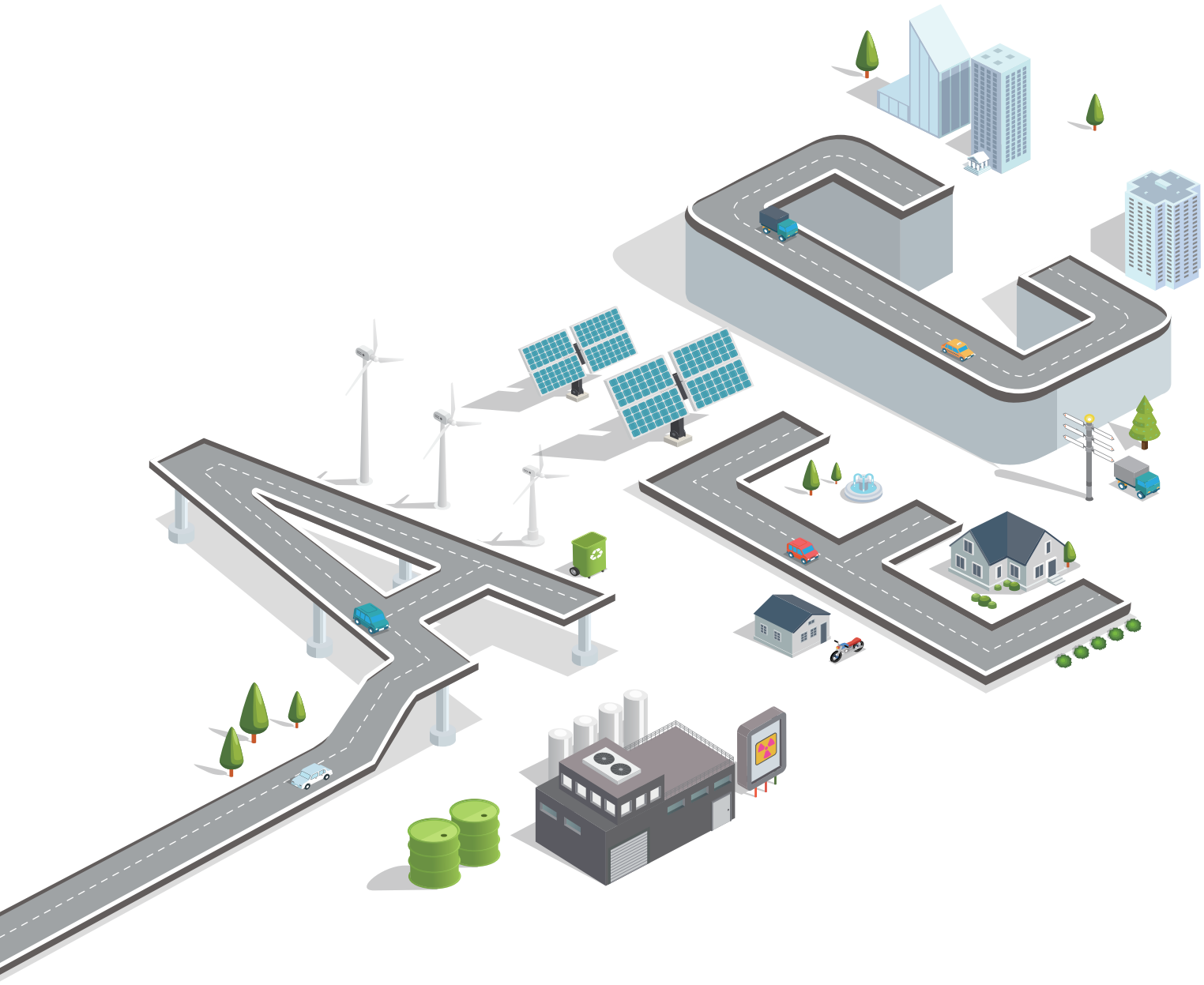
2020 Annual Report

行政院原子能委員會
109 年年報

Atomic Energy Council, Executive Yuan

行政院原子能委員會　編印

行政院原子能委員會
Atomic Energy Council, Executive Yuan



2020 109年年報 Annual Report

全民的原能會 核安的守護者
AEC of the People Guardian of Nuclear Safety

行政院原子能委員會　編印

原能會願景

Words from the Chairman

主委的話

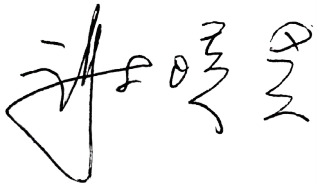
原能會是原子能管制機關，負責核能安全、輻射防護、緊急應變以及放射性廢棄物安全的監督，同時也肩負原子能科技在民生應用的研究發展。現階段原能會的重要使命是除役和核廢，核一廠已經開始進行除役工作，核二廠除役計畫的審查作業也已經完成了，110年核三廠除役計畫也將送原能會審查，在除役的進程上邁出了一大步。

綜觀109年原能會完成了核二廠除役計畫的審查作業；督促蘭嶼做好重裝安全管制，以為蘭嶼遷場之準備；擴大執行輻射屋居民1~5毫西弗健康檢查；強化非破壞照相檢驗業的安全管制；全國輻射自動監測站總數達到63站，讓全國輻射偵測網更為綿密；緊急投入生產核醫藥物，造福25000餘民眾健康；以AI技術合成瑞德西韋抗病毒藥物等技術等。

此外，原能會秉持著資訊應該公開透明的原則，更積極主動提供全民參與及瞭解原子能相關資訊的機會，重要的工作包括，融入地方特色自辦三場原子能科普展；另為使心智障礙者了解核子事故民眾防護訊息，完成易讀版的指引；此外更進一步籌設了全民參與委員會，透過開放監督，邀請專家學者、社會公正人士或民間團體的參與，提供我們有關民眾溝通事務的建言。

原能會一貫的主張就是要嚴守中立、秉持專業及資訊公開透明，以獲得民眾的信任與支持，109年雖然受疫情的影響，但原能會仍能在兼顧防役的同時，盡力做好安全管制和資訊公開的業務。期許未來原能會也能在過去奠定的基礎上精益求精，努力扮演好全民的原能會，以及核安守護者的角色。

主任委員



The Atomic Energy Council (AEC) is the atomic energy regulatory agency, which is responsible for overseeing nuclear safety, radiation protection, nuclear emergency response, and radioactive waste management. It also assumes the responsibility for research and development in the application of atomic energy technology for domestic purposes. Currently, its important missions are nuclear decommissioning and waste management. The decommissioning of the Chinshan Nuclear Power Plant is underway, while the review of the decommissioning plan of the Kuosheng Nuclear Power Plant has been completed. In 2021, the decommissioning plan of the Maanshan Nuclear Power Plant will be submitted to the AEC for review. All of these decommissioning progresses show that a significant step has been made.

In 2020, the AEC completed the review of the decommissioning plan of the Kuosheng Nuclear Power Plant; oversaw the safety regulation of repackaging work at the Lanyu Storage Site, so as to prepare for its relocation; increased physical checkup among people from 1 to 5 mSv of radiation dose; improved the safety regulation of the non-destructive radiographic testing industry; increased the total number of automated environmental radiation monitoring stations across Taiwan to 63, thereby providing Taiwan with a denser radiation detection net; urgently invested in the production of nuclear medicine, bringing health benefits to more than 25,000 people; and applied AI optimization process to synthesize the remdesivir antiviral drug.

Upholding the principle of open and transparent information, the AEC takes initiatives in providing all citizens with a chance to understand information on atomic energy. It has carried out the following important tasks: organizing three atomic energy science fairs that incorporate local features; completing the easy-to-read version of the guidelines for public protection in a nuclear accident so that people with intellectual disabilities can understand relevant information; and setting up the Public Participation Committee, in which experts and scholars, as well as representatives of social justice or private organizations, were invited to participate to provide advice on public communication affairs via open supervision.

The AEC's long-lasting belief is to maintain neutrality, uphold professionalism, and provide open and transparent information to gain the public's trust and support. In 2020, although affected by the pandemic, AEC remained committed to tasks regarding safety regulation and open information, while implementing epidemic prevention measures. AEC will continue to successfully develop from the foundation laid in the past, playing the role of "AEC of the people" and the "Guardian of Nuclear Safety."

Minister and Chairman

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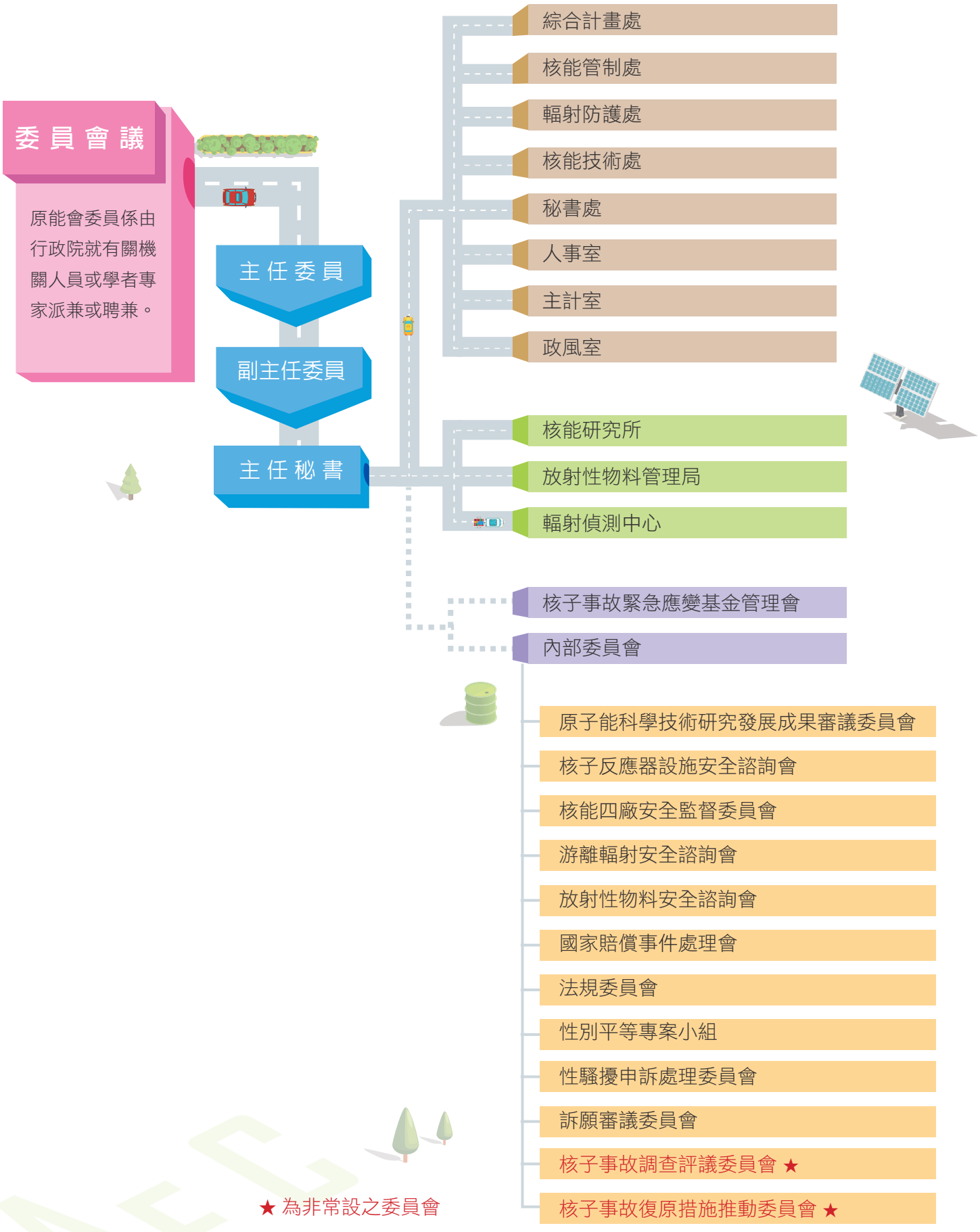
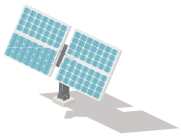

委員會議
原能會委員係由行政院就有關機關人員或學者專家派兼或聘兼。
主任委員
副主任委員
主任秘書
綜合計畫處
核能管制處
輻射防護處
核能技術處
秘書處
人事室
主計室
政風室
核能研究所
放射性物料管理局
輻射偵測中心
核子事故緊急應變基金管理會
內部委員會
原子能科學技術研究發展成果審議委員會
核子反應器設施安全諮詢會
核能四廠安全監督委員會
游離輻射安全諮詢會
放射性物料安全諮詢會
國家賠償事件處理會
法規委員會
性別平等專案小組
性騷擾申訴處理委員會
訴願審議委員會
核子事故調查評議委員會 ★
核子事故復原措施推動委員會 ★

★ 為非常設之委員會

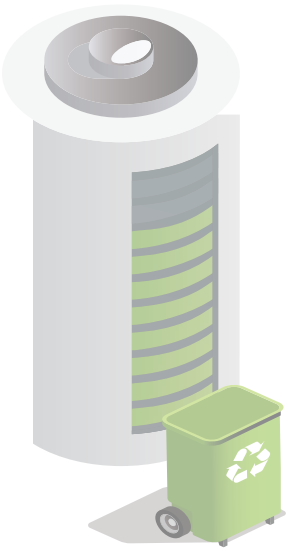


Council member meetings

The Atomic Energy Council members are appointed by the Executive Yuan from the personnel of relevant government, agencies, scholars or experts.

- Minister
- Deputy Minister
- General Secretary

- Department of Planning
- Department of Nuclear Regulation
- Department of Radiation Protection
- Department of Nuclear Technology
- Secretariat
- Personnel Office
- Accounting Office
- Government Ethics Office
- Institute of Nuclear Energy Research
- Fuel Cycle and Materials Administration
- Radiation Monitoring Center
- Nuclear Emergency Response Foundation
- Internal Council Member Committee, Consultation Committee
  - 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 Handing of State Compensation Cases
  - Advisory Committee on Nuclear Legislation
  - Gender Equality Committee
  - Complaints Committee against Sexual Harassment
  - Appeal Review Committee
  - Nuclear Accident Investigation and Evaluation Committee ★
  - Nuclear Emergency Recovery Committee ★



★ not-standing committee

第參章

人力與經費

Manpower and Budget

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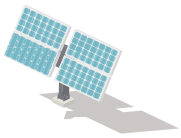
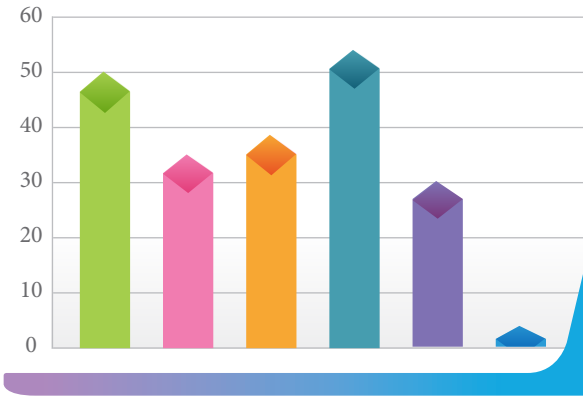
行政院原子能委員會 會本部



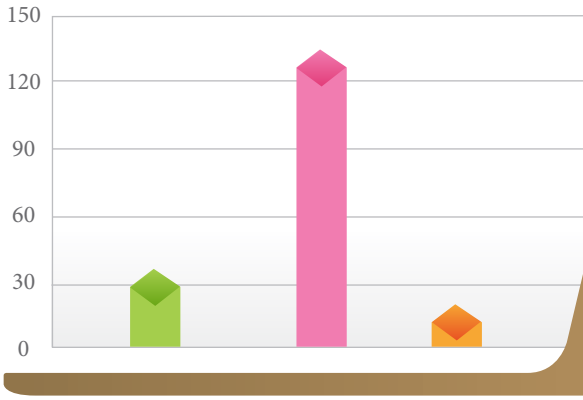
（一）109年度職員（含聘用人員7人）業務性質分配



一般行政	50 人（24.3%）
原子能科學發展	34 人（16.5%）
游離輻射安全	39 人（18.9%）
核能設施安全管制	52 人（25.2%）
原子能技術應用	30 人（14.6%）
核能管制技術研究	1 人（ 0.5%）

合計：206 人

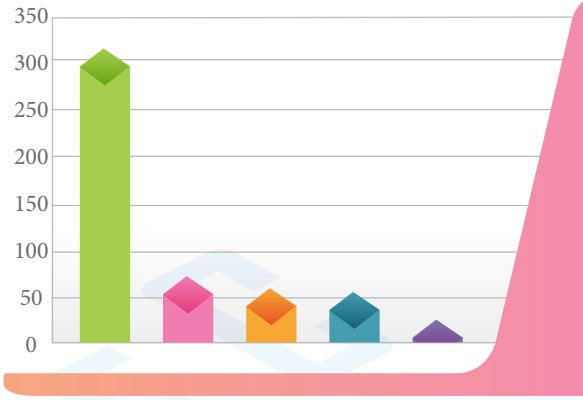
（二）109年度職員官等分配



簡任人員	34 人（17.0%）
薦任人員	144 人（72.4%）
委任人員	21 人（10.6%）

合計：199 人

（三）109年度經費支用概況

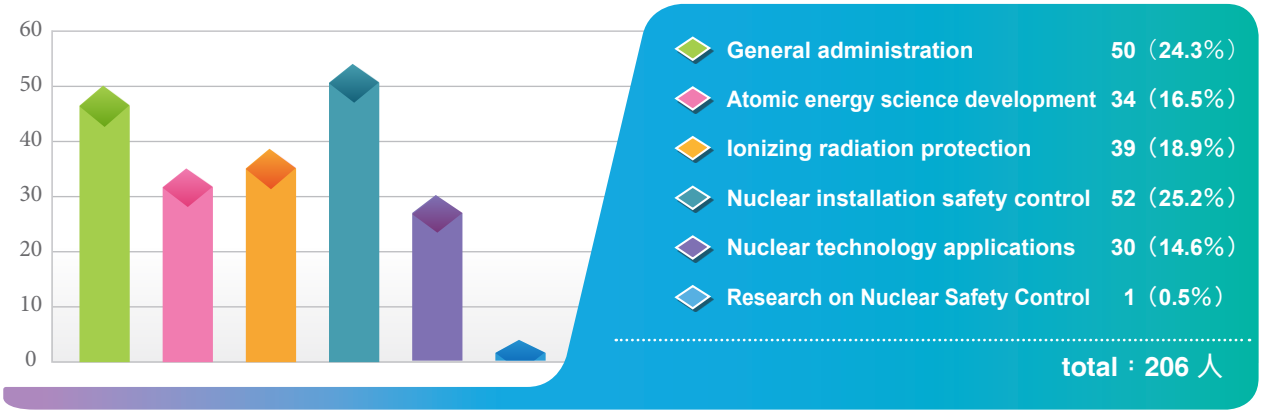


一般行政	316,269 千元（62.07%）
原子能科學發展	66,871 千元（13.13%）
游離輻射安全防護	55,447 千元（10.88%）
核能設施安全管制	54,973 千元（10.79%）
核子保安與應變	15,960 千元 （3.13%）

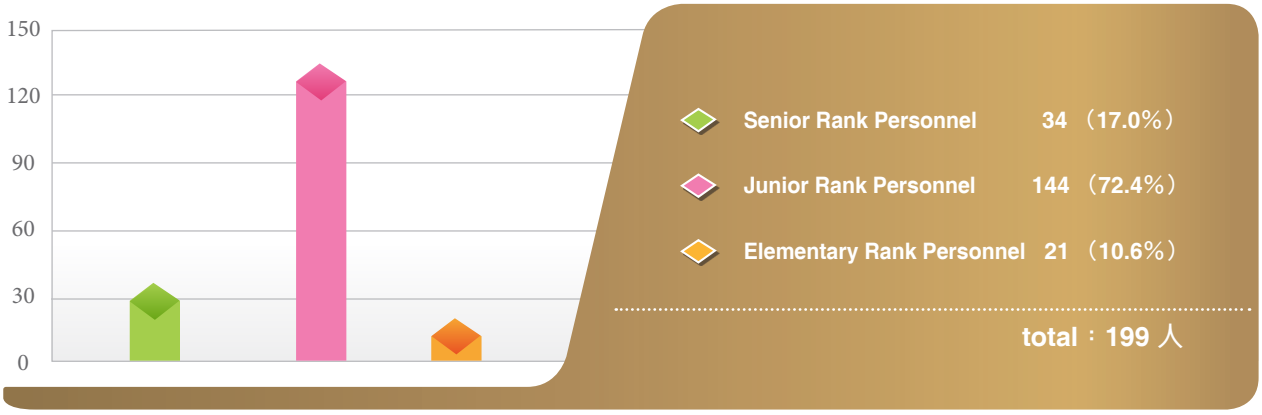
合計：509,520 千元

The Atomic Energy Council Headquarter

A. 2020 Human Resources Breakdown (Including seven hiring staffs)



B. 2020 Employee Ranking Breakdown



C. 2020 Budget/Expenditure Allocation

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重要施政成果

Important Governance Outcomes

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一、透明管制資訊 多元民眾參與

（一）開放監督 強化公眾參與除役乾貯安全管制

為增進地方民眾對於核一廠除役作業及乾貯設施安全的了解，充分落實公眾參與及資訊公開，原能會於 109 年 8 月 5 日持續辦理第 17 次「核一廠除役及乾式貯存訪查活動」。該活動邀請新北市政府、石門區公所、里長、區政顧問及環保團體等代表參加。

為確保乾貯設施之作業安全，原能會持續要求台電公司於 109 年度辦理乾貯設施統合演練作業，以維持作業人力及技術能量，為熱測試提前部署與做好萬全準備。當次訪查活動由台電公司簡報「核一廠除役作業現況」及「核一廠乾貯設施 109 年度統合演練作業執行成果」，並邀請訪查代表實地現勘二期乾貯設施預定地。訪查後會議，由原能會與台電公司針對與會代表之提問進行答復說明，並充分聽取建言。訪查活動有關訊息及訪查活動代表所提除役規劃、乾貯設施安全、強化公眾溝通等議題之辦理情形，亦登載於原能會網站，以落實資訊公開透明，讓民眾充分瞭解、安心、放心。

核一廠已於 108 年 7 月正式進入除役階段，原能會將持續嚴格督促台電公司依除役計畫規劃執行相關作業，以確保如期如質於 25 年期限內完成除役作業。因用過核燃料目前仍置於反應器與用過燃料池內，原能會持續要求台電公司積極與新北市政府溝通並取得共識，儘早啟用一期乾貯設施，以順遂除役拆廠作業。另行政院已於 108 年 8 月核定二期室內乾貯設施投資可行性評估報告，原能會將依據時程規劃，督促台電公司切實推動相關申照與興建作業。原能會是全民的原能會，將持續推動公眾參與，做好公眾溝通。

核一廠除役及乾式貯存訪查活動會議
Site visit meeting on Chinshan NPP decommissioning and dry storage facilities

(I) Enhancing Regulatory Information Transparency to Diversify Public Engagement

A. Openness for scrutiny: facilitating public participation in dry storage safety regulation during the decommissioning period

With a view to improving local communities' understanding for the operations of decommissioning and safety of dry storage facilities of Chinshan Nuclear Power Plant (NPP), as well as to implement public participation and information disclosure, AEC initialized the "17th Public Observation Program for the Decommissioning and Dry Storage Facilities in Chinshan Nuclear Power Plant" on August 5, 2020. Officials from New Taipei City Government and Shimen District Office, village chiefs and district affairs advisers of Shimen District, and representatives from environmental groups were invited to participate.

To ensure the safety of the dry storage facilities, Atomic Energy Council (AEC) requested Taipower Company (TPC) to conduct a dry-run practice for dry storage facilities in 2020, which would serve to maintain its technical capabilities and well prepared for the hot test. During the public observation activity, TPC gave a presentation on the "Current Status of the Decommissioning of Chinshan Nuclear Power Plant" and "Implementation consequent of the dry-run practice of the dry storage facilities ." The representatives were then invited to site visiting at the designated site of the phase two dry storage facilities. In the post-visit meeting, AEC and TPC responded to concerns praised by the members, including the decommissioning plan, safety of the dry storage facilities, and public communication improvement. All the information of the public observation activity was published on the official website of AEC, whereby the public could gain a clear understanding.

Chinshan NPP officially entered the decommissioning phase in July 2019. AEC continually supervise the decommissioning activities to ensure that the decommissioning will be completed within 25 years in accordance with the timeline and quality requirements. Currently, the spent fuels are still stored in the reactor and spent fuel pools, AEC has requested that TPC should actively communicate with New Taipei City Government to reach a consensus and start the phase one dry storage facility as quick as possible. In addition, the Executive Yuan approved the investment feasibility assessment report of the phase-two indoor dry storage facilities in August 2019. AEC will urge TPC to make substantial efforts in relevant permit applications and construction work in a proper timely manner. In the spirit of people's AEC, it will persist in promoting public participation and public communication.

核一廠除役及乾式貯存訪查活動現勘二期乾貯設施預定地
Field visit at the designated site of phase-two dry storage facilities during the site visit to Chinshan NPP decommissioning and dry storage facilities

（二）民眾參與 推動蘭嶼地區環境平行監測活動

為積極強化公眾參與，原能會於 109 年 4 月 28 至 29 日連續第 10 年辦理蘭嶼地區環境平行監測作業，目的為落實資訊公開、強化民眾參與及第三者驗證取樣偵測分析，於活動前邀請原住民族委員會、台東縣政府、蘭嶼鄉公所、鄉代會、各村村長、當地環保團體及鄉民一同參加本次蘭嶼環境平行監測活動。

鑒於 COVID-19（武漢肺炎）疫情，避免室內人群聚集，109 年度蘭嶼環境平行監測活動取消作業前說明會，改採用寄送作業說明簡報的方式，讓參與人員瞭解現場採樣之作業流程及方式。採樣期間，依照往例由參與民眾指定地點進行採樣，分別採集蘭嶼六個部落的農產品、土壤、水樣及草樣等環境試樣。各試樣檢測分析工作委由通過「全國認證基金會」（TAF）認證之國立清華大學原科中心執行，另同時分送樣品至原能會輻射偵測中心及台電公司放射試驗室進行計測分析，俾利比對驗證。

試樣完成分析後，由清華大學原科中心直接寄送分析結果報告至所有邀請參與單位，包含原民會、台東縣政府、蘭嶼鄉公所、鄉代會、各村辦公室及當地環保團體，原能會亦將 109 年度蘭嶼地區環境平行監測分析結果報告公開於網站，供民眾閱覽。自 100 年起歷年的蘭嶼環境試樣分析結果，均在背景劑量變動範圍內，沒有發現輻射異常。

1 2

1. 蘭嶼地區環境平行監測活動-採集水樣
   Parallel Monitoring Activity on Environmental Radiation in Lanyu Area: collecting water samples
2. 蘭嶼地區環境平行監測活動-採集草樣
   Parallel Monitoring Activity on Environmental Radiation in Lanyu Area: collecting grass samples

（三）與你有個約會 原子能科普活動

生活中處處可見環境游離輻射，原能會為增加民眾獲取原子能相關資訊之管道，提升參與原子能公共事務的意願，除持續參與國立臺灣科學教育館科學巡迴教育活動及 2020 第一屆臺灣科學節外，還自辦 3 場原子能科技科普展，前兩場分別於新竹巨城購物中心及彰化縣和美高中辦理，以原子能科學移動城堡為概念，並結合周邊國小學生的暑期學習獎勵及融入地方特色，讓科普活動走出都會區。此外，也首次開辦高中生解說服務的學習歷程申請，鼓勵學生學習原子能科普知識，並有 5 位彰化縣立和美高中學生，將擔任解說員心得化為文字登載於核能簡訊雙月刊，值得肯定。

B. Public participation: promoting local involvement in the parallel monitoring activity on environmental radiation in the Lanyu Area

To meet the objectives of information disclosure, public participation, and environmental radiation sampling and analyzing by a third party, AEC organized the Parallel Monitoring Activity on Environmental Radiation in Lanyu Area for the 10th consecutive year from April 28 to 29, 2020. Officials from the Council of Indigenous Peoples, Taitung County Government, Lanyu Township Office, and Lanyu Township Representative Council, village chiefs, representatives from local environmental groups, and residents were invited to take part in environmental radiation sampling processes in Lanyu.

In view of the COVID-19 pandemic and the need to avoid indoor gathering, this year's briefing session for the parallel monitoring activity on environmental radiation in Lanyu was cancelled. Instead, a briefing on procedures was mailed in advance to facilitate participants' understanding of the sampling procedures and methods. During the sampling stage, sampling locations were designated by the participants as was the case in previous years, and sets of samples comprising agricultural products, soil, water, and grass were taken in each of the six Lanyu tribes. Sample analysis was conducted by the Nuclear Science and Technology Development Center (NSTDC) of National Tsing Hua University (NTHU), which has been accredited by the Taiwan Accreditation Foundation (TAF). Other sets of samples were also sent to AEC's Radiation Monitoring Center and Taipower's Radiation Laboratory, respectively, for analysis, comparison and validation.

Once the analysis was completed, the results were sent directly by NTHU-NSTDC to all the groups invited to participate, including the Council of Indigenous Peoples, Taitung County Government, Lanyu Township Office, Lanyu Township Representative Council, village offices, and local environmental groups. This year's analysis results of Lanyu parallel sampling were also published on AEC website for public access. Since 2011, no abnormal radiation has been detected in the environmental samples collected in Lanyu area. All the data and derived radiation doses are within the variation range of background radiation.

