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Master Thesis

福島核災後的核能發電安全制度檢討—從國際法架構到臺灣的個案分析

An Overhaul on the Nuclear Safety Regime after the Fukushima Nuclear Disaster—from the International Legal Framework to the Case Study in Taiwan

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本論文係顧昌庭（R07247002）在國立臺灣大學氣候變遷與永續發展國際學位學程、所完成之碩士學位論文，於民國 109 年 1 月 10 日承下列考試委員審查通過及口試及格，特此證明。

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摘要

2011 年 3 月 11 號發生了日本歷史上有紀錄以來規模最大(9.0)的地震，並且造成福島核災，而這場災難讓我們必須重新審慎檢視既有的核能安全國際法架構。於此同時，臺灣的核電廠正面臨運轉執照已經或即將到期的問題，然而，許多關於執照換發或除役所衍生的問題卻尚未解決。因此，本研究將相對應的核安國際公約與臺灣的內國法進行比較，藉此萃取出好的立法例提供臺灣參考，以期能進而解決核電廠執照換發或除役期間所面對的問題。本研究藉由管制目的、管制工具、輔助措施和衡平措施這四個面向的分析，有系統地整理鮮少為人所知的 1970 到 90 年代正式通過的各部核能安全相關的國際公約。本研究發現當今既有的核能安全國際公約已能完整囊括全球核能和平使用的每個面向，包含反應爐的運轉、核廢料的處理、核事故的及早通報與國際互助。然而，這些公約對於核能安全的衡平措施和實質上國際技術支援的要求卻略顯不足。此外，本研究也發現儘管臺灣的核能安全法規大多已經符合各部國際公約授權各締約國所建立的行政與立法機制，但是對於代際正義和及早向國際社會通報核事故這兩件事情上，臺灣的核能安全法規尚有需要改進之處。因此，本論文建議臺灣的核能安全法規應儘快納入代際正義和國際通報機制，而國際公約也應加強衡平措施和跨國援助的量能。本論文亦透過國際公約和臺灣法規各面向之比較，希望這些公約和法規能同步汲取對方好的措施，進而提升臺灣與全球的核能發電安全制度。

關鍵字:核能安全、核電廠除役、核電廠執照換發、世代正義、福島核災

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Abstract

On March 11th, 2011, a magnitude-9.0 earthquake, the largest earthquake ever recorded in Japanese history, caused the Fukushima Nuclear Disaster. It unveils the necessity to reexamine the existing international legal framework on the nuclear safety regime. Meanwhile, Taiwanese nuclear power plants are urgently facing the license expiration dates, but several important issues in terms of license renewal or decommissioning have yet to be addressed. As a result, it is worthwhile to compare between the international legal framework and the case study in Taiwan in order to provide some good legislative examples for Taiwan to take into account. As a matter of fact, all the international nuclear safety conventions were adopted in the 1970s to 1990s, and they were rarely noticed by the researchers nowadays. Through the analysis on the attributes of objectives, implementing measures, assisting measures, and equitable measures, this thesis introduces those international nuclear safety conventions in a systematic manner. This study found out that the existing conventions have already covered a comprehensive range of nuclear activities, including the operation of reactor facilities, the treatment of radioactive wastes, the early notification of nuclear accidents, and the assistance from the international society; however, the equitable measures and assistant missions of the conventions remained insufficient. On the other hand, this research also found out that the nuclear safety laws in Taiwan mostly comply with the guidelines of the conventions, but the intergenerational justice and the early report system to the neighboring countries of a nuclear incident shall be established as soon as practicable. As a result, this thesis suggests that the nuclear safety conventions need to be enhanced in terms of the equity and international assisting missions whereas the laws in Taiwan must promptly incorporate the intergenerational justice and a thorough reporting mechanism. At last but not least, this study compares in between the relevant conventions and laws, hoping that both sides can learn from the good practices from the counterparts so as to improve the nuclear safety regime worldwide.

Keywords: Atomic Energy Security; Decommissioning Procedures of Nuclear Reactor Facilities; License Renewal Application of Nuclear Reactor Facilities; Intergenerational Justice; Fukushima Nuclear Accident

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Chapter 1. Introduction

On March 11th, 2011, an earthquake occurred with the epicenter located at 130 kilometers east of the city Sendai, Miyagi Prefecture, Japan. The magnitude of the earthquake was 9.0, the largest ever recorded in Japanese history. The earthquake caused a 15-meter-high tsunami that killed more than 15,000 people. Right after the earthquake, eleven operating nuclear reactors automatically shut down, including three in the Fukushima Daiichi Nuclear Station. At that time, Units 1, 2 and 3 nuclear reactors in the Fukushima Station were operating, and they automatically shut down after the earthquake. Units 4, 5 and 6 were under a routine maintenance, so they were not operating. Although Units 1, 2 and 3 automatically shut down, continued cooling was necessary in order to remove the residual heat of the nuclear reactors; however, the station loss power from the local electric grid because it was damaged by the earthquake and tsunami. Although each nuclear reactor was equipped with a diesel generator for backup electricity, it was also damaged by the tsunami, so the Fukushima Station experienced the "station blackout", a dangerous situation that the cooling system was supported only by the batteries. It requires several days of continuous cooling to remove the entire residual heat, but the batteries can only sustain for several hours. Eventually, the reactor cores were melted, and the radioactive pollution damaged the health of the local residents. The soil, water, crops, and infrastructures around the nuclear station were also radioactively polluted.[1]

Right after the nuclear damage, the compensation was urgently in need to mitigate the adversity on the victims,[2] and the international conferences started to discuss the adequacy of the existing nuclear liability conventions.[3] More importantly, if the nuclear safety conventions were adequate enough, the nuclear accident might not happen. The Fukushima Nuclear Disaster indeed underscored the importance to overhaul the international legal framework especially on the nuclear safety regime. Additionally, Taiwan is in a special circumstance right now where the license expiration dates of the nuclear reactors are around the corner. On the other hand, due to the special identity in the international community, Taiwan was not allowed to join any of the international conventions on nuclear safety. As a result, it is necessary to do a case study to examine whether or not Taiwan could follow up the progress of the international legal framework. If not, it is important to identify the good legislative examples that Taiwan should learn from.

As a result, this thesis explores the provisions of the six international nuclear safety conventions and the domestic laws in Taiwan to see if there are some necessary improvements that must be made urgently in order to enhance the safety of nuclear power and prevent the accidents from

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[1] Burns, G. S. (2018). The impact of the major nuclear power plant accidents on the international legal framework for nuclear power. In Nuclear Law Bulletin No. 101 (Nuclear Energy Agency, Organization for Economic Co-operation and Development Ed., pp. 7-30). (Nuclear Law Bulletin, No. 101). Boulogne-Billancourt, France: OECD/NEA.

[2] Cheng, M.-S. and Jhang, H.-D. (2011). An Examination on Taiwanese Nuclear Liability Laws (plans_04_e-100_03). Taipei, Taiwan: Library of Soochow University. (程明修主持(2011)。我國核子損害賠償法制度之研修(行政院原子能委員會研究計畫期末報告，plans_04_e-100_03)。臺北，東吳大學圖書館。)

[3] Burns, *supra* note 1, at 28-29.

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happening again in the future. Rather than the nuclear engineering experiments, the standard operation procedures on nuclear reactor facilities, or the prevention of complex natural disasters, this thesis focuses on the examination of the regulatory framework established by the international nuclear safety conventions. Meanwhile, the study compares the nuclear safety laws in Taiwan with the international nuclear safety conventions to see if the domestic laws could fulfill the obligations and core values of the international regime on the security of reactor facilities. Hopefully with the main findings and suggestions of the research, the international legal framework on nuclear safety would become more robust, so the reactor facilities could operate in a safer manner. On the other hand, the case study in Taiwan that was done by this thesis may also boost the domestic legislation to catch up with the pace of the international legal framework, apply the good practices from other countries, and resolve the intractable issues in Taiwan such as the disposal of high-level radioactive wastes, the environmental pollution of ionizing radiation, and the lack of consideration about the intergenerational justice.

In terms of the methodology, this thesis analyzes each nuclear safety convention and each Taiwanese nuclear safety law with respect to the objectives, implementing measures, assisting measures, and equitable measures. By referring to the relevant papers, reports and articles, this thesis analyzes the pros and cons on each of the four aspects for each convention and domestic law, and then provides the practical recommendations accordingly. This thesis also puts together the matching convention and domestic law to see which one did a better job on each specific aspect so that the convention and domestic law can both improve by learning from its counterpart. Moreover, this thesis makes the most of the results from such comparison by applying the results—the good practices from each convention and domestic law—to address the issues that Taiwanese nuclear stations are facing, wishing that the good practices from the international society can enhance the nuclear security, environmental protection, and the intergenerational justice in Taiwan whereas the merits of Taiwanese nuclear safety laws and practices could be taken into account by other countries and improve as a whole.

When it comes to novelty and significance, this thesis may be one of the first researches, if any, to discuss all six of the nuclear safety conventions, all four Taiwanese nuclear safety laws, and compare between the international legal framework and Taiwanese legislation with regard to the objectives, implementation, assisting measures, and equity. While the laws and conventions are highly complicated and diversified, it is much more well-organized and systematic by categorizing the articles into the four aspects. This method indeed provides a comprehensive interpretation on the nuclear safety regime that not only allows future works to research even further from this fundament, but also encourages scholars from all kinds of fields to discuss the international conventions and domestic laws based on the four components. Moreover, it is almost a decade from the Fukushima Nuclear Disaster, and human beings tend to forget the pain of past lessons as time passes. While climate change issues are more and more severe and the deadline of carbon reduction comes closer and closer, many countries have started to evaluate the possibilities of restarting, or increasing, the use of

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nuclear power. While the fear of Fukushima gradually diminished, this thesis indeed serves as a timely reminder about the need of nuclear safety enhancement.

As for the structure of this thesis, Chapter 2 evaluates the international nuclear safety conventions, Chapter 3 examines the nuclear safety laws in Taiwan, Chapter 4 focuses on the case study in Taiwan, and Chapter 5 is the conclusion. To be more specific, in Chapter 2.1., there will be an overview on the development of the six nuclear safety conventions in the past, followed by Chapter 2.2., which introduces the method that this thesis utilizes to analyze the conventions and laws. Then, from Chapter 2.3. to Chapter 2.8., the thesis discusses each of the six nuclear safety conventions one by one. In Chapter 2.9., there is a general statement on the merits and flaws of the six nuclear safety conventions. In terms of Taiwan's nuclear safety laws, Chapter 3.1. introduces each of the four domestic laws using the same method that was applied in Chapter 2. Then, in Chapter 3.2., each Taiwanese law is compared with the relevant nuclear safety convention which serves the same purpose. In Chapter 3.3., there is a general statement about the merits and flaws of Taiwan's nuclear safety laws. After that, there are two case studies that Taiwan is facing right now—Chapter 4.1. discusses the license renewal application of the Jinshan Nuclear Power Plant in Taiwan, and Chapter 4.2. illustrates the environmental concerns and radiological threat of the decommissioning issues of Taiwanese nuclear reactors. Last but not least, Chapter 4.3. briefs the main findings of the two case studies as well as the limitation of this research.

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Chapter 2. International Legal Framework on Nuclear Safety

The international conventions that are relevant to nuclear activities can be divided into two types: nuclear liability conventions and nuclear safety conventions. Nuclear liability conventions are to compensate the loss of life and property after a nuclear accident, and nuclear safety conventions are to prevent the accidents from happening, or to minimize the radiological consequence once an incident occurs. In order to enhance the nuclear security worldwide, this thesis focuses on the examination of the international nuclear safety conventions and leaves the nuclear liability conventions for future works to discuss.

The International Atomic Energy Agency (IAEA) was established on July 29th, 1957, and it is one of the most authoritative international organizations on nuclear safety. To date, there are 171 Member States in the IAEA. Even though this organization was founded independently of the United Nations through its own international treaty, the IAEA Statute, it reports to both the General Assembly and Security Council of the United Nations. Therefore, it is believed that the international nuclear safety conventions adopted by the IAEA are authoritative to secure reactor facilities worldwide and worthy of taking into consideration. However, it is also important to note that despite its credibility, not every country with operating nuclear power plants get to join this organization; for instance, Taiwan is not a Member State of the IAEA.

In accordance with the IAEA, there are currently four major international nuclear safety conventions: the Convention on Nuclear Safety, the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management, the Convention on the Early Notification of a Nuclear Accident, and the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency.[4] In addition, the IAEA recommends each country to also take the Convention on the Physical Protection of Nuclear Material and Nuclear Facilities and the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter into account, as stated in the thirteenth paragraph in the preamble of the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management.[5] Therefore, there are a total of six international conventions highly related to the nuclear safety regime. This chapter will first elaborate the development of these international nuclear safety conventions, and then introduce the analytical method that this research applies to evaluate the conventions. Finally, there will be detailed and critical analysis for each of the nuclear safety conventions.

2.1. Development of Nuclear Safety Conventions

Figure 1, Figure 2, and Figure 3 are the timelines of the adoption, entrance into force, and amendments for each of the six conventions, respectively. Typically, a convention would be opened for signature shortly after its adoption; for instance, the Convention on Nuclear Safety was opened for signature on 20 September 1994, only three months after its adoption on 17

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[4] Ibid., 23-28.

[5] International Atomic Energy Agency (1997). Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management. Vienna, Austria: International Atomic Energy Agency.

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June 1994.[6] As a result, the timelines did not show the date when each convention was opened for signature. In addition, there are some preliminary conditions before an amendment proposal could be adopted or enter into force. Take the Convention on Nuclear Safety for example, according to Article 32, all Contracting Parties must reach a consensus in order to adopt a proposed amendment. In the absence of consensus, the amendment proposal has to enter a Diplomatic Conference and obtains a two-thirds majority vote before its adoption.[7] As a result, although States Parties might propose a number of amendments on a convention from time to time, only few of them could successfully complete the adoptions. For instance, after the Fukushima Nuclear Disaster, Russia, Spain and Switzerland each drafted an amendment proposal on the Convention on Nuclear Safety, but each of the proposed amendments failed to reach the adoption.[8] Thus, the following timeline did not reveal any proposed amendment which was declined; instead, it only shows the adopted amendments and the time when they entered into force. On the other hand, even when an amendment proposal was already adopted, there are some further conditions before it could enter into force. For example, in the Convention on Nuclear Safety, Article 32.5 states that the adopted amendment would come into force only in those Contracting Parties which have ratified, accepted, approved or confirmed it on the ninetieth day after the receipt by the Depositary of the relevant instruments by at least three fourths of the Contracting Parties.[9] This is probably the reason why there is a long gap between the adoption date and the date of entrance into force—As it could be seen in the following timelines, in both the Convention on the Physical Protection of Nuclear Material and Nuclear Facilities and the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, it took approximately ten years to let each amendment proposal enter into force.

[6] International Atomic Energy Agency (1994). Convention on Nuclear Safety. Vienna, Austria: International Atomic Energy Agency.
[7] Ibid., Article 32.
[8] Burns, *supra* note 1, at 25-26.
[9] International Atomic Energy Agency, *supra* note 6, at 12.

