chinshan NPP entered the decommissioning phase in July 2019. To properly plan for, and handle, the unused nuclear fuel in the plant, Taipower carried out an outbound shipment of 112 bundles of fuel, including 92 bundles of unirradiated fuel from the core of Unit 1 of Chinshan NPP and 20 bundles of new fuel from the nuclear fuel depot, to the manufacturer in December 2020 for dismantling and recovery of uranium. During the handling process and shipment of nuclear fuel, we set up a joint inspection team to conduct rigorous inspections on the cleaning, decontamination, packaging, containerization, loading, and transportation of nuclear fuel to ensure safety.

Taking into account the overall energy policies of Taiwan and in view of the maximization of the value of nuclear fuel assets at Lungmen NPP, Taipower also carried out an outbound transportation of nuclear fuel from Lungmen NPP. From July 2018 to March 2021, all 1,744 bundles of fuel were transported in nine batches to overseas fuel manufacturers for further disposal (Figure 26). We also set up an inspection task force and a rapid response task force to rigorously monitor and control Taipower's nuclear fuel transportation during each of the nine shipments to achieve zero nuclear disasters, zero radiation accidents, and zero industrial incidents and a smooth and safe outbound transportation of all nuclear fuel.

The outbound transportation of nuclear fuel to overseas manufacturers for recycling and disposal facilitates' subsequent decommissioning implementation: it reduces the need for dry storage capacity, prevents unused nuclear fuel from being further disposed at final disposal

facilities, and avoids the mixing of unused nuclear fuel with spent nuclear fuel for storage and disposal.

Figure 26: Outbound transportation of nuclear fuel

3/ Solving the predicament of containerizing low-level radioactive waste with high dose rates in Taiwan: Technical development of INER-LRW-C2 low-level radioactive waste containers

The decommissioning process of nuclear facilities generates a considerable amount of low-level radioactive waste with high dose rates. The effective containerization of this type of waste not only maintains decommissioning safety, but also saves a great deal of cost, while facilitating the implementation of decommissioning.

To ensure the smooth implementation of future decommissioning projects and to solve the predicament that there were no suitable containers to effectively containerize this type of waste in Taiwan, our INER developed the INER-LRW-C2 low-level radioactive waste container to improve the safety and efficiency of containerizing low-level radioactive waste with higher dose rates. The application for a permit to use the containers was approved by our Fuel Cycle and Materials Administration on November 13, 2020.

INER-LRW-C2 low-level radioactive waste containers are made of steel plates that are welded, hot-dip galvanized, and coated with paint (Figure 27). Having undergone various tests, such as spray test, shock test, hang test, penetration test, accumulation test, and free drop test, all of which met the regulatory requirements, the containers can ensure transportation and storage safety, are economical, and can be mass-produced, while meeting future decommissioning needs of nuclear facilities.

Figure 27: A safety test of an INER-LRW-C2 low-level radioactive waste container at the INER

4/ Assisting in the decommissioning and cleanup of nuclear facilities by increasing worker radiation protection and operational safety: The development of remote control serpentine robotic arm technology

When confronted with high radiation, high dust, or confined operating space during decommissioning at nuclear power plants, the use of remote-controlled robots or robotic arms to perform tasks can prevent workers from radioactive exposure and potential occupational injuries.

To enhance the safety of decommissioning nuclear power plants, our INER has actively conducted research and development in the field of remote decommissioning technologies. The remote control serpentine robotic arm developed by the INER is designed with a 6-section arm and has waterproof, multi-degree of freedom, and vertical rise-and-fall functions with a maximum of 5 kg driving force. It also has motion control software developed to support its maneuvering (Figure 28). Most of the traditional mechanical arms have only a 2-section structure, and each section has only 2 degrees of freedom. The serpentine robotic arm has 15 degrees of freedom, so it can be accurately positioned and flexibly operated in a cramped and narrow space. The hollow cavity design of the serpentine robotic arm allows for power and signal cables to pass through the inside of the robotic arm and reach the front-end clamps. The front-end clamps are equipped with high-resolution cameras for visual feedback and an automatic head-changing module at the front-end device, which allow for the free selection of required clamps, cutters, laser cutting heads, and

other tools so that the robotic arm can perform a variety of tasks, such as remote high-activity waste clamping and sorting, or pipe cutting.

The INER's serpentine robotic arm technology will be applied in the decommissioning of nuclear facilities in Taiwan. The INER will continue to conduct waste cleanup and testing programs, establish independent research and development capabilities for multi-joint robotic arms, and, in turn, effectively perform nuclear facility decommissioning and cleanup.

Figure 28: A test on the turning function of the serpentine robotic arm's obstacle avoidance at the INER

E. Strengthening the safety and security of nuclear facilities

The core objectives here are to maintain the safety of existing, operating nuclear facilities, perform environmental radiation monitoring, and enhance the safety and safeguarding capabilities of nuclear facilities to ensure that the facilities meet safety requirements. In addition, in case of a major accident, emergency response plans have been formulated, rehearsals are carried out, and joint nuclear emergency exercises are also being planned.

The following is an account of each of the three areas of the operational safety of nuclear facilities, environmental radiation monitoring, and security protection enhancement and emergency response drills.

Operational safety of nuclear facilities

(1) Challenges and opportunities

According to the government's nuclear-free homeland policy, all nuclear power plants in Taiwan will cease operation and enter the decommissioning phase upon the expiration of their respective operating licenses. Of the three nuclear power plants in Taiwan, Chinshan NPP has entered the

decommissioning phase, while the units at Kuosheng and Maanshan NPPs are scheduled to enter decommissioning in 2023 and 2025, respectively. We are responsible for the safety control of Taiwan's nuclear power plants in accordance with the authority granted by the State. Before the expiration of the operating licenses of the existing nuclear power plants and their subsequent decommissioning, we will continue to strictly enforce monitoring and control on operational safety to ensure Taipower's compliance with safety requirements and protect the safety of the public.

(2) Policy guidelines and objectives

Before the operating licenses of the existing nuclear power plants expire, we will continuously monitor and control the safety and reliability of the operating nuclear power plants to ensure their compliance with safety requirements. Actions taken are summarized below:

1/ Strictly enforcing safety audits and inspections on nuclear power plants

a/ Strictly enforcing on-site supervision to ensure operational compliance with safety regulations and procedures

We will continue to send inspectors to conduct various on-site inspections, including resident inspections, unannounced inspections, outage inspections, and project inspections in order to gain a clear and timely insight into the operational performance of power plants, verify plant operations, maintain testing and safety management status, and ensure operational and procedural compliance with regulations, guidelines, and manuals.

b/ Carrying out rigorous safety reviews on nuclear power plants

As the competent authority, we carefully plan and carry out safety reviews on Taipower's applications for license document amendments, safety analysis reports, and outage plans for nuclear power plants, e.g., final safety analysis reports and applications for the modification of operating technical specifications, outage safety management and implementation plans, fuel replacement safety analysis reports, and design modifications. For those reviews involving a wide range of fields or technical expertise, we also invite experts and academics to form a review task force with our colleagues to conduct joint and thorough reviews. Only when compliance with regulatory safety requirements have been concluded in the review will the plans, reports, and applications be approved.

c/ Convening control meetings to discuss important issues, taking timely control measures, and requiring power plants to correct deficiencies

We have set up the Advisory Committee on Nuclear Reactor Facility Safety, consisting of experts and academics. The committee convenes regular meetings to make recommendations to us regarding the safety issues of nuclear reactor facilities and the nuclear safety matters of public

concern; it also invites our units or Taipower to provide explanations based on the nature of the issues. We also convene regulatory meetings to discuss issues related to nuclear safety control in order to understand Taipower's practices at nuclear power plants and express our regulatory positions, so as to effectively achieve communication and regulatory purposes.