C. Let's meet up: atomic science exhibition

Ionizing radiation exists all around us. To increase public access to atomic energy-related information and their willingness to take part in public affairs related to atomic energy, AEC continuously participated in science education tours organized by the National Taiwan Science Education Center (NTSEC) and attended in the first Taiwan Science Festival held in 2020. In addition, AEC hosted three sessions of atomic science fairs. The first two sessions were held at Big City Shopping Center in Hsinchu and Hemei Senior High School in Changhua, respectively. Efforts were made to adopt the concept of an "atomic science mobile castle" and to incorporate summer learning rewards program of the surrounding elementary schools, as well as to reflect local characteristics, with the goal to bring science fairs out of metropolitan areas. Besides, senior high school students were given an opportunity, for the first time, to apply for the role of interpreter, which could be included in their learning portfolio, to encourage learning about atomic science. Five students from Changhua County Hemei Senior High School published reflections of their interpreters' experiences on the bimonthly Nuclear Newsletter, which is worthy of praise.

10 月的第三場「i 上原子能 綠能 e 世界」科普展則參考民眾的回饋意見，重新規劃展項為「輻射應用」、「除役核廢」及「綠能科技」三個展區，擴大在台北華山文創產業園區辦理。策展首日並與中華郵政公司合作開設臨時郵局，發行「原子能科技科普展」郵票套票組，另於 11 日「臺灣女孩日」邀請參與活動宣傳片的女學生現身展場體驗、直播，以傳達女學生也愛科普的意念，打破「男理工 女人文」的性別刻板印象。

三場自辦科普展吸引近 1 萬 6 千人次的民眾進場參觀，參與學習單學習的國小生人數超過 7 千 4 百餘人，高中生也有 121 人參加學習歷程的解說服務。原能會由活動回收的問卷、參加解說學習的學生以及「原能會 輻務小站」粉絲的回饋中得知，參加民眾認為科普展貼近生活、生動有趣，同時也能獲得許多意想不到的原子能資訊，更有民眾透過首長信箱表達對策展的肯定。

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1. 民眾熱情參與原子能科普活動
The public enthusiastically participating in the atomic science fair

2. 藉著VR遊戲了解核電廠除役產生的廢棄物分類
Gaining insights into waste classification during nuclear power plant decommissioning through VR games

由於 COVID-19（武漢肺炎）疫情的關係，原能會在辦理科普活動時都配合中央流行疫情指揮中心的防疫措施，工作人員和參加民眾全程配戴口罩、入場實聯制及量測體溫，並落實個人衛生防護及於策展前與每日活動結束後均進行場地消毒，以使民眾能安全、輕鬆地享受科普活動。

科普防疫第一步 確實量測不馬虎
Temperature-taking: the first step in epidemic prevention

The third, scale-up session, "I Love Atomic Energy, Green Energy of the World," took place at Taipei Huashan Creative Park in October. Taking into account the public feedback, the theme was reorganized into three display areas: "Radiation Applications", "Nuclear Decommissioning and Radwastes", and "Green Energy Technology." On the first day of the fair, a temporary post office was installed in cooperation with Chunghwa Post Co. Ltd., and an Atomic Science Fair stamp collection set was released. On October 11th, Taiwan Girls' Day, female students who participated in the promotional video were invited to experience and live broadcast the event, with the purpose of conveying the idea that female students are also interested in science, so as to break the gender stereotype of "science and engineering boys, literature and humanities girls."

The three science fairs hosted by AEC attracted nearly 16,000 visitors, with over 7,400 elementary school students utilizing their learning sheets and 121 senior high school students performing as interpreters as a way to enrich their learning portfolio. From a post-activity survey, feedback from student interpreters and the fan page "AEC Radiation Station," AEC learned that the participants found the science fair lively and relevant to living, and that they were able to obtain a lot of information about atomic energy that they had not known before attending the event. Some visitors even expressed their affirmation of the fair through the Minister's mailbox.

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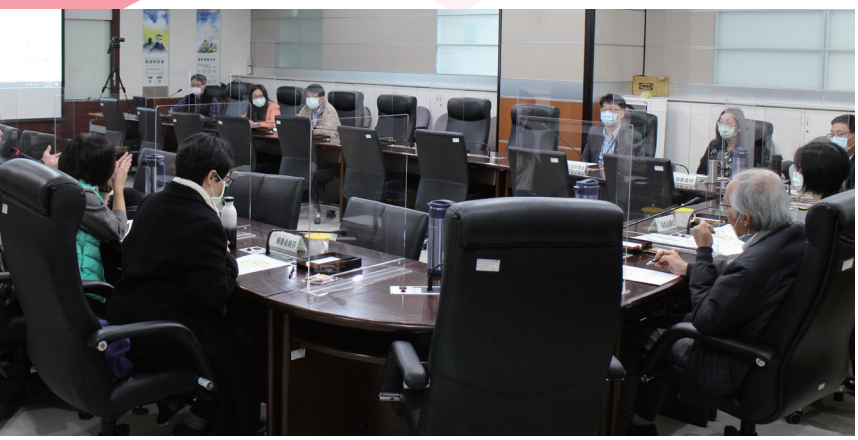
1.「原子能科學移動城堡」原子能科技科普展暑期學習單
Atomic Science Fair summer learning sheet, "Atomic Science Mobile Castle"

2. 暑期學習單甄選獲獎學生與老師合影
Photo of students awarded for their summer learning sheet and their teacher

防疫新生活 手部消毒不馬虎
Hand-disinfection: the epidemic new life movement

In response to COVID-19, AEC strictly complied with the epidemic prevention measures of the Central Epidemic Command Center during the science fairs and events. All the staffers and participants wore masks throughout the events; temperatures were taken and real-name registration was required upon entry. Personal hygiene and protection were promoted and venues were disinfected before and after each day's activities so that the public could enjoy science fairs and events in a safe and relaxing environment.



全民參與委員會委員審議作業要點
Members of the Committee on Public Participation reviewing guidelines

（四） 開放溝通平台 籌設全民參與委員會

原能會為促進各項公眾參與活動和提升辦理安全管制事務之成效，特設置「全民參與委員會」，透過邀請專家學者、社會公正人士或民間團體擔任委員，以提供原能會有關民眾溝通事務的建言。109年計辦理 2 次會議，7 月 30 日第一場的預備會議，委員們先就全民參與委員會的定位、任務及作業要點，充份討論後提出許多寶貴的意見，並經 12 月 4 日召開第二次會議審議後，在 12 月 30 日正式公布「全民參與委員會作業要點」，以使原能會的公眾參與及溝通工作更能接地氣、符合全民期待。

（五）辦理核二廠除役計畫審查地方說明會

原能會為完善核二廠除役計畫安全審查作業，除召集專家學者與原能會同仁組成專案團隊嚴格審查核二廠除役計畫外，亦邀請地方民眾至核電廠實地查訪、舉辦地方說明會與拜訪地方意見領袖，傾聽民眾意見與心聲，將其納入除役計畫審查作業參考。原能會考量國內 COVID-19（武漢肺炎）疫情，在疫情稍緩即審慎擬訂防疫計畫，於 109 年 8 月 7 日在萬里區公所舉辦核二廠除役計畫審查地方說明會，參加人員包括行政院相關部會機關、地方行政機關代表、民意代表、意見領袖與公民團體等，會議由原能會及台電公司分別說明核二廠除役規劃現況與除役計畫審查情形後，開放與會人員表達意見及現場回覆，並於會後整理會議紀錄，逐項提出書面回應，讓民眾了解原能會對除役安全之管制作為，並公布於對外網頁。

109年7月31日核二廠除役計畫現場訪查活動
A site visit at the review of the Kuosheng NPP decommissioning plan held on July 31, 2020.

D. Open communication platform: setting up the Committee on Public Participation

To promote various activities for public participation and enhance the effectiveness of safety regulation matters, we established the "Committee on Public Participation", in which experts, scholars, impartial social representatives, and civil society organizations are invited to serve as committee members to advise AEC on matters involving communication with the public. Two committee meetings were held in 2020. At the first preparatory meeting on July 30th, members discussed the positioning, tasks, and guidelines of the Committee and offered many valuable comments. Following the review meeting held on December 4th, the "Guidelines for the Committee on Public Participation" were formally promulgated on December 30th, with the aim for our work on public participation and communication being more down-to-earth and meeting public expectations.

全民參與委員會預備會議
The preparatory meeting of the Committee on Public Participation

E. Holding a public meeting on the topic of "Reviewing the Decommissioning Plan of the Kuosheng Nuclear Power Plant"

To enhance the review on the Kuosheng NPP decommissioning plan, the AEC has set up a task force consisting of experts, scholars, and AEC specialists. Moreover, the AEC has also invited members of local communities to visit the nuclear power plant, held local public meetings, and met with local opinion leaders. Comments and thoughts of the public have been heard and used as reference for the review of the decommissioning plan. The AEC held a local public meeting on the review of the Kuosheng NPP decommissioning plan on August 7, 2020 at the Wanli District Office. Taking the COVID-19 situation in Taiwan into account, the AEC also cautiously drew up a COVID-19 prevention plan for the meeting. The attendees include officials from relevant ministries and agencies of the Executive Yuan, local government officials, elected public representatives, local opinion leaders, and civic groups. The meeting began with the AEC's and Taipower's briefings on the status of the Kuosheng NPP decommissioning plan and its reviewing process, respectively. Participants were then invited to express their opinions and concerns; responses were given immediately. Meeting minutes were compiled afterwards, and written responses were provided item by item and released on the AEC's website so that the public can gain a better understanding of the AEC's safety regulation measures during decommissioning.

該次會議民眾關切事項涵蓋最終處置、乾式貯存、地方回饋等，對於涉及其它單位事項，已由原能會轉知請其參考辦理。原能會本於除役安全主管機關之責，依法嚴格審查除役計畫，並持續辦理民眾參與活動，使除役安全管制作業更為周延。

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1.原能會張欣處長於109年8月7日核二廠除役計畫審查地方說明會致詞
AEC Department Director General Chang gives a speech at the local public meeting on the review of the Kuosheng NPP decommissioning plan on August 7, 2020.

2. 與會來賓於109年8月7日核二廠除役計畫審查地方說明會提問
A participant raises a question at the local public meeting on the review of the Kuosheng NPP decommissioning plan on August 7, 2020.

3. 賴品妤立法委員於109年8月7日核二廠除役計畫審查地方說明會表達意見
Legislator Lai Pin-Yu expresses her opinions at the local public meeting on the review of the Kuosheng NPP decommissioning plan held on August 7, 2020.

（六）易讀版核子事故應變指南Easy-to-read

為提升防災資訊易讀性，以使心智障礙者能夠了解核子事故民眾防護行動內容，原能會與專業團體合作完成易讀版核子事故應變指南「關於核子事故，你應該知道的事！」，其文字、內容、圖片、顏色、字體大小都符合歐盟易讀規範，在製作過程中也邀請心智障礙者擔任審稿委員，並依委員意見修正，以使用者的角度製作，增加使用友善性。

At the meeting, the public expressed concern about radwaste final disposal, spent fuel dry storage, and local feedback fund, etc. For issues involving other agencies, the AEC has forwarded them relevant information. As the competent authority for decommissioning safety, the AEC will continue to rigorously review decommissioning plans in accordance with the law and organize activities for public participation to ensure thorough adherence to regulatory requirement throughout the decommissioning process.

F. Easy-to-read version of the Protective Actions Guidelines for Nuclear Emergency

To improve the readability of emergency response information and to facilitate understanding of the contents of public protective actions in a nuclear accident among people with intellectual disabilities, AEC has worked with professional organizations to compile an easy-to-read version of the Protective Actions Guidelines for Nuclear Emergency, "What You Should Know about Nuclear Accidents." The text, content, pictures, colors, font, and size are all in line with the European Union's readability guideline. During the process of compilation, people with intellectual disabilities were also invited as reviewers, and their comments were taken into account for revision, with the aim of increasing the level of user-friendliness of the booklet from the perspective of users.

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1. 易讀版核子事故應變指南
   Easy-to-read version of the Protective Actions Guidelines for Nuclear Emergency
2. 品管員審稿會議
   Quality control reviewer meeting

（七）執行基隆家庭訪問計畫，瞭解需求並傳遞防護資訊

原能會為瞭解核電廠緊急應變計畫區 (EPZ) 民眾應變需求並提供相關防護資訊，109 年執行核安演習之核二廠附近基隆地區家庭訪問，透過與里長溝通合作，由在地民眾擔任家訪員，逐戶拜訪 1 萬餘戶。訪問過程中，參與里長對此做法均給予高度肯定，除蒐集核子事故緊急應變整備相關資訊，也使民眾熟悉災害發生時的應變措施及防護知識，有助於民眾對防災知識的紮根，落實政府在核子事故的平時整備作業。訪問後發送 110 年防護月曆，藉月曆長期保存之特性，讓防護資訊垂手可得所需核災防護要領。

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1. 訪員逐戶訪問(一)
   House visit 1
2. 訪員逐戶訪問(二)
   House visit 2
3. 原能會110年防護月曆
   AEC 2021 calendar with protective actions theme

G. Carrying out a house visit program in Keelung to gain insights into the public's needs and convey information on protective actions

To understand the needs of residents in nuclear power plant emergency planning zones (EPZs) during an emergency and to provide relevant information on protective actions, AEC has carried out a house visit program near Kuosheng NPP in the Keelung area after the 2020 Nuclear Emergency Exercise. Through communicating and coordinating with village chiefs, local residents were hired to perform as interviewers, and over 10,000 households were visited. This program, highly praised by village chiefs, not only for family data collection for nuclear emergency response and preparedness, but also familiarized the residents with information of the emergency response and protective actions taken during an emergency. This, in turn, helped the residents to have a better understanding of emergency response and the government's preparedness efforts for nuclear accidents. After the visit, residents were given the 2021 calendar with protective actions theme. It is hoped that the long-lasting nature of the calendar would make information of emergency protective actions easily accessed.

二、切實監督核電廠安全

（一）完成核二廠除役計畫審查

1. 核二廠除役計畫送審前先期作業

核二廠 1、2 號機運轉執照將分別於 110 年 12 月 27 日及 112 年 3 月 14 日屆期，依「核子反應器設施管制法」規定，台電公司應於機組預定永久停止運轉之三年前提出除役許可申請，因此台電公司已依規定於 107 年 12 月 27 日前向原能會提出核二廠除役許可申請，並檢附申請書及核二廠除役計畫。

為提升核二廠除役計畫審查作業之品質和效率，以能如期如質完成除役計畫審查作業，針對核二廠除役計畫送審前先期作業，原能會已超前部署，執行先期業務，內容包括核一廠除役計畫審查、除役計畫審查導則等經驗回饋，以及執行核二廠除役計畫先期整備作業專案查訪、公眾溝通會議等，以確保核二廠除役計畫審查作業順利執行。

2. 核二廠除役計畫審查作業

原能會於 108 年 1 月完成核二廠除役計畫程序審查，確認申請文件符合應備要件後，開始籌組專案審查團隊進行實質審查。專案審查團隊係由外部專家學者 22 人與原能會同仁 56 人組成，依計畫章節及專長分組，召開 3 回合分組審查會議及綜合審查聯席會議（第三回合綜合審查聯席會議於 109 年 2 月 13 日舉辦），並提出 336 項審查意見，請台電公司就提問提出澄清。又，原能會為完善審查作業，於 109 年 7 月 8 日、31 日辦理二次現場訪查與 109 年 8 月 7 日辦理地方說明會，將民眾意見納入。

(II) Achieving Effective Supervision of Nuclear Power Plant Safety

A. Concluding the review of the Kuosheng Nuclear Power Plant decommissioning plan

a. Preparatory phase for the review of the Kuosheng Nuclear Power Plant decommissioning plan

The operating licenses of Kuosheng NPP Units 1 and 2 will expire on December 27, 2021 and March 14, 2023, respectively. In accordance with the Nuclear Reactor Facilities Regulation Act, the TPC is required to submit an application for the decommissioning permit three years prior to the scheduled permanent shutdown at any unit. As such, the TPC submitted an application for the decommissioning permit for the Kuosheng NPP to the AEC before December 27, 2018, along with an application form and the Kuosheng NPP decommissioning plan.

In an effort to improve the quality and efficiency of the review process of the Kuosheng NPP decommissioning plan, and to complete the review in accordance with timeline and quality requirements, the AEC proceeded with preparatory work for reviewing the Kuosheng NPP decommissioning plan ahead of schedule. Preparatory work included gathering experiences and feedback from the review of the Chinshan NPP decommissioning plan and the review guidelines for decommissioning plans, conducting preparatory inspections for the Kuosheng NPP decommissioning plan, and organizing meetings for public communication in preparation for smooth execution of the review of the Kuosheng NPP decommissioning plan.

b. The review of the Kuosheng Nuclear Power Plant decommissioning plan

The procedural review of the Kuosheng NPP decommissioning plan was completed in January 2019. Upon confirming that the application documents met requirements, the AEC proceeded to organize a task force consisting of 22 external experts and scholars and 56 AEC staffers to conduct the review. The task force was further divided into different panels based on member expertise and chapter divisions of the plan. Three rounds of panel review meetings and joint comprehensive review meetings were convened. (The third round of the joint comprehensive review meeting was held on February 13, 2020.) A total of 336 review comments were given for the TPC's clarification. In addition, in order to facilitate the review process, the AEC conducted two site visits: one on July 8, 2020, and the other on July 31, 2020, and held a local public meeting on August 7, 2020. Comments from the public raised in these meetings were taken for reference in the review.

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1. 109年7月31日原能會於核二廠辦理核二廠除役計畫審查第2次現場訪查
   The second site visit for the review of the Kuosheng NPP decommissioning plan conducted on July 31, 2020.
2. 109年7月31日張欣處長於核二廠除役計畫現場訪查活動致詞
   AEC Department Director-General Chang gives a speech at the site visit event for the Kuosheng NPP decommissioning plan on July 31, 2020.

原能會於 109 年 9 月 8 日辦理核二廠除役計畫審查總結會議，確認除役計畫足以保障公眾之健康安全，符合相關法令規定，且台電公司之技術與管理能力及財務狀況應足以勝任除役之執行後，於 109 年 10 月 20 日正式審查通過台電公司核二廠除役計畫。原能會並於對外網站建立核電廠除役專區，將核二廠除役計畫及審查作業情形、安全審查報告、公眾參與作業等辦理情形，公布於網站，供各界參閱。

109年8月7日原能會於萬里區公所辦理核二廠除役計畫審查地方說明會
A local public meeting on the review of the Kuosheng NPP decommissioning plan held at Wanli District Office on August 7, 2020.

3. 辦理核二廠除役許可核發作業

核電廠除役是國內關切的議題，原能會作為全民的原能會，在完成核二廠除役計畫審查作業後，仍將持續監督台電公司確實按照除役計畫與重要管制事項規劃核二廠除役作業，後續待台電公司提出環保署認可之核二廠除役計畫環境影響評估相關資料，以證實符合環境保護及生態保育相關法令，原能會於確認核二廠除役計畫符合核管法第 23 條之規定後，始辦理核發除役許可相關事宜。

（二）加強監督核電廠防疫作業

因應 COVID-19（武漢肺炎）疫情爆發，原能會於 109 年 3 月 5 日函請經濟部督促台電公司及早建立因應措施，避免疫情影響核電廠安全，原能會並以核安管制角度超前部署，於 1 月底即要求台電公司督促其所屬各核電廠規劃相關應變措施，成立防範 COVID-19(武漢肺炎) 疫情擴散應變小組，一旦核電廠發生疫情時緊急應變並通報原能會。

後續因應全球疫情快速擴展，3 月 20 日原能會再度發函要求台電公司加強核電廠員工 (含包商) 之防疫管控，訂定作業程序，加強防疫自主管理措施，原能會並將其納入視察項目，多次派員赴各核電廠視察，確認各電廠防疫工作均能落實執行，包括清查核電廠工作人員是否曾前往疫區、人員口罩配戴管制與體溫量測、環境消毒等相關措施。此外，原能會並再三強調台電公司核電廠主控制室之持照運轉值班人力須符合安全管制法規要求，若因疫情嚴重，造成運轉所需持照人力不足時，機組須依規定停機，以維持機組安全。

The concluding meeting for the review of the Kuosheng NPP decommissioning plan was held on September 8, 2020. Upon confirming that the decommissioning plan complies with relevant regulatory requirements of the Nuclear Reactor Facilities Regulation Act, the AEC approved the TPC's decommissioning plan for the Kuosheng NPP on October 20, 2020. The AEC also created a designated section on its website for nuclear power plant decommissioning where information regarding the Kuosheng NPP decommissioning plan, its review status, safety evaluation reports, and matters related to public participation are posted for public access.

c. The issuance of the Kuosheng Nuclear Power Plant decommissioning permit

Decommissioning nuclear power plants is a matter of national concern. As the people's AEC, after completing the review of the Kuosheng NPP decommissioning plan, the AEC will continue to oversee the TPC to ensure full compliance with the decommissioning plan and regulations in its plans to execute the Kuosheng NPP decommissioning work. Next, the TPC must submit an environmental impact assessment of the Kuosheng NPP decommissioning plan approved by the Environmental Protection Administration to verify that the decommissioning plan complies with relevant environmental protection and ecological conservation laws and regulations. After confirming that the Kuosheng NPP decommissioning plan conforms to Article 23 of the Nuclear Reactor Facilities Regulation Act, the AEC will begin the process of issuing the decommissioning permit.

B.Improving supervision of COVID-19 prevention measures in nuclear power plants

In response to the COVID-19 outbreak, the AEC issued a letter to the Ministry of Economic Affairs on March 5, 2020, asking it to urge the TPC to establish response measures as soon as possible to prevent any negative impact from the pandemic on the safety of nuclear power plants. As early as the end of January, 2020, the AEC has assumed preemptive approach to nuclear safety regulation, requesting that the TPC supervise its nuclear power plants to establish contingency measures and set up a COVID-19 pandemic response team. The response team's responsibilities include carrying out the contingency measures, preventing the spread of COVID-19, and notifying the AEC in the event of an outbreak in its nuclear power plants.

Prompted by the rapid spread of the global pandemic, the AEC issued another letter on March 20, 2020, requesting that the TPC strengthen COVID-19 prevention and control measures in its nuclear power plants (including contractors), establish operational procedures, and promote self-management practices. To incorporating COVID-19 prevention practices into the AEC's inspection program, the AEC has dispatched inspectors on different occasions to each nuclear power plant to ensure that COVID-19 prevention work is carried out completely, including checking whether any nuclear power plant staff had visited COVID-19 affected areas, enforcing of mask-wearing and temperature-taking, and ensuring disinfection of the facilities. In addition, the AEC has repeatedly emphasized that licensed operators on duty in the main control rooms of the TPC's nuclear power plants must meet regulatory requirements. In the event that a severe COVID-19 outbreak results in insufficient licensed operators for operation, the affected unit shall be shut down according to relevant regulations to ensure unit safety.

109 年間核二廠 1 號機於 2 月 20 日進行 EOC-27 大修，核三廠 2 號機於 4 月 7 日進行 EOC-25 大修。二次大修作業除原有電廠工作人員外，並有包商及委託外籍技師之工作項目，為避免疫情影響大修品質，原能會要求台電公司成立大修作業應變中心及建立通報機制、規劃因應突發狀況之人員隔離與排班等，台電公司並增購紅外線熱像測溫儀，嚴格管制大修工作人員進出。有關需外籍技師之大修項目，例如非破壞檢測結果判定等項目，已改由台電公司提供數據及遠距判定方式辦理。在嚴格督促電廠落實防疫管理下，核二、三廠均如期如質完成大修。

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1. 109年2月19日原能會視察核二廠防疫情形
   Inspecting COVID-19 prevention practices of the Kuosheng NPP on February 19, 2020.
2. 109年2月20日原能會視察核一廠防疫情形
   Inspecting COVID-19 prevention practices of the Chinshan NPP on February 20, 2020.

另考量國際間疫情仍然嚴峻，為謹慎起見，原能會已要求台電公司蒐集國際核電廠之防疫作為並研議納為國內參考，如日本九州電力公司玄海核電廠承包商感染 COVID-19（武漢肺炎）之後續防疫強化行動，作為國內核電廠防疫作業之參考。原能會持續派員視察各核電廠，及要求台電公司滾動式檢討防疫作業，確保核電廠運轉及除役安全。

There were two refueling outage inspections conducted in 2020, one in the Kuosheng Nuclear Power Plant Unit 1 on February 20 and the other in the Maanshan Nuclear Power Plant Unit 2 on April 7. In addition to the original power plant staff, the two refueling outage also involved contractors and commissioned foreign technicians. To prevent the refueling outage quality being compromised by the pandemic, the AEC asked the TPC to set up a response center for refueling outages, establish an alert mechanism, and develop procedures to address isolation requirements and shift scheduling in case of any suspected infection. The TPC also purchased infrared thermal imaging cameras for temperature measurement to strictly control the entry and exit of personnel during refueling outages. For refueling outage work that requires foreign technicians, such as interpreting non-destructive testing results, a remote process has been adopted whereby relevant data can be provided by the TPC for foreign technicians to review. Under the AEC's rigorous oversight of power plant COVID-19 prevention and management, both the Kuosheng NPP and the Maanshan NPP refueling outages had been completed on schedule and with expected quality.

Considering that the COVID-19 pandemic situation in international contexts remains bleak, the AEC assumed a discreet and proactive approach by asking the TPC to collect COVID-19 prevention practices in international nuclear power plants to see if they can be adopted to domestic practices. One example is the reinforced follow-up actions on COVID-19 prevention measures taken by the Genkai Nuclear Power Plant of Japan's Kyushu Electric Power Company following accuse of COVID-19 infection of one of its contractors. The AEC continues to dispatch inspectors to each nuclear power plant and requires the TPC to conduct rolling reviews of COVID-19 prevention practices to ensure the continued safety of nuclear power plant operations and decommissioning.

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1. 109年8月25日原能會視察核三廠防疫情形
Inspecting COVID-19 prevention practices of the Maanshan NPP on August 25, 2020.

2. 109年11月27日張欣處長視察核二廠防疫措施
AEC Department Director-General Chang inspects COVID-19 prevention practices of the Kuosheng NPP on November 27, 2020.

（三）嚴格監督核電廠作業安全 深化人員管制效能

原能會負責國內核電廠之安全管制，為監督各核電廠之安全性與可靠性，採取辦理各項視察、舉行管制會議及專案審查等作為，確保國內現有核二、三廠之運轉及核一廠各項除役作業均符合安全標準，並分別於109年5月12日、6月19日、9月18日、12月25日辦理4場「核子反應器設施安全諮詢會」，邀請學者專家參與會議，提供核能管制專業諮詢，強化核電廠安全監督效能。原能會秉持保障民眾安全之精神，持續精進相關管制作為，以提升管制成效。

1. 持續監督核電廠安全

原能會於109年間除派遣視察員赴核電廠執行現場駐廠視察外，並執行核安管制紅綠燈視察、核安總體檢視察、火災防護專案視察等共32次專案團隊視察作業。109年間核二、三廠機組大修，原能會除依規定於大修前要求台電提報機組大修計畫、稽查計畫並進行審查外，亦於大修期間加派人力，針對安全重要設備相關作業進行現場品質查證，機組起動前亦整合大修期間各項視察及現場大修作業查證結果，確認機組現場狀態符合起動管制要求後，才同意機組起動及併聯發電之申請。原能會分別於109年3月27日及5月22日同意核二廠1號及核三廠2號機組起動運轉，並持續監督機組狀況，以確保機組運轉安全。

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1. 109年3月11日核二廠不預警視察
An unannounced inspection at the Kuosheng NPP on March 11, 2020.
2. 109年9月26日核二廠不預警視察
An unannounced inspection at the Kuosheng NPP on September 26, 2020.