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Figure 1. Nuclear Disaster vs Adoption

The timeline depicts the sequence of the major nuclear accidents happened in the past and the adoption time of the major international nuclear safety conventions.

Source:

International Atomic Energy Agency (1972). Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter. Vienna, Austria: International Atomic Energy Agency.
International Atomic Energy Agency (1979). Convention on the Physical Protection of Nuclear Material. Vienna, Austria: International Atomic Energy Agency.
International Atomic Energy Agency (1986). Convention on Early Notification of a Nuclear Accident. Vienna, Austria: International Atomic Energy Agency.
International Atomic Energy Agency (1986). Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency. Vienna, Austria: International Atomic Energy Agency.
International Atomic Energy Agency (1994). Convention on Nuclear Safety. Vienna, Austria: International Atomic Energy Agency.
International Atomic Energy Agency (1997). Joint Convention on the Safety of Spent Fuel Manangement and on the Safety of Radioactive Waste Management. Vienna, Austria: International Atomic Energy Agency.
Burns, G. S. (2018). The impact of the major nuclear power plant accidents on the international legal framework for nuclear power. In Nuclear Law Bulletin No. 101 (Nuclear Energy Agency, Organization for Economic Co-operation and Development Ed., pp. 7-30). (Nuclear Law Bulletin, No. 101). Boulogne-Billancourt, France: OECD/NEA.

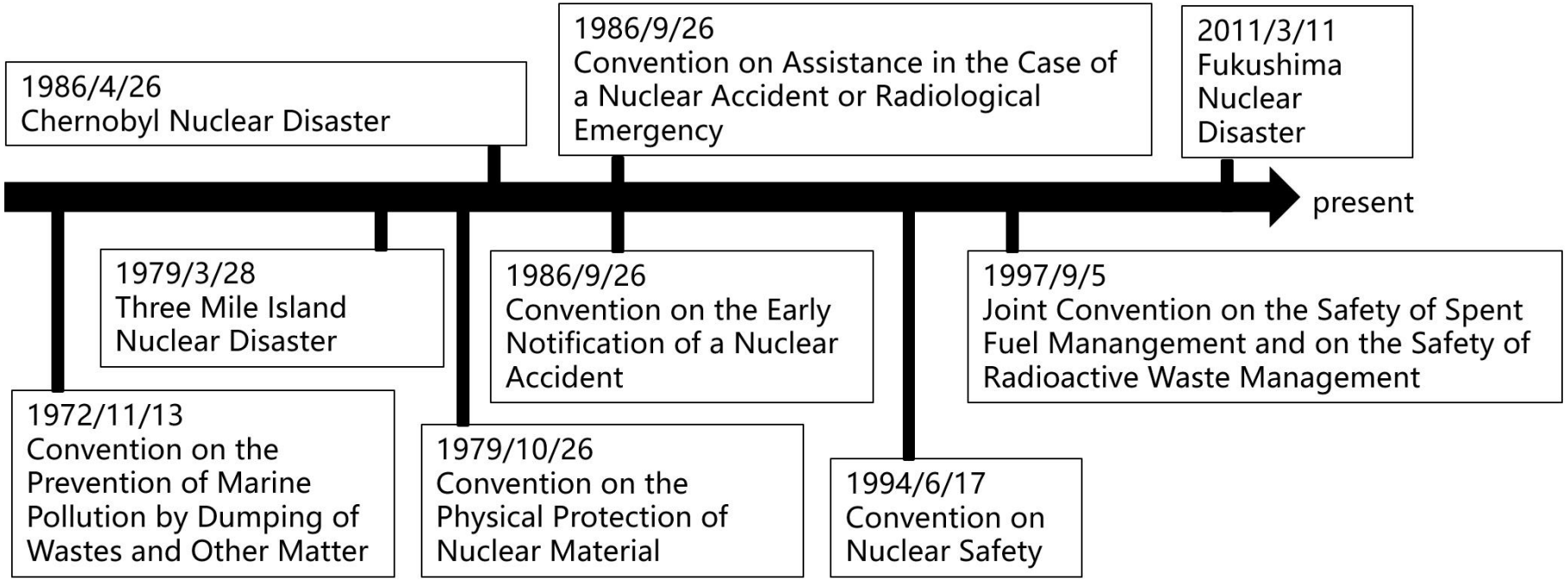

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Figure 2. Nuclear Disaster vs Entrance into Force

The timeline depicts the sequence of the major nuclear accidents happened in the past and the time when the major international nuclear safety conventions entered into force.

Source:

International Atomic Energy Agency (**1972**). Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter. Vienna, Austria: International Atomic Energy Agency.
International Atomic Energy Agency (**1979**). Convention on the Physical Protection of Nuclear Material. Vienna, Austria: International Atomic Energy Agency.
International Atomic Energy Agency (**1986**). Convention on Early Notification of a Nuclear Accident. Vienna, Austria: International Atomic Energy Agency.
International Atomic Energy Agency (**1986**). Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency. Vienna, Austria: International Atomic Energy Agency.
International Atomic Energy Agency (**1994**). Convention on Nuclear Safety. Vienna, Austria: International Atomic Energy Agency.
International Atomic Energy Agency (**1997**). Joint Convention on the Safety of Spent Fuel Manangement and on the Safety of Radioactive Waste Management. Vienna, Austria: International Atomic Energy Agency.
Burns, G. S. (**2018**). The impact of the major nuclear power plant accidents on the international legal framework for nuclear power. In Nuclear Law Bulletin No. 101 (Nuclear Energy Agency, Organization for Economic Co-operation and Development Ed., pp. 7-30). (Nuclear Law Bulletin, No. 101). Boulogne-Billancourt, France: OECD/NEA.

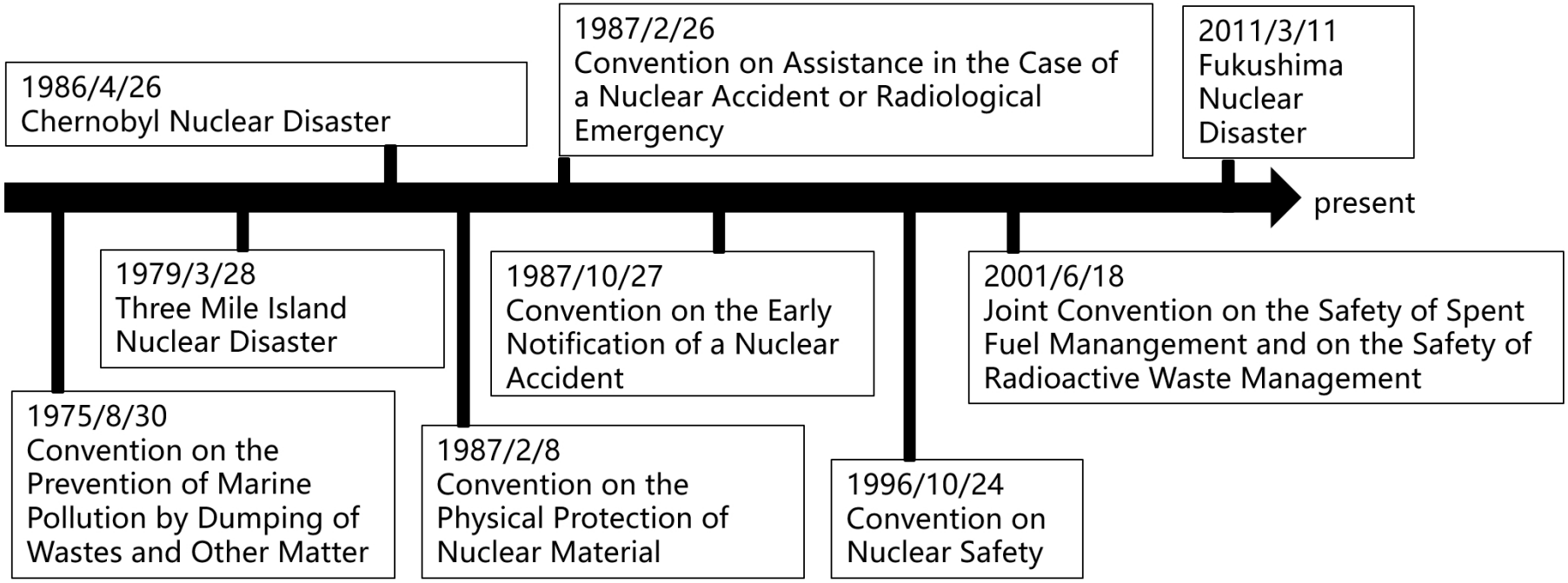
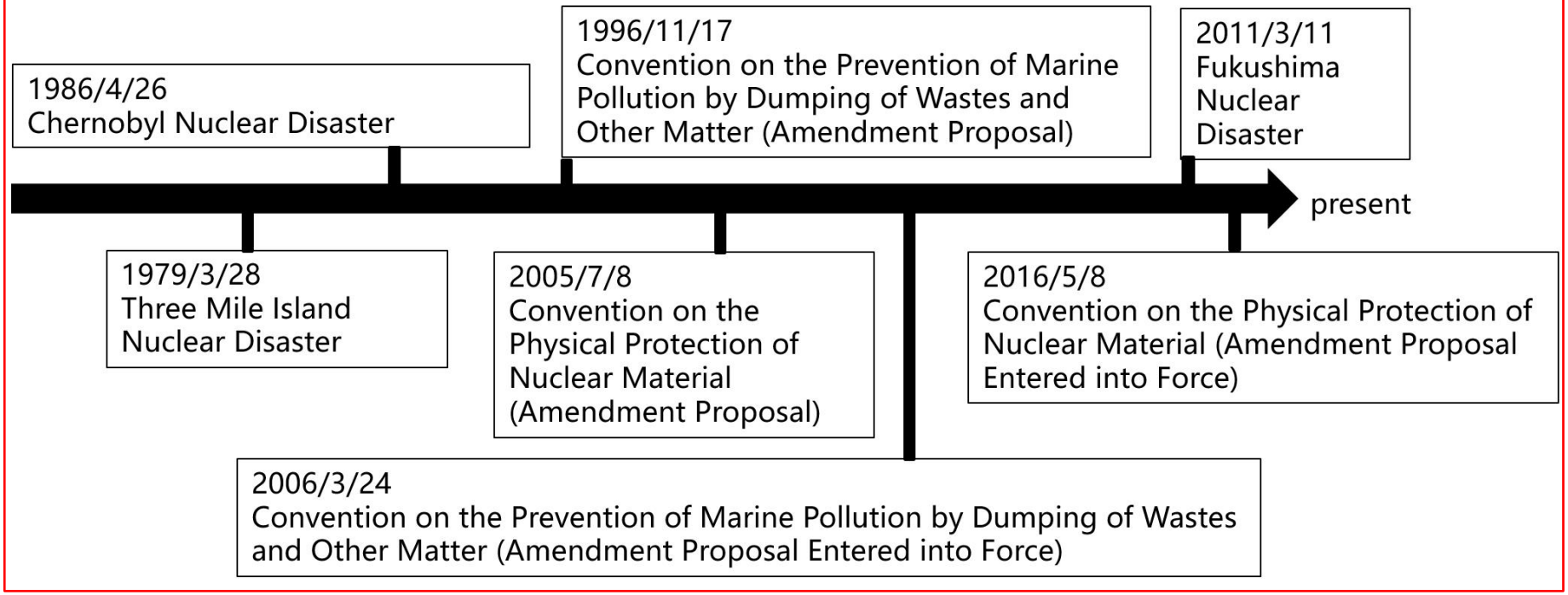


Figure 3. Nuclear Disaster vs Amendments

The timeline depicts the sequence of the major nuclear accidents happened in the past and the amendments of the major international nuclear safety conventions.

Source:

International Atomic Energy Agency (1972). Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter. Vienna, Austria: International Atomic Energy Agency.
International Atomic Energy Agency (1979). Convention on the Physical Protection of Nuclear Material. Vienna, Austria: International Atomic Energy Agency.
International Atomic Energy Agency (1986). Convention on Early Notification of a Nuclear Accident. Vienna, Austria: International Atomic Energy Agency.
International Atomic Energy Agency (1986). Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency. Vienna, Austria: International Atomic Energy Agency.
International Atomic Energy Agency (1994). Convention on Nuclear Safety. Vienna, Austria: International Atomic Energy Agency.
International Atomic Energy Agency (1997). Joint Convention on the Safety of Spent Fuel Manangement and on the Safety of Radioactive Waste Management. Vienna, Austria: International Atomic Energy Agency.
Burns, G. S. (2018). The impact of the major nuclear power plant accidents on the international legal framework for nuclear power. In Nuclear Law Bulletin No. 101 (Nuclear Energy Agency, Organization for Economic Co-operation and Development Ed., pp. 7-30). (Nuclear Law Bulletin, No. 101). Boulogne-Billancourt, France: OECD/NEA.



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According to Burns (2018), the nuclear safety conventions were developed in an early stage after the Three Mile Island Nuclear Disaster in 1979 and experienced a rapid progress with international consensus after the Chernobyl Nuclear Disaster in 1986.[10] From Figure 1, Figure 2 and Figure 3, it could be observed that shortly after the Three Mile Island Nuclear Disaster, the Convention on the Physical Protection of Nuclear Material and Nuclear Facilities was adopted. Moreover, shortly within two years following the Chernobyl Nuclear Disaster, two nuclear safety conventions were adopted and three nuclear safety conventions entered into force. Despite all the efforts, another major nuclear accident—the Fukushima Nuclear Disaster—still occurred. Therefore, it is inevitable to overhaul the existing nuclear safety conventions and find out what are the probable defects resulting in the Fukushima Nuclear Disaster.

2.2. Analytical Method for Nuclear Safety Conventions and Taiwanese Laws

This study applies the approach designed by Professor Jiunn-Rong Yeh.[11] In the approach, each international convention was analyzed with four aspects: objectives, implementing measures, assisting measures, and equitable measures.[12] This is an effective way to analyze an international convention because international conventions are always complicated and contain many articles. By dividing an international convention into objectives, implementing measures, assisting measures, and equitable measures, it is much clearer and much more organized to see the merits and drawbacks of each convention. Furthermore, this thesis also utilizes the same analytical method to analyze the nuclear safety laws in Taiwan in Chapter 3 and then tries to compare the relevant conventions with the matching Taiwanese laws.

In accordance with the Vienna Convention on the Law of Treaties,[13] a signatory may not violate the objectives of the signed convention even before its deposition of the instruments of ratification, acceptance, approval or accession. Since the objectives of each convention have such a special regulatory power even before the convention enters into force for that State Party, in the following sections, this study would first discuss the adequacy and appropriateness of the objectives for each nuclear safety convention, followed by the analysis of implementing, assisting, and equitable measures.