In the event that a power plant violates regulatory provisions or requires reviews and improvement, we will take control measures, such as restricting operation, imposing fines, and issuing violation notifications or improvement notices, taking into account the severity and impact of a violation, so as to ensure timely corrections for deficiencies or reviews for improvement, and, in turn, operational compliance of power plants with regulatory provisions and safety requirements.

2/ Requesting nuclear power plants to strengthen their capabilities in responding to natural disasters

Taiwan's nuclear power plants were designed with the considerations on the capability to protect against natural disasters; after being put into operation, their capabilities must be continuously reviewed and strengthened in light of emerging evidence and international experiences. For example, following the new evidence of the Shanchiao Fault and the Hengchun Fault, and the experience of the Fukushima Daiichi nuclear disaster in Japan, we requested Taipower to conduct necessary investigations and evaluations and take supplementary improvement and strengthening measures to enhance the safety protection capabilities of nuclear power plants and ensure the safety of nuclear power units.

3/ Open and transparent regulatory information

To facilitate the public's understanding of regulatory information concerning nuclear power plants in operation, in the spirit of "the AEC of the people," we strive to make various regulatory information available for public access, including daily regulatory information and monthly regulatory minutes of power plants in operation, safety consultation and control meetings, regulatory reports, the records of power plant non-compliance incidents and fines imposed, etc. In the event of a major regulatory review, such as general and comprehensive nuclear safety inspections and Kuosheng NPP fuel pool modification, a designated section on our website will also be set up so that the public can follow the progress of related safety reviews.

To further enhance transparency in the operational safety status of nuclear power plants, we have adopted the U.S. Nuclear Regulatory Commission's Reactor Oversight Process (ROP) and established a green-red light nuclear safety system. The safety performance indicators of nuclear power plant safety systems and equipment are combined with inspection indicators derived from safety inspection results; green, white, amber, and red lights are used to show the safety performance of nuclear power plants. This makes it easier for the public to understand the safety status of each nuclear power generation unit.

4/ Organizing international exchanges and keeping in line with international norms

To keep safety regulatory control on nuclear power plants in line with international standards, we are committed to establishing cooperative and exchange relationships with international nuclear safety regulatory agencies. Under the Taiwan-U.S. Agreement for Cooperation Concerning Peaceful Uses of Nuclear Energy, the Taiwan-Japan Memorandum for the Mutual Cooperation in the Field of Nuclear and Radiation Safety Regulation in the Peaceful Use of Nuclear Energy, and the Taiwan-France Framework Cooperation Agreements in the Field of Radiation Protection and Nuclear Safety, we conduct extensive cooperation and regular exchanges with the United States, France, and Japan on nuclear safety and other related issues. In addition, we hold annual Taiwan-U.S. Bilateral Technical Meetings with the U.S. Nuclear Regulatory Commission under the Taiwan-U.S. Agreement for Cooperation Concerning Peaceful Uses of Nuclear Energy for more in-depth discussions and cooperation on nuclear safety regulatory issues.

(3) Rigorous review and future planning

As the competent authority for nuclear safety, we have the responsibility of performing safety audits and supervisory inspections at nuclear power plants. Before the expiration of the operating licenses of existing nuclear power plants and hence their subsequent cessation of operation and the beginning of the decommissioning phase by 2025, we will continuously carry out rigorous safety monitoring and regulatory control based on the current regulatory foundation. All nuclear power plants are required to carry out safe operations and maintenance following regulatory provisions and relevant procedures, and pay attention to the impact of the imminent shutdowns of nuclear power plants on the mental aspect of plant personnel to ensure operational safety. The main practices are outlined as follows:

1/ We will strive to carry out rigorous safety audits and supervisory inspections on nuclear power plants and request that Taipower pay attention to the impact of the imminent shutdowns of nuclear power plants on the mental aspect of plant personnel.

2/ We will continue to hold regulatory control meetings to discuss important issues and take timely control measures to urge power plants to review, correct, and improve deficiencies.

3/ We will remain committed to international exchanges and pay attention to international regulatory experiences concerning the transition from operation to decommissioning for regulatory control in Taiwan.

4/ We will continue to meet the objective of information disclosure and publish safety regulatory information on our official website.

(4) Highlights from the undertaking

1/ Strictly enforcing safety inspections on nuclear power plants in operation and requesting timely

corrections in response to improvement requirements identified during inspections

Take 2020 as an example. Under the existing inspection framework, we conducted a total of 619 person-days of resident inspections at Kuosheng and Maanshan NPPs in 2020. In addition, six unannounced inspections, six outage inspections (232 person-days), eight green-red light nuclear safety inspections, and two general and comprehensive nuclear safety inspections were conducted (Figures 29 to 32). Improvement notices covering a total of 33 improvement items were issued, requesting power plants to review, improve, and strengthen on such areas as equipment maintenance, personnel training, and radiation protection, so as to ensure their operational safety.

To strengthen verification and control over outage safety and maintenance and testing quality, we organize inspection teams to conduct random inspections on outage safety management, maintenance, testing, and quality during nuclear power plant outages. In addition, when Taipower submits a restart application after an outage, we also send inspectors to conduct enhanced inspections. Only when the documents submitted for review, on-site inspections during the outage, the results of the enhanced inspections, and the on-site condition of the unit have been concluded to meet restarting requirements will we approve the application. During the restarting and ramping period of a unit, our inspectors also conduct continuous verifications of relevant operations to ensure compliance of power plants with regulatory provisions.

To prevent the potential negative impact of typhoons on the external power systems or the plant area of nuclear power plants, we request power plants to strengthen their natural disaster preparedness and response efforts by implementing various typhoon and flood prevention measures according to relevant procedures. When a typhoon emergency center is to be set up at a nuclear power plant, we also send resident inspectors to oversee response efforts on-site 24 hours a day and regularly report the status of the units during typhoons until the typhoon alert has been lifted. Take Typhoon Atsani in 2020 as an example. When the typhoon alert for potentially affected areas that include Maanshan NPP was issued, we sent resident inspectors to the site to keep close track of the status of the power units at the plant and to ensure that the power plant was carrying out typhoon and flood prevention procedures in accordance with relevant provisions, so as to maintain the safety of the power units.

2/ Requesting Taipower to supervise the implementation of COVID-19 prevention measures at nuclear power plants and sending inspectors to inspect the epidemic prevention and response measures at power plants in view of the possible impact of the COVID-19 epidemic on nuclear power plants

To prevent the potential impact of COVID-19 on the operational safety and decommissioning projects of nuclear power plants in Taiwan, we sent a letter to the MOEA, urging it to assist Taipower in establishing response measures as early as possible in order to prevent the epidemic from impacting the operational stability and safety of nuclear power plants. We also requested Taipower to adopt a conservative approach in response to the changes in the epidemic

situation, implement contingency measures against the epidemic, and conduct rolling reviews.

To understand the implementation of epidemic prevention measures at each nuclear power plant, we have requested Taipower to establish a notification mechanism and report the epidemic investigation results of nuclear power plant employees to us according to the epidemic investigation information guidelines provided by the Central Epidemic Command Center, so as to better grasp the health situation of nuclear power plant employees. We check the implementation of epidemic prevention measures at nuclear power plants during our regular plant inspections. In response to the COVID-19 Fall-Winter Epidemic Prevention Program, we also organized a task force to visit each nuclear power plant and stepped up our inspections on epidemic prevention practices (Figures 33 and 34). To prevent the epidemic from compromising the quality of outage inspections due to the anticipation that the flow of people entering and exiting power plants would increase during an outage, we also requested Taipower to set up an outage response center and establish a notification mechanism to strictly control the entry and exit of outage workers; we have also stepped up our inspections on epidemic prevention efforts during an outage and urged power plants to implement epidemic prevention management.