另外原能會為惕勵核電廠人員於夜間及假日均能保持良好精神狀態，109年共辦理9次不預警視察，確認電廠各項作業均符合安全要求。109年閃電颱風警報發布後，颱風影響範圍包含核三廠，原能會即加派2位人員駐廠，徹夜查核電廠防颱防汛作業，確保機組運轉不受颱風影響。核一廠除役拆除作業部份，109年台電核一廠已完成連絡鐵塔拆除作業，原能會並進行現場作業管制，後續並審查核備氣渦輪機等設備拆除作業方案，嚴格監督核一廠除役安全。以上各項視察結果均適時公開於原能會網站。

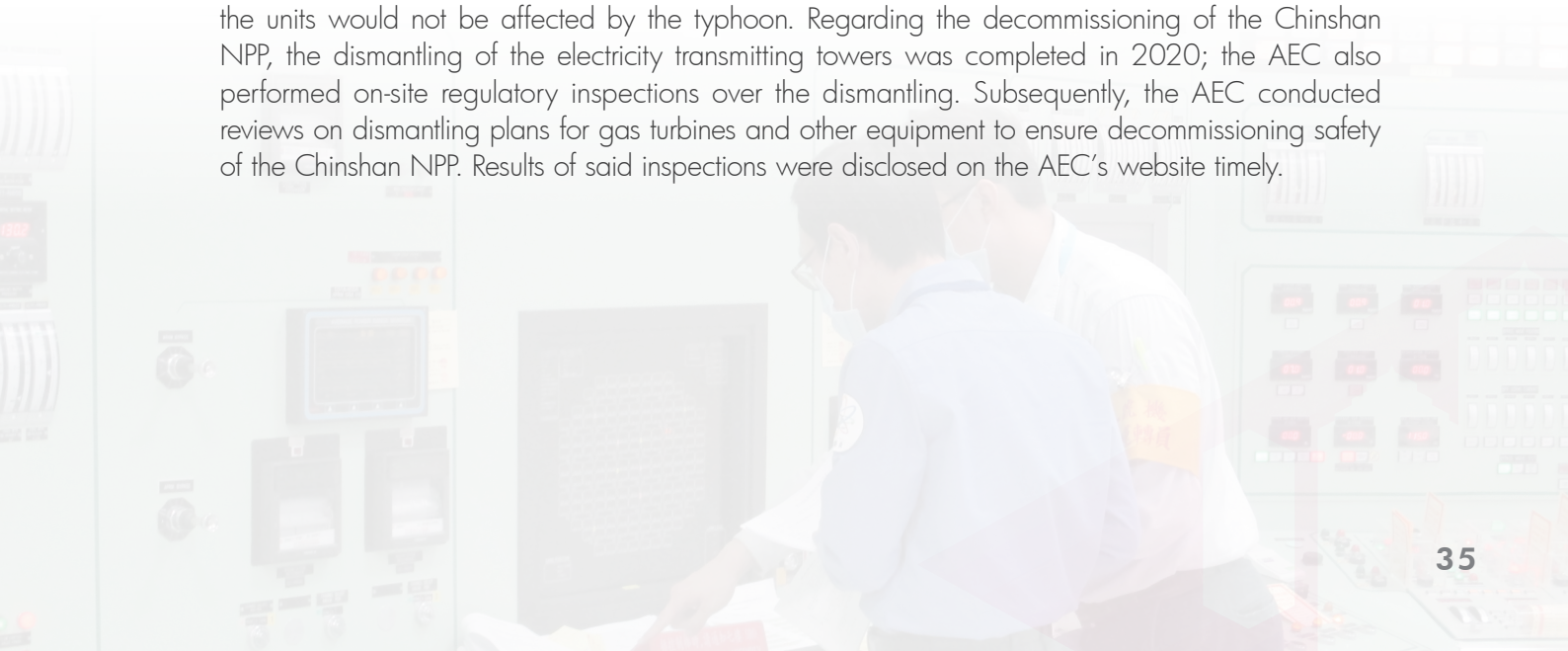
C. Rigorous oversight of the safety operation of nuclear power plants and the strengthening of inspection capabilities

As the competent authority on the safety and reliability of nuclear power plants, the AEC conducts inspections, regulation meetings, and project reviews to ensure that operation of the Kuosheng NPP and the Maanshan NPP and the decommissioning work of the Chinshan NPP comply with relevant safety regulations. As such, four Advisory Committee Meetings on Nuclear Reactor Facility Safety were held on May 12, June 19, September 18, and December 25, 2020. Experts and scholars were invited to the meetings where they offered professional consultation on the improvement of the efficiency of NPP safety regulation. To ensure the safety of the public, the AEC continues to enhance relevant regulatory measures to promote regulatory effectiveness.

a. Continuing to effectively oversee the safety of nuclear power plants

In addition to dispatching inspectors for on-site inspections at nuclear power plants in 2020, the AEC also conducted a total of 32 team inspections, including reactor oversight process inspections, inspections on post-Fukushima Enhancement measures, and inspections on fire protection. During the refueling outage of the Kuosheng NPP and the Maanshan NPP in 2020, the AEC requested, in accordance with regulations, that the TPC submit refueling outage plans and inspection plans for its review prior to the scheduled refueling outage. In addition, the AEC also assigned additional manpower to carry out on-site inspections of the safety of refueling outage activities. Before the restart of the units, the AEC integrated the results of all inspections and on-site checks conducted during the refueling outage. After confirming that the conditions of the units met regulatory requirements for restart, the AEC approved the restart of the Kuosheng NPP Unit 1 and the Maanshan NPP Unit 2 on March 27 and May 22, 2020, respectively. The AEC has continued overseeing the conditions of these units to ensure their operational safety.

Furthermore, in an effort to encourage nuclear power plant operatives to maintain a good work spirit on night and holiday shifts, the AEC conducted nine unannounced inspections in 2020 to ensure that all operations were in compliance with safety requirements. After a typhoon warning for Tropical Storm Atsani was issued, which was forecasted to impact the region where the Maanshan NPP was located, the AEC immediately sent two additional staff members to the plant to carry out overnight checks on the plant's typhoon and flood contingency measures and to ensure that the operation of the units would not be affected by the typhoon. Regarding the decommissioning of the Chinshan NPP, the dismantling of the electricity transmitting towers was completed in 2020; the AEC also performed on-site regulatory inspections over the dismantling. Subsequently, the AEC conducted reviews on dismantling plans for gas turbines and other equipment to ensure decommissioning safety of the Chinshan NPP. Results of said inspections were disclosed on the AEC's website timely.



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1. 109年8月14日核一廠二期室內乾貯地上物拆除作業方案現場視察
   An on-site inspection at the Chinshan NPP of the dismantling plan of equipment for phase two indoor dry storage facilities on August 14, 2020.
2. 109年8月14日核一廠二期室內乾貯地上物拆除作業方案現場視察
   An on-site inspection at the Chinshan NPP of the dismantling plan of equipment for phase two indoor dry storage facilities on August 14, 2020.

2. 深化人員視察管制效能

因 COVID-19（武漢肺炎）疫情影響，原能會於 109 年暫停派員參加國外訓練及國際核安管制技術交流活動，為持續強化視察員管制技術能力，原能會改以邀請專家學者共進行 16 場專題報告，內容包括除役經驗分享，非破壞人員驗證及監查作業、火山活動與斷層錯動位移等技術議題，以深化同仁技術能力。在國際交流活動方面，原能會仍透過視訊會議方式，分別於 5 月及 9 月參與經濟合作暨發展組織核能署 (OECD/NEA) 之電廠組件運轉經驗劣化和老化計畫 (CODAP) 會議。

（四）COVID-19疫情下之國際核安交流

雖然受到今年初開始持續至今的 COVID-19（武漢肺炎）疫情之影響，國際相關人員流動因而受到各國邊境管制措施而減緩，但原能會配合中央疫情指揮中心防疫策略積極協調，將相關安全技術交流以妥適方式辦理或進行資訊交換。原能會於 12 月 9 日以視訊形式與日本原子力規制委員會辦理交流會議，會中台日雙方就核安管制近況、核電廠適職方案，以及 COVID-19 疫情下相關電廠管制因應措施等方面交流，在國際疫情嚴峻的考驗下，確保國內的管制作為與國際接軌。

b. Strengthening inspection capabilities

Due to the impact of COVID-19, the AEC has suspended staff overseas training programs and its participation in international exchange events on nuclear safety regulations and technologies in 2020. In order to improve regulatory capabilities of its inspectors, the AEC, in turn, has invited experts and scholars who gave a total of 16 keynote presentations: topics covered in these presentations from experience sharing on decommissioning, verification and monitoring of non-destructive testing, volcanic activity and fault movement and displacement, and other technical issues. In terms of international exchanges, by way of video-conferencing, the AEC has participated in Component Operational Experience, Degradation & Aging Programme (CODAP) meetings hosted by the Nuclear Energy Agency of the Organisation for Economic Cooperation and Development (OECD/NEA) in May and September, 2020, respectively.

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1. 109年8月18日核三廠不預警視察
An unannounced inspection at the Maanshan NPP on August 18, 2020.
2. 109年8月18日核三廠不預警視察
An unannounced inspection at the Maanshan NPP on August 18, 2020.

D. International exchanges on nuclear safety under the COVID-19 pandemic

The ongoing outbreak of COVID-19 that began at the beginning of 2020 has slowed down international movement of personnel due to border control measures imposed by various countries. Nevertheless, in compliance with the Central Epidemic Command Center's epidemic prevention measures, we have been active with our coordination efforts in conducting safety technology and information exchanges in an appropriate manner. On December 9th, by way of video-conferencing, we and Japan's NRA organized an exchange meeting, during which the two sides exchanged views on the current status of nuclear safety and regulation, fitness-for-duty program for nuclear power plants, and measures for regulatory control of power plants under the COVID-19 outbreak. These efforts were made to ensure that Taiwan's regulatory control practices are in line with international standards in such tough times of a global pandemic.

三、精進輻射防護安全管理

（一）「輻射安全守護者」精進我國的輻射防護法規體系

我國游離輻射防護法規主要是參考國際放射防護委員會 (ICRP)、國際原子能總署 (IAEA) 或歐盟等國際輻防組織所出版之安全標準與建議書，並多方嚴謹考量我國管制實務與業者作業現況而訂之。透過完善法規體系與架構，嚴密管制與輔導，以保障民眾、輻射從業人員與環境輻射安全。

現行游離輻射防護法規是參考 ICRP 60 號報告訂定，惟隨著近十餘年許多生物及物理上新研究資料的出現，再加上國際間越來越重視輻防管理的合宜性與細緻度，因此 IAEA 參考 ICRP 103 號報告，於 2014 年發布了最新輻射安全標準，提供各國輻防法規修訂之參考，原能會也依據此標準之精神，刻正進行輻防法規的研修與精進，主要方向如下：

1. 輻射防護三原則（正當化、最適化及限制化）雖然不變，但強調「最適化」過程與管理的重要性，也就是希望在劑量限度下，業者透過劑量約束的方式，努力地將輻射劑量合理降低，以期在輻射應用與劑量防護上達到雙贏的目標。

2. 過去輻防管制著重在「人造射源」的管理，但隨著「天然放射性物質」使用爭議時常發生，造成管制上的困擾。因此新的法規，會將輻射管理的分類更為細緻化，細分為計畫曝露、緊急曝露與既存曝露三情境，將輻防三原則融合三曝露情境，建立分源、分眾、分級之優化管制，作更嚴密有效的安全管理。

3. 配合輻射生物效應的新發現，一些物理、生物的管制參數，也會隨之調整。特別是輻射工作人員之眼球年劑量限度，將由 150 毫西弗下降為 20 毫西弗，以保護工作人員水晶體安全。另外依據新的流行病學報告、統計模式與對健康風險的重新定義，法規中的輻射加權因數、組織加權因數也會隨之更新。

(III) Enhancing Radiation Protection and Safety Management

A. Guardian of radiation safety: improving regulatory framework governing radiation protection

Taiwan's Ionizing Radiation Protection Act and its related regulations have been formulated by referencing the safety standards and recommendations published by the International Commission on Radiological Protection (ICRP), the International Atomic Energy Agency (IAEA), and the European Union and other international radiation protection organizations, as well as by considering carefully Taiwan's regulatory practices and current operations in the industry. By improving regulatory framework and exercising stringent regulatory measures and guidance, AEC hopes to ensure radiation protection for the public, rediation practitioners and the environment.

Current Ionizing Radiation Protection Act was formulated by taking ICRP Publication 60 as a reference. However, many new research findings in biology and physics have become available in the past decade, and there is a growing international emphasis on the appropriateness and sophistication of radiation protection management. Consequently, the IAEA published the latest radiation safety standards in 2014 with referenced ICRP Publication 103, providing reference for other nations in the revision of radiation protection laws and regulations. In accordance with the spirit of this standards, AEC has been currently conducting to revise and enhance radiation protection laws and regulations. The main focuses are as follows:

a. Although the three principles of radiation protection (justification, optimization, and dose limitation) remain unchanged, the importance of the process and management of "optimization" is highlighted. That is, with the principle of dose limitation, registrants or licensees are expected to strive to reasonably reduce radiation dose by means of dose constraint, in order that a win-win situation between radiation applications and radiation protection can be achieved.

b. In the past, radiation protection regulation focused on the management of "artificial radiation sources." However, with the frequent occurrence of controversies over the use of "naturally occurring radioactive materials" , it has resulted in regulatory problems. Therefore, the new regulations will further refine the classification of radiation management into three exposure situations: planned, emergency, and existing exposure situations. In addition, the three principles of radiation protection will be incorporated and applied in all three exposure situations , and optimized regulations on source segmentation, audience segmentation, and classification will be established to have a more stringent and effective safety management.

c. To reflect new findings in biological effect of radiation, related physical and biological regulatory parameters will also be adjusted accordingly. In particular, the annual dose limit to the lens of the eye of radiation workers will be reduced from 150 mSv to 20 mSv to protect the safety of their crystalline lens. In addition, radiation weighting factors and tissue weighting factors in the regulations will also be updated based on new epidemiological reports, statistical models, and the redefinition of health risks.

為使我國輻防法規能持續與國際同步，原能會正透過委託研究計畫，進行建置眼球劑量計及校驗系統，與專家學者合作進行修法研議、並辦理業者研商說明會，以聽取業界之實務回饋。原能會將與時俱進、穩健務實進行法規精進作業，扮演好「輻射安全守護者」角色，以保障民眾、輻射從業人員與環境輻射安全。

109年9月25日舉辦「游離輻射防護安全標準法規精進研討會」（臺北場）
Seminar on "Improving Safety Standards for Protection against Ionizing Radiation" held on September 25, 2020 (Taipei Session).

109年10月14日舉辦「游離輻射防護安全標準法規精進研討會」（高雄場）
Seminar on "Improving Safety Standards for Protection against Ionizing Radiation" held on October 14, 2020 (Kaohsiung Session)

（二）「輻射安全守門員」全國輻射工作人員的劑量管理

輻射從業人員接受劑量的多寡，可實際反映各國輻射安全管制的成效。為掌控全國輻射從業人員之輻射劑量，依「游離輻射防護法」第 15 條規定，雇主應對人員實施個別劑量監測，且原能會於 89 年建立了「全國輻射人員劑量資料庫」，要求各劑量評定機構將每個月人員劑量資料傳送至資料庫，並進行資料彙整與統計分析，以利嚴密監控，確保從業人員輻射安全。

109年10月21日及12月2日召開「游離輻射防護法修正研析」專家會議
Expert panel meeting on the "Study of the Revision of Ionizing Radiation Protection Act" convened on October 21 and December 2, 2020

With a view to keep Taiwan's radiation protection laws and regulations in line with international standards, AEC has been establishing a measurement method for eye lens dose and calibration system by commissioning a research project. AEC has also been collaborating and consulting with experts and scholars for regulations revision. Furthermore, AEC has organized business seminars to gather practical feedback from industry. AEC will keep pace with the times, steadily and pragmatically carry out regulation improvement, and play its role well as the "Guardian of Radiation Safety", so as to ensure radiation protection for the public, radiation workers, and the environment.

B. Radiation Safety Gatekeeper: national occupational dose management

The amount of radiation dose received by radiation workers reflects the effectiveness of radiation safety management in a country. In an effort to control the radiation dose exposure of radiation workers nationwide, Article 15 of the "Ionizing Radiation Protection Act" stipulates that an employer shall monitor each radiation worker's dose. Furthermore, following the set up of the "National Radiation Worker Dose Database" in 2000, AEC requested that each dose assessment organization transfer workers' monthly dose data to the database and conduct data aggregation and statistical analysis to facilitate close monitoring and ensure radiation safety of workers.

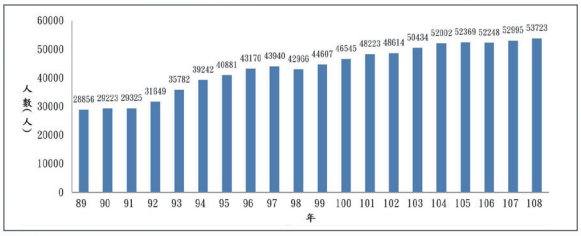
輻射劑量佩章配戴方式
The proper way of wearing a radiation dose badge

由於輻射在民生領域的應用越趨廣泛，我國輻射從業人員的數量也隨之逐年增加，現今大約有 5 萬 3 千餘人，分布於核能設施、醫療院所、學校研究機構、工業及軍警機關等。其中男性與女性的人數歷年來約為 7 比 3，以整體趨勢來看，女性人數的比例逐年微幅增加，自 96 年以後，即維持在 33% 以上。

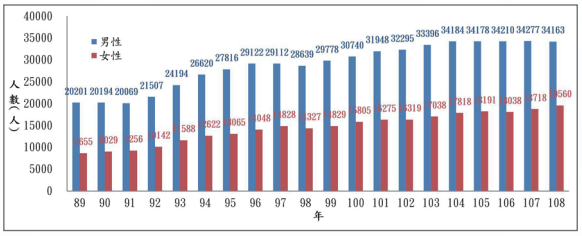
統計顯示，全國輻射從業人員的年平均劑量，呈逐年下降的趨勢，由 89 年的 0.49 毫西弗降至 108 年的 0.10 毫西弗。其中，大多數從業人員的劑量是在背景值的範圍，以 108 年為例，全國 90% 的輻射從業人員都沒有接受到高於背景值的輻射劑量，而另外 10% 有接受到高於背景值輻射劑量的從業人員，其平均劑量值，也從 89 年 2.54 毫西弗降至 105 年 1.07 毫西弗，顯示我國輻射安全及曝露合理抑低之管制績效持續進步中。

除了掌握全國輻射從業人員的劑量統計資料，原能會也嚴密監控個別從業人員所接受的劑量，確保每位輻射從業人員所接受的劑量不超過法規限度並合理抑低，並自 97 年起施行除以往從業人員劑量限度每年不得超過 50 毫西弗的規定，再加上每連續五年週期之劑量不得超過 100 毫西弗的規定，更加保障從業人員的輻射安全。

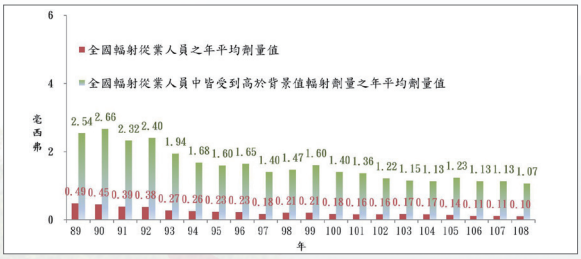
劑量統計結果顯示，在 89 年有 2 位從業人員、90 及 91 年各有 1 位從業人員接受的年劑量大於 50 毫西弗，92 年至今，均未有從業人員接受的劑量大於 50 毫西弗。且全國輻射從業人員中，個人年劑量大於 20 毫西弗之人數，也從 89 年的 101 位，至 108 年大幅減少至 2 位，而從 97 年至 108 年中，期間 12 年來總計只有 5 位從業人員 1 年接受大於 20 毫西弗的劑量，顯示我國的輻射安全管制及輻射作業場所的自主管理均有相當的進步。



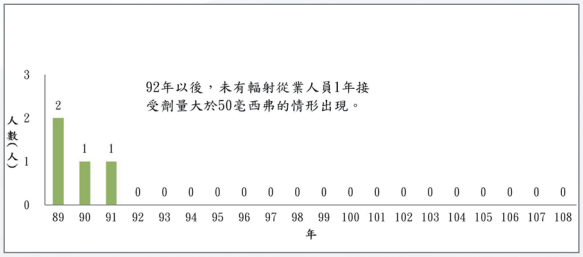
▲全國輻射從業人員總數統計（89年~108年）
Total number of radiation workers in Taiwan (2000-2019)



▲全國輻射從業人員性別人數統計（89~108年）
Total number of radiation workers in Taiwan by gender (2000-2019)



▲全國輻射從業人員之平均劑量統計（89~108年）
Average dose of radiation workers in Taiwan (2000-2019)



▲個人年劑量大於50毫西弗人數統計（89~108年）
Number of individuals with an annual dose greater than 50 mSv (2000-2019)

As applications of radiation in people's lives are becoming more and more extensive, the number of Taiwan's radiation practitioners is also growing on a yearly basis. Currently, there are approximately 53,000 people working in nuclear facilities, medical institutions, academic and research institutes, industries, the military, and police agencies. Over the years, the male-female ratio has remained at around 7 to 3. In terms of the overall trend, the proportion of females has been increasing slightly year by year, and has remained at above 33% since 2007.

Statistical figures indicate that the average annual dose of radiation workers nationwide has been decreasing yearly, from 0.49 mSv in 2000 to 0.10 mSv in 2019, where most of the workers' dose amount was in the range of background doses. In 2019, for example, 90% of the nation's radiation workers did not receive doses above background levels, while the average dose of the other 10% of workers who did receive doses higher than background levels dropped from 2.54 mSv in 2000 to 1.07 mSv in 2016. This shows that the regulatory performance of Taiwan's radiation safety and efforts to reduce radiation exposure to as low as reasonably achievable have continuously improved.

In addition to the dose statistics of the nation's radiation practitioners, AEC also closely monitors doses received by individual practitioners to ensure that the dose received by each radiation worker does not exceed regulatory limits and is as low as reasonably achievable. In addition to the previous dose limit of 50 mSv per year, an additional dose limit of 100 mSv for a set of five consecutive years has been imposed since 2008 to protect the radiation safety of workers.

Dose statistics show that two practitioners in 2000, one practitioner in 2001, and one practitioner in 2002 received an annual dose greater than 50 mSv. However, no practitioner has received an annual dose greater than 50 mSv since 2003. In addition, the number of radiation workers in Taiwan who received an annual dose of more than 20 mSv has also significantly decreased from 101 in 2000 to two in 2019. During the 12 years between 2008 and 2019, only a total of five practitioners received doses greater than 20 mSv in a year. This shows that Taiwan's regulatory measures on radiation safety and the self management of radiation facilities have progressed considerably.

（三）「輻射安全搜查隊」核能電廠除役之輻射特性調查

核電廠與其它類型電廠的最大差異，在於核電廠運轉過程中會產生放射性物質，這些放射性物質會留存在廠內部分管路、設備、建物，持續釋放輻射，人員在廠房內工作時，便會接受到輻射劑量。因劑量的英文為 dose，與中文「豆子」同音，所以核電廠工作人員常將接受輻射劑量稱為「吃豆子」，為了避免人員吃太多豆子，電廠通常會採取限制工作區域及作業時間等管制措施，但是當核電廠屆期除役，人員須在廠房內各區域長時間進行拆除、除污等作業，如能充分瞭解廠房內放射性物質分布及輻射強度等特性，便有助於管理除役核電廠的輻射安全。

原能會已要求台電公司妥適規劃核電廠除役之輻射特性調查，並透過實地查核，掌握台電公司調查情形，相關說明如下：

1. 書面審查

「核子反應器設施管制法」規定，台電公司需在除役前 3 年提報除役計畫，而依據「核子反應器設施除役計畫導則」，台電公司應於除役計畫中說明廠址與設施之特性調查及評估結果。台電公司於 104 年及 107 年分別提出核一廠及核二廠除役計畫，經原能會審查，兩電廠之除役計畫已於 106 年及 109 年審結。

惟因台電公司調查廠址輻射特性時，電廠仍在運轉階段，故台電公司僅進行初步調查，對此原能會以重要管制事項要求，台電公司應另行研提除役輻射特性調查偵檢計畫，於核電廠進入除役階段後進行詳細調查，並於完成調查後提交報告送審。為規範前述除役輻射特性調查偵檢計畫的撰寫項目，原能會擬訂「核子反應器設施除役輻射特性調查偵檢計畫導則」，並訂定其對應的審查導則，以利審查委員作為參考。

2. 實地查核

核電廠進入除役階段後，原能會每季均安排定期視察，至核電廠瞭解台電公司的廠址輻射特性調查執行情形，檢視其作業程序及現場偵測、取樣方式，確保相關作業符合輻射特性調查偵檢計畫。另為確認台電公司調查數據是否合理，原能會另安排實驗室人員至現場抽驗，藉由交叉比對，確保偵測數據的正確性。

1. 核二廠除役計畫審查會議
   Review meeting of Kuosheng NPP decommissioning plan
2. 除役計畫審查委員視察台電公司之分析實驗室
   Reviewers of decommissioning plans inspecting Taipower's analysis laboratory
3. 原能會查驗核能電廠除役輻射特性調查品質
   Checking the investigation quality of radiation characteristics in a decommissioning nuclear power plant

C. Radiation Safety Search Unit: investigation of radiation characteristics for nuclear power plant decommissioning

The most significant difference between nuclear power plants and other types of power plants is that radioactive materials are produced in an operating nuclear power plant. These radioactive materials will remain in some of the plant's pipelines, equipment, and buildings; they will continue to emit radiation; consequently, workers will receive radiation doses while working in the plant. Since the English word "dose" sounds very much like the Chinese word "beans" (Dou Zi), nuclear power plant workers often refer to "receiving radiation doses" as "eating beans." To keep workers from eating too many "beans", nuclear power plants usually adopt control measures such as restricted work areas and limited operating hours. Nevertheless, when a nuclear power plant enters the decommissioning phase, workers have to stay in various areas of the plant for long hours to carry out dismantling and decontamination work. If the characteristics such as the distribution of radioactive substances in the plant and radiation intensity are fully understood, it will help with radiation safety management of a decommissioning nuclear power plant.

AEC has requested that Taipower properly plan and conduct an investigation on the radiation characteristics of a decommissioning nuclear power plant. AEC also performs on-site checks with a view to oversee Taipower's investigation. Relevant measures are as follows:

a. Document review

The "Nuclear Reactor Facilities Regulation Act" stipulates that Taipower shall submit a decommissioning plan three years prior to the scheduled permanent cessation of operation of nuclear reactor facilities. Moreover, the "Guidelines for Decommissioning Plan of Nuclear Reactor Facilities" specifies that Taipower shall provide the investigation and evaluation results of the characteristics of the plant and facilities in the decommissioning plan. Taipower, in accordance with regulations, submitted Chinshan NPP and Kuosheng NPP decommissioning plans in 2015 and 2018, respectively. We conducted and concluded the review of the two decommissioning plans in 2017 and 2020, respectively.

However, Taipower's investigations on the plants' radiation characteristics were carried out when the plants were still in operation; consequently, only preliminary investigations were conducted. Taking this as an important regulatory matter, we requested that Taipower devise a separate plan to investigate and detect radiation characteristics in decommissioning nuclear facilities. A thorough investigation should be conducted when the nuclear power plants enter the decommissioning phase, and a report should be submitted for review once the investigation has been completed. In order to regulate the compilation of the aforementioned investigation and detection plan of radiation characteristics in decommissioning nuclear facilities, we drafted the "Guidelines for Investigation and Detection Plan of Radiation Characteristics in Decommissioning Nuclear Reactor Facilities" and drew up corresponding review guidelines for the reference of reviewers.

b. On-site checks

After a nuclear power plant enters the decommissioning phase, we arrange regular, quarterly inspections at the plant to understand the progress of Taipower's investigation on the plant's radiation characteristics, while reviewing its operating procedures, on-site detection, and sampling methods in order to ensure that relevant procedures are in compliance with the investigation and detection plan of radiation characteristics. In an effort to reassure the reasonableness of Taipower's investigation data, we also send laboratory operatives to perform random tests on site to ensure the accuracy of detected data through cross-referencing.

核子事故中央災害應變中心前進協調所演練
Drill at the Forward Coordination Post, National Nuclear Emergency Response Center

四、強化輻災應變與整備能量及資安措施

（一）核安演習首度納入防疫作為，提升複合式災害應變量能

109 年核安第 26 號演習於核二廠及鄰近地區舉行，分兵棋推演及實兵演練二階段實施，由中央與地方政府、國軍及民眾協力完成，總參與人數計 13,057 人。本次演習亦邀請民間團體加入演習評核組，以及無預警狀況設計小組，演習情境首度想定在 COVID-19(武漢肺炎) 疫情期間，發生重大天然災害併同核二廠核子事故之複合式災害，將防疫作為落實於各項平時整備及演練中。

1. 兵棋推演

兵棋推演於 8 月 6 日實施，與國家災害防救科技中心合作引入智慧科技防災，設計地震災損情境；推演過程對參演單位下達無預警狀況與探討 COVID-19（武漢肺炎）防疫措施及民眾關切議題，如火山活動研判與應處、假訊息澄清與處理、北北基區域聯合因應複合式災害，以及跨區域支援救災資源整合與調度等，中央及地方共 9 個應變單位聯合推演，參與人數計 393 人。

各應變單位進行視訊會議
Video-conference between response units

(IV) Enhancing Radiological Emergencies Response and Preparedness and Measures for Information Security

A. Incorporating epidemic prevention measures in Nuclear Emergency Exercises to strengthen complex disaster response capabilities

The 2020 Nuclear Emergency Exercise (No. 26) took place at Kuosheng NPP and its surrounding areas. A total of 13,057 people from the central and local governments, the military, and civilians participated and collaborated in the exercise, which was carried out in two stages: a table-top exercise and a full-scale exercise. Civil groups were also invited to join the assessment panel and unannounced scenarios planning team for the exercise. For the first time, the exercise scenario was set during the COVID-19 outbreak when complex disasters, i.e., a major natural disaster and a nuclear accident at Kuosheng NPP, occurred simultaneously, with epidemic prevention measures being incorporated into exercises.

a. Table-top exercise

The table-top exercise, jointly conducted with the National Science and Technology Center for Disaster Reduction on August 6th, introduced intelligent technology for response efforts in an earthquake disaster simulation. During the exercise, participating units were given unannounced scenarios, such as COVID-19 prevention measures and issues of public concern, e.g., volcano monitoring and response, disinformation clarification and handling, joint response to complex disasters in the Taipei-Keelung metropolitan area, and cross-regional support for disaster relief and resource management. A total of 393 people from nine response units from the central and local governments participated in the table-top exercise.