As for implementing measures, it could be inferred that there are at least two kinds—“command and control” and “economic incentives”.[14] Under “command and control”, there are five sub-categories: prohibition, quantitative regulations, permission, compensation of damage, and sanctions.[15] "Command and control" is generally utilized under the physical control of a

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[10] Burns, *supra* note 1, at 30.
[11] Yeh, J.-R. (1999). Global Environmental Issues—from the Viewpoint of Taiwan. Taipei, Taiwan: CHULIU PUBLISHER. (葉俊榮(1999)。全球環境議題:臺灣觀點。臺北市:巨流。)
[12] Ibid., 129.
[13] United Nations (1980). Vienna Convention on the Law of Treaties. In MULTILATERAL (United Nations Ed., pp. 331-512). (United Nations-Treaty Series, No. 18232). New York, NY: United Nations.
[14] Yeh, *supra* note 11, at 130-131.
[15] Ibid., 131-134.

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sovereign state.[16] For example, if a criminal violates human rights, he will be punished by the domestic law. On the other hand, "economic incentives" were widely applied in terms of the issues that are related to the inherent difference in between the developed and developing countries, such as the emission of greenhouse gas.[17] In the following sections, it could be seen that the implementing measures of the nuclear safety conventions were not strictly confined to either "economic incentives" or "command and control" approaches. Instead, those conventions authorize each State Party the power to develop its domestic legislation and executive methods as long as the objectives of the conventions could be met.

In terms of assisting measures, there are at least three types, including “information dissemination”, “implementation assessment”, and “resolution of disputes”.[18] "Information dissemination" is used to inform each Contracting Party about any important message and update that is related to the convention; "implementation assessment" is to regularly evaluate the implementing status of the convention in each State Party; and "resolution of disputes" is to revolve the disagreements among the States Parties in terms of the explanation or reinforcement in any article of the convention. Overall, assisting measures are to help the conventions to execute more smoothly and effectively, and they are necessary for every international convention no matter what kind.

Last but not least, "equitable measures" are to compensate the vulnerable developing countries. Thus, they are more likely to be seen in the abovementioned greenhouse gas emission issues or in the international environmental laws [19] where there is inherent difference between the developed and developing countries. It would be good to have equitable measures to transfer the advanced technology and skillful personnel to the countries that are in need.

Depending on the objectives and nature of the convention, it is not necessarily a bad thing if a convention lacks certain items.[20] On the other hand, even if a convention covers all the aspects, some of the articles might be redundant and useless.[21] The following sections will analyze the six nuclear safety conventions based on this analytical method, and then each convention would be examined if there were any deficiency or redundancy.

2.3. Convention on Nuclear Safety

Table 1 categorizes the articles in the Convention on Nuclear Safety into the four broad categories: objectives, implementing measures, assisting measures, and equitable measures based on the function of each article.

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[16] Schwelb, E. (1968). Civil and Political Rights: The International Measures of Implementation. The American Journal of International Law, 62(4), 827. https://doi.org/10.2307/2197013

[17] Yeh, J.-R. (2015). Climate Change Management and Laws. Taipei, Taiwan: National Taiwan University Press. (葉俊榮(2015)。氣候變遷治理與法律。臺北市:臺大出版中心。)

[18] Yeh, *supra* note 11, at 137-140.

[19] Hunter, D., Salzman, J., and Zaelke, D. (2015). International Environmental Law and Policy. Minnesota, MN: Foundation Press.

[20] Canfa, W. (2007). Chinese Environmental Law Enforcement: Current Deficiencies and Suggested Reforms. Vermont Journal of Environmental Law, 8, 159-193.

[21] Quinn, E. (2011). The Refugee Convention Sixty Years On: Relevant or Redundant. Working Notes, 68, 19-25.

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Moreover, both the categories of implementing measures and assisting measures could be broken down into more detailed subsets as elaborated in the introduction of the analytical method.

Objectives		Article 1
Implementing Measures	Prohibition	Articles 14 and 17
	Quantitative Regulations	
	Permission	Articles 7.2.2 and 17
	Compensation of Damage	Article 4
	Sanctions	Article 9
Assisting Measures	Information Dissemination	Article 5 and Chapter 3
	Implementation Assessment	Chapter 3
	Resolution of Disputes	Article 29
Equitable Measures		Article 11

Table 1. Convention on Nuclear Safety

The table puts the articles into different categories based on the specific function of each article.

Source:

International Atomic Energy Agency (1994). Convention on Nuclear Safety. Vienna, Austria: International Atomic Energy Agency.

Yeh, J.-R. (1999). Global Environmental Issues—from the Viewpoint of Taiwan. Taipei, Taiwan: CHULIU PUBLISHER. (葉俊榮(1999)。全球環境議題:臺灣觀點。臺北市:巨流。)

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The following sections will evaluate the adequacy and deficiency of the Convention on Nuclear Safety with respect to its objectives, implementation, assisting approaches, and equity.

2.3.1. Objectives

As described in Article 1 of the Convention, the objectives of this Convention are to enhance national measures and international safety related technical cooperation in order to achieve and maintain a high level of nuclear safety worldwide, prevent accidents with radiological consequences, mitigate radiological consequences should they occur, establish effective defenses in potential radiological hazards of nuclear installations, and maintain the effective defenses. With the above effort, hopefully it could protect individuals, society, and the environment from harmful radiation of the nuclear installations.[22] From the objectives, it could be inferred that this Convention requires each State Party to set up its own domestic legislation, regulatory methods, and safety standards rather than the central authority—IAEA—sets up a universal standard and obligates every Contracting Party to follow. Some people may argue that it would be better for the IAEA to set up a common regulation for all States Parties to follow, but actually it is very difficult because "state sovereignty" is the principle of international law.[23] As Hunter et al. (2015) illustrates in Chapter 8.2., Principles Shaping International Environmental Law and Policy, of their publication, state sovereignty in the legal sense signifies independence—that is, "the right to exercise, within a portion of the globe and to the exclusion of other States, the functions of a State such as the exercise of jurisdiction and enforcement of laws over persons therein."[24] In other words, there is no international convention which has the right to make a State Party obey the obligations. As a result, it would be more practical to let each State Party establish its own domestic legislation and reinforcement procedures, and then review each State Party's implementing status by regularly holding diplomatic conferences, and this is basically the way that was adopted in the Convention on Nuclear Safety. In addition, although the objectives of the Convention aim to facilitate technical cooperation, some people might think that it is better to ban the technically poor countries from constructing nuclear power plants. Once again, no international law could violate state sovereignty,[25] so technical cooperation is by far the best way to secure the nuclear safety worldwide.

2.3.2. Implementing Measures

In the Convention on Nuclear Safety, pursuant to Article 18, within the national law, each Contracting Party shall take the legislative, regulatory and administrative measures necessary for implementing its obligations under this Convention.[26] This certainly makes sense because each State Party has its own sovereignty; no international convention has the right to interfere the domestic affairs.[27] As a result, it is much more practical to let the States Parties decide their own affairs while the Convention provides a general

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[22] International Atomic Energy Agency, *supra* note 6, at Article 1.
[23] Hunter, *supra* note 19, at Chapter 8.
[24] Ibid.
[25] Ibid.
[26] International Atomic Energy Agency, *supra* note 6, at Article 4.
[27] Hunter, *supra* note 19, at Chapter 8.2.

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direction. After all, any compulsory international convention is impossible. Even the "compulsory jurisdiction" of the International Court of Justice is not compulsory; instead, any State has the option not to accept the Court's jurisdiction. If and only if the State has granted its consent, it must subject itself to the Court's jurisdiction.[28]

When it comes to the legislative and regulatory framework, Article 19 says that each Contracting Party shall establish and maintain a legislative and regulatory framework to govern the safety of spent fuel and radioactive waste management.[29] Meanwhile, the legislative and regulatory framework should provide for the establishment of applicable national safety requirements and regulations for radiation safety a system of licensing of spent fuel and radioactive waste management activities a system of prohibition of the operation of a spent fuel or radioactive waste management facility without a license the enforcement of applicable regulations and of the terms of the licenses and a clear allocation of responsibilities of the bodies involved in different steps of spent fuel and of radioactive waste management.

In terms of the regulatory body that implements the legislative and regulatory framework, Article 20 provides that each Contracting Party should support the regulatory body with adequate authority, competent financial resources, and human resources to fulfill its assigned responsibilities. Moreover, each Contracting Party shall take the appropriate steps to ensure separation between the functions of the regulatory body and the functions of organizations that are involved in spent fuel management or radioactive waste management. As a matter of fact, the background of making this Convention was under the stress of the previous Chernobyl Nuclear Accident. Back in the time, the nuclear safety technology was not generally mature in most of the countries,[30] so it was difficult to set up a high standard that was universal for the entire world. It was rather applicable to let each State Party develop its own regulatory body and implementation organization like what was mentioned in this Convention. However, theoretically, under the design of the Convention, the peer review process should have boosted the progress of nuclear safety technology of each State Party over the years. As mentioned in Article 5 in the Convention, each Contracting Party must report the domestic measures that it took to meet the obligations of this Convention. Such report would then be reviewed in the regularly held review meetings; the peer pressure should force each State Party to enhance its domestic nuclear safety measures. Unfortunately, it turns out that the peer review mechanism is more likely to be a form with very little realistic effects. According to the "2011 Annual Report" submitted by the IAEA, in which the Fukushima Nuclear Disaster occurred in March 2011, in April 2011, the review meeting of the Contracting Parties to the

[28] Alexandrov, S. A. (2006). The Compulsory Jurisdiction of the International Court of Justice: How Compulsory Is It? Chinese Journal of International Law, 5(1), 29–38. https://doi.org/10.1093/chinesejil/jml008

[29] International Atomic Energy Agency, *supra* note 6, at Article 7.

[30] Jankowitsch-Prevor, O. (2006). The convention on nuclear safety. In The Convention on Nuclear Safety, In: International Nuclear Law in the Post-Chernobyl Period, A Joint Report by the OECD Nuclear Energy Agency and the International Atomic Energy Agency (pp. 155-168).

doi: 10.6342/NTU202000431

Convention on Nuclear Safety was convened in Vienna.[31] By instinct, in the review meeting especially right after the catastrophic nuclear disaster, the contracting parties should aggressively reexamine the existing articles and come up with a lot of improvements. However, it turned out that the Contracting Parties only made a specific statement in response to the accident.[32]

2.3.3. Assisting Measures

In Chapter 3 of the Convention, there are detailed deliberation procedures of each review meeting. Furthermore, Article 29 provides that the disputes in between two or more Contracting Parties should be discussed and resolved in a review meeting.[33] Overall, the assisting measures are robust in this Convention that cover information dissemination, implementation assessment, and resolution of disputes. Even so, just like what was mentioned in the above discussion of implementing measures, there is doubt that the review meetings are simply a form without any effective influence on the improvement of nuclear safety. Or maybe the content of the review meetings are rich and effective, but it is the confidentiality provided in Article 36 in this Convention[34] that makes the IAEA Annual Report seems hollow.

2.3.4. Equitable Measures

In this Convention, Article 11 did mention that the financial and human resources must be plentiful enough and available throughout the lifetime of a nuclear installation, and that each Contracting Party shall take the appropriate steps to ensure that sufficient numbers of qualified staff with appropriate education, training and retraining are available for all safety related activities for each nuclear installation,[35] but it did not mention how the developed countries could aid the developing countries in terms of the fund and techniques. Some may argue that such equitable measures are unnecessary since there are many energy options, and the countries without the necessary fund and techniques could simply decide not to use nuclear power plants. However, as mentioned earlier for several times, each country has the absolute sovereignty to decide its domestic affairs,[36] so the States Parties must add the equitable measures as soon as possible in the future in order that the nuclear safety in the developing countries could be improved and hopefully the nuclear disasters would never happen again.

2.4. Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management

Table 2 categorizes the articles in the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management into the four broad categories: objectives, implementing measures, assisting measures, and equitable measures based on the function of each article. Moreover, both the categories of implementing measures and assisting

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[31] International Atomic Energy Agency (2012). IAEA Annual Report 2011. Vienna, Austria: International Atomic Energy Agency.
[32] Burns, *supra* note 1, at 25.
[33] International Atomic Energy Agency, *supra* note 6, at 8-11.
[34] Ibid., Article 36.
[35] Ibid., Article 19.
[36] Hunter, *supra* note 19, at Chapter 8.

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measures could be broken down into more detailed subsets as elaborated in the introduction of the analytical method.

Objectives		Article 1
Implementing Measures	Prohibition	Articles 18, 19, and 20
	Quantitative Regulations	Articles 18, 19, and 20
	Permission	Articles 18, 19, and 20
	Compensation of Damage	Articles 18 and 21
	Sanctions	Articles 18 and 20
Assisting Measures	Information Dissemination	Articles 6.1.3 and 34
	Implementation Assessment	Articles 30 and 32
	Resolution of Disputes	Article 38
Equitable Measures		Article 22

Table 2. Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioloactive Waste Management

The table puts the articles of Joint Convention into different categories based on the specific function of each article.

Source:

International Atomic Energy Agency (1997). Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management. Vienna, Austria: International Atomic Energy Agency.

Yeh, J.-R. (1999). Global Environmental Issues—from the Viewpoint of Taiwan. Taipei, Taiwan: CHULIU PUBLISHER. (葉俊榮(1999)。全球環境議題:臺灣觀點。臺北市:巨流。)

The following sections will evaluate the adequacy and deficiency of the Joint Convention with respect to its objectives, implementation, assisting approaches, and equity.

2.4.1. Objectives

As illustrated in Article 1, the objectives of this Convention are to “achieve and maintain a high level of safety worldwide in spent fuel and radioactive waste management.”[37] Furthermore, Article 1 also says that this Convention “aims to ensure that during all stages of spent fuel and radioactive waste management, there are effective defenses against potential hazards so that

[37] International Atomic Energy Agency, *supra* note 5, at Article 1.

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individuals, society, and the environment are protected from harmful effects of ionizing radiation."[38] At last but not least, this Convention "aims to prevent accidents with radiological consequences and to mitigate their consequences should they occur during any stage of spent fuel or radioactive waste management."[39] Hopefully in this way, "the usage of nuclear energy would not compromise the ability of future generations to meet their needs and aspirations."[40]

As mentioned earlier, in accordance with the Vienna Convention on the Law of Treaties, once a State Party has signed an international convention, it may no longer violate the objectives of that Convention even if it has not deposited the instruments of ratification, acceptance, approval or accession yet.[41] From this regard, those who drafted the Joint Convention seem to have done a good job crafting the objectives because the signatories could no longer do anything that is opposite to the hazard mitigation, accident prevention, and the intergenerational justice in terms of nuclear fuel and waste. According to Di Nucci and Isidoro Losada (2015), the principles in the Joint Convention are non-binding, and there are no sanctions in the case of non-compliance. Even so, the Joint Convention is recognized internationally, and most countries have voluntarily incorporated these standards into their regulatory frameworks.[42] Therefore, it is indeed an effective and successful Convention.