Figure 29: Inspectors performing an on-site inspection on equipment at Maanshan NPP

Figure 30: An inspector performing an on-site inspection on equipment at Kuosheng NPP

Figure 31: Inspectors performing an unannounced inspection at Kuosheng NPP

Figure 32: Inspectors performing an unannounced inspection at Maanshan NPP

Figure 33: Inspectors performing an inspection on epidemic prevention measures at Maanshan NPP

Figure 34: An inspector performing an inspection on epidemic prevention measures at Kuosheng NPP

3/ Strictly reviewing the application for the output power derating of Unit 1 at Kuosheng NPP

Due to the constraints of spent fuel storage capacity, only 120 bundles of new fuel were refueled into Unit 1 at Kuosheng NPP during its EOC-27 outage. According to Taipower's calculation, this meant that the unit could maintain full load operation until March 2021, instead of December 27, 2021, the expiry date of its operating license. Therefore, without changing the approved total fuel consumption and the maximum number of operating days, Taipower planned to operate the unit at a reduced power level during fuel cycle 28, from the full-load power output (i.e., 2971 MWt) gradually down to 80% of the rated power output, following which the unit will be taken offline and maintained at the shutdown/outage phase. Taipower submitted an application for end-of-cycle output power derating for fuel cycle 28 of Unit 1 at Kuosheng NPP, as well as its safety analysis reports to us. We recruited experts and academics to form a project review team with our colleagues to conduct a rigorous review on output power derating timelines and related parameter changes, power output control, system component impact, power generation equipment

considerations, operational considerations, operational procedures, etc. Only after Taipower clarified all the questions raised in the review, completed report revisions, and confirmed that the unit could meet output power derating requirements did we approve its application. We have also included the review requirements and Taipower's commitments as follow-up control items, requesting Taipower's compliance in ensuring operational safety for the end-of-cycle output power derating for fuel cycle 28 of Unit 1 at Kuosheng NPP.

4/ Striving to strengthen safety and protective practices at nuclear power plants in operation against natural hazards

Prior to the Fukushima Daiichi nuclear disaster in Japan, we requested Taipower to conduct a seismic enhancement program for nuclear power plants in response to the emerging evidence of the Shanchiao Fault and the Hengchun Fault by re-investigating, re-analyzing, and re-evaluating the seismic resistance of Chinshan, Kuosheng, and Maanshan NPPs on the basis of the investigation results and to complete the reinforcement of two safe shutdown paths in June 2014.

After the Fukushima Daiichi nuclear disaster in Japan, we reviewed the capabilities of Taiwan's nuclear power plant reactor units in responding to accidents similar to the Fukushima Daiichi nuclear disaster by referring to the safety enhancement measures adopted by the U.S. Nuclear Regulatory Commission, the IAEA, and international nuclear agencies in the European Union (EU) and Japan. In addition, we also conducted general and comprehensive nuclear safety inspections on the basis of the design standards, geological environment, and operating conditions of Taiwan's nuclear power plants and carried out pressure tests on nuclear power plants with reference to the EU pressure test guidelines. Based on the results of the general inspection and pressure test, we requested Taipower to systematically strengthen its earthquake, tsunami, and volcanic explosion preventive and response capabilities. In addition, we also requested Taipower to increase rescue hardware and equipment and strengthen response measures and real-time decision-making for complex disasters. To date, Taipower has upgraded the water tightness of important plants, constructed watertight doors, reinforced the seismic resistance of important plants, purchased additional mobile rescue power supplies, increased backup water sources for rescues, and established ultimate emergency measures to enhance the overall and comprehensive safety and protective capabilities in responding to a complex disaster similar to the Fukushima Daiichi nuclear disaster in Japan.

5/ Establishing a transparent Reactor Oversight Process

We have referred to the U.S. Nuclear Regulatory Commission's Reactor Oversight Process and established a green-red light nuclear safety system, which combines the safety performance indicators of nuclear power plant safety systems and equipment with inspection indicators derived from our safety inspection results. The corresponding light status on the green-red light nuclear safety control system for the operating nuclear reactor units, covering areas of reactor safety initiating events, rescue systems, barrier integrity, emergency response, radiation protection, and

wastewater treatment, is published on a quarterly basis (Figure 35). The green light represents no safety concerns, the white light signifies minor safety concerns, and the amber light shows moderate safety concerns. The green, white, amber, and red lights are used to present the safety performance of nuclear power plants, making it easier for the public to see at a glance the current safety status of each nuclear power plant generation unit.

Figure 35: The green-red light nuclear safety system of nuclear power plants in operation in Taiwan

6/ Conducting nuclear safety reviews based on international nuclear safety conventions to ensure that Taiwan's nuclear safety levels are in line with international standards

The Convention on Nuclear Safety (CNS), published by the IAEA and entered into force on October 24, 1996, requires member states to submit regular CNS national reports. Through the efforts of the member states in fulfilling their obligations under the convention, it is expected that the safety of nuclear power generation can be maintained, and, in turn, a high-level of nuclear safety can be achieved worldwide. To demonstrate the effectiveness of Taiwan's nuclear regulatory control on safety and to follow the spirit of the CNS, we have taken the initiative and participated in the CNS mechanism for self-examination since 2005, despite not being a member of the IAEA; we have also negotiated with the U.S. Nuclear Regulatory Commission to conduct regular peer reviews on each other's reports to ensure that Taiwan's nuclear safety standards are in line with international specifications. To date, we have published three editions of the R.O.C. National Report (Figure 36) and will continuously conduct rolling reviews and explore Taiwan's practices and efforts in meeting the 14 CNS obligations in maintaining the safety of nuclear power generation. Currently, the 2020 R.O.C. National Report has been sent to the U.S. for a peer review. However, due to the impact of the COVID-19 epidemic, relevant timelines will be adjusted on a rolling basis according to the actual mutual review situation with the U.S. The Report will be published online upon the completion of mutual reviews.

Figure 36: The Chinese and English versions of the R.O.C. National Report under the Convention on Nuclear Safety

Environmental radiation monitoring

(1) Challenges and opportunities

To maintain the safety and security of Taiwan's nuclear facilities, our Radiation Monitoring Center (RMC) continuously performs environmental radiation detection, testing, and monitoring around nuclear facilities and maintains, as well as strengthens, the automatic environmental radiation monitoring alert system to ensure the stable and normal functioning of the system and the accuracy of the monitoring data, so as to keep track of the environmental radiation conditions around nuclear facilities and provide the public with real-time environmental monitoring information.

(2) Policy guidelines and objectives

To implement the policy guidelines for the continuous monitoring of environmental radiation conditions around nuclear facilities and to achieve the goals of various testing, detection, and automatic real-time monitoring for operational stability, two policy implementation measures and performance indicators have been set out, which are summarized below:

1/ Organizing national environmental radiation monitoring programs and strengthening environmental monitoring mechanisms for nuclear facilities

We carry out environmental radiation monitoring activities around Taiwan's nuclear facilities (nuclear power plants, nuclear research facilities, and the Lanyu low-level radioactive storage site), set up thermoluminescent detectors to detect direct environmental radiation dose rates, take samples of airborne particles, grass, drinking water, river water, groundwater, pond and lake water, mountain spring water, seawater, milk, chickens and ducks, rice, leafy and root vegetables, seasonal

vegetables, marine fish, seaweed, shellfish, indicator organisms, soil, shore sand, and bottom mud, and conduct radioactive analysis to assess whether the radiation dose from nuclear facilities to the public is within the limits of regulatory provisions.