1 2

1. 新北市災害應變中心兵棋推演
   Table-top exercise at the New Taipei City Emergency Response Center
2. 基隆市災害應變中心兵棋推演
   Table-top exercise at the Keelung City Emergency Response Center

2. 實兵演練

實兵演練於 9 月 9 日至 11 日辦理，參與人數計 13,057 人，為歷年最高，分三項進行說明：

⑴ 強化應變作業方面：

① 無預警狀況演練，驗證應變作業：設計天然災害併同核子事故之二套演習情境、並下達核能二廠 3 項無預警狀況演練、廠外應變單位 5 項應變抽演科目。8 月 30 日另執行核能二廠非上班時間無預警動員測試。

② 首次進行大屯火山群活動監測與輻射災害情資整合，由原能會與國家災害防救科技中心合作開發輻射災害情資網，介接大屯火山群活動監測數據，同時呈現全國環境輻射監測數值，以整合災害情資，提供應變人員決策作業及超前部署完整資訊。

③ 跨區域動員，展現支援機制及能量：動員中部化學兵、臺北市政府、核能一廠、輻射偵測中心等人員並攜帶支援設備，提供應變所需支援能量。另邀集 7 個民間志工團體進駐避難收容處所，整合志工支援能量，提供收容民眾各項需求。

④ 首次結合第 5 代行動通訊技術傳輸無人機輻射偵測數據，將輻射偵測的結果以更快速的方式回傳，有效提升應變決策時效。

⑵ 拓展訊息發布管道方面：

除既有民眾預警系統、手機警訊 (CBS、LBS)，本次演習增加民防廣播系統、警廣電台、新北市政府及基隆市政府官方 LINE 群組及在地臉書社團等多元訊息通知管道，讓民眾及時收到相關訊息。

⑶ 民眾及師生參與方面：

① 因應 COVID-19(武漢肺炎) 疫情，演習執行期間，各單位均配合落實防疫新生活運動；另新北市政府假想居家檢疫民眾疏散需求，運用防疫計程車送往指定之防疫旅館，以及包括避難收容處所執行防疫演練，有效呈現政府面臨複合式災害之應變作為。

b. Full-scale exercise

The fully participation exercise, taken place from September 9th to 11th, was participated by 13,057 people, the highest number over the years. Three aspects are presented below:

(a) Enhancing response operation

i. Unannounced scenarios to verify response capabilities:

Two sets of drill scenarios of natural disasters combined with nuclear accidents were devised, three unannounced scenarios were given at Kuosheng NPP, and five randomly selected drill scenarios were conducted by offsite response units. In addition, an unannounced mobilization drill during non-working hours was carried out at Kuosheng NPP on August 30th.

ii. Monitoring the Tatun Volcano activity and integrating monitoring data into radiological emergency platform:

The Radiological Disaster Prevention Information Service Platform, co-developed by AEC and the National Science and Technology Center for Disaster Reduction, integrated disaster response information by incorporating monitoring data from Tatun Volcano and environmental radiation monitoring data to provide response personnel for decision-making.

iii. Cross-region mobilization:

Chemical Corps units from central of Taiwan and staff with equipments from the Taipei City Government, Chinshan NPP, and AEC Radiation Monitoring Center were mobilized to joint the response mission. In addition, seven civilian volunteer groups were invited to be stationed at shelter center to provide the service of sheltered people.

vi. 5G mobile communication:

For the first time, drone radiation detection data were transmitted via the 5G mobile communication technology, enabling a faster transmission of radiation detection data for decision-making.

(b) Expanding message distribution channels

In addition to the existing public alert and notification system and cell phone alert systems (Cell Broadcast Services/CBS and Location-based Services/LBS), more notification channels, such as the Civil Defense Broadcasting System, Police Broadcasting Service, the official LINE groups of the New Taipei City Government and Keelung City Government, and local communities on Facebook , were introduced during the exercise to ensure the timely notification to the public.

(c) The residence, school and student got involved:

i. In response to the COVID-19 pandemic, all units have conformed to the epidemic prevention measures by the CECC when carrying out the exercise. In addition, the New Taipei City Government has exercised an evacuation of people in home quarantine, who took taxis to designated quarantine hotels, and the epidemic prevention measures were carried out at the shelter centers. Both the drills have demonstrated the effectiveness of the government in responding to complex disasters.

防疫計程車載運居家檢疫民眾疏散演練
A taxi picking up a person in home quarantine in an evacuation

② 為顧及弱勢族群在收容安置時面臨可能的不便，在避難收容處所，設置特別照護區，提供更友善收容環境，以實踐身心障礙者權利公約之精神。

③ 本次演習新北市及基隆市之核能二廠緊急應變計畫區所有學校共同參與，擇定 2 校依應變程序啟動預防性疏散機制，其他學校進行室內核安防護教育，以熟稔安全防護知識。

陸海空域環境輻射偵測
Land, Sea, and Air Radiation Monitoring

ii. In view of potential inconveniences that may be experienced by disadvantaged groups in shelters, a special care area was set up in the shelters to provide a friendly environment in accordance with the Convention on the Rights of Persons with Disabilities.

iii. All the schools located in Kuosheng NPP Emergency Planning Zones in New Taipei City and Keelung City participated in the exercise. Two schools were selected to participate in a drill where a preventive evacuation mechanism was initiated in accordance with emergency response procedures; at the other schools, nuclear safety education program were to provide students with safety and protection knowledge.

1. 基隆市中山高中預防性疏散及核安防護教育演練
   A preventive evacuation drill at Keelung Municipal ZhongShan Senior High School
2. 避難收容所友善環境及輻射諮詢
   Friendly environment and a consultation post about radiation protection at shelters

（二）精進核電廠警衛效能與外部支援協同防護

1. 藉由兵棋推演與專業訓練，精進核能電廠警衛應變效能

警衛與應變武力為核子保安的重要環節，除持續監督核能電廠維持實體防護與資通安全外，109 年著重於精進核能電廠警衛與應變效能。7 月首次辦理「核能電廠警衛效能評估」訓練，課程內容包含核能電廠應變效能與設施弱點分析，並進行桌上演練實作課程。10 月首次於核一廠以兵棋推演方式執行核子保安與反恐演練，推演應變武力因應保安事件，探討警衛效能及發掘設施弱點並加以強化。

2. 聯合軍警進行核子保安演練，強化外部支援協同防護

由於國際現勢及國家面臨的威脅提升，原能會非常重視對核能電廠的防護，強調必須結合外部支援軍警聯合防禦各項攻擊造成的破壞。為檢視核能電廠的外部協同支援程序與應變量能，109 年各核能電廠的核子保安與反恐演練納入軍、警與海巡等外部單位聯合演練，操演熟練武力支援及通訊程序，強化各種危機情境的應變能力。

1 2

1. 警衛效能訓練進行兵棋推演實作
   A tabletop exercise in the nuclear security performance training program
2. 核三廠反恐與保安演練結合海巡部隊支援
   A nuclear security and anti-terrorism drill with the Coast Guard at Maanshan NPP

（三）超前部署災害應變整備

1. 完備輻射災害應變整備規範

完成輻射災害防救業務計畫修正，更新輻射災害防救重點工作，強化身心障礙權益與性別平等意識，增列防疫作為，精進我國輻射災害防救整體規劃，與國家災害防救政策接軌，並供地方政府精進輻射災害防救業務依循。

B. Enhancing security performance and collaboration with external support at nuclear power plant

a. Improving security performance through tabletop exercises and training program at nuclear power plant

Security guards and response forces play a key role in nuclear security at NPP. In addition to oversight physical protection and cyber security, AEC also made efforts to enhance security guards and response forces performance at nuclear power plant . In July 2020, AEC conducted a training course on "Assessment on Security Performance at Nuclear Power Plant", which consist of security response performance and facility vulnerabilities analysis, as well as tabletop exercises. In October, a nuclear security and anti-terrorism tabletop exercise was conducted at Chinshan NPP, wherein its response forces in response to a malicious intrusion was exercised, the vulnerabilities of facility have been identified and remediated.

b. Joint exercise on nuclear security with the military and police to strengthen the collaboration with offsite response force

Due to the current international situation and increasing threat facing Taiwan, AEC has raised serious concerns on the protection of nuclear facilities and the collaboration with external response force from the military and police to prevent from sabotage or hostile attacks. To review collaborating with external response forces, as well as the response performance of security guards at nuclear power plants, joint exercise with the military, police, and coast guard on nuclear security and anti-terrorism were carried out at each nuclear power plant in 2020.

C. Early deployment of disaster response and preparedness

a. Completing and improving regulatory planning on radiological emergency response and preparedness

AEC has completed the revision of Radiological Disaster Prevention and Response Plans, including updating key tasks in radiological emergency prevention and response, and strengthening the rights of persons with disabilities and awareness of gender equality. As well as epidemic prevention measures were taken into account to improve the overall planning for radiological emergency response. In line with national emergency response policies, the Response Plans also serve as guidelines for local governments to improve radiological emergency prevention and response operations.

2. 提升我國輻災應變整備能量

透過輔導、演訓、強化支援系統三方向，充實地方政府與原能會輻射應變技術隊之輻射災害防救知能，增進國家整體輻災應變能量。

(1) 輔導：配合行政院執行地方政府災害防救與全民防衛動員計畫審議及業務訪評、輔導地方政府落實輻射災害防救整備工作。

(2) 演訓：為增進地方政府第一線應變人員及業務承辦人員對輻射災害應變之瞭解，辦理北中南東 4 場次「地方政府輻射災害防救講習」，計 183 人參與，除課程講授、實例分享，並運用課堂所學之應變要領，進行放射性物質意外事件應變模擬推演，加乘學習成效。另外，結合地方政府辦理的訓練與演練，拓展與精進輻射災害應變量能，加強地方政府第一線應變人員處理輻射災害能力，109 年共計協助地方政府進行 6 場次訓練，計 977 人參訓。另協助新竹縣辦理輻射災害防救演練，強化中央地方輻射災害聯防作業，以及辦理原能會輻射應變技術隊專業訓練，透過課堂講授與放射性物質搜索實地操作，強化輻射偵測與應變專業知能。

(3) 充實支援系統：改版更新供地方政府應變使用之「放射性物質使用場所查詢服務系統」，提高使用友善性，利用圖像化方式增進資料易讀性，並增設放射性物質防災處理方式資訊及注意事項，供第一線應變人員參考。另因應輻射災害後可能衍生之大量食品與環境樣品檢測需求，原能會與國立陽明大學及國立屏東科技大學合作建置放射性分析備援實驗室，2 間實驗室建置完成後，除已取得全國認證基金會 (TAF) 與衛生福利部食品藥物管理署 (TFDA) 食品放射性分析檢測認證，109 年並拓展分析領域至環境樣品，並取得 TAF 增項認證，有助於提升整體分析備援能量。

地方政府輻射災害防救講習之放射性物質意外事件應變模擬推演

Simulation of emergency response involving radioactive materials during a "Local Government Radiological Emergency Response Seminar"

b. Increasing national capabilities for radiological response and preparedness

Three routes: counseling, training, and strengthening of the support system have been set to boost the radiological emergency response knowledge and abilities of local governments and AEC Radiation Emergency Response Technical Team in an effort to increase the overall national radiological emergency response capabilities.

(a) Counseling:

Coordinating with the Executive Yuan, AEC conducted a review on local governments' Disaster Prevention and Response and All-out Defense Mobilization Plan, carried out visits and evaluation, and provided counseling for local governments to implement radiological emergency response and preparedness work.

(b) Training:

With a view to improve the understanding of radiological emergency response among front-line response workers and response contact persons in local governments, four sessions of "Local Government Radiological Emergency Response Seminars" were held in Northern, Central, Southern and Eastern Taiwan, with a total of 183 participants. Through lectures and case sharing, participants learned response essentials and techniques, which were then applied in simulations of emergency response involving radioactive materials to enhance the effectiveness of their learning. Coordinating with local governments, AEC also organized training sessions and exercises to improve front-line response workers' ability in handling radiological emergencies. This, in turn, helped expand the radiological emergency response capabilities of the local governments. In 2020, a total of six such training sessions were offered and participated by 977 people. In addition, AEC assisted Hsinchu County in carrying out radiological emergency response drills to strengthen joint radiological emergency response operations by the central and local governments. AEC also conducted professional training sessions for AEC Radiation Emergency Response Technical Team to strengthen the professional knowledge and abilities in radiation detection and response through both classroom lectures and field operations to search radioactive materials.

(c) The strengthening of the support system:

The "Locations of Using Radioactive Materials Search Platform" has been revised and updated for local governments' emergency response. User-friendliness improved, data readability enhanced by means of graphical user interface, and radioactive material emergency response information and precautions established are all included for the reference and handling of front-line response workers. AEC also collaborated with National Yang-Ming University and National Pingtung University of Science and Technology to build two backup laboratories for radioactive analysis to meet the surging capacity needs for the testing food and environmental samples that may arise following a radiological incident. Upon completion, the two laboratories were certified by the Taiwan Accreditation Foundation (TAF) and Taiwan Food and Drug Administration (TFDA), Ministry of Health and Welfare for food radioactivity testing and analysis. In 2020, they were further certified by the TAF for the testing and analysis of environmental samples, which contributes to the overall analytical backup capacity of the nation.

3. 嚴密原能會防疫應變作為

因應 COVID-19（武漢肺炎）疫情，1 月 30 日即訂定「原能會因應 COVID-19（武漢肺炎）疫情防疫應變措施」，除定期召開防疫工作小組會議，規劃與追蹤各項防疫作業，並完成分區辦公、異地辦公及因應確診個案模擬應變演練，於核能研究所建置核安監管中心備援場所，確保業務維持運作。

（四）遵循資安法規範，推動資安強化措施

1. 辦理資安法規定事項

原能會依據政府「資安即國安」的政策，積極辦理資安法規定事項，包含資通安全防護計畫、資通系統分級及防護基準、內部資通安全稽核、委外廠商稽核、業務持續運作演練、資訊系統安全性檢測、資安教育訓練等事項，在全會同仁積極參與下，按資安法規定於 109 年應辦理事項已全部達成。

2. 導入資安管理制度 (ISMS)

原能會為保護資訊資產的機密性、可用性與完整性，提升資安防護水準，持續推動資訊安全管理制度 (ISMS)，經由審查資訊作業流程，訂定資通安全政策，再進行資產盤點及及風險評鑑作業，制訂適合各單位作業的資通安全相關文件，並透過資通安全教育訓練、內部稽核結果與緊急事件通報的檢討，持續改進資通安全管理作業。

3. 通過 ISO 27001 驗證取得證書

原能會於 109 年重新辦理 ISO 27001 驗證作業，第三方驗證單位於 109 年 9 月 16 日至原能會進行審查作業，審查結果通過並取得 3 年有效證書。

五、精進原子能科技研發

（一）多醣克錁看見肝功能

1. 維持足夠肝功能是存活決勝關鍵

全世界十分之一人口罹患慢性肝炎，是肝硬化及肝癌的高危險群；而活命的關鍵在於「維持足夠肝功能」，但目前沒有準確的肝功能定量技術。去唾液酸醣蛋白受體 (asialoglycoprotein receptor, ASGPR) 是位於肝實質細胞膜表面的特異性受體，和血清蛋白的吸收、代謝、排除有關，可以反應肝實質細胞的功能。

c. Stringent response measures in epidemic prevention

In response to the COVID-19 outbreak, "AEC Response Measures for the COVID-19 Epidemic" was formulated as early as January 30th. Regular meetings were held for the epidemic prevention task force, and various epidemic prevention actions have been planned and tracked. AEC have also completed the planning for staff members to work at different parts of the office building and/or at different office locations, and carried out simulated response drills for confirmed cases of COVID-19. Moreover, a backup site for the Nuclear Safety Duty Center was built at the Institute of Nuclear Energy Research to ensure operational continuity and stability.

D. Enhancing cyber security measures in compliance with Cyber Security Management Act

a. Provisions stipulated in Cyber Security Management Act

In accordance with national policies on "Information security is national security" by President Tsai, AEC actively engaged in matters stipulated in Cyber Security Management Act, including cyber security protection plans, a baseline survey for the classification and protection of information system, internal audits for cyber security readiness, external audits of contracted suppliers, operational continuity exercises, the testing of information system security, and cyber information security education and training courses. With the active participation of all AEC Staff, all the action items were completed in 2020 in accordance with cyber security laws.

b. Implementing Information Security Management System (ISMS)

In order to protect the confidentiality, usability, and integrity of information assets and improve the standards of information security protection, AEC has strived to implement the Information Security Management System (ISMS). Information security policies have been formulated after the reviewing of information workflow, and relevant information security documents suitable for each unit's operation have been drafted following asset inventory and risk assessment. AEC has also been making great efforts to improve information security management through organizing information security education and training courses, and conducting reviews on internal audit results and notifications of cyber security incidents.

c. Achieving the ISO 27001 certification

AEC re-applied for the ISO 27001 certification in 2020. A third-party audit company conducted the audit at the AEC on September 16, 2020, following which AEC was awarded the certification, which is valid for three years.

(V) Advancing the Research and Development of Atomic Energy Technology

A. Dolacga: an imaging agent for testing liver function

a. Adequate liver function: key to survival

One tenth of the world's population suffers from chronic hepatitis, which also puts them at high risk of cirrhosis and liver cancer. The key to survival is maintaining adequate liver function, which currently lacks accurate assessment technology. The asialoglycoprotein receptor (ASGPR), located on the surface of the hepatic parenchymal cell membrane, is a specific receptor related to the absorption, metabolism, and clearance of serum proteins, and can reflect the function of hepatic parenchymal cells.

核研所開發的多蕾克鎵肝功能造影劑 (Dolacga) 與 ASGPR 造影技術，可靈敏看出肝病病程的變化。動物試驗數據顯示，若肝臟 ASGPR 數量低於 25%，個體一周內就會死亡。而若肝臟 ASGPR 數量維持於 50% 以上，即使帶有肝硬化，仍可以維持很好的生存能力。

核研所開發的多蕾克鎵肝功能造影劑之原料藥主成分是六聚乳糖胜肽。六聚乳醣胜肽的設計是一個仿生概念，因為自然界與 ASGPR 結合的蛋白都是末端帶有半乳醣，因此核研所發展的六聚乳醣胜肽係以三個胺基酸胜肽為骨架，一端聚合六個乳醣鏈，來仿生模擬人體內的去唾液酸醣蛋白，另一端鍵結一個螯合基。帶有螯合基的六聚乳醣胜肽可以螯合金屬同位素鎵 -68 作為被正子儀器測量的造影劑。核研多蕾克鎵肝功能造影劑作為肝功能檢驗，是全球第一個肝標靶醣胜肽肝功能檢驗藥劑，適用於切肝、換肝手術前治療策略或作為慢性肝炎嚴重度之評估，肝病病患搭配正子放射斷層掃描儀使用，透過個體肝功能病程的掌握，預測可有效降低病患死亡率。

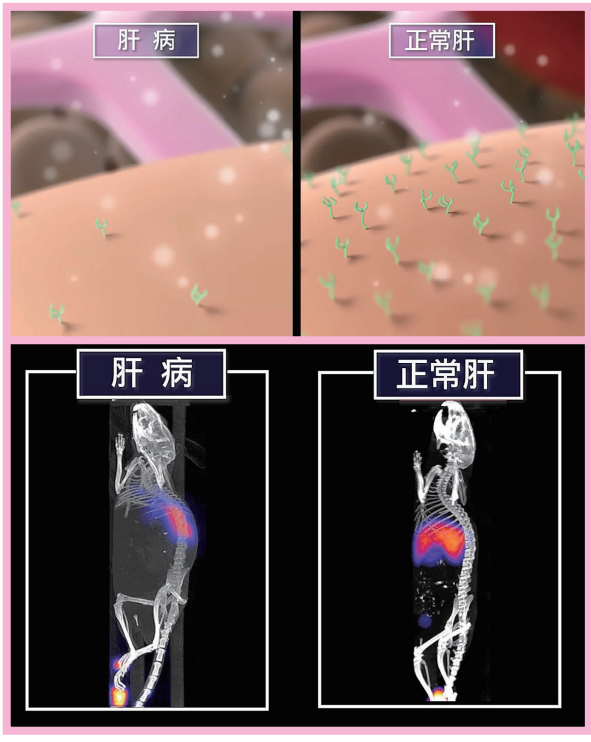
2. 通過臨床試驗具絕佳肝標靶特性

核研多蕾克鎵肝功能造影劑具絕佳的肝標靶特性，且所開發的 ASGPR 造影技術很容易辨認出肝病的差異度，可以明顯看出肝癌缺損的部分，以及定量出慢性肝炎的差異、一眼就可看出正常與肝病的造影差別。

市面上唯一的 ASGPR 造影劑是大分子蛋白質的 GSA (galactosyl serum albumin) ，醣的數量不固定 (N=2-50)，對 ASGPR 的標靶性僅 70%，只有在日本使用，並沒有通過美國法規核准。核研多蕾克鎵肝功能造影劑是以六聚乳醣胜肽為主體，乳糖數量恆定為 6 個，對 ASGPR 的標靶性近乎 100%，並通過美國法規核准可用在人體臨床試驗。它可以即加即用，只需將鎵 -68 加到核研多蕾克鎵肝功能造影劑的凍晶瓶中溶解靜置 15 分鐘就可以做為造影劑使用。

3. 創新技術突破獲多國專利

核研所的創新突破技術已獲多國超過 20 項專利，其中與材料有關的美國專利有 6 件、中華民國專利 6 件、日本、歐洲各 1 件。核研所擁有實力堅強的研究團隊，將致力於擔任新藥研發的引擎角色，為全體人類創造更美好的明天。



▶ 肝臟實質細胞細胞膜表面的去唾液酸醣蛋白受體數量，在正常肝臟和肝病肝臟有差異（上圖），因此透過去唾液酸醣蛋白受體造影術，可靈敏看出正常肝與肝病的造影差別（下圖）。

Dolacga liver function imaging agent and ASGPR biomarker imaging technology, innovated by the Institute of Nuclear Energy Research (INER), can readily show the extent and changes in the course of liver diseases. Results from animal testing showed that a subject would die within one week if its ASGPR quantity was lower than 25%. However, if the ASGPR quantity of a subject was maintained at 50% or higher, it could still maintain a good survival level, even if it had cirrhosis.

The active pharmaceutical ingredient (API) of INER Dolacga liver function imaging agent is composed of hexa-lactose peptide, which is designed with a bionic concept, as all the natural proteins bound to ASGPR have galactose at the end. The hexa-lactose peptide developed by the INER is based on a backbone of three amino-acid peptides, with six lactose chains polymerized at one end to mimic asialoglycoprotein in the human body, and a chelating ligand bound at the other end. Hexa-lactose peptides containing chelating ligands can chelate gallium-68 metallic isotope and perform as an imaging agent for measurement by positron instruments. INER Dolacga liver function imaging agent used to assess liver function is the first liver-targeting glycopeptide drug for liver function imaging in the world. It is suitable for pre-surgical treatment strategies for liver resection and liver transplantation, or for the assessment of the severity of chronic hepatitis. It is predicted that using a positron emission tomography scanner to gain insight to changes in liver function will lead to the effective reduction of patients' mortality rate.

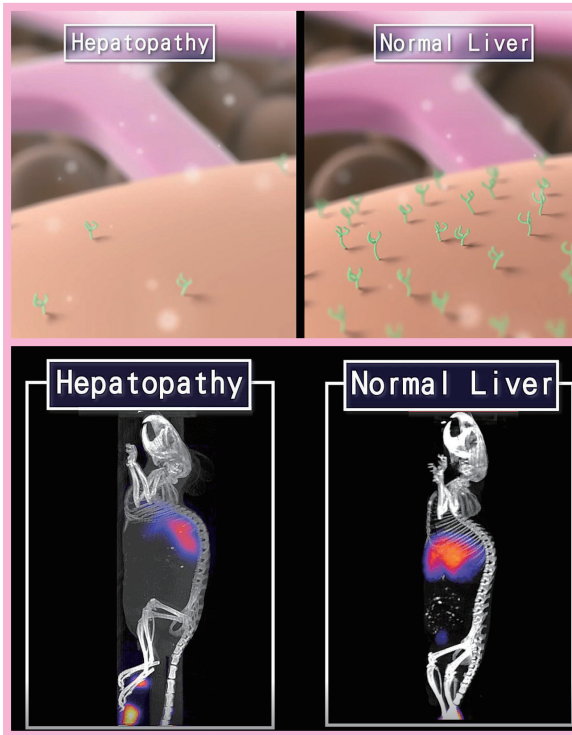
b. Successfully completing clinical trials with excellent liver-targeting properties

INER's Dolacga liver function imaging agent has excellent liver-targeting properties, and its ASGPR biomarker imaging technology can immediately show differences between a normal liver and a diseased liver. It can easily identify differences in liver diseases, changes in the course of chronic hepatitis, and the defective parts of a cancer-infected liver.

The only commercially available ASGPR imaging agent is galactosyl serum albumin (GSA). GSA has large protein molecules and a variable number of sugars (N=2-50); its targetability for ASGPR is only 70%. Currently, GSA is only used in Japan and has not been approved by U.S. regulatory authorities. INER Dolacga liver function imaging agent is based on hexa-lactose peptides with a constant number of six lactose chains, and has nearly 100% targetability for ASGPR. It has been approved by U.S. regulatory authorities for use in human clinical trials. It can readily be used by adding gallium-68 to a freeze-crystallizer bottle containing INER Dolacga liver function imaging agent and allowing it to dissolve in 15 minutes.

c. An innovative technological breakthrough patented in many countries

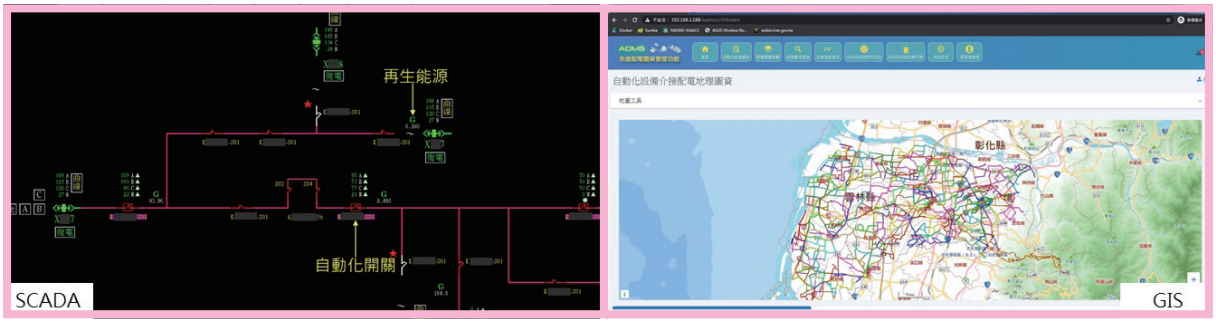
INER's innovative technologies have been granted more than 20 patents in many countries, including six in the U.S., six in the R.O.C., one in Japan, and one in Europe for materials-related technologies. With a robust research team, INER is committed to serving as an engine for new medicine development and creating a better tomorrow for all people.



▶ The number of asialoglycoprotein receptors on the surface of the hepatic parenchymal cell membrane differs between a normal liver and a diseased liver (top). By utilizing asialoglycoprotein receptor imaging technology, the differences in the imaging results between a normal liver and a diseased liver can be sensitively detected (bottom).

（二）含綠能之本土化配電網路管理系統開發

近年來隨著環境永續議題受到高度關注，綠能產業也隨之蓬勃發展，未來將有大量再生能源併入配電饋線。目前配電網路管理系統之饋線資料蒐集監控缺乏再生能源即時運轉資訊，當饋線發生故障後，若以饋線負載量作為轉供依據，則可能導致饋線轉供後裕度不足及電壓過低之情形發生。因此，研究團隊進行再生能源發電預估策略開發，根據再生能源裝置容量及其位置、溫度及照度、時間、及饋線資訊端末設備之電流與電壓值資訊，藉以計算饋線的實際用電量。



本土化配電網路管理系統畫面
Screens of the domestic distribution network management system

含綠能之本土化配電網路管理系統整合饋線資料蒐集監控、地理空間資訊、及配電潮流程式，其功能如下：

1. 饋線資料蒐集監控整合配電潮流計算，提供具綠能之饋線裕度、電壓與位置、及線路損失等轉供建議方案。
2. 提供地理空間資訊告警功能，如運轉電壓異常數值告警及標示功能，提醒調度人員留意饋線狀態。
3. 動態呈現饋線供電、停電、及轉供區域範圍與供電電流方向之地理空間資訊，達成輔助電力調度功能。

本系統於 108 年 4 月已在台電雲林區處上線運轉，有效管理雲林縣全縣 334 條饋線與約 600MW 再生能源併網發電；統計 108 年 7 月至 109 年 6 月已有 79 次成功判斷，協助台電於 5 分鐘內完成饋線事故之偵測、定位、隔離與復電，提高饋線調度運轉與管理再生能源能力。本研發成果參加 2020 TIE 台灣創新技術博覽會發明競賽，榮獲鉑金獎。

2020 TIE台灣創新技術博覽會上台領獎合照
Award-receiving ceremony at the 2020 Taiwan Innotech Expo

B. Development of domestic distribution network management system incorporating green energy

Environmental sustainability has received great attention in recent years, and the green energy industry has flourished. As a result, large amounts of renewable energy will be integrated into distribution feeders in the future. Currently, Supervisory Control and Data Acquisition (SCADA) in the distribution network management system lacks real-time operational information of renewable energy. When a fault occurs, if the feeder load is used as the basis for feeder transfer, it may lead to insufficient capacity allowance and low voltage after feeder transfer. Therefore, INER research team developed a renewable energy generation estimation strategy to calculate the actual electricity consumption of the feeder based on the installed capacity and location of the renewable energy devices, temperature and illumination, time of day and hour, and the current and voltage values of Feeder Terminal Unit (FTU).

The domestic distribution network management system incorporating green energy integrates SCADA, Geographic Information System (GIS), and distribution power flow programs. It has the following functions:

a. SCADA integrates a distribution power flow algorithm to provide information, such as capacity allowance, voltage and location, as well as line loss incorporating green energy for load transfer solutions.

b. Alert functions on GIS, such as alarm and the marking of an abnormal voltage value during operation, are provided to prompt the dispatcher to pay attention to the feeder status.

c. Feeder supply and outage, transfer area, and direction of current supply, is presented dynamically to support power dispatch on GIS.