2.4.2. Implementing Measures

As mentioned before, just like any other nuclear safety conventions, the Joint Convention lets each State Party develop each of its own methods to meet the standards of the convention. For example, based on Article 18, "within the national law, each Contracting Party shall take the legislative, regulatory and administrative measures necessary for implementing its obligations under this Convention." This is a very good approach because back in the time when the Joint Convention was under the process of adoption, even the technically advanced countries were not certain about how to come up with the universal standard for each country to comply with, and such phenomenon could be seen in the 2002 IAEA Annual report, the one that was released one year after the Joint Convention entered into force in June 2001. In the "Spent Fuel Management" section of the IAEA 2002 Annual Report, it could be seen that the IAEA would send consultant to the States Parties that have advanced spent fuel management technology. The results recorded by the consultants would then be put together and become the recommendations of Member States. Such recommendations were planned to release in 2003.[43] Although this seems to be the wonderful solution, it was only applied in the spent fuel management, but not on the management of radioactive waste. In

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[38] Ibid.
[39] Ibid., Article 1.3.
[40] Ibid., Article 1.2.
[41] United Nations, *supra* note 13.
[42] Di Nucci, M. R., & Isidoro Losada, A. M. (2015). An Open Door for Spent Fuel and Radioactive Waste Export? In Nuclear Waste Governance (pp. 79–97). Springer Fachmedien Wiesbaden. https://doi.org/10.1007/978-3-658-08962-7_3
[43] International Atomic Energy Agency (2003). IAEA Annual Report 2002. Vienna, Austria: International Atomic Energy Agency.

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the same IAEA 2002 Annual Report, the "Management of Radioactive Waste" section outlined the five key points, but none of them mentioned the way to craft a general standard for every Member State to follow.[44] In spite of such deficiency, it seems to be a good idea that "A Radioactive Waste Management Registry was developed and the software package made available to Member States."[45] This would allow the experts of each State Party to peer review the site selections and safety of the radioactive waste disposal facilities worldwide.

In 2003, not only did the spent fuel management standard come out, but the Contracting Parties also showed great concern and cooperation toward the universal spent fuel governing criteria, as illustrated in the "Joint Convention" section of the IAEA 2003 Annual Report.[46] While all States Parties had shown great willingness to comply with the Joint Convention in its early time since it entered into force, the only concern back then was "the comparatively small number of Contracting Parties—numbering 33 at the end of 2003."[47] This number had increased to 69 as described in the IAEA 2018 Annual Report, and all the countries that are currently operating nuclear power plants have signed the Joint Convention except for Taiwan.[48] The Joint Convention is indeed in a good shape in terms of spent fuel management with clear universal standards, high participations from all Members States, and a complete coverage of all nuclear power plant countries worldwide.

When it comes to the radioactive waste management, on page 44 of the IAEA 2003 Annual Report clearly says that the document "The Long Term Storage of Radioactive Waste: Safety and Sustainability" was already passed by the Board of Governors in 2003.[49] In the document "The Long Term Storage of Radioactive Waste: Safety and Sustainability", the experts have provided plentiful information on the storage and disposal of the radioactive waste. For example, it tells each country to store the fresh radioactive waste for 3 to 5 years before it is moved to the dry storage. Moreover, the containers for the storage must be extremely durable and resistant to corrosion. The containers should be stored inside the concrete structure with security fence surrounding the structure to prevent people from entering it, and elaborate methods must be applied to detect any leakage of contaminants.[50] It is very likely that the radioactive waste issue could be perfectly resolved as long as each State Party complies with the guidelines. Although there might be skepticisms about the possibility that the radiation leaks out from the storage facility, according to Harrar et al. (1990), the nuclear waste storage facility is totally safe. Harrar et al. (1990) examined the water from the wells in Nevada that were extremely close to the discharge of nuclear power plant, but after detailed investigation, it was firmly concluded that there was absolutely no

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[44] Ibid., 59.
[45] Ibid.
[46] International Atomic Energy Agency (2004). IAEA Annual Report 2003. Vienna, Austria: International Atomic Energy Agency.
[47] Ibid., 5.
[48] International Atomic Energy Agency (2019). IAEA Annual Report 2018. Vienna, Austria: International Atomic Energy Agency.
[49] International Atomic Energy Agency, *supra* note 46, at 44.
[50] International Atomic Energy Agency (2003). The Long Term Storage of Radioactive Waste: Safety and Sustainable. Vienna, Austria: International Atomic Energy Agency.

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such radioactive contaminants in the samples.[51] From the experiment, it could be seen that even the cooling water that runs through the nuclear reactor cores contains no radioactive pollutants, not to mention the safe and secure nuclear waste storage facilities in which the nuclear waste is sealed in extremely durable and corrosion-resistant containers and those containers are sealed in the concrete structure while the concrete structure is surrounded by fence with 24-hour continuous and elaborate monitoring on the leakage of contaminants. The only problem might be the nuclear waste disposal issue afterwards. In accordance with the document "The Long Term Storage of Radioactive Waste: Safety and Sustainability", when the activity of the radioactive waste is below a certain level, it is ready for the geological disposal. The ideal disposal site should be 500 to 1,000 meters underground with no significant fracture zones or faults.[52] This kind of geologically ideal site is indeed difficult to find in those small island states that are situated in the collision zone of different tectonic plates like Taiwan.

2.4.3. Assisting Measures

As mentioned in the previous sections, in the analytical method that is applied by this research, the assisting measures could be broken down into three types: information dissemination, implementation assessment, and resolution of disputes.[53] The Joint Convention indeed completely covers all the three aspects.

In terms of information dissemination, Article 29 provides the preparatory meeting for all Contracting Parties to determine the date of the first review meeting, set up Rules of Procedure and Financial Rules, and determine the structure, submission deadline, and reviewing process of the national reports.[54] This is undoubtedly a very good start for the Joint Convention. In fact, the preparatory meeting was the first meeting ever since the Joint Convention entered into force. By determining the date for the first review meeting, all Contracting Parties get to exchange the valuable information based on each of their own operational experiences in the early stage of the Joint Convention in the first review meeting. By setting up the Rules of Procedure and Financial Rules directly in the preparatory meeting, every Member State get to have the first-hand information on two of the most important document for future operation. Last but not least, since the States Parties determined the structure, submission deadline, and reviewing process of the national reports directly in the preparatory meeting, they had a clear idea about how to prepare for their own national reports over the following years for the first review meeting. The Joint Convention certainly did a phenomenal job when it comes to information dissemination, and it is worthwhile for other Conventions to learn from in the future whether they are relevant to nuclear power or not.

As for implementation assessment, Article 32 regulates that the national reports must include the management practices, the location and essential

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[51] Harrar, J. E., Carley, J. F., Isherwood, W. F., and Raber, E. (1990). Report of the Committee to Review the Use of J-13 Well Water in Nevada Nuclear Waste Storage Investigations. Virginia, VA: National Technical Information Service, US Department of Commerce.

[52] International Atomic Energy Agency, *supra* note 50, at 4-10.

[53] Yeh, *supra* note 11, at 137-140.

[54] International Atomic Energy Agency, *supra* note 5, at Article 29.

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features of each management facility, a specific inventory of the domestic spent fuel and radioactive waste, and a specific list of the domestic decommissioning nuclear installations.[55] This approach is excellent because the States Parties can peer review the implementing status of each country based on the submitted national reports. If they find out anything wrong in a Member State either because its domestic management practices did not follow the standard operation procedures (i.e. the aforementioned "The Long Term Storage of Radioactive Waste: Safety and Sustainability" issued by the experts) or due to the dangerous site selection of a management facility (e.g. the disposal site is too close to an active fault), they can immediately require that State Party to improve. For instance, in the "Review Services" part under the "Management of Radioactive Waste" section in the IAEA 2009 Annual Report, it was recorded that all the radioactive waste management facilities in Ukraine were subject to a large-scale review by the IAEA. Moreover, the Central Organization for Radioactive Waste facilities in the Netherlands was also evaluated by the IAEA to see if the treatment and storage process complied with the safety standards. The technical documentation of a proposed low-level radioactive waste disposal facility in Saligny, Romania was also reviewed by the IAEA.[56] The safety standards were based on the "IAEA Safety Standards Series No. GSR Part 5", which contains detailed requirements on the protection of human health, the preservation of the environment, the treatment on nuclear waste before disposal, and the development of the management facilities.[57] The nuclear safety conventions generally let each State Party develop its own regulatory system and implementing measures, as discussed in the previous sections. However, it seems that the review meetings are still capable of governing the nuclear safety worldwide once a problem is pointed out during the international conference of all Member States. In the aforementioned cases, the facilities in the Netherlands, Ukraine, and Romania were all subject to the evaluation by the IAEA.

At last but not least, when it comes to the resolution of disputes, Article 38 provides that the Contracting Parties shall consult within the framework of a meeting to resolve the disagreement.[58] This seems inadequate especially when considering the potential conflicts that might occur in terms of the spent fuel and radioactive waste management issues. As mentioned earlier, countries like Taiwan could hardly find a place for permanent nuclear waste disposal because there are too many geological fault lines. An alternative way to cope with this problem is to export the nuclear waste to other countries where the geologic conditions are more stable. According to the latest edition of "Regulations for the Safe Transport of Radioactive Material (2018 Edition)", before each shipment of any package, it shall be ensured that the package design matches the radionuclides that are being transported, the attachments that do not match the requirements have been lifted, and certain types of

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[55] Ibid., Article 32.

[56] International Atomic Energy Agency (2010). IAEA Annual Report 2009. Vienna, Austria: International Atomic Energy Agency.

[57] International Atomic Energy Agency (2009). Predisposal Management of Radioactive Waste. Vienna, Austria: International Atomic Energy Agency.

[58] International Atomic Energy Agency, *supra* note 5, at Article 38.

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packages have been “held until equilibrium conditions have been approached closely enough to demonstrate compliance with the requirements for temperature and pressure.”[59] In spite of the strict and detailed regulations, conflicts concerning the international transportation of nuclear waste may occur from time to time. Chen et al. (2008) concluded, “The difficulty is resulted from the political scope rather than the technical scope”.[60] Gawande (2001) also pointed out that if the transportation route is going to pass through “more populous urban areas, property values appear to have been lowered in a substantive manner.”[61] From this regard, the Joint Convention should have come up with rules that are more detailed on the resolution of disputes. This way, each State Party would have a better understanding about the pathways that they can access in order to defend the national interests. Meanwhile, it would be easier for the International Court of Justice to make the judgment based on the relevant articles.

2.4.4. Equitable Measures

In the Joint Convention, Article 22 provides that “each Contracting Party shall ensure the qualified staff is available throughout the operating lifetime of a spent fuel and a radioactive waste facility.”[62] However, it did not mention how to help the developing countries with the fund and techniques. It did not address the intergenerational justice, either. Even so, from the IAEA 2010 Annual Report, it could be seen that some equitable measures were applied to manage the radioactive wastes in the developing countries.[63] In page 71 of the report, it was recorded that the IAEA “conducted a six week pilot course at the Technical University of Clausthal, Germany, in the area of training in radioactive wastes management.”[64] This must be a meaningful equitable measure that spread the advanced technology and management experiences to the developing countries around the world. In accordance with the IAEA, “Member States that participated in the course included China, Croatia, Estonia, Iraq, Romania and South Africa.”[65] Another equitable measure that was conducted in the same annual report was the “borehole disposal”. As the IAEA 2010 Annual Report describes on page 72, “To assist countries lacking the financial, human and technical resources to ensure adequate long term management and disposal, the Agency has developed the borehole disposal system, a simple and economically viable option for use by any interested country.”[66] Moreover, “In 2010, implementation of this option was begun in a

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[59] International Atomic Energy Agency (2018). Regulations for the Safe Transport of Radioactive Material (2018 Edition). Vienna, Austria: International Atomic Energy Agency.

[60] CHEN, Y., WANG, C., & LIN, S. (2008). A multi-objective geographic information system for route selection of nuclear waste transport☆. Omega, 36(3), 363–372. https://doi.org/10.1016/j.omega.2006.04.018

[61] Gawande, K., & Jenkins-Smith, H. (2001). Nuclear Waste Transport and Residential Property Values: Estimating the Effects of Perceived Risks. Journal of Environmental Economics and Management, 42(2), 207–233. https://doi.org/10.1006/jeem.2000.1155

[62] International Atomic Energy Agency, *supra* note 5, at Article 22.

[63] International Atomic Energy Agency (2011). IAEA Annual Report 2010. Vienna, Austria: International Atomic Energy Agency.

[64] Ibid., 71.

[65] Ibid.

[66] Ibid., 72.

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demonstration project in Ghana."[67] Even though the borehole disposal seems like an ideal solution to cope with the radioactive wastes generated by a nuclear power plant, there are two issues. First, countries like Taiwan could hardly apply such method since it requires an ideal site with no major fault line passing by. Secondly, even if the containers are perfectly sturdy that the radioactive pollutants would never leak out, how could we make sure that our future generations might not accidentally excavate the borehole hundreds of years later? Thus, it would be much better if the Joint Convention could add an additional clause to define the intergenerational justice in details. This way, the aforementioned issue may be resolved.

2.5. Convention on Early Notification of a Nuclear Accident

Table 3 categorizes the articles in the Convention on Early Notification of a Nuclear Accident into the four broad categories: objectives, implementing measures, assisting measures, and equitable measures based on the function of each article. Moreover, both the categories of implementing measures and assisting measures could be broken down into more detailed subsets as elaborated in the introduction of the analytical method.

[67] Ibid.

doi: 10.6342/NTU202000431

Objectives		Preamble
Implementing Measures	Information Dissemination	Article 4
		Articles 5, 6, and 7
Assisting Measures	Implementation Assessment	
	Resolution of Disputes	Article 11
Equitable Measures		Article 8

Table 3. Convention on Early Notification of a Nuclear Accident

The table puts the articles of the Early Notification Convention into different categories based on the specific function of each article.

Source:

International Atomic Energy Agency (1986). Convention on Early Notification of a Nuclear Accident. Vienna, Austria: International Atomic Energy Agency.

Yeh, J.-R. (1999). Global Environmental Issues—from the Viewpoint of Taiwan. Taipei, Taiwan: CHULIU PUBLISHER. (葉俊榮(1999)。全球環境議題:臺灣觀點。臺北市:巨流。)

The following sections will evaluate the adequacy and deficiency of the Early Notification Convention with respect to its objectives, implementation, assisting approaches, and equity.

2.5.1. Objectives

This Convention desires to strengthen further international cooperation in the safe development and use of nuclear energy, so each State Party must provide relevant information about nuclear accidents as early as possible in order that transboundary radiological consequences can be minimized.[68] As a matter of fact, the Chernobyl Nuclear Disaster took place on April 26th, 1986. Soon after that, this Early Notification Convention was adopted on September 26th, 1986, only five months after the disaster. With prominent international

[68] International Atomic Energy Agency (1986). Convention on Early Notification of a Nuclear Accident. Vienna, Austria: International Atomic Energy Agency.

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consensus,[69] this Convention entered into force on October 27th, 1987, the year following the Chernobyl Nuclear Disaster.