2/ Performing automatic real-time environmental radiation monitoring throughout Taiwan and integrating wireless communication network technologies to complete the radiation safety monitoring and alert network and database

Our RMC has set up 63 environmental radiation monitoring stations in the surroundings of nuclear facilities and the municipalities and counties of Taiwan proper (Figure 37). Among them, 24 automatic monitoring stations were set up in the surroundings of nuclear facilities, including five stations at Chinshan NPP, six stations at Kuosheng NPP, six stations at Maanshan NPP, two stations at the INER, two stations at National Tsing-Hua University, and three stations at the Lanyu low-level radioactive storage site. The national radiation safety automatic monitoring and alert system operates 24 hours a day; the system automatically records the direct radiation status of the local environment and automatically transmits the real-time monitoring data from each location to our RMC every five minutes via the communication network. The data are also automatically transmitted to our Nuclear Safety Duty Center for it to monitor the changes in the data.

(3) Rigorous review and future planning

Our RMC monitors environmental radiation around nuclear facilities, implements various testing and detection activities, and ensures the stable functioning of the automatic real-time monitoring system.

1/ In accordance with relevant regulatory provisions, the RMC monitors environmental radiation around nuclear facilities, performs sampling, compiles and analyzes monitoring and sampling results, and evaluates the radiation dose caused by nuclear facilities to the public in the surrounding areas.

2/ The RMC refines the hardware and software for automatic environmental radiation monitoring, strengthens the stability of the system, and enhances the application of information.

3/ The RMC publishes reports to disclose monitoring data on a regular basis.

(4) Highlights from the undertaking

As of 2020, our RMC has set up 63 environmental radiation monitoring stations nationwide. The stations transmit real-time monitoring data to the RMC and Nuclear Safety Duty Center every five minutes to ensure the radiation safety of the public and the environment. The data are also posted on our website, and the public can make real-time inquiries via various information channels.

In response to overseas radiation pollution, we have invited relevant ministries and councils to discuss and promote the Taiwan Sea Radiation Monitoring and Investigation Plan since 2017, introducing projects that performed background investigations on the radioactive content of seas near Taiwan. In March 2020, we learned that the wastewater generated and stored at the Fukushima Daiichi Nuclear Power Plant after the Fukushima nuclear disaster was soon to be full, and that it was highly likely that the power plant discharges said wastewater into the sea. Accordingly, in May of the same year, the RMC cooperated with relevant ministries and councils to conduct the Taiwan Sea Tritium Radiation Background Investigation Plan. As of the end of 2021, we have established complete Taiwan sea radiation background data including seawater radioactive cesium, seawater tritium, marine creature radioactive cesium, and shore sand radioactive cesium. These data will be used as the standard values for future marine environmental radiation monitoring to ensure public safety.

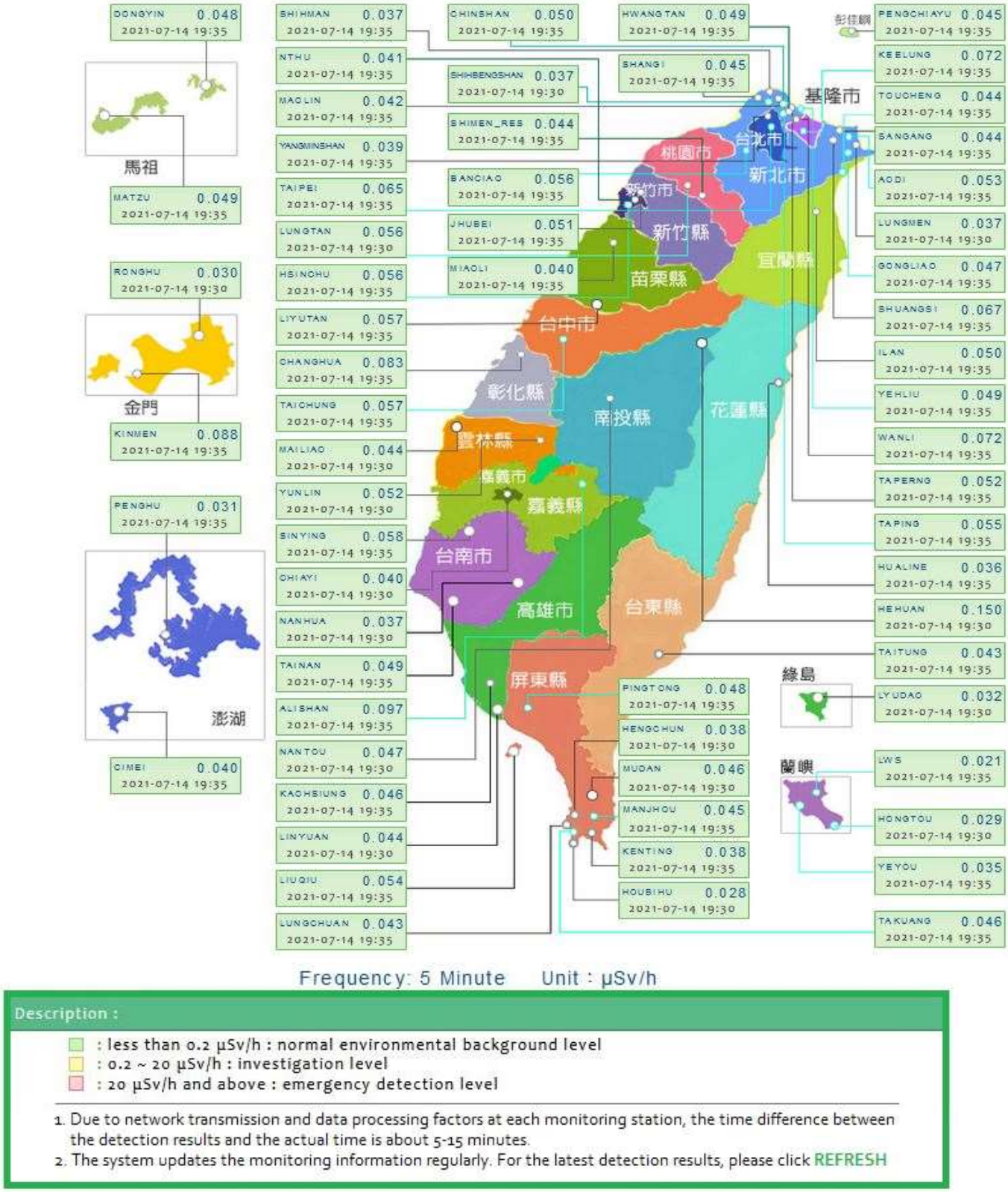


Figure 37: Our Radiation Monitoring Center's real-time environmental radiation monitoring diagram

Security protection enhancement and emergency response drills

(1) Challenges and opportunities

1/ Enhancing the protection of critical infrastructure

After the 9/11 terrorist attacks in the United States, countries around the world have recognized that the targets of terrorism are not limited to government agencies but also include critical infrastructure; how to cause the most severe damage with the least cost has become the most likely approach of terrorists. Nuclear power plants are part of Taiwan's critical infrastructure; a terrorist attack on a nuclear power plant would not only affect the livelihood of the people who rely on electricity but could also lead to a nuclear accident. In the face of terrorist threats, we have requested Taipower to develop and formulate the Security Plan and the Security Incident Response Plan for nuclear power plants to strengthen the implementation of security plans and the effectiveness of nuclear power plant protection. In addition, Taipower has also been requested to establish the Security Maintenance and Natural Disaster Support Agreement with local military, police, and security forces (including the Coast Patrol Corps of the Coast Guard Administration and local police and military units). In the event of a security threat facing a nuclear power plant, actions can be carried out immediately according to the contingency plans (Figure 38). If a threat or crisis has been assessed to be beyond the defense capabilities of the nuclear power plant's resident security guards, the nuclear power plant may request support from nearby police agencies and military units.