1
2

1. 即時運轉資訊及異常告警
   Real-time operational information and alert for abnormality
2. 動態呈現饋線供/停電、及轉供區域範圍與供電電流方向
   Feeder supply and outage, transfer area, and direction of current supply presented dynamically

The system has been put into operation at Taiwan Power Company (TPC) Yunlin District since April 2019; it has effectively managed 334 feeders and approximately 600MW of renewable energy grid-connected power generation in Yunlin County. From July 2019 to June 2020, 79 successful judgments were made by the system, assisting TPC to execute fault detection, isolation and restoration of feeders within 5 minutes, and improving the ability of dispatch and renewable energy management. This outcome was awarded the Platinum Award at the 2020 Taiwan Innotech Expo (TIE).

（三）創新之腎功能造影劑前驅物S-Bz-MAG_3合成技術應用於原料藥之擴量生產

1. S-Bz-MAG_3 之簡介

Tc-99m-MAG_3 為專一性診斷腎血流量及腎小管功能製劑，能精確分析腎小管分泌排泄的藥理特質，成為全世界腎功能重要的診斷藥物之一；S-Bz-MAG_3 作為腎功能造影劑的前驅物，核研所不斷精進其合成研發技術，促成 Tc-99m-MAG_3 的順利生產與核准上市，不僅使國內腎臟泌尿系統病患，獲得更精準及有效的醫療診斷服務，更成為推動本土化核醫製藥產業的圭範。

2. S-Bz-MAG_3 合成技術之創新特點

精簡步驟提昇總產率：將 S-Bz-MAG_3 原合成途徑進行調整，由以往之四步驟簡化為三步驟，其關鍵在於將 S-Bz-MAG_3 結構中的三個胺基酸單元在新製程中一次稼接完成，而非舊製程的逐段稼接。改良之 S-Bz-MAG_3 製程，三步驟總產率為 64 %，較舊製程四步驟提昇了約 10-20 %。

純度提高降低副作用：改良製程產出的 S-Bz-MAG_3，除了產率大幅提昇外，產品的外觀為晶型一致的白色固體，並經高效能液相層析儀 (HPLC) 檢測，其純度均達 99 % 以上。產品熔點也因純度上升及雜質減少而提高了 2~3 ℃，顯示在純度品質上有長足的精進。並且因雜質含量的減少，降低了可能因雜質引起之副作用的機率。

簡易製程容易量產：舊製程的 S-Bz-MAG_3 合成中間產物需要以繁複的管柱層析進行純化作業，而改良製程的中間產物是以萃取及結晶方式純化，有利於提高純度且容易操作，有利於商業化之擴量生產。

由於此一創新製程具有上述的三項特點，極具技轉國內藥廠進行生產之潛力，因此獲得 2020 台灣創新博覽會發明競賽鉑金獎殊榮的肯定。

C. Innovative synthesis technology for S-Bz-MAG_3 as a precursor of renal function imaging agent applied to scale up API production

a. Introduction of S-Bz-MAG_3

Tc-99m-MAG_3, a specific diagnostic agent for renal blood flow and renal tubular function, can accurately analyze the pharmacological characteristics of renal tubular secretion and excretion; it is one of the most important diagnostic agents for renal function worldwide. S-Bz-MAG_3 is a precursor of renal function imaging agent; the INER has been refining its synthesis technology to facilitate the smooth production and approval of Tc-99m-MAG_3, which not only contributes to more accurate and effective medical diagnostic services to domestic patients with renal and urological conditions, but also serves as a model for promoting the local nuclear medicine industry.

b. The innovative characteristics of S-Bz-MAG_3 synthesis technology

Total yield increased by streamlining the steps:

The original synthesis pathway of S-Bz-MAG_3 is adjusted from a previous four-step reaction to three steps. The key is to complete the grafting of the three amino acid units in the S-Bz-MAG_3 structure at one time, rather than the step-by-step method used in the conventional process. The improved three-step S-Bz-MAG_3 process has a total yield of 64%, which is about 10-20% higher than that of the old, four-step process.

Improved purity and reduced side effects:

S-Bz-MAG_3 produced by the improved process not only has a significantly higher yield, but also has a uniform white solid crystal appearance; it has been tested by high performance liquid chromatography (HPLC) and found to have a purity of over 99%. The melting point has also increased by 2-3°C due to the increased purity and reduction of impurities, which shows a significant improvement in purity quality. Furthermore, the reduction of impurity content also reduces the probability of side effects caused by impurities.

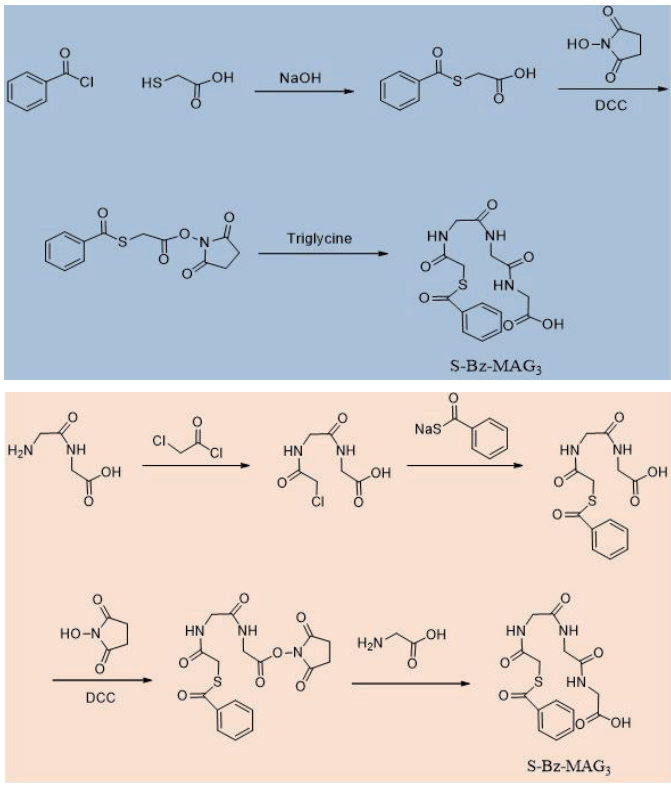
Simple manufacturing process making it easy to scale up production:

The synthesis intermediate product of S-Bz-MAG_3 in the conventional process requires complicated column chromatography purification, while the intermediate product in the modified process is purified by extraction and crystallization, which is conducive to increasing the purity, easy to carry out, and favorable to commercial scale-up production.

Since this innovative process has the three above characteristics, it holds great potential to be transferred to domestic pharmaceutical companies for production and was therefore recognized with the Platinum Award in the 2020 Taiwan Innotech Expo.

3. 產業展望

核研所已將 S-Bz-MAG_3 原料藥各項製程相關技術，已以「造影劑前驅物 S-Bz-MAG_3 之製備方法」之主題申請專利，於 108 年獲得中華民國專利發明第 I663174 號，並經由放大製程設備測試，證實可以進行每批次 5~10 公克以上的擴量製程，不但可突破此一原料藥量產的瓶頸，並在智財保護外，積極向國內外各大醫院及藥廠，介紹及推廣此一應用於腎臟泌尿系統診斷之商品。期盼能將此造影劑前驅物原料藥擴量製程技術轉移給民間產業，使國內腎臟泌尿系統病患，獲得更精準有效的醫療診斷服務，讓核研所作為原料藥研發的先驅，造福更多有需要的民眾。



1. S-Bz-MAG_3改良製程（一次稼接胺基酸單元）
   Modified S-Bz-MAG_3 process (the grafting of the amino acid units at one time)
2. S-Bz-MAG_3舊有製程（逐段稼接胺基酸單元）
   Conventional S-Bz-MAG_3 process (the step-by-step grafting of the amino acid units)

（四）3D立體彩色X光造影解決方案

1. X 光造影將由黑白進入彩色世界

X 光造影發展至今超過 120 餘年（如圖一），前 80 年以 2D 影像為主；自 1972 年電腦斷層造影 (Computed Tomography, CT) 的發明將 X 光導入具深度資訊的 3D 影像，大大提高待測物體內空間的鑑別能力，後續發展則以技術規格精進與新式造影技術為主，直至近年來以複合式半導體技術為基礎的光子計數偵檢器 (Photon Counting Detector, PCD) 被提出後，X 光造影將跳脫傳統黑白影像，進入具材質辨識 (Material Decomposition) 能力的彩色世界。

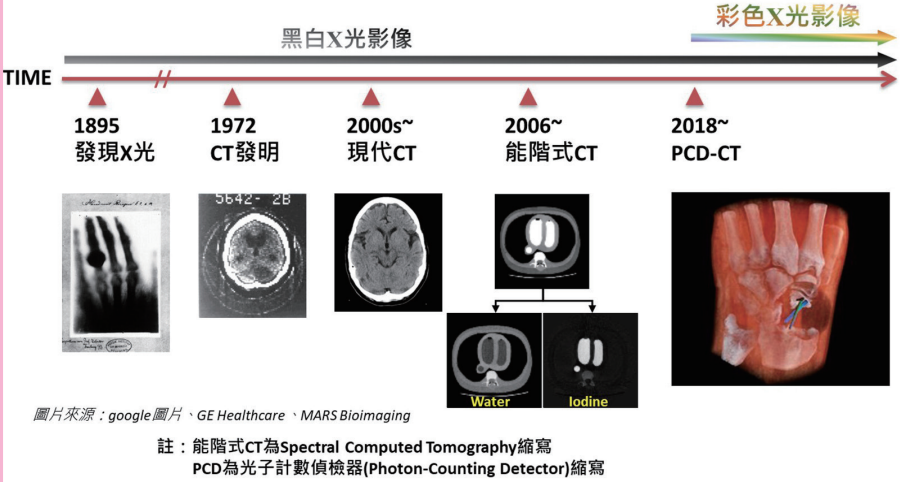
c. Industry Outlook

INER applied for a patent for the S-Bz-MAG_3 API process under the title of "Method for Preparing S-Bz-MAG_3 as a Precursor of Contrast Media" and was awarded R.O.C. Patent (Invention No. I663174) in 2019. The process has been tested by an expansion process and verified that it can be carried out in batches of a larger quantity of five to ten grams per batch. Not only did the process successfully break the bottleneck for the scale-up of the API production, but the product for renal and urological diagnosis can also be introduced and promoted under the protection of intellectual property to major hospitals and pharmaceutical companies both in Taiwan and abroad. We hope to transfer the scale-up process technology of contrast precursor API to the private sector, so that domestic patients with renal and urological conditions will be able to receive more accurate and effective medical diagnostic services, enabling INER to play the role of a pioneer in API research and development for the wellbeing of people in need.

D. 3D color x-ray imaging solutions

a. X-ray imaging entering the world of color from black and white

X-ray imaging has been developed for more than 120 years. The first 80 years were dominated by 2D images; following the invention of computed tomography (CT) in 1972, x-rays have been applied in 3D imaging with in-depth information, greatly improving the ability to identify the space within the object examined. Subsequent developments focused mainly on the refinement of technical specifications and new imaging technologies. When the photon-counting detector (PCD) based on compound semiconductor technology was introduced in recent years, x-ray imaging finally broke away from the traditional black and white images and entered the color world with material decomposition capabilities.



X光造影技術發展歷程
History of the development of x-ray imaging technologies"

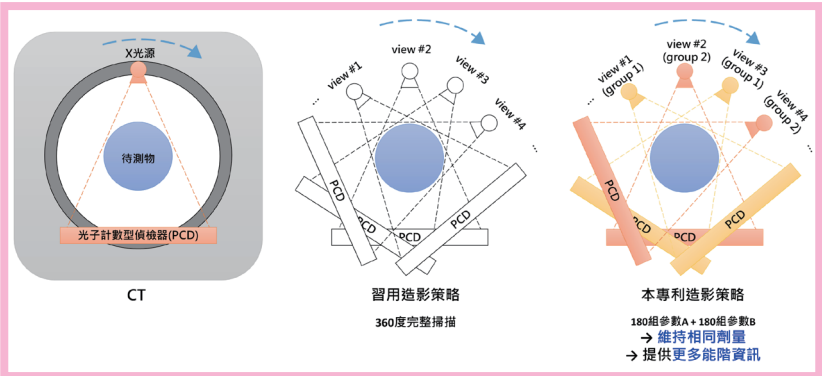
2. 核研所 3D 立體彩色 X 光造影解決方案－調控掃描策略達多能階偵檢器成像效能

目前彩色 X 光造影技術的研發進程，受限於高昂的硬體設置成本，如關鍵的 PCD 偵檢器，其可對應之材質辨識（顏色）數量與價格呈數倍成長（例：相同偵檢面積的 2 能階 PCD 約新台幣 250 萬元、4 能階 PCD 約新台幣 1,000 萬元、8 能階 PCD 約新台幣 4,000 萬元）。

核研所開發 3D 立體彩色 X 光造影解決方案（下稱本技術），含創新之專利稀疏角度 (Sparse-angle) 掃描策略（如圖二）、獨特之最大概似估計材質解析 (Maximum Likelihood Estimation-Material Decomposition, MLE-MD) 方法與疊代式影像重建 (Iterative reconstruction) 等完整配套技術，可從軟體面向將 2 能階 PCD 解析能力提升至 4 能階以上 PCD 之成像效能，且不增加硬體成本與造影劑量，大幅降低核心硬體組件成本與相關技術研發之門檻，本技術已獲台灣、美國、歐盟與日本發明專利，將使各式醫學、非醫學應用得以加速於民生端實現。

3. 3D 立體彩色 X 光造影潛在應用例

X 光影像即將由黑白進入彩色時代，可廣泛應用於醫用與非醫用領域（如圖三），本技術為其關鍵技術之一，對於醫學成像應用來說，解析超過 2 種材質能提升材質解析的精準度，可將目前 X 光黑白影像升級至全彩成像，並應用於多重對比劑造影技術達成多個無放射性標誌對比劑同步成像目標等；對於非醫學應用來說，待測物組成往往相當複雜，因此具有可解析超過 2 種材質的技術可提升成像技術之應用性。以安全檢測為例，核研所將模擬塑膠炸藥植入正常筆記型電腦，透過本技術造影即可依有效原子序標記對應顏色，並保持影像解析度，可提供安檢人員除了依物體形狀、尺寸等特徵額外的資訊，進一步提升安檢效能。



左：CT設備成像架構示意圖
中：習用造影策略，以相同造影參數擷取全角度能譜數據
右：本技術專利造影策略，以序列式擷取稀疏投影角度能譜數據
Left: Schematic diagram of CT imaging equipment
Middle: Conventional imaging strategy using the same imaging parameters to acquire full-angle spectrometry data
Right: The patented imaging strategy acquiring sparse-angle projection spectrometry data in a sequential manner

未來核研所將持續專注於 3D 立體彩色 X 光造影相關核心技術開發，可望實現於工業非破壞性檢測 (NDT)、行李安檢與醫用 CT 造影等應用上，進一步提升工業檢測與醫療診斷效能。

b. INER 3D color x-ray imaging solutions: adjusting scanning strategies to achieve imaging performance with multi-energy x-ray detection

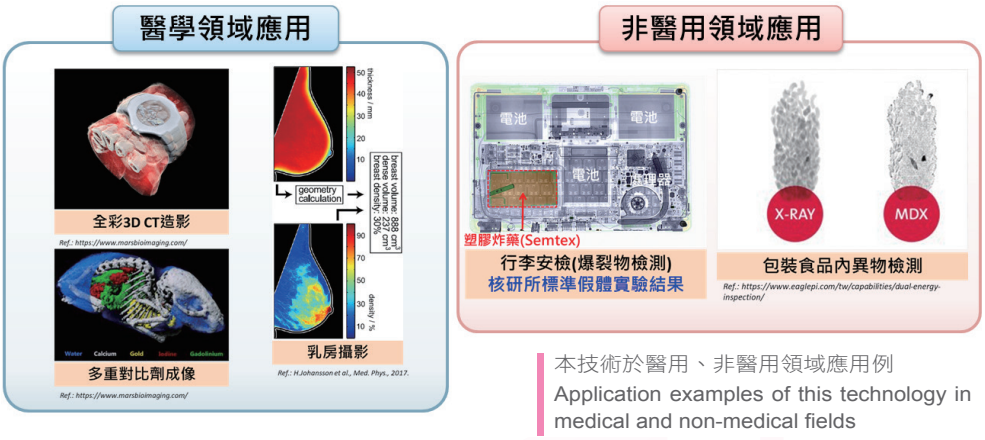
Currently, the development of color x-ray imaging technology is limited by the high hardware setup cost, such as the PCD detector, as well as price that multiplies exponentially with the number of the corresponding material identification (color). For the same detection area, for example, a two-energy-bin PCD costs around NT$2.5 million, while a 4-energy-bin PCD goes up to about NT$10 million, and an eight-energy-bin PCD jumps to about NT$40 million.

INER 3D color x-ray imaging solutions is a complete package technology, including an innovative patented sparse-angle scanning strategy, a unique maximum likelihood estimation-material decomposition (MLE-MD) method, and iterative reconstruction techniques. It can improve the imaging performance by increasing two-energy-bin PCD resolution to four-energy-bin PCD resolution or higher from the software end without increasing hardware costs or imaging radiation dose, thereby significantly reducing the costs of core hardware components and the threshold of related technology development. This technology has been patented in Taiwan, the United States, the European Union, and Japan; it will enable a variety of medical and non-medical applications to be realized in people's lives in a speedy manner.

c. Potential applications of 3D color x-ray imaging

X-ray images are about to enter the color era from the black and white era, and a wide range of medical and non-medical applications will soon be possible, with this technology being one of the critical technologies. For applications in medical imaging, resolving more than two materials can improve the accuracy of material decomposition. One area of application is to upgrade current black-and-white x-ray imaging into full-color imaging, and apply it with multi-agent imaging techniques to achieve multiple simultaneous non-radiolabeled agent imaging. For applications in non-medical imaging, since the composition of the object to be measured is often complex, a technology with the ability to resolve more than two materials can increase the applicability of the imaging technology. Take security inspection as an example. INER conducted a simulation where plastic explosives were implanted into a normal notebook computer. Imaging using this technology enabled the marking of corresponding colors according to valid effective_atomic numbers while maintaining image resolution; this can provide additional information besides object shape, size, and other characteristics to further enhance the effectiveness of security inspection.

Going forward, INER will continue to focus on the development of core technologies related to 3D color x-ray imaging, which is expected to be realized in industrial non-destructive testing (NDT), baggage security screening, and medical CT imaging applications to meet the objectives of further enhancing industrial testing effectiveness and medical diagnostic performance.

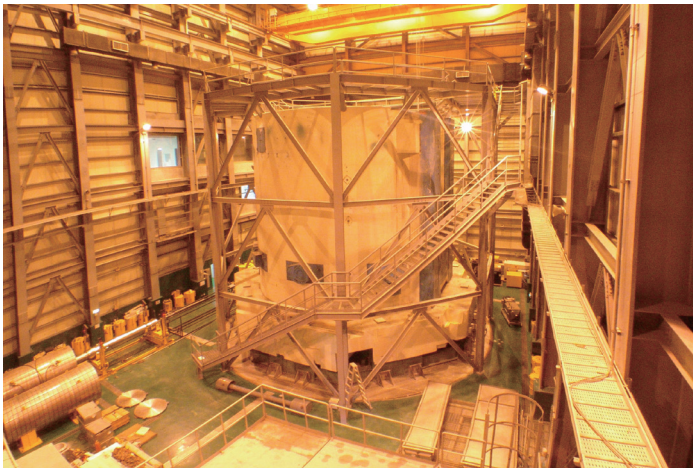


本技術於醫用、非醫用領域應用例
Application examples of this technology in medical and non-medical fields

（五）台灣研究用反應器(TRR)除役技術發展與應用

1. 台灣研究用反應器 (TRR) 背景簡介

台灣研究用反應器 (Taiwan Research Reactor, TRR) 是國內最大型的研究用反應器，額定輸出功率為 40 MW，民國 58 年委託加拿大核能公司 (Atomic Energy of Canada Limited, AECL) 設計建造，62 年 1 月 3 日達到臨界運轉，反應爐特色是以重水作為中子緩速劑，以輕水冷卻，以石墨作為中子反射體，使用的燃料為天然鈾。TRR 是國內原子能民生應用研究與人才培育的重鎮，在設計、興建、運轉，甚至進入除役階段，都持續以其獨特角色提供了重大貢獻。TRR 歷經 15 年運轉於 77 年 1 月完成階段性任務後停止運轉，核研所於 92 年提送「台灣研究用反應器 (TRR) 設施除役計畫書」至原能會審查，並於 93 年 4 月取得除役許可。



TRR爐體廢棄物貯存情形
Waste storage in the core barrel of the TRR

2. 台灣研究用反應器 (TRR) 設施除役進程與技術發展簡介

TRR 除役計畫第一期程主要任務為附屬設施拆除與燃料池清理。二座主要附屬設施濕貯槽與緊急冷卻水塔，分別於 95 年、100 年完成拆除工作。燃料池清理已陸續完成包含廢離子交換樹脂取出安全貯存、用過核子燃料及鈾粉安定化與包裝貯存以及污染池水淨化處理，109 年完成池體表面除污作業使廠房符合再利用標準。

TRR燃料池池體除污
Decontamination of spent fuel pool surface of the TRR

E. The development and application of decommissioning technology: the Taiwan Research Reactor (TRR)

a. Background of the Taiwan Research Reactor (TRR)

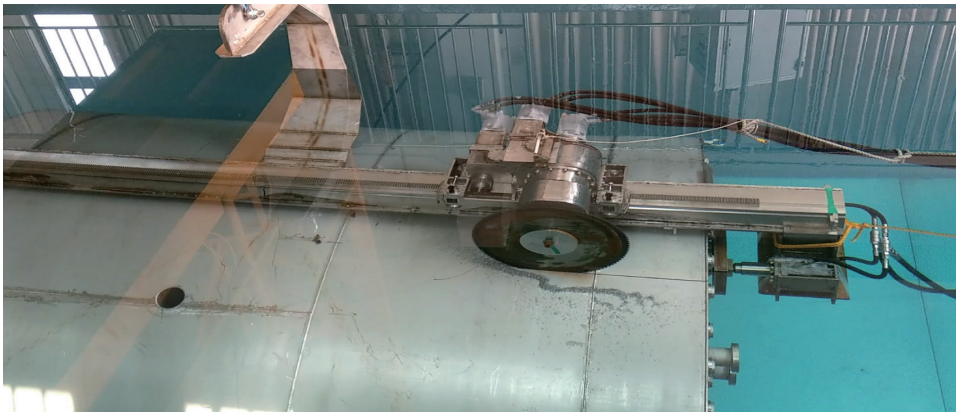
The Taiwan Research Reactor (TRR), the largest research reactor in Taiwan with a rated output power of 40 MW, was designed and built by the Atomic Energy of Canada Limited (AECL) in 1969, and reached critical operation on January 3, 1973. The reactor used heavy water as the neutron moderator, light water for cooling, graphite as the neutron reflector, and natural uranium as fuel. A major center of research and talent training in Taiwan for the applications of atomic energy in people's lives, the TRR continues to make significant contributions with its unique role in design, construction, operation, and now in decommissioning. After 15 years of operation, the TRR was determined to final shut-down by INER in January 1988 upon the completion of a milestone phase. In 2003, INER submitted the "Taiwan Research Reactor (TRR) Facility Decommissioning Plan" to AEC for review and obtained the decommissioning permit in April 2004.

b. Introduction of the decommissioning process and technology development of the Taiwan Research Reactor (TRR) facilities

The TRR decommissioning program is mainly divided into three phases, including the decommissioning preparation phase, the decommissioning dismantling and cleaning phase, and the site restoration phase. The decommissioning preparation phase is 2 years, the decommissioning dismantling phase is 21 years, and the site restoration phase is 2 years, totaling are 25 years. The area of TRR decommissioning includes ancillary facilities, spent nuclear fuel pools, spent nuclear fuel dry storage (DSP), wastes in the core barrel and storage and treatment facilities of ancillary wastes. Currently The TRR decommissioning program is proceeding to the decommissioning and dismantling phase. The dismantling of the two major ancillary facilities: the wet storage block and emergency cooling tower, were completed in 2006 and 2011, respectively. As regards spent fuel pools, waste ion exchange resins have been removed and stored safely; spent nuclear fuel and uranium powder have been stabilized, packaged and stored; contaminated pool water has been purified. The decontamination of pool surface was completed in 2020, placing the plant in compliance with repurpose and reuse standards.

第二期程主要任務為燃料乾貯場清除與爐體廢棄物拆解，燃料乾貯場清除107年起由核研所著手整體工程規劃，結合國內專業技師設計確保工程安全，並建置土壤與混凝土量測系統，妥善廢棄物分類管理並可抑低放射性廢棄物產生，預計於111年完成清除作業。爐體廢棄物拆解作業涉及多項除役技術，包含中子活化分析、爐體取樣與廢棄物特性調查，水下濕式切割站設計建造，吊運及拆解切割機具設計開發與整合，以及廢棄物盛裝容器包裝規劃與管理等，109年已完成包含水下遙控圓盤鋸與帶鋸機等切割原型機具開發，在兼顧安全與法規要求下，可望如期如質完成TRR除役任務。

核研所除役技術發展及累積的工程實務經驗為國家資產，為核設施除役技術本土化基石，未來發展將朝向整合國內工程專業，建立自主核設施除役關鍵技術，並推廣應用於核電廠除役之工作需求。



TRR爐體水下遙控圓盤鋸原型
Prototype underwater remote-control circular saw for TRR core barrel

（六）應用AI優化製程合成瑞德西韋，成為國家的堅強防疫後盾

COVID-19（武漢肺炎）是由嚴重急性呼吸系統症候群冠狀病毒2型(SARS-CoV-2)引發而來；截至西元2020年12月9日，全球已有191個國家和地區，累計超過6,825萬名確診個案，及約155萬名患者死亡。瑞德西韋(Remdesivir)是由美國吉利德藥廠開發的一種新型實驗性抗病毒藥物，至今被認為是對新冠肺炎重症患者最理想的治療藥物。

核研所從事核醫藥物研發多年，歷年來已開發並申請核發診斷或治療用核醫藥物藥品許可證17張，近年來並投入以AI人工智慧應用於藥物合成的研究。本案一開始瑞德西韋原物料缺貨，無法取得起始物，因此由AI化學逆合成追溯拆解，建議之合成步驟，經由研究團隊以長期經驗進行篩選判斷，並作化學驗證，由最簡單的D-核糖(D-Ribose)原料開始，以優化的選擇性保護基及去保護策略，僅八個步驟就成功合成出瑞德西韋。不僅較原製程減少了二個步驟，總產率亦較高。

The mainly follow-up tasks are the cleanup of spent nuclear fuel dry storage, the dismantling of wastes in the core barrel, and the decommissioning of ancillary wastes storage and treatment facilities. INER started the overall planning for the cleanup of the spent fuel dry storage site in 2008. The design of professional technicians in Taiwan has been incorporated to ensure project safety; a soil and concrete measurement system has been built to properly classify and manage wastes, as well as reduce radioactive wastes generation. The cleanup is scheduled to be completed in 2022. The dismantling of wastes in the core barrel involves a number of decommissioning technologies, such as neutron activation analysis, core barrel sampling and waste characteristics investigation, the design and construction of underwater wet cutting station, the design and integration of cutting equipment lifting and dismantling, and the planning and management of waste containers and packaging. The development for prototype cutting machines, including an underwater remote control circular saw and band saw, was completed in 2020. There are five sets of TRR ancillary wastes storage and treatment facilities, two of them has completed decommissioning in 2020, and the other three sets will be decommissioned by 2026. The decommissioning of the TRR is expected to be completed within the scheduled time frame and with expected quality results in accordance with the safety and regulatory requirements.

The decommissioning technologies developed by INER, as well as its accumulated engineering experiences, are national assets and the cornerstone for the localization of nuclear facility decommissioning technologies. Future developments will be geared toward integrating domestic engineering expertise, establishing key, independent nuclear facility decommissioning technologies, and promoting applications to be used in the decommissioning of nuclear power plants.