It could be inferred that the foundation of the Early Notification Convention was mainly due to the fact that the Russian Federation did not timely notify other countries about the Chernobyl Nuclear Disaster. Instead, the Russian Federation tried to hide the fact, and the "initial information that an accident had occurred came from detection of elevated radiation readings in Sweden, before the Soviet Government had informed the international community that the accident had occurred." It is very likely that when the rest of world finally learned about the incident, many people had already eaten the radioactively polluted food and drunk the radioactively polluted water. For the purpose of preventing the tragedy from happening again, the Early Notification Convention was crafted, and from its clear and concise objectives, it could be inferred that this is an excellent convention that will certainly force every State Party to inform the nuclear accident in the first moment. A good example is that the Japanese Government timely informed the IAEA after the Fukushima Nuclear Disaster occurred.[70] Indeed, in accordance with the Vienna Convention on the Law of Treaties, a signatory may not violate the objectives of the signed convention even before its deposition of the instruments of ratification, acceptance, approval or accession.[71] As a result, the objectives of the Early Notification Convention could certainly obligate each Member State to timely inform the nuclear accidents and let the international society know about it immediately.

2.5.2. Implementing Measures

Once a nuclear accident occurs, Article 4 says that the IAEA shall promptly inform the countries which are or may be physically affected. The notification includes the nature, the occurrence time, and the exact location of the nuclear accident. Moreover, the IAEA shall also provide the available information relevant to minimizing the radiological consequences in those countries.[72] This is undoubtedly the perfect example of a good convention in terms of the implementing measures. This Convention allows any country that might be potentially affected by the nuclear incident to know about where it happened, when it occurred, and which type of accident it was. With the information, each country can assess its potential impact and evacuate its local residents if necessary. Despite the robustness of the implementing measures, there has been very few chances to put the Convention into practice since there is only one major nuclear accident—the Fukushima Nuclear Disaster—after this Convention entered into force. Moreover, since the magnitude of the radioactive release was much milder than the one in the Chernobyl Accident, only the local residents in Fukushima, rather than anywhere else in the world, needed to evacuate. As mentioned by Cheng and Jhang (2011), only the local residents who lived within 30 kilometers away from the Fukushima Nuclear Power Plant needed to evacuate.[73] As a result,

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[69] Burns, *supra* note 1.
[70] Ibid., 22.
[71] United Nations, *supra* note 13.
[72] International Atomic Energy Agency, *supra* note 68, at Article 4.
[73] Cheng and Jhang, *supra* note 2, at 77-83.

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although the Japanese Government made a timely notification to the international society,[74] the significance of the report was relatively small.

Aside from the notifications of the Member States, the IAEA has done a comprehensive and thorough work on the "Incident and Emergency Preparedness and Response", as elaborated in an individual chapter in the IAEA 2011 Annual Report.[75] It is the annual report that was released in the year that the Fukushima Accident took place. According to the annual report, "the Emergency Preparedness Review (EPREV) service, offered to Member States since 1999, focuses on independent assessments of national preparedness for responding to radiation incidents and emergencies, and of compliance with Agency Safety Requirements."[76] The safety requirement includes the "Preparedness and Response for a Nuclear or Radiological Emergency (IAEA Safety Standards Series No. GS-R-2)" which is a comprehensive guiding book published by the IAEA.[77] In addition, according to this guiding book, it has been superseded by another guiding book "Preparedness and Response for a Nuclear or Radiological Emergency (IAEA Safety Standards Series GSR Part 7)" since the year 2015.[78] In the most updated guiding book, detailed requirements on the emergency response for a nuclear accident are provided. For example, in page 82 of this guiding book, it requires that there must be a response organization under the national level, and "each response organization shall prepare an emergency plan or plans for coordinating and performing their assigned functions as specified in Section 5 and in accordance with the hazard assessment and the protection strategy."[79] In Section 5 of the book, some great management practices could be observed. For instance, it was regulated in Paragraph 5.38.(a) that for facilities in category I, "arrangements shall be made for taking urgent protective actions and other response actions before any significant release of radioactive material occurs."[80] Furthermore, the book breaks down the radioactive facilities into five categories in which category I is the most dangerous one including the commercial nuclear power plants, and category II is less dangerous than category I that includes the research nuclear power plants—the scales are much smaller than the commercial ones because they are only for the research purpose. Category III is even safer which is inclusive of some hospital instruments that would emit radioactive waves. Categories IV and V are even less critical.[81] Therefore, it totally makes sense that Paragraph 5.38.(a) sets up the strictest regulations for the facilities in Category I considering its magnitude and consequence of a nuclear accident. There are still a lot of reasonable and excellent practices in this informative guiding book.

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[74] Burns, *supra* note 1, at 22.
[75] International Atomic Energy Agency, *supra* note 31, at 65-69.
[76] Ibid., 72.
[77] Ibid.
[78] International Atomic Energy Agency (2002). Preparedness and Response for a Nuclear or Radiological Emergency (IAEA Safety Standards Series No. GS-R-2). Vienna, Austria: International Atomic Energy Agency.
[79] International Atomic Energy Agency (2015). Preparedness and Response for a Nuclear or Radiological Emergency (IAEA Safety Standards Series GSR Part 7). Vienna, Austria: International Atomic Energy Agency.
[80] Ibid., 29.
[81] Ibid., 43-44.

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Unfortunately, the requirements of this guiding book are not compulsory. Instead, it is very likely that the regulations were reinforced in the States Parties either because those countries volunteered to participate in the program, or because the IAEA felt like those States Parties were relatively weak in terms of the emergency response. As described in the annual report, "In 2011, EPREV missions were conducted in Albania, Estonia, Georgia, Latvia, Pakistan and the Russian Federation."[82] In addition to that, "the regulatory aspects of the national radiation emergency preparedness systems were assessed in the Republic of Korea, Slovenia, Switzerland, and the United Arab Emirates within the framework of Integrated Regulatory Review Service (IRRS) missions."[83] It definitely would be much better if the requirements in the guiding book could be a universal standard for every State Party to comply with rather than just a couple of countries mentioned above. After all, neither this Early Notification Convention nor the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency that will be discussed in the upcoming section has incorporated the domestic emergency response plans into one of the obligations. If the IAEA could incorporate these requirements into one of those Conventions, or to craft an individual Convention just for the domestic emergency response plan, and then make the review service universal to each Member State to see if they could follow up the standards, it is highly believed that the international nuclear security could be elevated to the next level.

2.5.3. Assisting Measures

As illustrated in the previous discussion, the analytical method breaks down the assisting measures into three categories: information dissemination, implementation assessment, and resolution of disputes.[84] The Early Notification Convention includes information dissemination and resolution of disputes, but it lacks implementation assessment.

When it comes to information dissemination, Article 5 provides that if a nuclear accident occurs, the State Party must tell other countries the assumed or established cause and the foreseeable development of the nuclear accident relevant to the transboundary release of the radioactive materials.[85] This is a good article because the required information will allow the countries which may be potentially influenced to be prepared for the upcoming crisis. In addition to that, Article 5 also requires the State Party where the nuclear accident takes place to provide the information on current and forecast meteorological and hydrological conditions.[86] This is also a reasonable and important regulation because such information is necessary for forecasting the transboundary release of the radioactive materials.

As for the settlement of disputes, Article 11 provides that the Parties to the dispute shall consult with a view to the settlement of the dispute by negotiation or by any other peaceful means of settling disputes acceptable to them. This is also a good article because there are already a lot of treaties governing the compensation issue once a nuclear accident occurs. These treaties include

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[82] International Atomic Energy Agency, *supra* note 31, at 72.
[83] Ibid.
[84] Yeh, *supra* note 11, at 137-140.
[85] International Atomic Energy Agency, *supra* note 68, at Article 5.
[86] Ibid.

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the 2004 Paris Protocol, the 1997 Vienna Protocol, the Convention on Supplementary Compensation for Nuclear Damage, and so on.[87] The Early Notification Convention could refer to one of those conventions if there is any dispute concerning the compensation of a radiological incident. However, this study would not dig into any one of those nuclear liability treaties since the focus of the research is about nuclear safety.

As for the lack of implementation assessment, just like what was mentioned earlier, this study suggests that the EPREV missions could become an obligation. This way, the implementing status in each State Party will be evaluated to see if it matches the requirements of the guiding book "Preparedness and Response for a Nuclear or Radiological Emergency (IAEA Safety Standards Series GSR Part 7)", hence significantly improving the nuclear safety in the international level.

2.5.4. Equitable Measures

To help the vulnerable countries and to maintain international justice, Article 8 provides that the IAEA should conduct investigations into the feasibility and establishment of an appropriate radiation monitoring system to a country which does not have nuclear activities itself and borders on a State having an active nuclear program but did not sign this Convention.[88] Once again, this article is excellent. Since the country who did not sign this Convention would not be requested to comply with the regulations, it may or may not notify the bordering states once a nuclear accident occurs. As a result, the IAEA must do the research to know what countries are having nuclear power plant programs right now and are not States Parties of the Early Notification Convention. After doing the research, the IAEA could establish the monitoring systems in the territories of the vulnerable countries mentioned above. In practice, this article has yet to be applied though, since all the countries that are operating nuclear power plants right now are Member States of this Convention except for the island state—Taiwan.[89]

2.6. Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency

Table 4 categorizes the articles in the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency into the four broad categories: objectives, implementing measures, assisting measures, and equitable measures based on the function of each article. Moreover, both the categories of implementing measures and assisting measures could be broken down into more detailed subsets as elaborated in the introduction of the analytical method.

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[87] Cheng and Jhang, *supra* note 2, at 121-122.
[88] International Atomic Energy Agency, *supra* note 68, at Article 8.
[89] International Atomic Energy Agency (1997). Status lists of Early Notification Convention. Vienna, Austria: International Atomic Energy Agency.

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Objectives		Preamble, Articles 1 and 2
Implementing Measures	Prohibition	
	Quantitative Regulations	
	Permission	Articles 8 and 9
	Compensation of Damage	Articles 8 and 10
	Sanctions	Article 8
Assisting Measures	Information Dissemination	Articles 6, 11, 17, and 18
	Implementation Assessment	
	Resolution of Disputes	Article 13
Equitable Measures		Article 7

Table 4. Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency

The table puts the articles of the Assistance Convention into different categories based on the specific function of each article.

Source:

International Atomic Energy Agency (1986). Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency. Vienna, Austria: International Atomic Energy Agency.

Yeh, J.-R. (1999). Global Environmental Issues—from the Viewpoint of Taiwan. Taipei, Taiwan: CHULIU PUBLISHER. (葉俊榮(1999)。全球環境議題:臺灣觀點。臺北市:巨流。)

The following sections will evaluate the adequacy and deficiency of the Assistance Convention with respect to its objectives, implementation, assisting approaches, and equity.

2.6.1. Objectives

In Article 1, it could be seen that this Convention aims to make States Parties cooperate among them and with the IAEA to facilitate prompt assistance in the event of a nuclear accident or radiological emergency to minimize its consequences and to protect life, property and the environment from the effects of radioactive releases.[90] This Convention was adopted on

[90] International Atomic Energy Agency (1986). Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency. Vienna, Austria: International Atomic Energy Agency.

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September 26th, 1986, exactly the same date as the aforementioned Early Notification Convention. As a result, it could be inferred that right after the Chernobyl Nuclear Disaster, the strong international consensus[91] not only aimed at preventing any future tragedy of hiding the fact of a nuclear accident, as stated in the objectives of the Early Notification Convention, but also sought for the international cooperation to help the countries that suffered from the radiological consequence of a nuclear disaster. All in all, the objectives in both Conventions are nice. Considering that the Vienna Convention on the Law of Treaties obligates every signatory not violating the objectives of the signed convention even before its deposition of the instruments of ratification, acceptance, approval or accession,[92] the Early Notification Convention and the Assistance Convention as a whole could guarantee a timely report and international aids for any small or big nuclear accident in the future.

2.6.2. Implementing Measures

In this Convention, Article 3 regulates the direction and control of assistance. The State Party where the nuclear disaster occurs could ask the international society for help, and the personnel and instruments from other countries would be sent to that State Party. In accordance with Article 3, the overall direction, control, coordination and supervision of the assistance shall be the responsibility within its territory of the requesting country. As a result, the ownership of equipment and materials provided by either Party during the periods of assistance shall be unaffected, and their return shall be ensured.[93] This implementing measure definitely makes sense because of two reasons. First, the Member State where the nuclear incident takes place is the one who knows the most about why it happens and what kinds of help it needs, so that Member State should govern the resources, equipment, and personnel brought in by other States Parties for sure. Secondly, just like the spirit of the aforementioned nuclear liability protocols, any transboundary damage caused by a nuclear accident should be compensated. Since the instrument and personnel belong to the assisting States Parties, the requesting country definitely has the responsibility to restore everything back to normal and return it back to the owner as the nuclear accident ends.

Once again, this Convention has no chance to be put into practice because there was only one major nuclear disaster—the Fukushima Accident—following its entrance into force. Meanwhile, the Japanese Government was very courteous that it did not ask the international society for help[94] despite the fact that it has the right to do so in accordance with the Assistance Convention. At the same time, it is worthwhile to note that the number of ionizing radiation events recorded in 2011, the year when the Fukushima Accident occurred, was the lowest for the past 15 years.[95] Figure 4 was retrieved from the IAEA Annual Report 2018,[96] the latest annual report available. In the graph, it could be observed that the blue line (marked as “Recorded Events”) had the lowest number of 105 in the year 2011. After that,

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[91] Burns, *supra* note 1.
[92] United Nations, *supra* note 13.
[93] International Atomic Energy Agency, *supra* note 90, at Article 3.
[94] Burns, *supra* note 1.
[95] International Atomic Energy Agency, *supra* note 48, at 78.
[96] Ibid.

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it has an increasing trend, and it peaks in the year 2018 with the number of 313. This is definitely not a good phenomenon because theoretically, the attitude of operating nuclear facilities should be much more careful than ever before since the Fukushima Nuclear Disaster. Moreover, many countries around the world have tremendously cut down the usage of nuclear power plants since the Fukushima Disaster, and one example is that Japan had its domestic nuclear power plants generate a total of more than 200 terawatt hours of electricity in 2010, but the number dramatically decreased to less than 20 in the year 2013.[97] It shall be straightforward that a decrease in nuclear power plant usage and a more cautious operation worldwide will altogether lead to a significant decrease in the recorded events, however, the number of recorded events surged as shown in Figure 4. To resolve this adversity, it is highly suggested that the Convention on Nuclear Safety shall be improved.