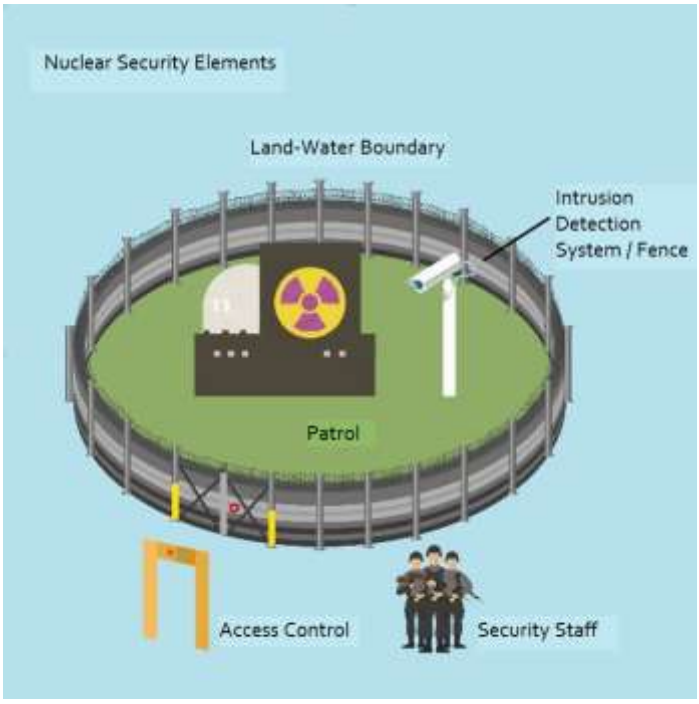


Figure 38: Physical protection for the security of nuclear facilities

2/ Conducting joint nuclear emergency exercises with the central government, local governments, and Taipower

The importance of nuclear power plant safety cannot be overemphasized. In addition to stringent control measures to ensure the operational stability and safety of the reactor units, we also require that all emergency response measures and preparedness be maintained and improved regularly, so that in the unlikely event of an accident, response actions can be properly implemented to reduce the level of damage. The operating licenses for nuclear power plants in Taiwan are expiring successively. If the core fuel cannot be removed in time when the operating license expires, we will request Taipower to maintain the plant's emergency response capabilities by following the control measures observed by an operating nuclear power plant, so as to ensure that no radioactive substances are released into the environment in the event of an accident. In addition, when the nuclear power plant's emergency planning zone has not yet been exempted, nuclear emergency exercises will still be conducted, the scale of the drills will be reviewed in accordance with the plant's risk level, and the inventory of disaster relief resources will be updated, so as to maintain off-site emergency response capabilities.

3/ Power plant emergency drills

Through drills, nuclear power plants can verify the rationality of their contingency manpower allocation and the practicality of their contingency plans and operating procedures. In accordance with the Nuclear Emergency Response Act, nuclear power plants in operation are required to conduct emergency response drills once a year; for decommissioning nuclear power plants with spent fuel still in the spent fuel pool, emergency response drills should also be conducted once a year to ensure that response personnel are familiar with the response mechanism and equipment. Members of the public who are concerned about nuclear power plant safety can also be invited to visit the plants during the drills and, in turn, gain a better understanding of the reinforcing actions taken by nuclear power plants after the Fukushima Daiichi nuclear disaster in Japan (Figure 39).

Figure 39: A contingency exercise at the Technical Support Center at Maanshan NPP in 2021

(2) Policy guidelines and objectives

1/ Enhancing the protection of critical infrastructure

To achieve the robustness of nuclear security protection for nuclear facilities, we request that nuclear power plants establish a complete nuclear security system, including delineating security control zones, tightening access control, intrusion detection, delaying facilities, security police defense, etc. In addition, nuclear power plants are required to strengthen the security checks of employees and contractors to prevent the occurrence of their being taken or used as threats by criminals. Moreover, in response to air threats, the airspace over the nuclear power plants is designated as a no-fly zone; an air warning mechanism and related contingency actions are also established.

To improve the transparency in the operational safety status of nuclear power plants, we have adopted the U.S. Reactor Oversight Process by establishing safety performance indicators for emergency response preparedness and nuclear security monitoring, as well as tracking and evaluating the performance of nuclear power plant emergency response and nuclear security preparedness to ensure the safety of nuclear power plants (Figure 40).

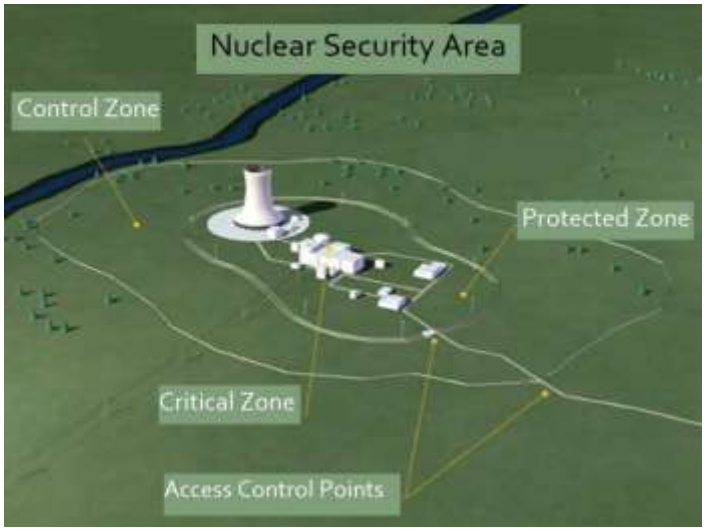


Figure 40: Nuclear security control zones at nuclear facilities

2/ Conducting joint nuclear emergency exercises with the central government, local governments, and Taipower

In accordance with the provisions of the Nuclear Emergency Response Act, we will continuously make joint efforts on nuclear accident emergency response preparedness with central and local governments, as well as with Taipower units; through the verification of annual joint nuclear emergency exercises, we will carry out the refinement and revision of emergency response procedures on a rolling basis to ensure public safety (Figure 41).

Figure 41: Nuclear accident emergency response work division

3/ Power plant emergency drills

In accordance with the Nuclear Emergency Response Act, nuclear power plants in operation are required to conduct emergency response drills once a year to ensure the familiarity of response

personnel with response mechanisms and equipment (Figure 42). The drills cover accident notification and information transmission, emergency response organization and mobilization, accident control and repair, accident impact assessment, nuclear security and counter-terrorism, radiation detection and dose assessment, personnel protective (rescue) actions in facilities, and matters concerning press releases. On the basis of the Guidelines on Performance Indicators for Emergency Response Preparedness, nuclear power plants calculate quarterly performance indicator values by taking into account the classification of emergency accidents in drills or training sessions, timeliness and accuracy of notification, the participation of members of emergency response organizations in key positions in the enhancement of their response experience, regular testing on the public alert system, and the number of successful tests of the alert apparatus.