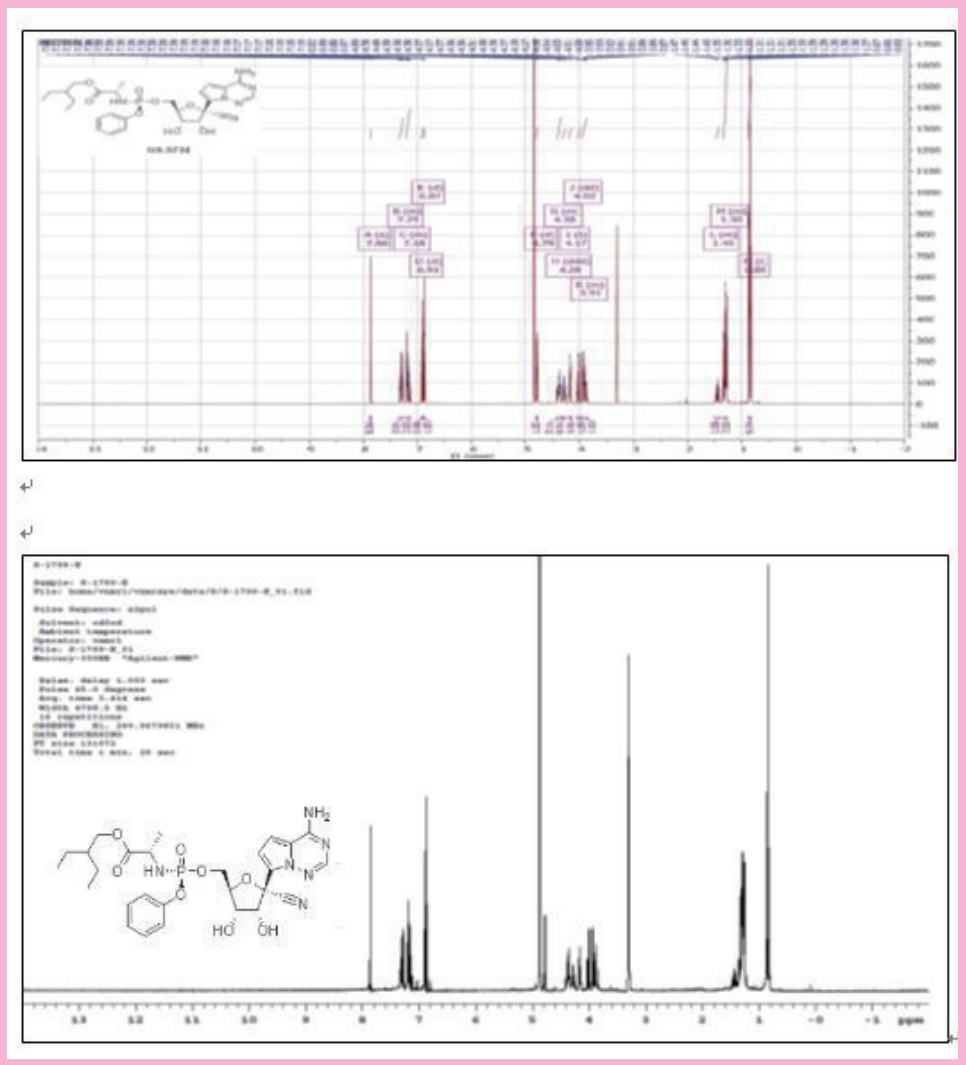
F. Applying AI optimization process to synthesize remdesivir: a robust support for the nation's epidemic prevention

COVID-19 is a disease caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). As of December 9, 2020, more than 68.25 million cases have been confirmed and approximately 1.55 million people have died of COVID-19 in 191 countries and territories around the world. Remdesivir is a new experimental antiviral drug developed by Gilead Sciences Inc. in the United States and is considered the most ideal treatment for patients with severe COVID-19.

INER has been engaged in the research and development of nuclear medicine for many years. Over the years, it has developed and applied for 17 drug permit licenses for diagnostic or therapeutic nuclear medicine, and in recent years it has also invested in research on the application of artificial intelligence (AI) to drug synthesis. This project began because the starting materials for synthesis could not be obtained due to a shortage of raw materials. The research team then resorted to using AI for chemical retrosynthesis to retrospectively dismantle and subsequently propose new steps for synthesis. The research team carried out processes for screening and performed judgments based on its robust experiences accumulated over the years, as well as conducting chemical validation, and successfully synthesized remdesivir. Using optimized selective protection and deprotection strategies and starting from a simple raw material, D-Ribose, remdesivir can be synthesized in only eight steps, which are two steps fewer than the original process, with a higher overall yield.

核研所製程在執行過程中，亦嘗試找出各步驟最佳反應條件，有利於擴量生產，制定標準作業程序 (SOP)，且每個合成步驟的中間產物及最終產物，皆進行各項分子結構鑑定，例如以核磁共振光譜儀 (NMR) 鑑定產物分子之周圍及骨架結構，傅立葉轉換紅外線光譜儀 (FTIR) 解析產物的極性官能基，質譜儀 (MS) 確認分子量，確保每一項中間產物及最終藥品的正確性，並能符合藥品研發之化學製造管制 (Chemistry, Manufacturing and Controls, CMC) 精神，落實醫藥商品化之可能性。

核研所歷經兩個月的研發期程，成功合成出兩批次瑞德西韋，並且均經過 1H、13C- 核磁共振光譜儀、傅立葉轉換紅外光譜儀及質譜儀全圖譜佐證數據，與文獻圖譜數據比對，兩者完全吻合。核研所創新製程與原文獻製程不同，反應步驟更為精簡，後續將會提出製程專利，因應國際間第二波疫情升溫，未來可與原廠之藥物專利進行相互授權，便於協助技轉國內藥廠生產，為國家防疫工作做出貢獻，甚至可以在其他藥物開發上展開創新研究。



瑞德西韋文獻報載(上)及核研所合成(下)之1H-NMR圖譜，二者吻合
The spectra in the literature of remdesivir (top) matches that of 1H-NMR, synthesized by INER (bottom)

In implementing the process, INER also tried to identify optimal reaction conditions for each step which may be favorable to scale up production, and to develop standard operating procedures (SOPs). In addition, the intermediate and final products of each synthesis step also underwent various molecular structure identification. For example, a nuclear magnetic resonance (NMR) spectrometer was used to identify the surrounding molecular and skeletal structures of the products; Fourier transform infrared (FTIR) spectrometer to analyze the polar functional groups of the products; mass spectrometer (MS) to confirm molecular weight. These efforts were made to ensure the correctness of each intermediate product and the final pharmaceutical product, as well as to comply with the essence of chemistry, manufacturing and controls (CMC) for pharmaceutical research and development in realizing the possibility of drug commercialization.

After two months of research and development, INER successfully synthesized two batches of remdesivir. Data collected from 1H- and 13C-NMR spectrometer, FTIR spectrometer, and mass spectrometer were confirmed to perfectly match data from the extant literature.

INER's innovative process, with simpler and more concise reaction steps, differs from that of the previous literature. In response to the increasing threat of the second wave of the pandemic, INER will submit a patent application for the process and propose cross-licensing with the proprietary patent to facilitate technology transfer to domestic pharmaceutical production, so as to contribute to the nation's epidemic prevention efforts, and even start innovative research in the development of other drugs.

六、落實放射性物料管理

（一）落實非核家園 嚴密做好核子燃料運送管制

核一廠於 108 年 7 月邁入除役階段，台電公司為減少乾式貯存容量需求及節省後續處置費用，將核一廠一號機爐心 92 束未照射燃料及核子燃料倉庫內 20 束新燃料外運至原廠家。本案經原能會嚴密審查台電公司「核一廠 92 束新燃料分析報告」、「核一廠核子燃料外運之廠區作業計畫」、「核子燃料運送計畫與安全管制計畫」及輸出、運送申請後，符合「核子燃料運作安全管理規則」及「放射性物質運送安全規則」之規定，於 109 年 11 月同意核一廠核子燃料輸出及運送。原能會於作業期間並組成聯合檢查小組，就未照射燃料清洗除污、裝箱、裝櫃及外運等各項作業，進行專案檢查以確保作業之安全。原能會要求核子燃料盛裝於符合安全規定的專用運輸護箱，經國際原子能總署派員查驗及封緘後，依原能會核准之計畫確實執行運送作業。核一廠未使用燃料之處理與外運，經原能會全程嚴密管制，把關核安、輻安及工安，並依作業時程如期完成目標。

台電公司為核子燃料資產最大價值化之經營策略，於 109 年持續執行龍門電廠核子燃料 4 批次計 752 束燃料之外運作業。此外，台電公司為維持核二廠與核三廠正常運轉，於 109 年度執行 2 批次核子燃料輸入運送，原能會皆全程派員檢查。原能會於每批次燃料運送作業，嚴格要求台電公司依據國際原子能總署 (IAEA) 的「核物料和核子設施實體防護核子保安規範」規定，嚴守核子燃料運送作業保密措施，亦監督台電公司加強工安、輻安、核子保防及保安等管制，原能會對於每次燃料外運，皆成立檢查專案小組及應變小組，全程監督運送作業，順利安全完成外運。

台電公司自 66 年迄今，共執行 196 次核子燃料運送作業，在原能會嚴密監督及武裝警察安全戒護下，均能安全達成任務。原能會作為全民的原能會，核安的守護者，持續嚴密管制台電公司做好核子燃料運送作業，確保安全。

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1. 原能會聯合檢查小組執行核一廠核子燃料廠區作業檢查
AEC joint inspection task force conducting an inspection on the operation of nuclear fuel storage site at Chinshan NPP

2. 龍門電廠核子燃料外運作業
Outbound transportation of nuclear fuel from Lungmen NPP

(VI) Achieving Effective Radioactive Material Management

A. Pushing forward a nuclear-free homeland: rigorous regulation over nuclear fuel transportation

Chinshan NPP entered the decommissioning phase in July 2019. To reduce the need for dry storage capacity and save on subsequent disposal costs, Taipower planned to arrange an outbound shipment of 92 bundles of unirradiated fuel from the core of Chinshan NPP Unit 1 and 20 bundles of new fuel from the nuclear fuel depot to the manufacturer. Upon close review of the "Report on the Analysis of 92 Bundles of New Fuel of Chinshan Nuclear Power Plant", the "Operational Plan for the Outbound Transportation of Nuclear Fuel of Chinshan Nuclear Power Plant", and the "Nuclear Fuel Transportation Plan and Safety Control Plan," as well as export and transportation applications submitted by Taipower, AEC approved the outbound shipment and transportation of nuclear fuel from Chinshan NPP in November 2020 on the basis of compliance with the "Regulations for the Nuclear Fuels Operational Safety Management" and the "Regulations for the Transportation Safety of Radioactive Materials." During the implementation, a joint inspection team was formed and conducted project inspections on the cleaning, decontamination, packaging, containerization, loading, and transportation of unirradiated fuel to ensure implementation safety. AEC required that the nuclear fuel should be packaged in special shipping casks that meet safety requirements. Upon inspection and sealing by IAEA inspectors, the transportation project was carried out in accordance with relevant plans approved by AEC. The handling and transportation of unused fuel from Chinshan NPP, carried out under close and stringent regulatory measures to ensure nuclear safety, radiation safety, and industrial safety, were completed within the scheduled time frame.

In view of its business strategy to maximize the value of its nuclear fuel assets, Taipower continued its efforts in carrying out the process for the outbound transportation of nuclear fuel from Lungmen NPP in 2020. Four batches of outbound shipments with a total of 752 bundles of fuel were transported to overseas. Furthermore, Taipower also carried out two batches of nuclear fuel inbound transportation in 2020 in order to maintain operational continuity at Kuosheng NPP and Maanshan NPP; AEC also conducted inspections during the entire course of the transportation. For each fuel shipment, AEC strictly requested that Taipower adhere to the provisions of IAEA "Nuclear Security Recommendations on Physical Protection of Nuclear Materials and Nuclear Facilities", and abide by the confidentiality measures governing the transportation of nuclear materials in a stringent manner. AEC also oversaw Taipower to strengthen its control on industrial safety, radiation safety, and nuclear safeguards and nuclear security. Moreover, AEC set up an inspection task force and a rapid response task force for each fuel outbound shipment to monitor the operation during its entire course to ensure safe and smooth transportation.

Since 1977, Taipower has carried out 196 nuclear fuel shipments; under AEC rigorous oversight and the security and protection provided by the armed police force, all of the shipments were completed safely. As the AEC of the people and the guardian of nuclear safety, we are dedicated to exercising stringent regulation over Taipower's transportation operations of nuclear fuel to ensure safety.

（二）接棒核電廠除役，完善除役廢棄物管制體系

國內核電廠已正式邁入除役階段，核廢處理成為核電廠除役的首要議題，原能會積極規劃執行除役廢棄物管制的前瞻準備作業。在管制法規精進方面，為加強放射性廢棄物設施申照審查流程中強化公眾溝通，參照國際間對申照審查流程要求公眾早期參與之精神，原能會完成修訂「放射性廢棄物處理貯存最終處置設施建造執照申請審核辦法」，要求放射性廢棄物處理、貯存或最終處置設施建造執照申請者，應於申請前舉辦公開之說明會，俾利場址所在地公眾瞭解設施設置申請案有關安全事項，有助於提升公眾接受度。

核電廠在除役過程中，產生的核廢料仍有賴電廠內處理系統進行減容與減量。對於仍需運轉之系統，原能會仍要求台電公司應依十年再評估之精神，完成安全評估之查驗，以確認運轉之安全。此外核電廠內部分核物料設施，配合除役計畫之推展需要進行清理與除役，原能會迄 109 年底已審定核一廠壕溝、核二廠一號貯存庫之清理計畫，目前正積極展開清理，另核一廠核子燃料貯存設施除役計畫也正在審理中。原能會就台電公司各設施的清理或除役，每月派員執行稽查，確保執行過程之安全。核一廠廢棄物壕溝清除後將做為該廠第二期室內乾式貯存設施之規劃用地，原能會將督促該計畫之執行，以順遂銜接第二期乾式貯存設施之開發，俾便核一廠除役計畫之推展。

原能會參考國際上除役電廠實務經驗，預先因應核電廠除役廢棄物新增之處理與貯存議題，已辦理 5 次「除役放射性廢棄物管制技術議題討論會」，對除役廢棄物管理、除役期間規劃增建廢棄物設施、廢棄物容器開發等重要議題，進行先期前瞻管制的探討，藉以提升除役廢棄物的安全管制。此外，原能會參酌國際原子能總署的放射性廢棄物處置前管理之安全要求指引，著手修正「放射性廢棄物處理貯存及其設施安全管理規則」，要求放射性廢棄物容器，與放射性廢棄物管理各階段作業具備技術可行性，將容器各階段作業之安全性均納入考量，以提升廢棄物容器的安全性。

核一廠廢棄物貯存壕溝除役作業
The decommissioning of waste storage trench at Chinshan NPP

B. Consolidating nuclear power plant decommissioning and improving the decommissioning waste control system

Taiwan's nuclear power plants have officially entered the decommissioning stage; nuclear waste disposal has thus become the primary issue for decommissioning nuclear power plants. To that end, AEC has been actively planning the preparatory work ahead of the implementation of decommissioning waste control. In terms of regulatory refinement, with a view to strengthen public communication in licensing review process for radioactive waste facilities, AEC has taken into account international practices of requiring early public participation in the licensing review process and subsequently revised the "Regulations for the Review and Approval of Applications for Construction License of Radioactive Waste Treatment, Storage, and Final Disposal Facilities." The Regulations stipulate that applicants for construction license of radioactive waste treatment, storage, or final disposal facilities shall hold a public explanatory meeting prior to submitting the application, in order to help residents near the facility site to better understand relevant safety aspects of the application for the construction of the facility and, in turn, increase the acceptability of the public.

Nuclear waste generated during the decommissioning phase still relies on the power plant's internal treatment system for volume and mass reduction. For the systems that are still operating, AEC requires that Taipower complete a safety assessment inspection in accordance with the spirit of "reevaluation in 10 years" to confirm operational safety. In addition, some of the nuclear material facilities in the nuclear power plants need to undergo cleanup and decommissioning in compliance with the decommissioning plan. As of the end of 2020, AEC has approved the cleanup plans for the trenches at Chinshan NPP and the storage facilities at Kuosheng NPP, both of which are being carried out. Moreover, the decommissioning plan for the nuclear fuel storage facilities at Chinshan NPP is currently under review. AEC conducts monthly inspections on the cleanup and decommissioning of Taipower facilities to ensure safety during the implementation. After the removal of waste from the trenches at Chinshan NPP, the site will be used as the planned location for phase two indoor dry storage facilities of the plant. AEC will oversee the implementation of this project to facilitate the smooth development of phase two dry storage facilities and, in turn, the progress in carrying out the Chinshan NPP decommissioning plan.

Taking into consideration international experiences in decommissioning power plants, AEC has organized five "Seminars on Issues of Regulatory Technologies Concerning Radioactive Waste during Decommissioning" in anticipation of new issues regarding waste disposal and storage to be encountered by decommissioning nuclear power plants. Important issues, such as decommissioning waste management, the planning of additional waste facilities during decommissioning, and waste container development, were explored in a preparatory and forward-looking manner with a view to enhance regulatory control on the safety of decommissioning waste. With reference to the IAEA's guidelines on safety requirements for radioactive waste management prior to disposal, AEC has proceeded to amend the "Regulations on the Treatment and Storage of Radioactive Waste and Safety Management of the Facilities." Taking into account all stages concerning containers to strengthen the safety of waste containers, the Regulations stipulate that radioactive waste containers and radioactive waste management operations at all stages must be technically feasible.

（三）督促蘭嶼遷場　做好重裝安全管制

政府關切原住民族權益並重視核廢料遷出蘭嶼的議題，原能會依循總統府原住民族歷史正義與轉型正義委員會第 5 次委員會議之決定，定期邀集經濟部及原住民族委員會，共同督促台電公司積極辦理遷場事宜與前置準備作業，並具體要求台電公司應加強規劃執行核廢料重裝作業、運送所需之船舶設計與製造、碼頭疏浚計畫及民眾溝通等遷場前準備作業。原能會為強化放射性廢棄物海洋運送的審查與管制，著手研訂低放射性廢棄物海洋運送船舶輻射安全規範，作為未來蘭嶼遷場時船舶運送輻射安全的審查依據。

原能會要求台電公司做好遷場先期準備作業，台電公司提出「提升蘭嶼貯存場營運安全實施計畫」，將現有貯存壕溝內的廢棄物桶，全數以熱浸鍍鋅的厚實容器進行重裝，更進一步提升貯存安全。原能會於 108 年 11 月同意台電公司開始執行，要求台電公司於重裝作業期間，加強與當地居民溝通，考量用人在地化，並確實落實三級品保作業。原能會為嚴密管制相關作業，派員執行駐場安全檢查，從台電公司開始執行至 109 年 12 月底止，原能會已執行駐場檢查人力 218 人日。

原能會為先期防範 COVID-19（武漢肺炎）疫情，可能造成蘭嶼核廢料重裝作業之影響，於 109 年 1 月要求台電公司蘭嶼貯存場應妥為宣導與防範，以及早規劃相關具體及應變措施。台電公司提出蘭嶼貯存場因應 COVID-19（武漢肺炎）之防疫整備與管理作為報告，經原能會審定後，逐步落實於重裝作業等相關作業中。

在核廢料未遷出蘭嶼之前，原能會除持續嚴格監督蘭嶼貯存場運轉安全及環境輻射安全外，並已連續 10 年辦理蘭嶼地區環境輻射平行監測活動，藉由邀請蘭嶼當地居民、地方領袖及機關代表共同參與，由參與之民眾指定輻射偵測地點，採集土壤、水樣、草樣及農產品等環境試樣，並由第三方進行環境試樣平行分析，分析結果原能會均公布於原能會網站上供民眾查詢，藉由資訊公開與公眾參與，促進在地民眾的瞭解與互信，確保公眾之輻射安全及環境品質。

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1. 蘭嶼貯存場重裝作業安全管制
   Safety regulation of the repackaging work at Lanyu Storage Site
2. 109年度蘭嶼地區環境平行監測活動
   2020 Parallel Monitoring Activity on Environmental Radiation in Lanyu Area

C. Overseeing Lanyu Storage Site relocation and carrying out effective safety regulation for repackaging

The rights of indigenous peoples are a great concern of the government, and the relocation of nuclear waste from Lanyu is a matter to which it attaches great importance. In accordance with the decision of the fifth meeting of the Presidential Office Indigenous Historical Justice and Transitional Justice Committee, AEC regularly invites the Ministry of Economic Affairs and the Council of Indigenous Peoples to jointly urge and oversee Taipower to actively conduct site relocation and relevant preparatory work. Some specific work in preparation for site relocation includes the planning and implementation of nuclear waste repackaging, the design and manufacturing of vessels required for transportation, dredging plans for the dock, and communication with the public. To strengthen the review and regulatory measure of marine transportation of radioactive waste, we have begun to draft regulations governing radiation safety in marine transportation of low-level radioactive waste, which will serve as a basis for the review on radiation safety of transportation vessels used in the relocation of Lanyu Storage Site.

AEC has requested that Taipower properly conduct preparatory work prior to site relocation. Taipower has proposed an "Implementation Plan for Enhancing the Operational Safety of Lanyu Storage Site", in which it plans to re-package all the waste drums stored in trenches with thick, hot-dip galvanized containers to further increase storage safety. AEC approved Taipower's proposal in November 2019, and requested that Taipower strengthen communication with local residents, employ local residents where possible, and properly observe the three-level quality assurance mechanism during repackaging. To rigorously regulate the related operations, AEC has sent inspectors to perform on-site safety checks. From the start of the project until December 2020, AEC has performed 218 person-days of on-site inspection.

Taking a proactive approach to prevent COVID-19 from affecting the repackaging work of nuclear waste in Lanyu, as early as January 2020, AEC requested that Taipower's Lanyu Storage Site submitted specific response measures in a speedy manner, as well as promoting and carrying out preventive measures. Taipower submitted a report on COVID-19 epidemic prevention preparedness and management of Lanyu Storage Site, which was reviewed and approved by AEC and implemented in repackaging and other related operations.

Before the nuclear waste is relocated from Lanyu, AEC is committed in the continuous and stringent monitoring of the operational safety of Lanyu Storage Site and environmental radiation safety. We have also conducted parallel monitoring activity on environmental radiation in the Lanyu area for 10 consecutive years. Local residents, local leaders, and representatives of local authorities were invited to participate in the activity, in which sampling locations were designated by the participants and samples comprising soil, water, grass, and agricultural products were collected for a third party to conduct parallel analysis of environmental radiation. The analysis results were all published on AEC website for public access. Through information disclosure and public participation, AEC hopes to facilitate the understanding and trust of local residents and ensure the radiation safety of the public and quality of the environment.

（四）督促用過核燃料乾式貯存計畫　滾動檢討最終處置技術

用過核子燃料乾貯設施是核電廠除役的必要設施，原能會為督促台電公司積極推動乾貯設施興建計畫，自 108 年 1 月起，與台電公司建立技術溝通平台，每月召開管制討論會議，持續追蹤台電公司執行進度，函請經濟部督導台電公司積極辦理核一、二廠乾貯設施興建計畫，並督促台電公司積極與地方政府溝通協調解決方案，以利如期如質展開除役拆廠作業。

針對乾貯設施之安全管制，原能會要求台電公司於核一廠乾貯設施熱測試作業前，每年皆應執行統合演練，以維持熱測試作業人力及技術能量，原能會全程派員檢查演練成效。原能會另定期專案查核乾貯設施各項設備組件及監測系統維護保養作業成效，以確保未來乾貯設施營運安全。

1 2

1. 109年核一乾貯統合演練-傳送護箱自5樓吊至1樓情形
   Moving a transfer cask from the fifth floor to the first floor during the integration drill at Chinshan NPP in 2020
2. 109年核一乾貯設備組件維護保養專案檢查-乾貯設施管理況
   A project inspection checking the maintenance of equipment components of the dry storage facilities at Chinshan NPP in 2020

因應核一、二、三廠除役作業規劃，台電公司已陸續完成室內乾貯設施興建計畫投資可行性研究，原能會為超前部署安全管制技術，109 年度持續委託學研機構，進行高燃耗及受損用過核燃料乾式貯存管制技術研發工作，以逐步精進本土化審查導則及乾貯設施老化管理技術，並累積未來申照安全審查能量與平行驗證能力。

為督促台電公司持續精進並滾動檢討我國放射性廢棄物最終處置之技術建置，原能會依放射性物料管理法及相關規定，執行放射性廢棄物最終處置計畫之管制作業，逐年檢視台電公司處置技術之研究發展現況，同時要求積極尋求國際技術合作與交流，以提升本土處置技術水準。原能會要求台電公司參照國際原子能總署 (IAEA) 規定強化技術研發，提報「我國用過核子燃料最終處置技術可行性評估報告 (SNFD2017)」，相關報告業經嚴格審查後，於 109 年 2 月同意核備。審查結果顯示，台電公司處置技術發展已累積相當成果，惟仍須參照 IAEA 相關規定與國際處置技術發展現況，持續精進，以確保相關處置技術可達最佳現有技術，且符合國際水平。

原能會為核能安全監督與管制機關，已制定完善之放射性廢棄物最終處置管制法規體系。另為精進低放處置設施安全管制需求，於 109 年 11 月發布「低放射性廢棄物最終處置設施安全分析報告審查導則」，以供台電公司執行最終處置申照作業之依循。

D. Overseeing the plan for spent nuclear fuel dry storage and conducting rolling reviews on final disposal technologies

Spent nuclear fuel dry storage facilities are essential in the decommissioning of nuclear power plants. To that end, AEC has established a technical communication platform with Taipower to ensure its active engagement in carrying out the construction plan for dry storage facilities. Starting from January 2019, AEC convenes monthly control meetings and track Taipower's progress in implementing the plan. AEC has also sent a letter to the Ministry of Economic Affairs and asked it to urge Taipower to actively carry out the construction plans for dry storage facilities at Chinshan and Kuosheng NPPs, as well as communicate and coordinate with local governments on solutions to facilitate the commencement of decommissioning and dismantling of the plants in accordance with the timeline and quality requirements.

For the safety regulation of dry storage facilities, AEC requests that Taipower conduct annual dry-run practice prior to the hot test of dry storage facilities at Chinshan NPP for the purpose of maintaining manpower and technical capacity for the thermal testing. AEC inspected the implementation effectiveness during the dry-run practice, and conducted regular inspections to check the maintenance effectiveness of various equipment components and monitoring systems of dry storage facilities to ensure the safety of future dry storage facilities.

In response to the decommissioning planning of Chinshan, Kuosheng, and Maanshan NPPs, Taipower has successively completed the investment feasibility studies for the construction of indoor dry storage facilities. Taking a forward-looking approach to safety regulation technologies, in 2020, AEC commissioned academic and research institutes to conduct researches on dry storage control technologies for high fuel consumption and damaged spent nuclear fuel. The goal is to gradually refine local review guidelines and management technologies for aging dry storage facility, while accumulating capabilities for future license applications and parallel verification.

To ensure Taipower's continuous commitment to refining and conducting rolling reviews on the technical implementation work for the final disposal of radioactive waste in Taiwan, in accordance with the Nuclear Materials and Radioactive Waste Management Act and related regulations, AEC regulates the final disposal plan for radioactive waste, and review the research and development status of Taipower's disposal technologies on a yearly basis, while requesting it to actively seek international technical cooperation and exchanges in order to improve the level of domestic disposal technologies. AEC requested that Taipower strengthen its technology development in accordance with IAEA regulations and submit the "Technical Feasibility Assessment Report on Spent Nuclear Fuel Final Disposal in Taiwan (SNFD2017)", which was rigorously reviewed and subsequently approved in February 2020. The review results indicate that Taipower has developed considerable expertise in disposal technologies, but still needs to continuously refine them with reference to relevant IAEA regulations and the development of international disposal technologies to ensure that its disposal technologies are the best available technologies and meet international standards.

As the oversight and regulatory authority for nuclear energy safety, AEC has established a comprehensive radioactive waste final disposal control system. To meet the objective of enhancing the safety regulation of low-level radioactive waste final disposal facilities, AEC announced the "Review Guidelines for the Safety Anaysis Report of Low-Level Radioactive Waste Final Disposal Facilities" in November 2020, which serves as a reference for Taipower in its licensing application for final disposal facilities.

七、強化環境輻射監測

（一）恆春半島空中輻射偵測

核子事故發生後，利用飛行載具量測地面大範圍區域之輻射強度，可克服因為其他天然災害所造成道路中斷、交通不便等障礙，在短時間內提供污染物質分布的資訊，做為核子事故災時應變及各項民眾防護行動決策之參考，已在日本福島核事故中證明為有效方法。

我國的空中輻射偵測透過緊密的跨部會團隊合作，任務規劃由輻射偵測中心及核研所共同負責，飛行載具則商請國防部航特部及內政部空中勤務總隊的直升機，上機偵檢人員包括輻射偵測中心、核研所及國軍化兵群分工擔綱，偵檢人員需於執行前與直升機駕駛就擬調查偵測地區之地形、氣候調整航路規劃，以能在兼顧飛航安全與輻射安全下完成空中輻射偵測作業。

109 年之恆春半島空中輻射偵測作業，由空中勤務總隊第三大隊支援飛行載具，包含一次高度修正參數測試飛行在內共計 7 個航次偵測作業，範圍涵蓋恆春半島的車城鄉、滿州鄉與恆春鎮，已涵蓋核能三廠緊急應變計畫區及其鄰近 8-20 公里範圍。恆春半島地形及氣候複雜，例如里龍山附近因地形高度落差過大，偵測作業時遇到下沉氣流無法飛航，以致少部分區域無法完全依規劃航路進行；109 年的偵測結果需要進行背景扣除以及距地高度修正後，再換算輻射劑量率分布。

即便偵測作業執行過程遇到地形、側風、雲團及障礙物等許多困難，透過成員不斷溝通、培養團隊默契並累積作業經驗，仍依原定規劃完成恆春半島範圍之偵測。空中輻射偵測團隊也有信心，能在核子事故發生後，以最短的時間完成大範圍污染分布的偵測作業，有效支援核子事故緊急應變作業。

恆春半島範圍內空中輻射偵測劑量率分布結果
Radiation dose rate distribution results of the aerial radiation detection on the Hengchun Peninsula area

(VII) Strengthening Environmental Radiation Monitoring

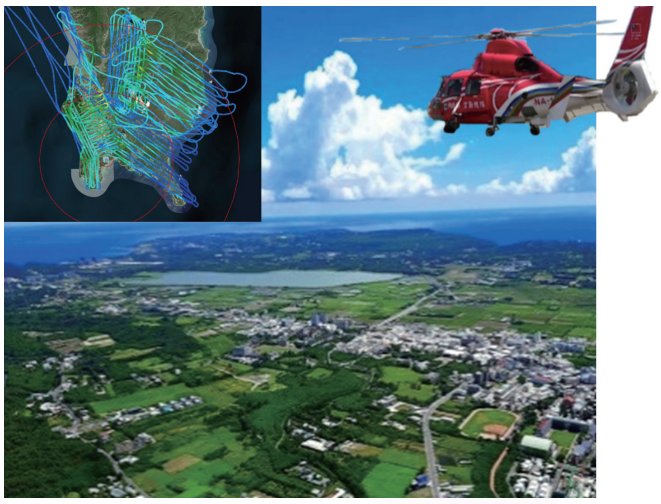
A. Aerial radiation detection on the Hengchun Peninsula

After a nuclear accident, aerial measurement system, due to their ability to overcome obstacles such as road blocks and traffic inconvenience caused by other natural disasters, can be utilized to measure radiation intensity in a large area on the ground within a short period of time. These measurements can provide information on the distribution of contaminants, and can be used as a reference for nuclear disaster response and various decisions regarding public protection actions. This method was proven to be effective in the Fukushima nuclear accident in Japan.