[97] Kuramochi, T. (2015). Review of energy and climate policy developments in Japan before and after Fukushima. Renewable and Sustainable Energy Reviews, 43, 1320–1332. https://doi.org/10.1016/j.rser.2014.12.001

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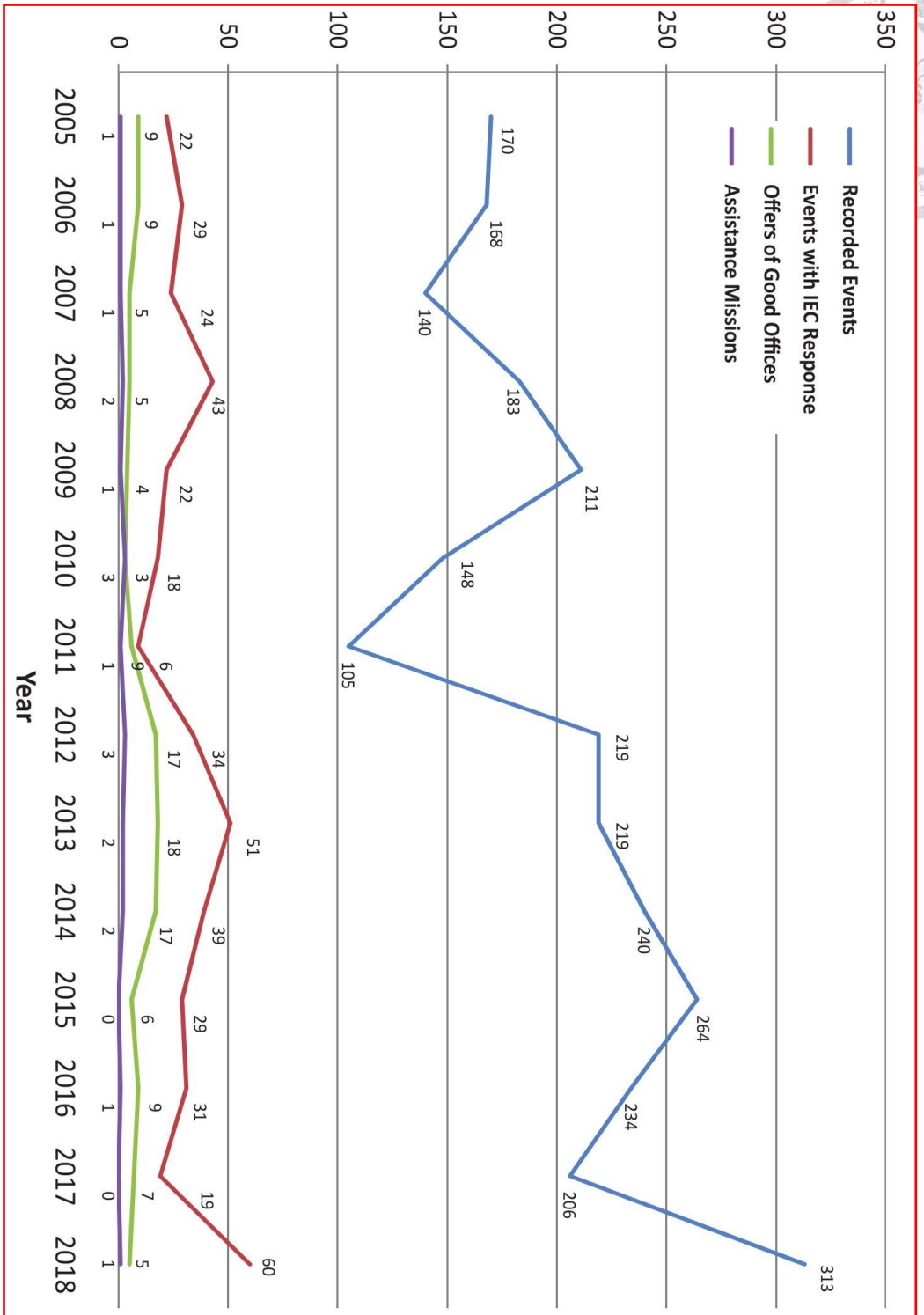

Figure 4. IAEA Emergency Response
From the figure, it could be seen that among all the nuclear events either small or big (marked as the blue line), the IAEA provides assistance to only a few of them (marked as the purple line).

Source: International Atomic Energy Agency (2019). IAEA Annual Report 2018. Vienna, Austria: International Atomic Energy Agency.

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Aside from the necessary improvements that must be made on the Nuclear Safety Convention, what is related to the Assistance Convention in Figure 4 is the number of "Events with IEC Response", as marked in the red line. "IEC" indicates the "Incident and Emergency Center", which was established by the IAEA in 2005 for the purpose of providing "round-the-clock assistance to Member States in dealing with nuclear and radiological events, including security-related threats, by coordinating the efforts, contributions and actions of experts within the IAEA, Member States and international organizations."[98] From Figure 4, it could be observed that among all the "Recorded Events", the ones that were responded by the IEC were relatively few—in 2011, the year of Fukushima Accident, there were a total of 105 recorded events, but only 9 of them were responded by the IEC, which means less than 10% of the ionizing radiation accidents were addressed by the IEC. There are two possible answers to this seemingly dangerous observation. First, although lots of nuclear accidents, either big or small, were being reported, most of them could actually be resolved by the State Party itself, so the IAEA need not send their experts and technicians in most of the cases. Another hypothesis is that the system of the Assistance Convention is problematic—either due to the lack of personnel and resource in the IEC to deal with every single nuclear accident, or because of the fact that the framework of the Assistance could not provide the aids in which the requiring Member State is asking for. Since the IAEA Annual Reports only listed the number of issues without revealing what the issues were, and no paper has discussed this problem so far, it is unavailable for this research to find out which hypothesis is the correct one unless future study consults the IAEA personnel in person. Even so, from the green line marked as "Offers of Good Offices" and the purple line marked as "Assistance Missions", it could be indicated that the latter hypothesis might more likely be true—Since the Assistance Convention was not effective enough, even though some of the recorded events were responded by the IEC, only few of the responded events could be offered with good offices. In addition, even if good offices were offered, it does not necessarily mean that the assistance mission would arrive. Sometimes the Member State still has to cope with the nuclear accident on itself. For example, in 2017, the IEC already provided good offices on 7 nuclear accidents worldwide, but none of them received assistance from other Member States. From this regard, it is highly recommended that the Assistance Convention shall add more incentives in the future to let the States Parties be more willing to provide international assistance on an ionizing radiation event.

[98] International Atomic Energy Agency (2019). Incident and Emergency Center. Retrieved from: https://www.iaea.org/about/organizational-structure/department-of-nuclear-safety-and-security/incident-and-emergency-centre

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2.6.3. Assisting Measures

As mentioned in the previous discussion, the analytical method breaks down the assisting measures into three subsets, including information dissemination, implementation assessment, and resolution of disputes.[99]

In terms of information dissemination, Article 4 requires each Member State to provide the competent authorities and the point of contact.[100] This is a good article because once a nuclear accident happens, the point of contact in each State Party could receive the latest information from the IAEA. If the disastrous country needs help, the competent authorities of each Member State could send its personnel and resources to the requiring State.

On the other hand, when it comes to resolution of disputes, Article 13 regulates that each State Party should apply peaceful negotiation to resolve any disputes. If the negotiation fails, the Member States should seek for arbitration or appeal to the International Court of Justice.[101] This might be problematic since the International Court of Justice was proved to be biased with strong evidence that "judges favor the States that appoint them and that judges favor States whose wealth level is close to that of their own States."[102] This may result in an unfair judgment that compromises the rights of the vulnerable countries. An ideal way to cope with this issue is that the States Parties should reach a consensus to modify this article into the way that the IAEA review meetings would replace the International Court of Justice's role on the resolution of disputes. Even so, the need of such a referendum is not urgent since in most of the cases, the arbitration body or international court was used by the leaders who are facing significant domestic audience costs when they try to make the voluntary and negotiated concessions. They utilize the International Court of Justice just for the function of the "political cover".[103] In this point of view, it is unlikely that the International Court of Justice would make any unfair judgment in terms of the disputes under this Assistance Convention.

As for the implementation assessment, just like what was mentioned earlier in the Early Notification Convention, the requirements established in the guiding book "Preparedness and Response for a Nuclear or Radiological Emergency (IAEA Safety Standards Series No. GSR Part 7)" should be compulsory rather than voluntary. This is something that the Contracting Parties shall reach a consensus to modify the Assistance Convention so that the nuclear safety would be improved worldwide. Despite the lack of compulsory approaches, there have been some excellent practices from the IAEA that are worthy of recognition in terms of the international assistance on a nuclear accident. According to the IAEA Annual Report 2018, the IAEA organized 14 Convention Exercises with States Parties and international organizations in 2017. The exercises tested emergency communication channels, assistance mechanisms, and the IAEA's assessment and prognosis

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[99] Yeh, *supra* note 11, at 137-140.
[100] International Atomic Energy Agency, *supra* note 90, at Article 4.
[101] Ibid., Article 13.
[102] Posner, E. A. and de Figueiredo, M. F. P. (2005). Is the International Court of Justice Biased? Journal of Legal Studies, 34, 599—630.
[103] Allee, T. L. and Huth, P. K. (2006). Legitimizing Dispute Settlement: International Legal Rulings as Domestic Political Cover. American Political Science Review, 100(2), 219—234.

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process.[104] Moreover, the updated publication "IAEA Response and Assistance Network (EPR-RANET 2018)" was published, and the manual contains "guidance on actions to be performed by States providing and requesting international assistance."[105] RANET is the abbreviation of the IAEA "Response and Assistance Network". The IAEA certainly has done an excellent job drafting this manual so that it contains detailed guidelines on all the important aspects under the RANET. For example, based on page 10 of the manual, States are responsible for identifying expertise, equipment and materials that can be made available to help another State in a nuclear accident.[106] This is a very good point because once the States Parties could keep track of their available resources in normal days, they could readily provide the assistance when a radiological emergency occurs. Another good example is on pages 135 to 143 in the manual, labeled as "Appendix I: Example Request for Assistance". This appendix clearly shows that if a Member State wants to request for assistance under the framework of this Convention, it must complete the forms which require it to fill in the crucial information such as the name and e-mail of its competent authority, the name and e-mail of its assistance coordinator, the event description, the actions taken or planned, and the type of assistance requested. Under the category of "the type of assistance requested", the Member State could select from a wide range of subcategories such as medical support, nuclear installation assessment and advice, radiation survey, and so forth.[107] Under different circumstances, the types of assistance in need may differ, so it is extremely important that each State Party must be very familiar with the format of this requesting forum. This way, they can immediately let the international society know exactly what they need. It was definitely a pity that the Japanese Government did not request any assistance under the framework of this Convention immediately after the Fukushima Disaster.[108] If they could ask for help on the "nuclear installation assessment and advice", the experts and technicians from the IAEA and other States may timely resolve the "station blackout" issue,[109] and the radiological tragedy might have been prevented. Therefore, when it comes to the implementation assessment of the Convention, there should be compulsory evaluation on each Member State in terms of the emergency response to ensure that they can react quickly and accurately to different scenarios based on the "IAEA Response and Assistance Network (EPR-RANET 2018)".

2.6.4. Equitable Measures

In accordance with the Convention, when the assisting Party asks for the reimbursement of costs, it shall consider the need of the developing countries.[110] This is definitely a good equitable measure. Although Article 7.1 gives the right to each Contracting Party that it could provide the assistance

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[104] International Atomic Energy Agency, *supra* note 48, at 83.
[105] Ibid., 84.
[106] International Atomic Energy Agency (2018). IAEA Response and Assistance Network (EPR-RANET 2018). Vienna, Austria: International Atomic Energy Agency.
[107] Ibid., Appendix I.
[108] Burns, *supra* note 1.
[109] Ibid., 23.
[110] International Atomic Energy Agency, *supra* note 90, at Article 7.3.

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without any cost, and Article 7.2 clearly says that the assisting Party could ask for the reimbursement of costs "incurred for the services rendered by persons or organizations acting on its behalf," Article 7.3 provides that it shall give due consideration to the needs of the developing countries and waive the reimbursement in whole or in part.[111] In page 1507 of the book "International Environmental Law and Policy", Hunter et al. (2015) also categorized the need of developing countries as one of the main topics under the "economic justice".[112] Moreover, in page 445, it clearly says that the economically vulnerable countries have the right to develop even if it needs to exploit domestic natural resources, and this is one of the principles shaping international environmental law and policy.[113] Meanwhile, the usage of nuclear power plants is for the purposes of preserving the natural resources and enhancing the economic competitiveness. In terms of environmental protection, as illustrated in page 234 of Professor Yeh's publication,[114] nuclear power is cleaner than wind, solar PV, biomass, storage, CCS, and thermal power. As a matter of fact, nuclear power and hydro power are the top two energy options which emit the smallest amount of greenhouse gas while generating the same amount of electricity. On the other hand, when it comes to the economic competitiveness, in accordance with Sims et al. (2003), the generation cost for PV and solar thermal, the most popular types of renewable energy, are 8.7 to 40.0 dollars per kWh.[115] This is much more expensive than fossil fuel power plants and nuclear power plants.[116] Thus, it is straightforward that nuclear power and fossil fuels are much more cost-effective than renewable energies. As for the comparison in between nuclear power and renewable energies, Du and Parsons (2009) concluded that the fuel cost for gas is 7.00 dollars per mmBtu, the fuel cost for coal is 2.60 dollars per mmBtu, and the fuel cost for nuclear power is only 0.67 dollars per mmBtu,[117] making nuclear the cheapest and most efficient energy option. All in all, nuclear power is the best energy option in both economic competitiveness and environmental protection. From the point of view, it is certainly a good thing to encourage the developing countries to use more nuclear power so that they could exploit fewer natural resources while maintaining the same economic development. Additionally, the environmental friendly results of nuclear power plants could compensate the previous exploitation of natural resources. Considering all these benefits, the equitable measures on nuclear reactors are necessary so that the developing countries would be encouraged to apply this optimal energy approach, and the Assistance Convention can do just that.

On page 21 (3.8. Financial Arrangements) of the abovementioned guiding book "IAEA Response and Assistance Network (EPR-RANET 2018)", it was

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[111] Ibid., Article 7.
[112] Hunter et al., *supra* note 19, at 1507.
[113] Ibid., 445.
[114] Yeh, *supra* note 17, at 234.
[115] Sims, R. E. H., Rogner, H.-H., and Gregory, K. (2003). Carbon emission and mitigation cost comparisons between fossil fuel, nuclear and renewable energy resources for electricity generation. Energy Policy, 31, 1315—1326.
[116] Ibid.
[117] Du, Y. and Parsons, J. E. (2009). Update on the Cost of Nuclear Power (09-004). Massachusetts, MA: A Joint Center of the Department of Economics, MIT Energy Initiative, and Sloan School of Management.

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mentioned that “States offering assistance need to consider any financial requirements in advance and specify the financial requirements in the offer of assistance.”[118] This is a good practice because it allows a developing country to evaluate beforehand whether to accept the assistance or not based on its financial status. In addition to that, the RANET guidance elaborated in the same chapter “Some financial support for RANET assistance activities may be provided through the IAEA’s regular budget or from other IAEA resources. The IAEA may cover the expenses for the initial mobilization and deployment of the Assessment and/or Assistance Mission.”[119] This shall be a tremendous relief on the financial burden for the developing countries. Unfortunately, all the useful information in the RANET guidance has yet to be addressed in the Assistance Convention. Thus, it is highly suggested that the Contracting Parties shall amend the Convention and add that the reinforcement rules of Article 7 “Reimbursement of Costs” in the Convention shall refer to the “IAEA Response and Assistance Network (EPR-RANET 2018)”, especially Chapter 3.8 “Financial Arrangements”. This way, the equitable measures will be readily available to the economically vulnerable States.