Figure 42: A power connecting drill by using a 4.16kV power supply vehicle at Chinshan NPP in 2021

(3) Rigorous review and future planning

1/ Enhancing the protection of critical infrastructure

In response to the rising threat of international terrorism and the rapid advancement of criminal technologies facing Taiwan, we have continuously requested that nuclear power plants strengthen their nuclear security and response capabilities (Figure 43). Refinement efforts in recent years have focused on: (1) annual training for military and police supporting units conducted at nuclear power plants; (2) joint tabletop exercises with supporting and collaboration units; (3) promoting training for Taipower's nuclear security professionals; and (4) strengthening the three-level quality assurance review mechanism for nuclear security.

Figure 43: A joint security exercise of a nuclear power plant and an external supporting and collaboration unit

2/ Conducting joint nuclear emergency exercises with the central government, local governments, and Taipower

To raise public awareness of nuclear safety and security, residents in nuclear power plant emergency planning zones are invited to participate in annual nuclear emergency exercises. For wider participation of the public, we work with local governments and invite residents in emergency planning zones to take part in awareness-raising activities and evacuation drills carried out in each village to enhance the residents' knowledge of nuclear safety and security (Figure 44).

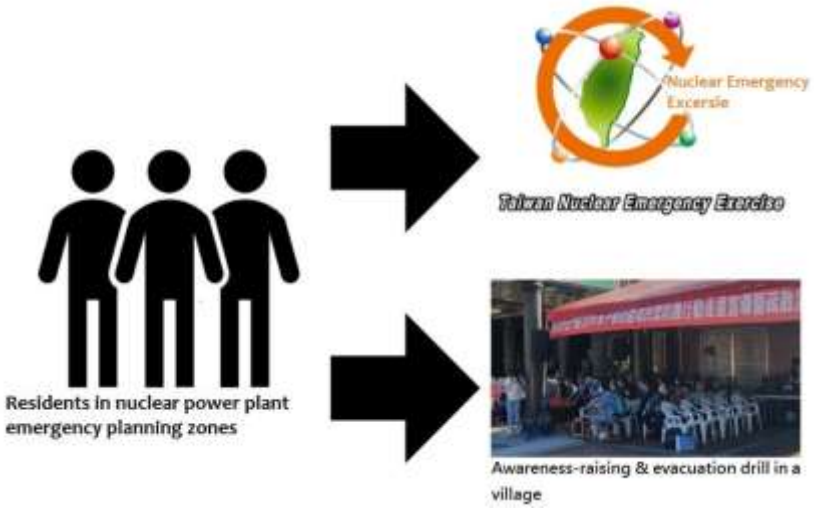


Figure 44: Residents participating in an awareness-raising and evacuation drill in a village

3/ Power plant emergency drill

In the emergency response preparedness meetings at the beginning of each year, we and Taipower conduct in-depth discussions with each nuclear power plant on the issues identified

during the inspections on emergency response planning and preparedness. Before a nuclear power plant conducts a drill, Taipower is required to prepare one to two sets of drill plans for our review and to abide by the confidentiality requirements regarding the drill plan prior to the exercise. To verify whether the response personnel could carry out rescue efforts for reactor units according to the designed drill scenarios and to test the reaction time of the response personnel in the drill, we will also send inspectors to the drill site of each nuclear power plant to inspect the drill and identify deficiencies or give improvement recommendations, which will then be used as a basis for nuclear power plants to review and improve, as well as for the reference of, and improvement for, the other nuclear power plants (Figure 45). Going forward, we will continuously refine exercise plans in response to the impact of nuclear power plants entering the decommissioning phase.

Figure 45: A drill on the rescue of the injured in a radiation incident at Chinshan NPP in 2021

(4) Highlights from the undertaking

1/ Enhancing the protection of critical infrastructure

We supervise the regulatory compliance of nuclear power plants in carrying out annual nuclear security and counter-terrorism drills; we also send inspectors to inspect the drills and make suggestions for improvement. Highlights of the 2021 drills conducted by the nuclear power plants include:

a/ Kuosheng NPP carried out the first joint, script-less tabletop nuclear security exercise with supporting and collaboration units to effectively analyze and explore potential security risks, so as to sustain the core operations of critical infrastructure (Figure 46).

Figure 46: A joint table-top exercise with military and police units at Kuosheng NPP in 2021

b/ Chinshan NPP carried out a full-participation nuclear security and counter-terrorism exercise, simulating the responses made when access control computer systems are hacked by ransomware, and carrying out a joint full-participation exercise with the police and external support units of the Coast Guard Administration, so as to strengthen the response capabilities of its security force (Figure 47).

Figure 47: A full-participation nuclear security and counter-terrorism exercise at Chinshan NPP in 2021

c/ Maanshan NPP conducted the first unscripted joint table-top nuclear security and counter-terrorism exercise for the Coast Guard Administration and local police to examine power plants' response procedures and capabilities for security incidents (Figure 48).

Figure 48: An unscripted table-top nuclear security and counter-terrorism exercise at Maanshan NPP in 2021

2/ Conducting joint nuclear emergency exercises with the central government, local governments, and Taipower

The main purpose of nuclear emergency exercises is to enhance the public's knowledge of nuclear safety and protection and to familiarize them with the government's emergency response measures. Therefore, full-participation off-plant nuclear exercises in recent years have been conducted, using real people, places, and scenarios to facilitate participants in their understanding of the government's emergency response processes in the event of a nuclear accident. Among these exercises, the 27th Nuclear Emergency Exercise, taken place in 2021, used Chinshan NPP that is in the process of being decommissioned as the target. The exercise examined the multiplicity and diversity of water and power sources provided by the NPP for unit rescue, and tested the capabilities of emergency responses of organizations outside the NPP in maintaining environmental radiation monitoring and sampling, ensuring that nuclear disaster response capabilities are maintained despite the pandemic (Figure 49).

Figure 49: The 27th Nuclear Emergency Exercise in 2021 to test the capabilities of a radiation monitoring center in maintaining environmental radiation monitoring

3/ Power plant emergency drills

The highlights of recent drills at nuclear power plants include:

a/ Emergency mobilization response:

In the drill script, personnel on-duty (including those from the firefighting shift) carried out response actions so that the effectiveness of on-duty manpower could be examined; then each response center carried out their respective responses.

b/ Accident control and emergency repair:

Scenarios based on which drills were carried out include power loss at a technical support center; switching to gasoline generators for power supply in response to battery depletion; supplying power with power supply vehicles to critical busbar in response to a Station Black Out (SBO); and response to volcanic ash.

c/ Drill on radiation injury:

A drill on radiation injury rescue, notification, and transportation to a hospital was conducted.

d/ Drill on disinformation clarification:

A drill on verifying the source of information with existing organizations and clarifying to the public to counteract the disinformation was conducted.

When a drill on nuclear power plant emergency response plan is carried out in conjunction with an off-plant nuclear emergency exercise, the public and all of those who are concerned about the safety of nuclear power plants are invited to the plant so that they could gain a better understanding of the plant's preparedness for emergency response.

In addition to testing the emergency response capabilities of the members of nuclear power plant emergency response teams and their proficiency in executing ultimate response measures, a drill on the nuclear power plant emergency response plan also verifies the capabilities of the nuclear power plant in emergency response commanding and dispatching with only on-duty personnel during holidays. During the drills, relevant emergency response equipment is also examined to see if the quantity and functions of the equipment are sufficient to meet the requirements in the event of an incident; the applicability of the Nuclear Power Plant Emergency Response Plan is also determined.