Taiwan's aeriel radiation detection is carried out through close interdepartmental cooperation. Mission planning is jointly undertaken by the Radiation Monitoring Center (RMC) and the Institute of Nuclear Energy Research (INER), while helicopters from the R.O.C. Army Aviation and Special Forces Command of Ministry of National Defense and the National Airborne Service Corps of Ministry of the Interior are used as flying vehicles for radiation detection. Reconnaissance personnel on board include members from the RMC, INER, and R.O.C. Army CBRN Corps, who are required to discuss with the helicopter pilot and adjust the route planning on the basis of the terrain and climate of the proposed investigation area before the operation, so that aerial radiation detection operations can be completed under both flight safety and radiation safety conditions.

The Third Brigade of the National Airborne Service Corps supported the helicopter used in the aerial measurement operation on the Hengchun Peninsula in 2020. A total of seven reconnaissances were carried out, including Checheng Township, Manjhou Township, and Hengchun Township of the Hengchun Peninsula, covering the emergency planning zone of Maanshan NPP and a 8-20 km radius of its surrounding area and one flight test to confirm altitude to ground level mapping parameters. Both the terrain and climate of Hengchun Peninsula are complicated. For example, subsidence airflow caused by large differences in altitude in the terrain of Lilong Mountain interrupted the reconnaissance and, as a result, a few routes could not be fully carried out in accordance with the plan. The detection results still needed to undergo background subtraction, altitude adjustment, and then conversed to ground level radiation dose rate distribution.

Although the detection operation encountered many difficulties caused by the terrain, crosswinds, cloud clusters, and obstacles; through continuous communication, team bonding, and accumulated experiences, the original detection plan of the Hengchun Peninsula area was still completed. The aerial radiation detection team is also confident that they can carry out detections of large contaminated areas framed in the event of a nuclear accident within the shortest possible time, and support nuclear emergency response operations effectively.



原能會偕同空中勤務總隊進行恆春半島輻射偵測作業
The AEC and National Airborne Service Corps carrying out a radiation detection operation on the Hengchun Peninsula

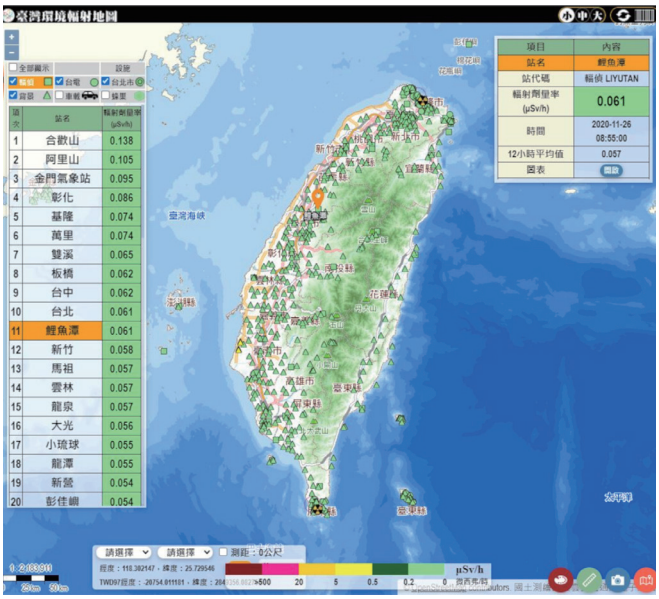
（二）台灣環境輻射地圖

原能會配合行政院推動「前瞻基礎建設 - 數位建設」計畫，以科技與科學知識為基礎，適時分析輻射災害變化。輻射偵測中心整合全國環境輻射偵測資訊並應用地理資訊系統，建立「台灣環境輻射地圖」，達到「政府資訊公開」、「災害情資共享」、「資訊再加值」等三個核心目的。

台灣環境輻射地圖已在 109 年完成第一階段建置作業，平行整合涵蓋原能會 63 站環境輻射自動監測站、台電公司 57 站環境輻射自動監測站、台北市政府 8 站環境輻射自動監測站及 459 處環境背景輻射偵測數據和 66 筆車載輻射偵測數據，再以蜂巢架構呈現數據的地理關聯性，以提供更友善的使用者介面供民眾查詢。

台灣環境輻射地圖參考歐盟作法，以邊長 5 公里之正六邊形區域，將國內劃分為 617 個蜂巢狀區域，並參考核子事故民眾防護行動應變與決策參考指引，以不同顏色在地圖中呈現輻射偵測數據，蜂巢狀區域依劑量率數值分級，一目了然；對使用者而言，只要輕鬆移動滑鼠指標到地圖各偵測點位上方或左側功能屬性視窗列表，立即呈現輻射偵測相關內容，包含時間、地點及輻射偵測數據等。台灣環境輻射地圖的底圖圖資已採用內政部國土測繪中心開放共用之圖資雲，有效結合政府數位建設規劃，節省未來維護成本。

台灣環境輻射地圖已於 109 年 12 月 28 日正式上線對民眾開放，提供民眾便利、快速查詢所感興趣的環境背景輻射狀況及即時輻射偵測數據；原能會未來也會持續累積相關偵測數據及新增數據種類，提供更完整的環境輻射資訊。



台灣環境輻射地圖
The Taiwan Environmental Radiation Map

B. The Taiwan Environmental Radiation Map

In support of the "Forward-Looking Infrastructure: Digital Construction" program promoted by the Executive Yuan, AEC applied technological and scientific knowledge and conducted a timely analysis on the changes in radiation hazards. By integrating national environmental radiation detection information and applying a geographic information system, the RMC established the "Taiwan Environmental Radiation Map", which attains the three core purposes of "government information disclosure", "disaster information sharing" and "value-added information."

The first phase of "Taiwan Environmental Radiation Map" was completed in 2020 by integrating data from 63 AEC realtime environmental radiation monitoring posts, 57 Taipower realtime environmental radiation monitoring posts, and 8 Taipei City Government realtime environmental radiation monitoring posts, as well as in situ environmental background radiation detection data from 459 locations and 66 readings of vehicle-borne radiation detection data. The integrated data were subsequently presented in a hexagonal structure to show the geographical correlation of the data, so as to provide the public with a more user-friendly interface.

Taking the European Union's practice as a reference, the "Taiwan Environmental Radiation Map" divides the territory of Taiwan into 617 hive-like, regular hexagonal areas with side lengths of five kilometers. Taking into consideration the guidelines for response and public protective actions in a nuclear accident, these hive-like areas are presented in different colors with corresponding radiation detection data, graded into different levels according to the detected dose rate value, which aids visualization. Users only need to move the mouse pointer to each detection location buttons on the map or to the function bar on the left, and corresponding radiation detection content, including time, location and radiation detection data, will be immediately displayed. The base map of "Taiwan Environmental Radiation Map" is from the public data of the National Land Surveying and Mapping Center of the Ministry of the Interior, which effectively integrates governmental resources of digital construction program and saves future maintenance costs.

The "Taiwan Environmental Radiation Map" was officially online on December 28, 2020 to provide the public with convenient and quick access to environmental background radiation conditions and real-time radiation detection data. The RMC will continue to accumulate relevant detection data and add new data types to provide more complete information on environmental radiation.

（三）增設環境輻射即時監測站

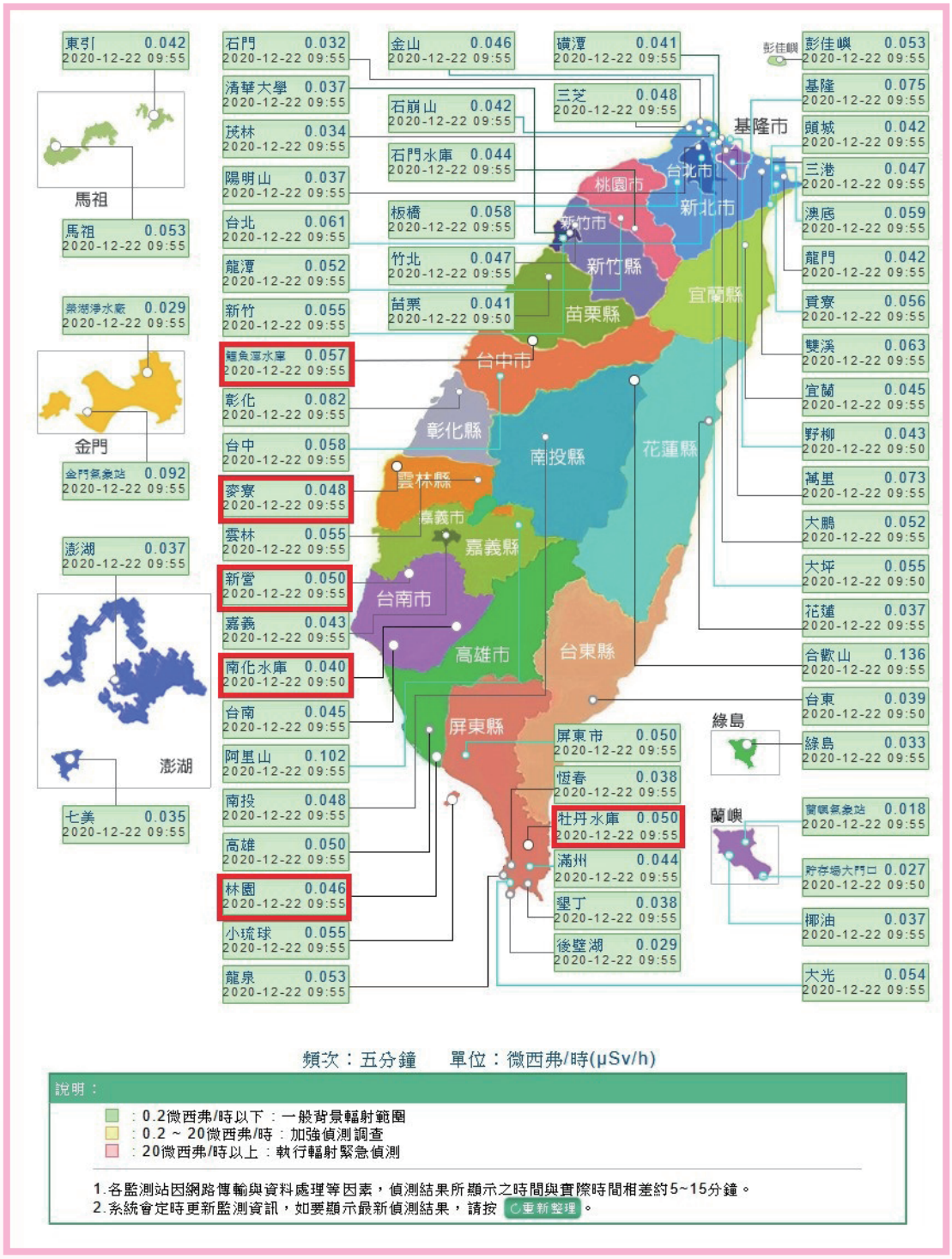
輻射偵測中心為確保國內環境輻射安全，建置了環境輻射即時監測網，至 109 年底已在台灣本島及離島地區建置 63 個環境輻射監測站，各監測站均全天候 24 小時運作，自動記錄當地環境直接輻射狀況，立即將記錄結果透過網路傳送至輻射偵測中心及核安監管中心，同時透過原能會網站 (https://www.aec.gov.tw) 即時提供環境輻射監測資訊，供民眾參考。

109 年輻射偵測中心在台灣水庫及工業區分別設置麥寮工業區、鯉魚潭水庫、南化水庫、林園工業區、新營工業區以及牡丹水庫 6 個環境輻射監測站，強化環境輻射監測範圍，讓民眾更能掌握生活周遭輻射狀況。

C. Setting up real-time environmental radiation monitoring posts

To ensure environmental radiation safety, the RMC has constructed the national environmental radiation monitoring network, which includes 63 environmental radiation monitoring spots in mainland Taiwan and outlying islands till 2020. It could monitor the environmental radiation changes 24/7 and the real-time monitoring data is updated to the RMC and the Nuclear Safety Duty Center through the internet for environmental radiation safety and the information is also public on AEC website (https://www.aec.gov.tw).

In 2020, the RMC set up six more environmental radiation monitoring posts in Taiwan's reservoirs and industrial parks, such as Mailiao Industrial Park, Liyutan Reservoir, Nanhua Reservoir, Linyuan Industrial Park, Sinying Industrial Park, and Mudan Reservoir, to expand the scope of environmental radiation monitoring for people to understand the radiation situation around them.



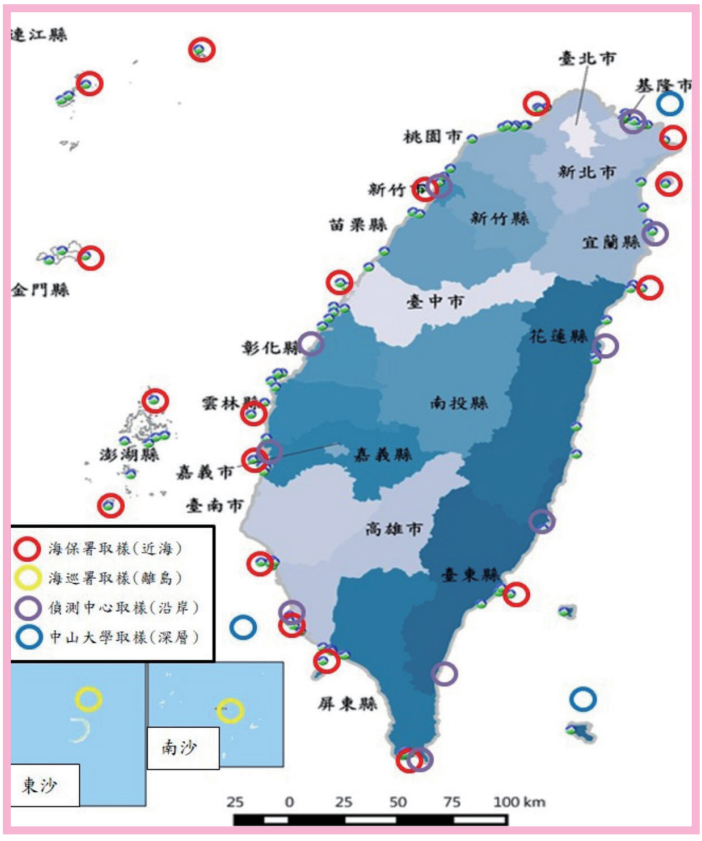
109年新增6站環境輻射監測站（紅色框線）
Six more environmental radiation monitoring posts set up in 2020 (in red rectangles)

（四）強化海域輻射監測

108 年 9 月媒體報導 100 年福島核電廠事故期間，東京電力公司因灌注大量水冷卻反應爐，產生含有輻射的核廢水，這些核廢水經過多重過濾及處理之後，產生以「氚」為主要核種的過濾水；由於過濾水儲存空間將在 111 年滿載，在外界關注日本如何處理之際，當時日本環境大臣表示，只能將過濾水排放入海洋稀釋或水蒸氣排放的方式處理，引起國人高度關注。

原能會為我國核能安全主管機關，遂以積極態度因應，洽請台灣日本關係協會，向日本政府表達關切之意，請日本政府於做成相關處理決定時，儘早知會我方，俾妥善相關因應措施。原能會並邀集外交部、海洋委員會、農業委員會及其所屬單位定期召開「日本福島核電廠含氚廢水排放跨部會因應平台會議」，透過平台會議請相關技術支援單位協助，以妥善因應準備作業。

原能會自 106 年起即已訂定「台灣海域輻射調查」相關計畫，進行台灣海域輻射背景調查與監測，計畫監測項目為台灣鄰近海域之海水、海產物、沉積物（含岸沙、河砂及海底沉積物），並以人工核種銫 -137 為主要監測核種，目前檢測海洋樣品已逾 1500 件次，結果皆無輻射異常現象。另輻射偵測中心於 109 年 5 月起透過跨部會合作模式，邀集海委會海保署、海委會海巡署及國立中大學增加執行「台灣海域氚輻射背景調查計畫」，監測範圍含括台灣沿海、離岸、離島及深層海水中之氚含量，取樣頻率為每半年 1 次（深層海水每年 1 次），目前相關海水樣品氚含量檢測結果皆小於最低可測活度（MDA=2.03 貝克 / 升），無輻射異常現象。



台灣海域氚輻射背景調查計畫取樣位置圖
Sampling location of "Radioactive Tritium Background Surveillance Program in Taiwan Sea area"

D. Strengthening radiation monitoring in Taiwan sea area

In September 2019, the media reported that during the Fukushima Nuclear Power Plant accident in 2011, radioactive nuclear wastewater was generated by Tokyo Electric Power Company from injecting large amounts of water to cool down the reactors. After undergoing multiple filtrations and treatments, this nuclear wastewater becomes filtered water with the main radionuclide "tritium". In 2022, the storage space for the filtered water will be full, and this has received great attention around the world. The Japanese Minister of the Environment said at the time that the only option would be to discharge the filtered water into the ocean and dilute it, or to vaporize it, which raises great concerns.

As the competent authority for nuclear safety in Taiwan, AEC has taken a proactive approach and asked the Taiwan-Japan Relations Association to express its concern, and request the Japanese government inform AEC as soon as possible when the decision is made, so that appropriate measures can be taken. AEC has also invited the Ministry of Foreign Affairs, Ocean Affairs Council, Council of Agriculture, and their affiliates to hold regular meetings of the "Inter-Ministerial Response Platform for the Discharge of Tritium-Containing Wastewater from the Fukushima Nuclear Power Plant in Japan", and request assistance from relevant technical support units through meetings in order to develop response measures properly.

AEC initiated the "Radiation Monitoring and Surveillance in Taiwan sea area" program in 2017 to investigate and monitor radiation background in Taiwan sea area. The program monitors seawater, marine products, and sediments (including coastal sand, river sand, and ocean sediments) along Taiwan's coast and outlying areas, and the radioactivity analysis mainly focus on the caesium-137 radionuclide. More than 1,500 marine samples have been measured so far, and the radioactivity analysis results were all within regulatory limits. Furthermore, the RMC invited the Ocean Conservation Administration and Coast Guard Administration of Ocean Affairs Council, as well as National Sun Yat-sen University, to carry out the "Radioactive Tritium Background Surveillance Program in Taiwan Sea area" since May 2020. Tritium content of samples in coastal areas, offshore waters, offshore islands, and deep seawater of Taiwan were monitored once every six months (deep seawater sampling once a year). The radioactivity analysis results indicated that the contents of tritium in relevant seawater samples less than the minimum detectable activity (MDA=2.03 Becquerel/liter), and were all within regulatory limits.

In response to the event of discharging tritium wastewater in Japan, the RMC has developed the measure methods to improve radiation detection efficiency and capabilities actively, as well as established standard operating procedures (SOPs) to meet the needs of radioactive tritium background surveillance in Taiwan sea area.

第伍章

大事紀

Chronicle of Events

AEC Annual Report

January

01.13

完成核研所「INER-LRW-C1低放射性廢棄物盛裝容器使用申請書」審查作業，並核發同意核備函。

The review of the "Application for the Usage License of INER-LRW-C1 Low-Level Radioactive Waste Containers" was completed, and a letter of approval was issued.

01.14

同意核備台電公司「用過核子燃料最終處置計畫書（2018年修訂版）」。

AEC approved Taipower's "Spent Nuclear Fuel Final Disposal Plan (2018 Revision)."

01.16

研提原能會109年度施政方針並提報行政院。

AEC proposed and submitted the 2020 administrative policies to the Executive Yuan.

01.16、01.21

赴核一廠、核二廠、核三廠進行年初查訪。

AEC conducted annual dialogue with the TPC and inspections at the Chinshan, Kuosheng, and Maanshan nuclear power plants.

01.16

為保障民眾年節食品輻射安全，輻射偵測中心派員至消費市場及年貨大街購買進口乾果、豆類、果醬、香菇、腰果、夏威夷豆、魷魚、小卷、昆布、白木耳、瓜子、核桃、枸杞、零食等38件，進行放射性含量檢測，檢測結果皆符合國家法規標準，相關結果於原能會網站發佈最新消息。

To assure radiation safety in food and drinking water during the Chinese New Year, the RMC dispatched staff to markets to purchase 38 food items, including imported dried fruits, beans, jams, mushrooms, cashew nuts, macadamia nuts, squids, neritic squids, kelp, white fungus, melon seeds, walnuts, lycium, and snacks, to analyze radioactivity content. All analytical results were within regulatory limits and the data were published on the AEC website.

01.18

執行核能電廠運轉期間監查機構（財團法人工業技術研究院）年度視察。

AEC conducted an annual inspection of the Industrial Technology Research Institute (ITRI), the authorized inspection agency for operating nuclear reactor facilities.

01.30

訂定原能會因應COVID-19（武漢肺炎）疫情防疫應變措施。

AEC "Response Measures for the COVID-19 Pandemic" were formulated.

1月-12月

執行全國48家放射線照相檢驗業者之輻射作業現場不預警安全稽查，強化輻射管制。

AEC implemented unannounced radiation work site inspection for 48 radiographic inspection operators across Taiwan to improve the quality of radiation protection regulation.

01.31-10.16

辦理完成核子設施違規事項處理作業要點增訂除役期間違規事項內容之部分規定修正與發布作業。

AEC amended and published the section on violations during decommissioning of The Guidelines for Handling Violations at Nuclear Facilities.

February

02.13
召開「核二廠除役計畫」第三回合綜合審查聯席會議
AEC held the third joint review meetings for the Kuosheng's decommissioning plan.

09.08
召開「核二廠除役計畫」綜合審查聯席總結會議
AEC held the joint review concluding meetings for the Kuosheng's decommissioning plan.

10.20
審查通過「核二廠除役計畫」，並公布安全審查報告
AEC approved the Kuosheng's decommissioning plan and published the safety review report.

02.20-03.30
執行「核二廠 1 號機第 27 次大修作業視察」及同意再起動之申請。
AEC conducted the 27th refueling outage inspection for the Kuosheng nuclear power plant unit 1 and approved the restart application.

02.21
同意核備台電公司「我國用過核子燃料最終處置技術可行性評估報告（SNFD2017）」。
AEC approved Taipower's "Technical Feasibility Assessment Report on Spent Nuclear Fuel Final Disposal in Taiwan (SNFD2017)."

02.24
發布修正「行政院原子能委員會游離輻射安全諮詢會設置要點」。
The "Regulations Governing the Organization of the Ionizing Radiation Safety Advisory Committee, the Atomic Energy Council, Executive Yuan" was revised and published.

02.07
執行清華大學水池式反應器（THOR）年度視察
AEC conducted annual inspection at the Tsing Hua Open-pool Reactor (THOR).

02.25
辦理 THOR 運轉執照換發申請前說明會
AEC held a briefing before the application for the renewal of THOR operating license.

09.17
完成 THOR 運轉執照換發申請第一次審查
AEC completed the first review meeting on the application for the renewal of THOR operating license.

11.24
完成 THOR 運轉執照換發申請第二次審查
AEC completed the second review meeting on the application for the renewal of THOR operating license.

02.17-02.21
09.21-09.25
11.02-11.06
執行 109 年核三廠核安管制紅綠燈「火災防護及熱沉效能、電力系統、維護有效性」專案視察。
AEC conducted the reactor oversight process inspections of "Fire Prevention and Heat Sink Effect, the Electrical System, and Maintenance Effectiveness" at the Maanshan NPP.

02.19
同意台電公司核二廠減容中心焚化爐恢復運轉。
AEC approved the restart of the incinerator at the volume reduction center of Taipower's Kuosheng Nuclear Power Plant.

02.27
完成 108 年下半年「臺灣地區放射性落塵與食品調查半年報」並上網公開。
Accomplished the second semi-annual report of "Fallout and Foodstuff Radioactivity Surveillance" in 2019 and published online.

03.18
完成「臺灣地區核設施 108 年環境輻射監測年報」，並上網公開。
Published the "Annual Report on Environmental Radiation Monitoring in Taiwan" on the website.

09.04
完成 109 年上半年「臺灣地區放射性落塵與食品調查半年報」並上網公開。
Accomplished the first semi-annual report of "Fallout and Foodstuff Radioactivity Surveillance" in 2020 and published online.

March

03.09

原能會官網「防疫資訊專區」上線。

A designated section "Epidemic Prevention Informaiton" was created and made available on our website.

03.11、03.24、03.28

執行「109 年度第 1 次核二廠、核三廠及核一廠不預警視察」。

AEC conducted its first unannounced inspection at the Kuosheng, Maanshan and Chinshan nuclear power plants.

03.16

完成「108 年海陸域調查與國民輻射劑量年度執行成果報告」並上網公開。

Accomplished "2019 Annual Report on the Survey of Radiation on land and sea area, and Population Dose Survey" and published online.

03.17

辦理 108 度個案管制計畫「區域能源智慧聯網技術發展與應用」期末查證作業。

AEC conducted a final verification for a 2020 agency-level program: the "Development and Application of Regional Energy Smart Grid Technology."

03.19

完成 109 年第 1 季「臺灣地區自來水試樣放射性分析結果」共計 119 件水樣分析，分析結果均符合法規限值，函送台灣自來水公司。

A total of 119 tap water samples from Taiwan Water Corporation were analyzed during the first quarter in 2020, all analytical results were within regulatory limits.

07.13

完成 109 年第 2 季「臺灣地區自來水試樣放射性分析結果」共計 110 件水樣分析，分析結果均符合法規限值，函送台灣自來水公司。

A total of 110 tap water samples from Taiwan Water Corporation were analyzed during the second quarter in 2020, all analytical results were within regulatory limits.

09.25

完成 109 年第 3 季「臺灣地區自來水試樣放射性分析結果」共計 122 件水樣分析，分析結果均符合規定，函送台灣自來水公司。

A total of 122 tap water samples from Taiwan Water Corporation were analyzed during the thurd quarter in 2020, all analytical results were within regulatory limits.

12.16

完成 109 年第 4 季「臺灣地區自來水試樣放射性分析結果」共計 100 件水樣分析，分析結果均符合規定，函送台灣自來水公司。

A total of 100 tap water samples from Taiwan Water Corporation were analyzed during the fourth quarter in 2020, all analytical results were within regulatory limits.

03.24

召開「日本福島核電廠含氚廢水排放海洋我國因應措施協調會議」計有外交部、海洋委員會、農委會、交通部氣象局、原能會及核研所等單位參加，會中達成共識，原能會由輻射偵測中心成立通聯因應平台。

The "Coordination Meeting for the Discharge of Tritium-Containing Wastewater from the Fukushima Nuclear Power Plant in Japan" was held with the Ministry of Foreign Affairs, Ocean Affairs Council, Council of Agriculture, Central Weather Bureau of the Ministry of Transportation and Communications, AEC, and INER. A consensus was reached at the meeting for the RMC to establish a communication and response platform.

03.26-04.27

核研所研發之「纖維酒精」，二批次共 700 公升 75% 酒精已投入國家隊。

Two batches of "cellulosic ethanol" developed by INER, totaling 700 liters of 75% alcohol, were put into Taiwan's national team for COVID-19 prevention.

03.30-06.01

進行原能會分區辦公、異地辦公試辦作業。

A trial run for AEC staff to work at different parts of the office building and/or at different office locations was carried out.

April

04.06-05.15

完成執行核一廠乾式貯存設施 109 年年度統合演練作業專案檢查。

A project inspection on the 2020 Annual dry-run practice of the Dry Storage Facilities of Chinshan Nuclear Power Plant was conducted.

04.07-05.25

執行「核三廠 2 號機第 25 次大修作業視察」、「臨界申請加強查核視察」以及審查機組再起動申請。

AEC conducted the 25th refueling outage inspection and reinforced inspection before criticality for the Maanshan nuclear power plant unit 2 and approved the restart application.

04.16

核定「防疫期間核能設施接受國際原子能總署檢查應遵行事項」。

The "Rules Governing the Inspection of Nuclear Facilities by the International Atomic Energy Agency During Epidemics" was approved.

04.18-11.30

核研所因應疫情期間國內進口核醫藥物短缺問題，緊急投入生產「氯化亞鉈（鉈 -201）注射劑」及「檸檬酸鎵（鎵 -67）注射劑」核醫藥物，累計供應 25,700 人次病患造影使用。

In response to the shortage of imported nuclear medicines during the pandemic, INER launched an emergency production of nuclear medicines: "Thallous Chloride (Tl-201) Injection" and "Gallium Citrate (Ga-67) Injection", which were used in imaging procedures for 25,700 patients.

04.21-04.23

辦理原能會 COVID-19（武漢肺炎）模擬確診個案處理演練。

AEC conducted drills of response to confirmed cases of COVID-19.

04.28-04.29

辦理原能會 COVID-19（武漢肺炎）模擬確診個案處理演練。

AEC conducted drills of response to confirmed cases of COVID-19.

May

05.04-05.08
07.01-07.09
10.26-10.30

執行 109 年核二廠核安管制紅綠燈「電力系統、維護有效性、火災防護」專案視察。

AEC conducted the reactor oversight process inspections of "Electrical System, Maintenance Effectiveness, and Fire Prevention" at the Kuosheng NPP.

05.07-05.08

辦理空中輻射偵測儀器操作與車載模擬訓練。

RMC organized aerial radiation detection instruments operation and vehicle carry training.

06.09-06.10

辦理南部輻射監測中心新進人員基礎訓練。

RMC organized basic training for personnel in the Nuclear Emergency Southern Radiation Monitoring and Dose Assessment Center.