2.7. Convention on the Physical Protection of Nuclear Material and Nuclear Facilities

Table 5 categorizes the articles in the Convention on the Physical Protection of Nuclear Material and Nuclear Facilities into the four broad categories: objectives, implementing measures, assisting measures, and equitable measures based on the function of each article. Moreover, both the categories of implementing measures and assisting measures could be broken down into more detailed subsets as elaborated in the introduction of the analytical method.

[118] International Atomic Energy Agency, *supra* note 106, at 21.
[119] Ibid., Chapter 3.8.

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Objectives		Preamble, Articles 1 and 1A
Implementing Measures	Prohibition	Articles 2A, 3, 4, and Annex I
	Quantitative Regulations	Articles 3, 4, and Annex II
	Permission	Articles 11, 11A, and 11B
	Compensation of Damage	Article 4
	Sanctions	Articles 7, 8, 9, and 10
Assisting Measures	Information Dissemination	Articles 5, 6, 13, 13A, 14, 18, 20, 21, 22, and 23
	Implementation Assessment	Articles 14, 16, and 20
	Resolution of Disputes	Article 17
Equitable Measures		Article 12

Table 5. Convention on the Physical Protection of Nuclear Material and Nuclear Facilities

The table puts the articles of the Physical Protection Convention into different categories based on the specific function of each article.

Source:

International Atomic Energy Agency (1979). Convention on the Physical Protection of Nuclear Material and Nuclear Facilities. Vienna, Austria: International Atomic Energy Agency.

Yeh, J.-R. (1999). Global Environmental Issues—from the Viewpoint of Taiwan. Taipei, Taiwan: CHULIU PUBLISHER. (葉俊榮(1999)。全球環境議題:臺灣觀點。臺北市:巨流。)

The following sections will evaluate the adequacy and deficiency of the Physical Protection Convention with respect to its objectives, implementation, assisting approaches, and equity.

2.7.1. Objectives

The objectives of this Convention are mentioned in the preamble and Article 1A.[120] In the preamble, this Convention aims to let each Contracting

[120] International Atomic Energy Agency (1979). Convention on the Physical Protection of Nuclear Material and Nuclear Facilities. Vienna, Austria: International Atomic Energy Agency.

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Party recognize "the potential benefits to be derived from the peaceful application of nuclear energy"[121] and have in mind "the purposes and principles of the Charter of the United Nations concerning the maintenance of international peace and security and the promotion of friendly relations and cooperation among States".[122] Just like what was mentioned in the previous discussion, in accordance with the Vienna Convention on the Law of Treaties, a signatory may not violate the objectives of a convention even when it has not deposited its instrument of ratification, acceptance, approval or accession yet.[123] As a result, the Physical Protection Convention is able to ensure that the nuclear reactor facilities worldwide could only be used for peaceful purposes. From this regard, this is undoubtedly a very good, effective and important convention. Additionally, Article 1A provides that the purposes of this Convention are to "achieve and maintain worldwide effective physical protection of nuclear material used for peaceful purposes and of nuclear facilities used for peaceful purposes."[124] This is actually mostly the same as what was already mentioned in the preamble of this Convention. Thus, Article 1A is likely to be redundant, and it is suggested that this provision could be deleted. Basically, there are only three key points in the objectives of the Physical Protection Convention: peaceful use of nuclear power, security of nuclear materials during storage and transportation, and the prevention of radiation pollution against public health and environment.[125] Therefore, it is recommended that this Convention outlines the three main objectives and omits the rest of the redundant parts.

2.7.2. Implementing Measures

Article 2A requires each State Party to establish, implement and maintain an appropriate physical protection regime applicable to nuclear material and nuclear facilities under its jurisdiction with the aim of protecting against theft and other unlawful taking of nuclear material in use, storage and transport.[126] In other words, each Member State has to take care of its domestic nuclear material and design its own legislative and regulatory systems rather than the IAEA obligates each country to follow the identical physical protection procedures on the nuclear material. These implementing measures can do very well in normal circumstances in most countries around the world, but they are useless against the dangerous countries like Iran, Syria and North Korea who tend to secretly develop nuclear weapons. In page 101 of the latest IAEA Annual Report,[127] among the 182 States who have the Comprehensive Safeguards Agreements (CSAs) in force, 48 of them do not comply with the Additional Protocol (AP). In other words, for the 48 countries who have active CSAs but do not have active AP, the IAEA can only examine the nuclear facilities that are declared by those States. However, the IAEA could not assure whether or not those countries are secretly constructing other undercover nuclear facilities. Such implementing measures are definitely

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[121] Ibid., Preamble.
[122] Ibid.
[123] United Nations, *supra* note 13.
[124] International Atomic Energy Agency, *supra* note 120, Article 1A.
[125] Ibid., Preamble and Article 1A.
[126] Ibid., Article 2A.
[127] International Atomic Energy Agency, *supra* note 48, at 101.

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incapable of fulfilling the “peaceful usage requirements” of all nuclear materials worldwide as mentioned in the objectives of this Convention.

According to the IAEA, Syria secretly constructed a nuclear reactor without legally reporting to the international Agency. The illegal nuclear reactor was constructed in the Dair Alzour site, and it was destroyed by the Israeli attack in 2007 for fear that it might be used to develop nuclear weapons.[128] Although the IAEA required the Syria Government to report the rest of the illegal nuclear facilities, the Syria Government did not comply with the IAEA’s requests.[129] Another example is that although North Korea has signed the Non-Proliferation Treaty (NPT) Safeguards Agreements of nuclear materials, the IAEA could no longer execute the safeguard projects since 1994; hence it does not have any idea about the progress of the nuclear weapon development in North Korea.[130] From this regard, it is clear that this Convention cannot prevent a State from secretly developing nuclear weapons. Thus, the Contracting Parties shall enhance the governing capabilities of this Convention through amendment proposals. Moreover, terrorists might try to attack and occupy a commercial nuclear power plant anytime in the future, so it is worthwhile to overhaul the defending capabilities and emergency preparedness regularly in every commercial nuclear power plant around the world, but this has yet to be seen in the Convention.

2.7.3. Assisting Measures

In terms of assisting measures, Article 5 requires that “a State Party shall take appropriate steps to inform as soon as possible other States, which appear to it to be concerned, of any theft, robbery or other unlawful taking of nuclear material or credible threat thereof, and to inform, where appropriate, the IAEA and other relevant international organizations”.[131] This is a good provision, but the reaction of the IAEA seems inadequate. In Figure 4, out of the 313 nuclear incident cases reported to the IAEA in 2018, only one of them was provided with an assistance mission by the IAEA.[132] Even so, it is believed that the IAEA has already tried its best to cope with nuclear safety issues, and the IAEA has done an excellent job on that. The problem is that the nuclear safety issues are too complicated to handle adequately on every single aspect—from the emergency response to the terrorism of developing nuclear weapons secretly. While building upon the current fundament of the IAEA regulatory framework, all Contracting Parties shall seek for better ways to enhance nuclear security worldwide.

2.7.4. Equitable Measures

Although this Convention lacks the equitable measures to take care of the need on the developing countries, it does have equitable measures to protect the vulnerable suspects under detention. Article 12 provides that “any person regarding whom proceedings are being carried out in connection with any of the offences set forth in this Convention shall be guaranteed fair treatment at all stages of the proceedings.”[133] Despite the lack of equitable measures in the

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[128] Ibid., 99-110.
[129] Ibid.
[130] Ibid.
[131] International Atomic Energy Agency, *supra* note 120, at Article 5.
[132] International Atomic Energy Agency, *supra* note 48, at 75.
[133] International Atomic Energy Agency, *supra* note 120, at Article 12.

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Convention, from the latest IAEA Annual Report,[134] it could be seen that a number of equitable measures are being carried out.

2.8. Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter

Table 6 categorizes the articles in the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter into the four broad categories: objectives, implementing measures, assisting measures, and equitable measures based on the function of each article. Moreover, both the categories of implementing measures and assisting measures could be broken down into more detailed subsets as elaborated in the introduction of the analytical method.

[134] International Atomic Energy Agency, *supra* note 48, at 82-88.

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Objectives		Preamble, Articles 1, 2, and 13
Implementing Measures	Prohibition	Articles 4.1, 12, and Annex 1
	Quantitative Regulations	Articles 4.1.b, 4.1.c, 6, Annexes 2, and 3
	Permission	Articles 4.2, 5, and 6
	Compensation of Damage	Article 10
	Sanctions	Article 7.2
Assisting Measures	Information Dissemination	Articles 4.3, 5, 6.4, 7.3, 8, 14.3.c, 14.3.d, 15.1.b, 15.3, 20, 21, 22, and Annex 1.8
	Implementation Assessment	Articles 14 and 15
	Resolution of Disputes	Article 11
Equitable Measures		Articles 5, 7.4, 9, and 14.2

Table 6. Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter

The table puts the articles of the Marine Pollution Convention into different categories based on the specific function of each article.

Source:

International Atomic Energy Agency (1972). Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter. Vienna, Austria: International Atomic Energy Agency.

Yeh, J.-R. (1999). Global Environmental Issues—from the Viewpoint of Taiwan. Taipei, Taiwan: CHULIU PUBLISHER. (葉俊榮(1999)。全球環境議題:臺灣觀點。臺北市:巨流。)

The following sections will evaluate the adequacy and deficiency of the Marine Protection Convention with respect to its objectives, implementation, assisting approaches, and equity.

2.8.1. Objectives

The objectives of this Convention are mentioned in the preamble as well as Articles 1, 2, and 13.[135] In the preamble, it can be seen that the objectives of this Convention are to let the Contracting Parties "recognize the importance of the marine environment to human beings and all living creatures,"[136] and that each individual has the duty to comply with the Charter of the United Nations and the principles of international laws when developing its own environmental policies.[137] In accordance with Article 1, Contracting Parties shall advocate the effective controls of all marine pollutants; pledge to take all applicable methods to prevent the disposal of wastes from polluting the ocean; and secure human health, biological resources, environment, and the legitimate use of the ocean.[138] Last but not least, Article 2 encourages Contracting Parties to try their best within their scientific, technical, and economic status to coordinate the policies of each State to mitigate marine pollution.[139]

From the objectives, it can be seen that although the Convention did not emphasize that it is not allowed to dump nuclear waste, the Convention indeed covers a broad scope of marine protection ranging from each country's environmental policy to the compliance of the universal standard provided by the Charter of the United Nations. In other words, each State Party has the right to develop its own resources, but it also has the duty to ensure that the activities under its jurisdiction would not harm the environment of other States or the high seas.[140] If a State dumps nuclear waste into the ocean, it would definitely violate this provision, so such conduct is not allowed. From this point of view, the objectives of the Marine Pollution Convention are capable of banning nuclear power countries from dumping radioactive waste into the sea.

In addition to that, in the United Nations Convention on the Law of the Sea,[141] Section III defines the innocent passage of the territorial sea. Under Section III, Article 23 regulates the "foreign nuclear-powered ships and ships carrying nuclear or other inherently dangerous or noxious substances."[142] These provisions are undoubtedly crucial to marine protection in terms of the nuclear waste disposal issue, so it is suggested that the Marine Protection Convention shall add that all Member States must take it into consideration in addition to the existing provisions in the objective part.

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[135] International Atomic Energy Agency (1972). Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter. Vienna, Austria: International Atomic Energy Agency.
[136] Ibid., Preamble.
[137] Ibid.
[138] Ibid., Article 1.
[139] Ibid., Article 2.
[140] United Nations (1945). Charter of the United Nations and Statute of the International Court of Justice. San Francisco, SF: United Nations.
[141] United Nations (1983). United Nations Convention on the Law of the Sea. New York, NY: United Nations.
[142] Ibid., 7-8.

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2.8.2. Implementing Measures

As Table 6 shows, the Marine Protection Convention utilizes all five categories under implementing measures. In terms of prohibition, Annex 1 lists all the materials that are not allowed to be disposed, including "the high-level radioactive wastes or other high-level radioactive matter, defined on public health, biological or other grounds, by the competent international body in this field, at present the IAEA, as unsuitable for dumping at sea."[143] Although the Convention clearly states that any disposal of radioactive waste is prohibited, it has yet to emphasize the severe consequence of doing so. Instead, the Convention simply puts the radioactive waste together with other prohibited materials such as organohalogen compounds; mercury and mercury compounds; cadmium and cadmium compounds; persistent plastic; and so forth.[144] People might have a wrong impression that the disposal of nuclear waste is not too dangerous to the ecosystem because the impact is only comparable to the pollutants like organohalogen, mercury, cadmium and persistent plastic. Thus, it is suggested that the Marine Pollution Convention shall assign special concern to the radioactive waste.

When it comes to quantitative regulations, this Convention defines certain materials that could be disposed at sea, but the amount shall be within the regulations of the competent authority. For example, arsenic, lead, copper, zinc, organosilicon, cyanides, fluorides, and pesticides could only be disposed in a trace amount.[145] On the other hand, beryllium, chromium, nickel, vanadium, and scrap metal could be disposed at a larger amount.[146] As for permission, Article 4.2 provides that any permit shall be issued only after careful prior studies of the characteristics of the dumping site.[147] However, there is an exception. As Article 5 provides, if it is necessary to secure the safety of human life or of vessels, aircraft, platforms or other man-made structures at sea in cases of force majeure, then the dumping is allowed.[148] There is a threat of radioactive pollution because Article 5 indeed allows radioactive waste to be dumped under emergency condition. In fact, Article 5 itself is totally reasonable since the consequence of not dumping is likely to be much more serious. For instance, if an aircraft that transports nuclear waste is about to crash, if it dumps the containers into the ocean, the radioactive materials might not leak before the technicians pick them up. However, the explosion of the plane crash will certainly ignite all the nuclear wastes. Thus, Article 5 is totally right. The thing that should be improved is the defense in depth of the nuclear waste carriers.

Article 23 in the United Nations Convention on the Law of the Sea[149] states that "Foreign nuclear-powered ships and ships carrying nuclear or other inherently dangerous or noxious substances shall, when exercising the right of innocent passage through the territorial sea, carry documents and observe special precautionary measures established for such ships by international

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[143] International Atomic Agency, *supra* note 135, at Annex 1.
[144] Ibid.
[145] Ibid., at Annex 2.
[146] Ibid.
[147] Ibid., Article 4.2.
[148] Ibid., Article 5.
[149] United Nations, *supra* note 141, at Article 23.

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agreements." However, it did not specify the forms and requirements of such documents, the technical specifications of the carriers, and the international agreements, if any. The previously mentioned Charter of the United Nations[150] did not address this issue, either. Therefore, it is likely that there is a potential threat within the current regulatory regime of radioactive waste disposal at sea.

2.8.3. Assisting Measures

In terms of information dissemination, according to Article 6.4, every Contracting Party shall report the nature and quantities of all matter permitted by the domestic competent authority to be dumped as well as the location, time and method of dumping.[151] This is an excellent assisting measure because each country's environmental policy may differ, but with the help of the reporting system, the central organization can judge whether or not the dumping practice is legal and reasonable.