Moreover, in addition to the designed drill scenarios based on the emergency response plan, we will also give three to four additional no-warning drill scenarios in order to examine the emergency response capabilities of nuclear power plant personnel. In general, nuclear power plant emergency response personnel have been able to handle these sudden situations following emergency response procedures. We will continuously increase the number of no-warning drill scenarios to strengthen power plants' emergency response capabilities.

On the whole, nuclear power plants have carried out drills following emergency response procedures in terms of response by on-duty personnel during holidays, executing ultimate response measures, using the emergency backup power supply, rescuing and transporting the injured, commanding and coordinating affairs conducted by Taipower's emergency management committee, conducting incident evaluation, giving press releases, and conducting public consultation (Figure 50). We will continue to urge Taipower to improve its response capabilities and strengthen its response actions to ensure the safety of the public and the maintenance of their living environment.

Figure 50: A rehearsal for a press conference at the Emergency Public Information Center at Chinshan NPP in 2021

4/ Nuclear accident emergency preparedness and response capacity for the safeguarding of radiation safety: Helicopters carrying out drills on aerial radiation detection with integrated technologies

An important part of the government's disaster prevention system is to prevent the occurrence and expansion of nuclear accidents. This requires active preparedness and drills conducted on a regular basis. To ensure prompt and effective responses and dispatches in the event of a nuclear disaster, we have collaborated with relevant ministries, councils, and local governments in 2021, assessing our manpower, materials, and measures in the event that our NPPs suffer the most severe damage possible. On the basis of such assessments, the Nuclear Emergency Response Project Consolidation Report was prepared (Figure 51).

To ensure the effectiveness of our disaster responses, protect personnel radiation safety, and reduce the effects and risks of the COVID-19 pandemic in the event of a nuclear disaster during the COVID-19 pandemic, we have called for nuclear disaster-related units to hold relevant discussions, and improved our response mechanisms by formulating nuclear disaster response-related pandemic prevention measures and precautions in accordance with the recommendations made by the Central Epidemic Command Center. The aforementioned assessment results and pandemic response guidelines were used at the 27th Nuclear Emergency Exercise in 2021 to facilitate continued improvement.

Figure 51: Nuclear emergency response project consolidation report and nuclear disaster response guidelines during the COVID-19 pandemic

F. Promoting communication with society on nuclear waste disposal and enhancing the awareness of a nuclear-free homeland (all divisions and affiliated agencies)

1) Challenges and opportunities

Taiwan's nuclear power generation facilities were commissioned in 1978. After 40 years of operation, they are now entering the decommissioning stage. In addition to the technical aspects concerning the safety of decommissioning, other related issues also arise from decommissioning, such as nuclear waste management, the rights of local residents where nuclear power plants are located, and the selection of nuclear waste sites. The issues arising from the decommissioning of nuclear power plants are complex and intertwined, while multiple stakeholder groups are involved. Therefore, the government, especially the executive units which are responsible for the decommissioning of nuclear power plants and nuclear waste management, should plan for public participation before the decommissioning and fully communicate the policies with the public to gain their support and trust.

The goal of decommissioning programs is foremost to remove radioactive and non-radioactive hazardous substances associated with a nuclear facility or the operational system from regulatory control; during the removal process, workers, the general public, and their living environment must be protected. In other words, the purpose of decommissioning a nuclear facility is for it, once out of service, to be free

from not only regulatory control but also from responsibilities regarding safety issues. Therefore, the decommissioning plan of nuclear power plants must adopt both technical and democratic actions; in particular, the decommissioning plan needs to incorporate appropriate communication on policies and greater participation from the public.

Following the policy initiative of a Nuclear-Free Homeland, the "decommissioning of nuclear power plants" formally entered the policy agenda in 2016. However, there lacks a clear consensus regarding nuclear waste disposal among various stakeholders. Therefore, it is important to effectively provide sufficient policy information and participatory communication channels, not only to emphasize democratic values and procedural justice but also to gain public support and confidence in the policy management process and build mutual trust and cooperation between the public and the government.

(2) Policy guidelines and objectives

1/ Enhancing public participation and its effectiveness through our Committee on Public Participation

Nuclear safety is a concern of the general public; central to this are issues such as nuclear power plant decommissioning, nuclear waste disposal, nuclear disaster emergency response and public protective actions, environmental radiation monitoring, and atomic energy application in people's lives and related radiation safety. As such, we should not be limited to conducting public participation activities only for regulatory information; we should also take the initiative in examining mechanisms for public participation and public communication in order to listen to the opinions of all sectors and gain the trust and support of the public.

For this reason, we have formulated the Guidelines for the Committee on Public Participation and appointed experts and academics with relevant expertise in public participation or public communication, impartial social representatives, and representatives of civil groups to serve as members of the Committee and provide consultation and advice to us in terms of public participation and communication so that the spirit of an open government can be realized in the process of policy communication.

2/ Expanding communication with the public through atomic science fairs

Information about atomic energy safety has always been an issue of public concern, but it is indeed difficult information for the public to understand. Therefore, in addition to public participation activities on regulatory safety and control, we also recognize that science fairs not only serve the functions of public communication, but also facilitate the public's understanding of atomic energy and promote information transparency, which will then enhance the space and quality of social dialogue. To that end, we have actively organized atomic science fairs that incorporate popular scientific knowledge about radiation and nuclear safety, regulatory control, and R&D results into interactive experiencing activities and games with videos and plain-language

explanations in order to help people of all ages learn about atomic energy and green energy through fun activities.

Moreover, the science fairs also offered opportunities for senior high school students to serve as guides as a way to enrich their learning portfolio and introduced a learning sheet reward mechanism for elementary school students from the surrounding areas of science fairs, so as to help generate students' interest in atomic science. We have also made use of live broadcasts on social media to expand the reach and popularization of science.

3/ Public communication in the Lanyu area for dry storage facilities

To actively enhance public participation, we continue to conduct parallel monitoring activities on environmental radiation in the Lanyu area with the objectives of information disclosure, public participation, and third-party verification of sampling and analysis. Prior to the event, local resident groups and public and private organizations at all levels were invited to participate in the parallel monitoring activities in Lanyu. We have also made all parallel monitoring analysis reports from the past available on our website for public access.

To accommodate the understanding of local residents about the decommissioning of Chinshan NPP and the safety of dry storage facilities, as well as to fully realize public participation and information disclosure, we continue to organize Site Visits to Chinshan NPP Decommissioning and Dry Storage Facilities. Officials from New Taipei City Government and Shimen District, village chiefs and district affairs advisers of Shimen District, and representatives from environmental groups were invited to take part in the on-site visits. During the visits, participants' opinions and suggestions were taken, and discussion sessions were held; it is hoped that through these visits, the public could gain a sufficient understanding, and, in turn, feel at ease and reassured.

(3) Rigorous review and future planning

With regard to atomic science fairs, we have planned to organize three science fairs in Taipei, Taichung, and Pingtung in 2021; we are also planning to organize science exhibition tours in Hengchun Township and Manzhou Township, Pingtung County. Furthermore, we have also contacted the Ministry of Science and Technology to organize science-train exhibitions and planned to co-host a science exhibition with Beitou Hot Spring Museum.

The continuous and increasing efforts on popular science education and communication will be carried out according to the planning. In addition to maintaining a neutral and professional attitude in communicating with all sectors of the public, we are also actively and optimally complying with the spirit of an open government through the setup of the Committee on Public Participation to make regulatory information open and transparent for the public and expand public participation in atomic energy-related matters in a practical manner, so as to safeguard the public's right to "know." In addition, we will

step up our efforts to enhance the effectiveness of public participation through communicating with the public in atomic science activities about nuclear accident preparedness, the Lanyu area, and dry storage facilities.