06.12-06.17

辦理南部輻射監測中心進駐人員再訓練。

RMC organized re-training for personnel posted in the Nuclear Emergency Southern Radiation Monitoring and Dose Assessment Center.

05.09

舉辦 109 年度第 1 次「輻射防護專業測驗及操作人員輻射安全證書測驗」。

The 1st "Certification Examination for Radiation Protection Personnel and Radiation Operators on Radiation Safety" in 2020 was held.

05.12、06.19
09.18、12.25

召開「第 16 屆核子反應器設施安全諮詢會」。

AEC held four meetings for the 16th Advisory Committee on Nuclear Safety.

05.13、11.11

召開 109 年度核能電廠除役管制會議。

AEC held the 2020 Regulatory Meeting on Nuclear Power Plant Decommissioning.

05.19、05.29
06.03、06.09
06.10、06.16
06.18、06.20
06.24、07.24

辦理空中輻射偵測飛行訓練，搭乘空勤總隊高雄第三大隊、台北第四大隊之直升機，飛行偵測實務訓練及背景輻射偵測作業共 12 航次。

RMC organized aerial radiation detection training, a total of 12 flights were carried out for aerial detection training and background radiation detection operations by taking the helicopters of the National Airborne Service Corps' Third Brigade in Kaohsiung and First Brigade in Taipei.

05.21

國立陽明大學北部備援實驗室通過全國認證基金會 (TAF) 實驗室水樣認證。

The northern backup laboratory for nuclear accidents at the National Yang-Ming University was certified by the Taiwan Accreditation Foundation (TAF) for water sampling and analysis.

05.22

召開第 17 屆第 1 次「游離輻射安全諮詢會」。

The first session of the 17th "Ionizing Radiation Safety Advisory Board" was convened.

June

05.26
召開第六屆第四次放射性物料安全諮詢會，討論核一廠除役放射性廢棄物安全管制議題。

The sixth session's fourth advisory committee on radioactive materials safety was held to discuss issues of regulation concerning radioactive waste during decommissioning of Chinshan Nuclear Power Plant.

05.27
執行 109 年蘭嶼地區環境試樣平行監測放射性分析，計有水樣 6 件、植物（草樣）6 件及土壤樣 12 件，分析結果皆在背景值範圍。

RMC organized parallel radioactive analysis on environmental samples in Lanyu in 2020. There were six water samples, six grass samples, and twelve soil samples analyzed; all analytical results were within regulatory limits.

05.28-05.29
辦理 109 年低放處置計畫專案視察作業及用過核子燃料最終處置計畫專案視察作業。

Special inspections on the 2020 low-level radioactive waste disposal plan and spent nuclear fuel final disposal plan were conducted.

06.01
完成規劃「台灣海域氚輻射背景調查計畫」，建立台灣海域氚輻射背景資料，並函請海洋委員會海洋保育署及國立中山大學共同執行取樣作業。

The planning for "Radioactive Tritium Background Surveillance Program in Taiwan Sea area" was completed for establishing the database of radioactive tritium background in Taiwan sea area, and the sampling operations will be jointly conducted by the Ocean Affairs Council's Ocean Conservation Administration and National Sun Yat-sen University.

06.02-09.01
辦理「109 年輻射偵測中心輻射偵測專業人員教育訓練」，共計 40 小時，訓練人數計有 32 人。

The "2020 Professional Training Course for Radiation Detection at the RMC" was organized with a total of 40 training hours and 32 participants.

06.04-06.05
核研所舉辦輻射應變技術隊年度訓練課程，計有原能會、輻射偵測中心、核研所等單位約 40 人參加。

INER organized an annual training course for the Radiation Emergency Response Technical Team, with participation by 40 persons from the AEC, the RMC, and the INER.

06.05
發布我國「108 年度全國輻射工作人員劑量統計年報」。

The "2019 Annual Statistical Report on Occupational Radiation Exposure in Taiwan, Republic of China" was published.

06.08-06.12
07.01-07.09
09.21-09.25
執行 109 年「核三廠核能安全總體檢、核二廠核能安全總體檢、核一廠除役定期視察暨核能安全總體檢」專案視察。

AEC conducted "Post Fukushima Safety Enhancement inspection" at the Maanshan NPP and the Kuosheng NPP, and conducted "periodic inspection on decommissioning and Post Fukushima Safety Enhancement inspection" at the Chinshan NPP.

06.08-06.12
07.09-07.14
11.12
執行核三廠、核二廠、核一廠核子保安暨緊急應變整備年度視察。

Annual inspections on nuclear security and emergency preparedness were carried out at the Maanshan, Kuosheng, and Chinshan Nuclear Power Plants.

06.12
核研所以創新應用最新的人工智慧技術，利用逆合成方式優化合成步驟，成功合成出瑞德西韋藥物。

INER successfully synthesized remdesivir by applying the latest AI technology on chemical retrosynthesis to optimize synthesis steps.

06.15
輻射偵測中心放射化學分析實驗室整建完成，6 月份啟用，汰換老舊實驗設備，以提升實驗室分析品質。

The RMC's radioanalytical laboratory was renovated and was put into operation in June 2020. Old laboratory equipments were replaced to improve the quality of analysis.

June

06.23

召開 108 年度放射性廢棄物最終處置計畫執行成效評核會議。

An evaluation meeting of the 2019 radioactive waste final disposal plan was organized to discuss the effectiveness of its execution.

06.23、07.01、07.14 07.22、07.24、07.29

辦理地方拜訪活動：拜訪新北市萬里及金山區長，核二廠緊急計畫 8 公里內之新北市金山、萬里區及基隆市中山、安樂、七堵區里長，就核二廠除役計畫審查與管制作業進行意見交換，並聽取地方對除役之意見。

AEC organized several dialogues with district chiefs of New Taipei City's Wanli and Jinshan , and village chiefs of New Taipei City's Wanli and Jinshan, and Keelung City's Zhongshan, Anle, and Qidu, located within the 8 km radius of the emergency planning zone of Kuosheng NPP, to exchange opinions on the decommissioning plan review and regulatory process of Kuosheng NPP, as well as to listen to local opinions on decommissioning.

06.24

核定基隆市核子事故區域民眾防護應變計畫。

Keelung City's Response Plan for Public Protective Actions in a Nuclear Accident was approved.

06.30

原能會英文版網站改版正式上線。

Revise the English version of AEC website.

同意核備台電公司「第二核能發電廠 1 號低放射性廢棄物貯存庫清理作業計畫」。

AEC approved Taipower's "Cleanup Plan for the First Low-Level Radioactive Waste Storage Facility at Kuosheng Nuclear Power Plant."

06.15

完成麥寮工業區環境輻射監測站的設置並上線公開，全國監測站數達 58 站。

The environmental radiation monitoring post in Mailiao Industrial Park was set up and began operation; the number of monitoring posts in the country increased to 58.

07.06

完成鯉魚潭水庫環境輻射監測站的設置並上線公開，全國監測站數達 59 站。

The environmental radiation monitoring post in Liyutan Reservoir was set up and began operation; the number of monitoring posts in the country increased to 59.

07.20

完成南化水庫環境輻射監測站的設置並上線公開，全國監測站數達 60 站。

The environmental radiation monitoring post in Nanhua Reservoir was set up and began operation; the number of monitoring posts in the country increased to 60.

07.31

完成林園工業區環境輻射監測站的設置並上線公開，全國監測站數達 61 站。

The environmental radiation monitoring post in Linyuan Industrial Park was set up and began operation; the number of monitoring posts in the country increased to 61.

08.14

完成新營工業區環境輻射監測站的設置並上線公開，全國監測站數達 62 站。

The environmental radiation monitoring post in Sinying Industrial Park was set up and began operation; the number of monitoring posts in the country increased to 62.

09.15

完成屏東牡丹水庫環境輻射監測站的設置並上線公開，全國監測站數已達目標建置的 63 站。

The environmental radiation monitoring post in Mudan Reservoir in Pingtung was set up and began operation; the number of monitoring posts reaching the goal of 63.

July

07.01

邀集經濟部、原民會、台電公司召開「蘭嶼核廢料貯存場設置真相調查後續應辦有關遷場及補償事項第五次討論會議」。

AEC invited the Ministry of Economic Affairs, Council of Indigenous Peoples, and Taipower to jointly conduct the "Fifth Meeting for Site Relocation and Compensation Following the Truth Investigation on the Setup of Lanyu Nuclear Waste Storage Site."

國際原子能總署於該署網站公布 2019 年全球核子保防實施總結報告，宣告我國連續第 14 年為「所有核物料均用於核能和平用途」國家。

The International Atomic Energy Agency (IAEA) published "The Safeguards Statement for 2019" on its website, declaring Taiwan a country where "all the nuclear materials are used for peaceful purposes" for 14 consecutive years.

07.02

國際原子能總署 (IAEA)2 名檢察員至核研所微功率反應器 (TWK-) 進行設計資料查證 (DIV)，以確認微功率反應器處於封閉狀態，查證結果一切正常。

Two inspectors from IAEA conducted design information verification (DIV) of the Zero Power Reactor (TWK-) at INER to ensure that the reactor is housed in a containment structure. No anomalies were found during the verification.

07.07、07.09
07.13、07.16

於北、中、南、東區辦理「地方政府輻射災害防救講習」。

The courses for "Local Government Radiation Disaster Prevention and Rescue" were held at northern, central, southern and eastern of Taiwan.

07.08、07.31

辦理核二廠除役計畫現場訪查活動。

AEC organized site visit to the Kuosheng nuclear power plant for the reviewers of Kuosheng's decommissioning plan.

07.16

輻射偵測中心通過衛生福利部「食品檢驗機構認證」轉版認證。

The RMC passed the certification of a new edition for the "Accreditation of Food Testing Institutions" from the Ministry of Health and Welfare.

07.20

建置「民眾向本會申請提供核能資訊標準作業流程圖」，以簡化及提升效率

The "Standard Operating Procedure Flow Chart for the Public's Application of Nuclear Energy Information" was established to simplify the process and enhance efficiency.

07.22

「核威脅倡議組織」(NTI) 召開網路會議發佈「2020 年核武威脅倡議指數 (NTI Index) 報告」，其中有關網路安全 (cyber security) 部分，我國與羅馬尼亞是唯二獲得滿分之國家。

The Nuclear Threat Initiative (NTI) held an online conference and released the "2020 NTI Nuclear Security Index," in which Taiwan and Romania are the only two countries to receive a perfect score in the cyber security section.

07.23

核研所積極參與「台灣太空輻射環境驗測聯盟」，共七個代表單位於國研院太空中心共同簽署合作備忘錄，向完備我國太空環境檢測能量邁進一大步。

INER has actively participated in the "Taiwan Space Radiation Environment Verification & Testing Alliance." A memorandum of cooperation was signed by seven participating units at the National Space Organization of the National Applied Research Laboratories, which is a major step toward refining the testing capabilities of Taiwan's space environment.

07.23-07.24

辦理「核能電廠警衛效能評估訓練」。

A training course on "Nuclear Power Plant Security Performance Assessment" was conducted.

07.30、12.04

召開「全民參與委員會」第一次預備會議及討論會議，就全民參與委員會定位、任務及作業要點進行討論及審議。

The first preparatory discussion meeting of the "Committee on Public Participation" was organized to discuss and review the positioning, tasks and guidelines of the committee.

07.30-07.31、
09.09、11.06

視察核三廠、核二廠、核一廠緊急應變計畫演習。

AEC inspected the emergency response plan exercises at the Maanshan, Kuosheng, and Chinshan Nuclear Power Plants.

07.31

發布我國「108 年游離輻射應用與管理統計」年報。

The "2019Annual Statistical Report on Application and Management of Ionizing Radiation in Taiwan, Republic of China" was published.

August

08.01-08.02
08.22-08.23
10.09-10.12

於新竹、台中及台北辦理原子能科技科普展，希望透過科普展能接地氣，讓管制工作和研發成果更貼近民眾，三場次共吸引 15,854 參觀人次。

Three sessions of the atomic science fair took place in Hsinchu, Taichung, and Taipei, respectively, which attracted a total of 15,854 visitors. The fairs were held with the expectation to connect people and facilitate the public's understanding of relevant regulatory work and research.

08.05

辦理核一廠除役及乾式貯存訪查活動。

A public observation program to Chinshan Nuclear Power Plant decommissioning and dry storage facilities was organized.

08.06

於新北市核一廠模擬操作中心，辦理 109 年核安第 26 號演習兵棋推演。

The table-top exercise of 2020 National Nuclear Emergency Exercise took place at Chinshan Nuclear Power Plant's simulation center in New Taipei City.

核研所執行科技部「區域 (配) 電網強韌性研究與技術發展」，榮獲科技部 109 年度亮點計畫，且計畫團隊接受天下雜誌採訪。

INER carried out the "Regional Power (Distribution) Grid Enhanced Resiliency Research and Development" of the MOST, and was recognized as a 2020 MOST "Highlight Program." The program team subsequently received an interview by CommonWealth Magazine.

08.07

辦理核二廠除役計畫審查地方說明會。

AEC organized the local meeting for the Kuosheng Nuclear Power Plant decommissioning plan review.

修正發布「放射性廢棄物處理貯存最終處置設施建造執照申請審核辦法」第二條之一。

Amendment of article 2-1 of the "Regulations for the Review and Approval of Applications for Construction License of Radioactive Waste Treatment, Storage, and Final Disposal Facilities" was promulgated.

08.12

原能會網站通過無障礙 2.0 AA 驗證，取得標章。

AEC website has been certified a web content accessibility conformance level AA (2.0 AA).

08.17

執行委外廠商資通安全查核。

AEC conducted audits on contracted suppliers for cyber security.

08.19

年代電視台採訪核研所所長及拍攝微電網現場實體研發成果。且「微電網及本土化配電管理系統」研發成果專題於年代 much 38 台「發現新台灣節目」播出。

Era TV conducted an interview with Director-General of INER and filmed the R&D outcome of a microgrid on site. A special program on the R&D outcome of the "Microgrid and Localized Power Distribution Management System" was broadcasted on Era Much TV's "Discovering New Taiwan" program.

08.21

召開第 17 屆第 2 次「游離輻射安全諮詢會」。

The second session of the 17th "Ionizing Radiation Safety Advisory Board" was convened.

08.24-08.25

召開「109 年核子保防人員專業技術會議」。

The "2020 Nuclear Safeguard Technical Meeting" was held.

08.30、09.09-09.11

於核二廠鄰近地區及台北市，辦理 109 年核安第 26 號演習實兵演練。

The fully participation drill of 2020 National Nuclear Emergency Exercise was carried out in the Kuosheng Nuclear Power Plant and its neighboring areas and Taipei City.

08.18、08.21 09.26

執行「109 年度第 2 次核三廠、核一廠及核二廠不預警視察」。

AEC conducted its second unannounced inspection at the Maanshan, Chinshan, and Kuosheng nuclear power plants.

08.18

召開第六屆第五次放射性物料安全諮詢會，議題為低放射性廢棄物盛裝容器安全管制及台電公司發展規劃。

The sixth session's fifth advisory committee on radioactive materials safety was held to discuss regulation of low-level radioactive waste containers and Taipower's development plan.

08.25

召開「日本福島第一核電廠含氚廢水排放因應協調第三次會議（工作會議）」計有外交部、海洋委員會、農委會、交通部氣象局及原能會、核研所等單位參加，會中討論各部會工作執行情形及日本方面最新資訊，由原能會持續進行台灣海域環境輻射監測。

The third "Coordination Meeting for the Discharge of Tritium-Containing Wastewater from the Fukushima Nuclear Power Plant in Japan" was held with the Ministry of Foreign Affairs, Ocean Affairs Council, Council of Agriculture, Central Weather Bureau of the Ministry of Transportation and Communications, AEC and INER. Work progress of relevant ministries and administrations, and the latest information from Japan were discussed at the meeting. It is also discussed in the meeting that AEC will keep monitoring the environmental radiation in Taiwan sea area.

September

09.01

捷克參議院議長韋德齊訪問團成員 - 捷克國家輻射防護研究所核安組 Marek Ruščák 組長參訪核研所。

Marek Ruščák, head of the Division of Nuclear Safety Analyses and Research of the National Radiation Protection Institute of the Czech Republic, visited the Institute of Nuclear Energy Research as a member of the delegation led by Miloš Vystrčil, president of the Czech Senate.

捷克國家輻射防護研究所 (NRPI) Marek Ruščák 組長隨捷克參議長訪問團至核研所進行原子能相關合作交流事宜。

Marek Ruščák, division head of the National Radiation Protection Institute (NRPI) of the Czech Republic, visited INER with a delegation led by the president of the Czech Senate to discuss cooperation and exchange matters relating to atomic energy.

09.02

辦理「109 年核安演習實兵演練下週登場」記者會，向媒體說明第 26 號演習實兵演練之地點、項目、動員人力及演習特點。

The "2020 Nuclear Emergency Full Participation Exercise to be Conducted Next Week" press conference was held to provide the media with information, such as the locations, events, mobilized manpower, and drill features of the No. 26 Exercise.

09.03

建置「申請核子物料運送核子損害賠償責任之財務保證審核標準作業流程圖」。

The "Standard Operating Procedure Flow Chart for the Review of Financial Assurance for Nuclear Material Transportation Liability for Nuclear Damage" was implemented.

核研所與成功大學共同執行之「抗颱型浮動風機關鍵技術開發與實海域驗證計畫」，榮獲科技部 109 年度亮點計畫，且計畫團隊接受天下雜誌採訪。

INER and National Cheng Kung University jointly conducted the "Key Technological Development of a Typhoon-Resistant Floating Wind Turbine and Real-Sea Verification Program"; it was recognized as a 2020 MOST "Highlight Program." The program team subsequently received an interview by CommonWealth Magazine.

09.07

辦理原能會主管 110 年度預算說明會。

The briefing on the AEC 2021 annual budget was held.

09.10、10.06、10.23

視察核二廠、核一廠、核三廠核子保安及反恐演練。

AEC inspected the nuclear security and anti-terrorism drills at the Kuosheng, Chinshan, and Maanshan Nuclear Power Plants.

09.11

核研所負責之「109 年核安第 26 號演習北部輻射監測中心實兵演練」，順利完成任務。

INER successfully conducted a "Full Participation Exercise at the Northern Radiation Monitoring Center as part of the 2020 Nuclear Emergency Exercise (No. 26)."

09.12、10.25

受邀參與國立臺灣科學教育館辦理之「109 年行動科教館基隆市及新竹縣科學巡迴教育活動」。

AEC was invited to participate in the "2020 Mobile Science Education Keelung City and Hsinchu County Tours" hosted by the National Taiwan Science Education Center.

09.16

原能會通過 ISO 27001 驗證稽核作業，取得證書。

AEC passed ISO 27001 audit and received the certification.

輻射偵測中心完成海水氚分析技術精進，建立標準操作程序書，可針對平時環境中氚含量分析，也建立核子事故時高濃度氚之快速分析方法。

The RMC achieved technical refinement for the analysis of tritium in seawater. The standard operating procedures were also established for tritium content analysis on usual, and for rapid analysis of highly radioactive tritium during nuclear accidents.

09.17

辦理 109 年度放射性廢棄物處理設施運轉人員測驗。

The 2020 examination for operatives at radioactive waste treatment facilities was held.

09.22

核研所研發之釩液流電池可和再生能源搭配建置與併網，並於「2020 液流電池關鍵材料及儲能應用研討會」中發表。

INER's vanadium flow battery, presented at the "2020 Flow Battery Key Materials and Energy Storage Applications Conference", can be used in combination with renewable energy for grid integration.

09.24-09.26

核研所參加台灣創新博覽會 (TIE)3 大主題館之展示，亦提出 15 項技術參加競賽區比賽，經評選後共獲獎 8 項 (鉑金 *2，金牌 *3，銀牌 *1，銅牌 *2)，為近 4 年來之最佳成績。

INER participated in the 2020 Taiwan Innotech Expo, having exhibitions in all three themed areas. It also submitted 15 technologies in the competition and won eight awards (two platinum medal awards, three gold medal awards, one silver medal award, and two bronze medal award), for its best performance in four years.

09.25、10.14

於台北及高雄舉辦兩場「游離輻射防護安全標準法規精進研討會」。

Two sessions of "Seminar on Ionizing Radiation Safety Standards and Regulatory Improvement" were held in Taipei and Kaohsiung.

09.29

辦理 108 年「原子能科技學術合作研究計畫」成果發表會。

The 2019 "Atomic Science Collaborative Academic Research Program" presentation was held.

09.30

樹人醫事專校師生 54 人參訪輻射偵測中心環境輻射監測設施及放射性檢測分析實驗室。

54 participants of Shu-Zen Junior College of Medicine and Management visited the environmental radiation monitoring facilities and radioanalytical laboratory of the RMC.

12.14

慈濟科技大學師生 18 人參訪輻射偵測中心環境輻射監測設施及放射性檢測分析實驗室。

18 participants from Tzu Chi University of Science and Technology visited the environmental radiation monitoring facilities and radioanalytical laboratory of the RMC.

October

10.01-10.30

執行基隆市緊急應變計畫區家庭訪問作業。

AEC carried out a house-visit program in the emergency planning zone(EPZ) in Keelung City.

10.05

同意備查台電公司「核一廠氣渦輪機設備及廠房與第一抽水站設備拆除作業方案」。

AEC approved the TPC's dismantling plans for gas turbines and buildings, and the first pumping station of the Chinshan Nuclear Power Plant.

10.06-10.08 10.12-10.14

國際原子能總署 (IAEA) 檢察員針對核研所 TRR 二號護箱核燃料進行查驗，查驗過程順利。

IAEA inspectors conducted an inspection on the nuclear fuel contents of INER TRR-II cask, which went smoothly.

10.07

國立屏東科技大學南部備援實驗室取得環境樣品放射性分析檢測增項認證

The southern backup laboratory for nuclear accidents at National Pingtung University of Science and Technology was certified by the TAFfor the testing and radionuclides analysis of environmental samples.

10.13-10.16

執行蘭嶼貯存場廢棄物桶重裝作業 109 年專案檢查。

An inspection project on the re-packaging of waste drums at Lanyu Storage Site was carried out in 2020.

10.21

核研所辦理 2020「核設施除役技術研討會」，共有來自清華大學、台灣電力公司及工程顧問公司等 120 位相關領域專家學者參與。

INER hosted the "2020 Nuclear Facility Decommissioning Technology Conference", with participation by 120 experts and scholars in related fields from National Tsing-Hua University, Taipower, and engineering consulting firms.

10.21、12.02

召開兩場「游離輻射防護法修正研析」專家會議。

Two expert panel meetings on the "Study for the Revision of Ionizing Radiation Protection Act" were convened.

10.24

舉辦 109 年度第 2 次「輻射防護專業測驗及操作人員輻射安全證書測驗」。

The 2nd "Certification Examination for Radiation Protection Personnel and Radiation Operators on Radiation Safety" in 2020 was held.

10.31-11.01 11.14-11.15

受邀參與國立臺灣科學教育館辦理「2020 第一屆臺灣科學節」的「好奇樂遊園」和「好奇享科學」活動。

AEC was invited to take part in the "Curiosity Playground" and "Curious Science" events of the "First Taiwan Science Festival 2020" organized by the National Taiwan Science Education Center.

November

11.02

行政院為強化與永續發展政府資料開放，並提升政府資料品質及其加值應用效益，爰藉由標章認證及民眾參與機制，鼓勵各機關優化資料開放作業。獎項分為「資料開放金質獎」、「資料開放應用獎」、「資料開放人氣獎」，以及金質獎總分較前次進步 5 分 (含) 以上者，可獲品質進步獎。

本會作業較去年度增加 57 分，故榮獲行政院 109 年度政府資料開放進步獎。

To develop and sustain the level of openness of government data, as well as to enhance the quality of government data and their value-added applications, the Executive Yuan introduced a certificate verification and a public participation mechanism to encourage all agencies to optimize their operations for data openness. The awards consist of the "Open Data Golden Award", "Open Data Application Award", "Open Data Popularity Award", and "Open Data Quality Improvement Award" for those whose total scores have improved by 5 points or more from the previous year. We were awarded the Executive Yuan "Government Open Data Quality Improvement Award" in 2020 with an increase of 57 points compared to the year before.

核研所專利項目－「六聚乳糖 NOTA 衍生物、六聚乳糖正子肝受體造影劑的 Ga-68 放射標誌方法及六聚乳糖正子肝受體造影劑」榮獲經濟部主辦之「109 年國家發明創作獎」發明獎銀牌。

INER's patented invention: "Hexamer Lactose NOTA Derivatives, Hexamer Lactose Positron Liver Receptor Contrast Agent Ga-68 Radiolabeled Method, and Hexamer Lactose Positron Liver Receptor Contrast Agent" won the silver medal of the "2020 National Invention and Creation Award" sponsored by the Ministry of Economic Affairs.

訂定發布「低放射性廢棄物最終處置設施安全分析報告審查導則」。

The "Review Guidelines for the Safety Anaysis Report of Low-Level Radioactive Waste Final Disposal Facilities" were formulated and promulgated.

11.18、11.25

辦理南、北兩場次「109 年度核子事故緊急應變主管決策人員進階訓練」。

Two sessions of "2020 Annual Nuclear Emergency Response Advanced Training for Decision-Makers" were conducted in southern and northern Taiwan.

11.19

完成核三廠「低放射性廢棄物熱減容處理系統」設施換發運轉執照申請案審查作業，同意該設施繼續運轉至 121 年 3 月 12 日。

AEC completed the review of the operating license renewal application for the "Low-Level Radioactive Waste Thermal Volume Reduction Treatment Facility" at the Maanshan Nuclear Power Plant and approved the facility's operational continuation until March 12, 2032.

11.26

輻射偵測中心通過 IAEA 2020 年能力試驗，樣品及項目包含：

(1) 水樣：加馬、總貝他、鍶 -90。
(2) 濾紙試樣：加馬、總貝他。
(3) 生物樣品：加馬、總貝他。

The RMC passed the 2020 IAEA international proficiency testing and intercomparsion exercise, it includes:

(1) Water samples: gamma, total beta, strontium-90
(2)Filter paper samples: gamma, total beta
(3)Biological samples: gamma, total beta

11.27

完成原能會 111 年度科技發展計畫總體說明書並送至科技部。

The AEC 2022 General Descriptions of Technology Development Plan was completed and submitted to the Ministry of Science and Technology (MOST).

11.30

執行 109 年度輻射污染建築物居民醫療服務諮詢及後續醫療照護計畫，完成 657 位輻射屋居民健康檢查。

The "2020 Medical Consultation and Subsequent Medical Care Program for residents of radioactively contaminated buildings" was carried out, providing health examinations to 657 residents of radioactively contaminated buildings.

December

12.01

財團法人生技醫療科技政策研究中心主辦之第 17 屆國家新創獎，核研所榮獲 3 項「2020 年度續獎」，並於台北南港展覽館接受頒獎。

INER won three "2020 Renewal Awards" in the 17th National Innovation Award organized by the Research Center for Biotechnology and Medicine Policy, and received the awards at the Taipei Nangang Exhibition Center.

12.02-12.04

與財政部關務署高雄關合作辦理 109 年大港計畫工作坊暨大港計畫輻射異常事件處置教育訓練。

AEC and Kaohsiung Customs of the Ministry of Finance co-organized the "2020 Taiwan Megaport Intiative Workshop."

12.04、12.05、12.09

執行「109 年度第 3 次核二廠、核一廠及核三廠不預警視察」。

AEC conducted its third unannounced inspection at the Kuosheng, Chinshan, and Maanshan nuclear power plants.

12.07-12.08 12.10-12.11

辦理核一、二、三廠 COVID-19（武漢肺炎）秋冬防疫專案視察。

AEC conducted the fall-winter COVID-19 prevention measure inspection at the Chinshan, Kuosheng, and Maanshan Nuclear Power Plants.

12.09

以視訊形式與日本原子力規制委員會辦理交流會議。

AEC and the Nuclear Regulation Authority of Japan organized a video-conferencing on information exchange.

12.11

召開第 53 次核子設施類輻射防護管制會議。

The 53nd Session on "Radiation Protection and Regulation for nuclear facilities" was convened.

12.11、12.23

辦理 109 年「媒體溝通與輿情回應技巧」訓練課程，以增進原能會同仁運用簡報進行多媒體溝通及手機直播技巧之知能。

AEC conducted the 2020 "Media Communication and Public Opinion Response Skills" workshop to enhance the know-how of AEC staff in using presentations for multi-media communication and live broadcasting via mobile phones.

12.16

邀集經濟部、原民會、台電公司召開「蘭嶼核廢料貯存場設置真相調查後續應辦有關遷場及補償事項第六次討論會議」

AEC invited the Ministry of Economic Affairs, Council of Indigenous Peoples, and Taipower to jointly conduct the "Sixth Meeting for Site Relocation and Compensation Following the Truth Investigation on the Setup of Lanyu Nuclear Waste Storage Site."

12.22

召開第六屆第六次放射性物料安全諮詢會，議題為台電公司核一廠核子燃料外運作業。

The sixth session's sixth advisory committee on radioactive materials safety was held to discuss the outbound transportation of nuclear fuel from Taipower's Chinshan Nuclear Power Plant.

12.25

召開第 17 屆第 3 次「游離輻射安全諮詢會」。

The third session of the 16th "Ionizing Radiation Safety Advisory Board" was convened.

12.28

完成「台灣環境輻射地圖」的建置，提供民眾更友善查詢界面。

The "Taiwan Environmental Radiation Map" was completed, which provided the public with a more user-friendly interface.

12.29

函頒 109 年版輻射災害防救業務計畫。

The Radiological Disaster Prevention and Response Plans (2020) was issued.

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