(4) Highlights from the undertaking

1/ Promoting parallel monitoring in Lanyu

To actively enhance public participation, we have conducted parallel monitoring activities on environmental radiation in the Lanyu area for 10 consecutive years, with the objectives of information disclosure, public participation, and third-party verification of sampling and analysis. Prior to the events, the Council of Indigenous Peoples, Taitung County Government, Lanyu Township Office, Lanyu Township representatives, village chiefs, local environmental groups, and residents were all invited to take part in the parallel monitoring activities of environmental radiation in Lanyu. During the sampling stage, sampling locations were designated by the participants as was customary, and sets of environmental samples comprising agricultural products, soil, water, and grass were taken in each of the six Lanyu tribes (Figure 52). Sample testing and analysis were conducted by the Nuclear Science and Technology Development Center of National Tsing-Hua University, which has been accredited by the Taiwan Accreditation Foundation (TAF). Since 2011, no abnormal radiation has been detected in the environmental samples collected in the Lanyu area. All data and the derived radiation doses were within the variation range of background radiation.

Figure 52: A parallel monitoring activity on environmental radiation in the Lanyu area - collecting water and grass samples

2/ Visits to Chinshan NPP dry storage facilities by the public

Chinshan NPP entered the decommissioning phase in July 2019. The primary task for nuclear power plant decommissioning is to transfer spent nuclear fuel in nuclear reactors and spent fuel pools to dry storage facilities, following which subsequent decommissioning and dismantling of the plants may proceed. Taking into account relevant practices adopted in countries with advanced nuclear energy development, Taipower proceeded with the planning of constructing indoor dry storage facilities for spent nuclear fuel. To improve public understanding about the

decommissioning of Chinshan NPP and the construction timelines and quality of dry storage facilities, as well as to fully realize public participation and information disclosure, we continuously organize Site Visits to Chinshan NPP Decommissioning and Dry Storage Facilities (Figure 53). As of the end of 2021, 18 site visits have been organized and completed. Officials from New Taipei City Government and Shimen District, village chiefs and district affairs advisers of Shimen District, and representatives from environmental groups were invited to take part in the site visits. The representatives conducted field visits to understand the decommissioning progress; they were also invited to inspect an integration exercise at the Phase I outdoor dry storage facilities and visit the scheduled site of Phase II indoor dry storage facilities (Figures 54 and 55); their suggestions were also duly noted. Information about the visits and the status of the issues raised by the representatives, including the decommissioning plan, the safety of dry storage facilities, and public communication improvement, were also published on our website to meet the objective of information disclosure, whereby the public could gain a clear understanding and feel at ease and reassured. In the spirit of the AEC of the people, we will remain persistent in promoting public participation and public communication.

Figure 53: A briefing session at a site-visit

Figure 54: A field visit to Phase I dry storage facilities

Figure 55: A field visit to the scheduled site of Phase II indoor dry storage facilities

3/ Raising public awareness on the final disposal of radioactive waste: Popular science activities on the final disposal technologies of radioactive waste

To strengthen safety regulatory control on the final disposal of radioactive waste, increase public awareness on the safety requirements for nuclear waste disposal, and enhance the effectiveness of public communication, it is necessary to use simple and easy-to-understand concepts in conjunction with accessible and lively presentations so that the public can understand easily and, in turn, gain more confidence in the final disposal of nuclear waste in Taiwan.

Nuclear waste final disposal is of great concern to the public. Our INER has produced animated videos and publications to explain the source of radioactive waste and the concept of safe disposal and to share information about international experiences in disposal sites from safety and scientific perspectives. Through the display of models, the INER also hopes that the public will have a solid impression of how future disposal facilities may look and operate and what key functions the disposal facilities may have to ensure their long-term safety.

We strive to reach out to the public and use plain language to explain to them safety concepts concerning nuclear waste disposal and have organized the following popular science activities:

a/ An Atomic Science Fair was held at Taipei Huashan 1914 Creative Park from February 15 to 17, 2019.
b/ An exhibition event was held at the atrium of Big City Shopping Center in Hsinchu from August 1 to 2, 2020 (Figure 56).
c/ An exhibition event was held at the activity center of Changhua County Hemei Senior High School from August 22 to 23, 2020.
d/ An exhibition event was held at Taipei Huashan 1914 Creative Park from October 9 to 12, 2020.
e/ A popular science fair, "Atomic Energy for a Greener World," took place at the outdoor plaza of Tiger City Shopping Center in Taichung from April 17 to 18, 2021 (Figure 57).
f/ A popular science fair, "Falling in Love with Atomic and Green Energy, a World and Technology Carnival", was held with the Pingtung County Government at the Qianxi Park on December 3, 2021.

The utilization of models, animations, posters and leaflets, games, guide services, and Internet celebrity live broadcasts attracted the public, who enthusiastically participated and gained a deeper understanding of the issues related to final disposal. We hosted the Atomic Energy Council Online Popular Science Event from October 18 to December 10, 2021, using online interactive courses to teach students about spent nuclear fuel and nuclear waste processing procedure as well as other related atomic energy popular science information, making these popular science fairs a great success in promoting popular science education of a nuclear-free homeland.

Figure 56: An Atomic Mobile Castle Science Fair held in Hsinchu in 2020

Figure 57: An Internet celebrity attracting enthusiastic participation of visitors at an Atomic Science Fair held in Taichung in 2020

Chapter 5. Summary and Future Outlook

2021 was a special year and one where COVID-19 turned the world, including Taiwanese citizens' lives and living environments, upside down. It demonstrated the importance of promoting sustainable development. This year, we compiled the AEC Voluntary Departmental Review while engaging in various COVID-19 pandemic prevention endeavors, such as supervising nuclear energy radiation protection practitioners' pandemic prevention measures that strengthened people's safety protection and reduced the risks and impact of the pandemic; and completing the various sustainable development activities stipulated in "Goal 18: Achieve the goal of creating a nuclear-free homeland as stipulated in the Basic Environment Act." Additionally, we presented our achievements in the aforementioned areas.

Sustainable development can only be achieved by implementing planned actions in people's daily lives. Our key business focuses are nuclear safety protection and nuclear waste treatment. These two focuses echo the Taiwan Sustainable Development Goals and are people's projects and responsibilities from generation to generation. This year, our Voluntary Departmental Review achievements were the following: promote the decommissioning of NPPs in compliance with the law; continue to promote the selections of sites for establishment of low level radioactive waste final disposal facilities, allowing the Lanyu Storage Site to relocate quickly and smoothly; promote high level radioactive waste final disposal facility site establishment-related legal operations, assisting the decommissioning of NPPs; enhance the safety protection of nuclear energy facilities; and promote nuclear waste disposal-related social communication and improve the education on and promotion of creating a nuclear-free homeland. These achievements illustrate our results and highlights in promoting sustainable development.

In the future, we will continue to improve, practice information/open information disclosure and the concept of "open government," expand the concept of sustainable development outwards, establish public participation platforms and public participation committees, and accept suggestions from all domains when performing regular future reviews and updates.

We will continue to regularly update and submit our Voluntary Departmental Review. By making improvements and revisions annually, following international development trends, adjusting our various strategies and actions for improvement, possessing professional technology, strictly implementing our various control tasks in accordance with the law, ensuring radiation and nuclear energy safety, considering and solving problems from the perspective of the general public, and meeting the expectations of the public, we will transform into an "AEC for all."