2.8.4. Equitable Measures

Article 9 provides that the Contracting Parties shall "promote, through collaboration within the Organization and other international bodies, support for those Parties which request it for the training of scientific and technical personnel; the supply of necessary equipment and facilities for research and monitoring; and the disposal and treatment of waste and other measures to prevent or mitigate pollution caused by dumping."[152] Such equitable measures are great. By transferring the advanced techniques and technology of radioactive mitigation from the developed countries to the developing countries, the world as a whole reach the target of sustainable development on the aspect of marine environment.

Unfortunately, some issues might still remain unsolved despite all efforts of technical cooperation. For instance, the transport pathways of plastic remain poorly assessed.[153] Reisser et al. (2013) had done the marine plastic pollution research in the ocean surrounding Australia. The research found out that "the microplastics have the potential to affect organisms ranging from mega fauna to small fish and zooplankton".[154] Additionally, "plastic contamination levels in surface waters of Australia are similar to those in the Caribbean Sea and Gulf of Maine, but considerably lower than those found in the subtropical gyres and Mediterranean Sea."[155] Thus, it is clear that due to the oceanic circulation, the contaminants, no matter microplastics or radioactive wastes, are likely to concentrate in the stagnant waters. From this point of view, in addition to the existing radioactive detection systems, special attention shall be paid in the subtropical gyres, Mediterranean Sea, and other regions with the lack of circulation.

2.9. Merits and Flaws of the International Nuclear Safety Conventions

To sum up the main findings from 2.3. to 2.8., there are a number of merits and flaws in each of the nuclear safety convention. In terms of the merits, it is

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[150] United Nations, *supra* note 140.
[151] International Atomic Energy Agency, *supra* note 135, at Article 6.4.
[152] Ibid., Article 9.
[153] Reisser, J., Shaw, J., Wilcox, C., Hardesty, B. D., Proietti, M., Thums, M., & Pattiaratchi, C. (2013). Marine Plastic Pollution in Waters around Australia: Characteristics, Concentrations, and Pathways. PLoS ONE, 8(11), e80466. https://doi.org/10.1371/journal.pone.0080466
[154] Ibid.
[155] Ibid.

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good to see that all the international nuclear safety conventions authorize the Contracting Parties to develop each of their own domestic legislative and regulatory frameworks. This shall be the most effective way to govern nuclear activities worldwide because under state sovereignty, every country can decide whether to construct nuclear stations or not. As a result, rather than setting an international standard and banning the states that cannot fulfill the safety specifications from operating the reactor facilities, it is much more practical to guide all the Member States on the development of domestic legislative and administrative framework, and then review the implementation status of each Member State through the international conference every once in a while. Such measure is commonly applied in every nuclear safety convention. Another merit is that the Joint Convention readily takes the intergenerational justice into careful consideration by specifying the protection of the needs and aspirations of future generations in its objectives as well as providing in the implementing measures that each step of nuclear waste treatment may not harm the environment and threaten the intergenerational justice. Last but not least, the global warning and assisting regime after a nuclear incident has been clearly defined by the Early Notification Convention and Assistance Convention. The Early Notification Convention obligates the competent authority of each Member State to promptly notify the nature, occurrence time and exact location of a nuclear accident while the Assistance Convention facilitates the IAEA and Contracting Parties to provide the professional personnel and instruments to cope with the radiological consequence. Therefore, the six nuclear safety conventions as a whole indeed craft a comprehensive regime to address the potential concerns in every aspect of nuclear activities.

On the other hand, the general flaw among the nuclear safety conventions is that only the Marine Dumping Convention has been provided with the annex that specifies the safety specifications in details, but the other five conventions may be seen as brief and general. Thus, this thesis would like to see improvements. For instance, the Joint Convention shall be added with an appendix to clearly define the standards about “the abundant release of residual heat in the spent fuel”, “the specifications of the packaging in each type of nuclear material,” and “the types of interdependency in between each step of nuclear waste treatment.” Hopefully with such improvement, the Contracting Parties can better understand the safety standards of the nuclear safety conventions. This thesis also found out that the recorded nuclear incidents showed an increasing trend, which indicate that the existing provisions in the Convention on Nuclear Safety might need to be enhanced. Moreover, the international assistant missions were very few despite the comprehensive framework crafted by the Early Notification and Assistance Conventions. Meanwhile, the Marine Dumping Convention is a general statement that defines a broad range of materials with different allowable disposal amount into the ocean, so it might be better if the Convention could be incorporated with a new provision that emphasizes the prohibition of nuclear waste disposal into the ocean.

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Chapter 3. Taiwan's Nuclear Safety Laws

In Chapter 3.1., there will be an overview on Taiwanese laws that are related to nuclear safety. Next, in Chapter 3.2., the nuclear safety laws in Taiwan will be compared with the six international nuclear safety conventions that were introduced in Chapter 2. It is worthwhile to note that this thesis never intends to convey a message that the international nuclear safety conventions are always right; in other words, it cannot be inferred that the nuclear safety laws in Taiwan are wrong just because they do not perfectly comply with the conventions. Instead, this research just tries to see if there might be any inconsistency in between the conventions and laws, and then make some suggestions for the purpose that both the conventions and laws can learn from the good practices of the counterparts and improve together.

3.1. Domestic Legislation on Nuclear Safety

In Taiwan, there are four laws related to nuclear safety: Nuclear Reactor Facilities Regulation Act (核子反應器設施管制法),[156] Atomic Energy Law (原子能法),[157] The Nuclear Materials and Radioactive Waste Management Act (放射性物料管理法),[158] and Nuclear Emergency Response Act (核子事故緊急應變法).[159] This section uses the same method[160] that was introduced in Chapter 2.2. to summarize the four laws.

3.1.1. Nuclear Reactor Facilities Regulation Act

Table 7 categorizes the articles in the Nuclear Reactor Facilities Regulation Act into the four broad categories: objectives, implementing measures, assisting measures, and equitable measures based on the function of each article. Moreover, both the categories of implementing measures and assisting measures could be broken down into more detailed subsets as elaborated in Chapter 2.2.

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[156] Nuclear Reactor Facilities Regulation Act (2003). Article 1. (核子反應器設施管制法(2003)。第一條。)

[157] Atomic Energy Law (1971). Article 1. (原子能法(1971)。第一條。)

[158] The Nuclear Materials and Radioactive Waste Management Act (2002). Article 1. (放射性物料管理法(2002)。第一條。)

[159] Nuclear Emergency Response Act (2003). Article 1.1. (核子事故緊急應變法(2003)。第一條第一項。)

[160] Yeh, *supra* note 11, at 129-145.

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Objectives		Article 1
Implementing Measures	Prohibition	Articles 4.2 and 6.1
	Quantitative Regulations	Articles 4.1, 4.3, 6.2, and 22
	Permission	Articles 8, 11.2, 13, 16, 17, 23, and 25
	Compensation of Damage	
	Sanctions	Articles 11.3, 14, and Chapter 4
Assisting Measures	Information Dissemination	Articles 10, 14, and 24
	Implementation Assessment	Articles 9, 15, and 28
	Resolution of Disputes	
Equitable Measures		Articles 4.4, 11.1, and 12

Table 7. Nuclear Reactor Facilities Regulation Act

The table puts the articles of the Nuclear Reactor Facilities Regulation Act into different categories based on the specific function of each article.

Source:

Nuclear Reactor Facilities Regulation Act (2003). (核子反應器設施管制法(2003)。)

Yeh, J.-R. (1999). Global Environmental Issues—from the Viewpoint of Taiwan. Taipei, Taiwan: CHULIU PUBLISHER. (葉俊榮(1999)。全球環境議題:臺灣觀點。臺北市:巨流。)

The following sections will evaluate the adequacy and deficiency of the Nuclear Reactor Facilities Regulation Act with respect to its objectives, implementation, assisting approaches, and equity.

3.1.1.1. Objectives

Article 1 outlines the objectives of this Regulation Act—"to regulate nuclear reactor facilities in order to protect the public safety."[161] This objective

[161] Nuclear Reactor Facilities Regulation Act, *supra* note 156, at Article 1.

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is clear and concise. However, it was argued that the objective is hard to be achieved unless two crucial points are added: first, the Taipower Company—the licensee of the nuclear reactor facilities in Taiwan—must have the duty to provide the safety information to the general public in terms of the nuclear reactor operations; secondly, public hearings must become one of the processes before the Atomic Energy Agency issues any license pertaining to the Regulation Act.[162] By making the two modifications, it is believed that the safety related information would be disseminated, and the public can join the decision-making process at the same time. All in all, the objective of the Regulation Act will be fulfilled.

3.1.1.2. Implementing Measures

When it comes to prohibition, Article 4.2 says that "Residence within the exclusion area which is unrelated to the operation, the maintenance or the security of nuclear reactor facilities, shall be prohibited."[163] This regulation is reasonable because it could protect the residents from the exposure of radiation; meanwhile, it could also secure the nuclear reactor facilities from unexpected disturbance.

In terms of permission, Article 17 regulates that the Atomic Energy Council has the authority to permit "the import, export, removal of nuclear reactor and other relevant matters."[164] Meanwhile, Articles 23 and 25 give the Atomic Energy Council the rights to permit the decommissioning plans and the modifications of decommissioning plans.[165] From these provisions, it can be seen that the Atomic Energy Council was given too much power; however, the isolation between the Council and other organizations that are related to the operation of nuclear power plants is not enough.[166] This may lead to the potential crisis that the Council issues the permission due to the pressure from the institutions that it governs, but not exactly based on the safety standards. Thus, it was suggested that an independent regulatory agency shall be established as soon as possible.[167]

3.1.1.3. Assisting Measures

When it comes to implementing assessment, Article 9 provides that "one integrated safety assessment at least shall be implemented every ten years."[168] This is a reasonable regulation because the USNRC also requires a major examination on nuclear reactor facilities every ten years.[169] In addition to that, Article 28 provides that "Within six months of completion of the decommissioning plan of nuclear reactor facilities, the licensee shall submit to

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[162] Peng, W.-H. (2015). An Investigation on the Risk Management Regulations of Taiwanese Nuclear Power Plants—from the Viewpoint of Regulatory Framework and Procedures. Chiayi, Taiwan: Department of Law, National Chung-Cheng University. (彭惟欣(2015)。我國核能電廠風險管制規範之研究—以組織與程序保障功能出發。國立中正大學法律學系，嘉義縣。)

[163] Nuclear Reactor Facilities Regulation Act, *supra* note 156, at Article 4.2.

[164] Ibid., Article 17.

[165] Ibid., Articles 23 and 25.

[166] Peng, *supra* note 162, at Abstract.

[167] Ibid.

[168] Nuclear Reactor Facilities Regulation Act, *supra* note 156, at Article 9.

[169] Nick, S. K. (2018). Today is yesterday's pupil: Reactor license renewal in the United States. In Nuclear Law Bulletin No. 101 (Nuclear Energy Agency, Organization for Economic Co-operation and Development Ed., pp. 31-61). (Nuclear Law Bulletin, No. 101). Boulogne-Billancourt, France: OECD/NEA.

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the competent authorities for review and examination the report on environmental radiation monitoring on the site."[170] Thus, the Regulation Act is robust in terms of the implementation assessment because it governs both the operation period and decommissioning time of the nuclear reactor facilities.

As for information dissemination, Article 10 obligates that the licensee must "submit the report(s) related to operation, radiation safety, environmental radiation monitoring, reportable or emergency event, or prompt notification, the generation record on radioactive waste and any other report(s)" to the Atomic Energy Council.[171] However, it was argued that the Freedom of Government Information Law[172] is not adequate enough to force the nuclear safety information to be revealed to the general public.[173] Thus, it was suggested that new provisions shall be added into the Regulation Act that define the duty of the Taipower Company to provide the nuclear safety information to the general public.[174]

3.1.1.4. Equitable Measures

Article 4.4 provides that "Residence within the low population zone is generally permitted. However, to newly establish school, works, jail, hospital, long term nursing institute, recuperation and convalescent institute (charity) for the aged, a protective measures shall be provided."[175] This is a good regulation because it protects the vulnerable groups from the potential exposure of radiation. After all, the patients and aged people are susceptible to the harmful ionizing radiation.

3.1.2. Atomic Energy Law

Table 8 categorizes the articles in the Atomic Energy Law into the four broad categories: objectives, implementing measures, assisting measures, and equitable measures based on the function of each article. Moreover, both the categories of implementing measures and assisting measures could be broken down into more detailed subsets as elaborated in Chapter 2.2.

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[170] Nuclear Reactor Facilities Regulation Act, *supra* note 156, at Article 28.
[171] Ibid., Article 10.
[172] The Freedom of Government Information Law (2005). Chapter 3. (政府資訊公開法(2005)。第三章。)
[173] Peng, *supra* note 162, at Abstract.
[174] Ibid.
[175] Nuclear Reactor Facilities Regulation Act, *supra* note 156, at Article 4.4.

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Objectives		Article 1
Implementing Measures	Prohibition	Articles 21.4, 22.5, 23.6, 23.7 and 26.8
	Quantitative Regulations	Articles 24 and 26.11
	Permission	Articles 4-6, 10, 12-14, 16, 17, 21.1, 21.2, 21.7, 22.1-3, 22.8, 23.1, 23.3, 23.5, 26.1, 26.3, 26.6, 26.10, and 28
	Compensation of Damage	Article 29
	Sanctions	CH8
Assisting Measures	Information Dissemination	Articles 18, 21.2, 21.3, 21.6, 21.7, 22.2-4, 22.7, 22.8, 23.5, 23.8, 25, 26.2, 26.6, 26.7, and 26.10
	Implementation Assessment	Articles 23.4, 23.8, 26.5, 26.7, 26.9, and 26.10
	Resolution of Disputes	
Equitable Measures		Article 20

Table 8. Atomic Energy Law

The table puts the articles of the Atomic Energy Law into different categories based on the specific function of each article.

Source:

Atomic Energy Law (1971). (原子能法(1971)。)

Yeh, J.-R. (1999). Global Environmental Issues—from the Viewpoint of Taiwan. Taipei, Taiwan: CHULIU PUBLISHER. (葉俊榮(1999)。全球環境議題:臺灣觀點。臺北市:巨流。)

The following sections will evaluate the adequacy and deficiency of the Atomic Energy Law with respect to its objectives, implementation, assisting approaches, and equity.

3.1.2.1. Objectives

Article 1 says that the objective of this law is to "promote the research and development of nuclear science and technology, the exploitation of nuclear resources, and the peaceful utilization of nuclear energy."[176] This is a good provision because it complies with the core value of the international society. In the very beginning of the 2018 IAEA Annual Report, it also emphasized that

[176] Atomic Energy Law, *supra* note 157, at Article 1.

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over the past six decades, the top priority of the Agency is to develop and transfer nuclear technologies for peaceful applications.[177]

3.1.2.2. Implementing Measures

In terms of prohibition, Article 21.4 provides that "Import or export of nuclear source material, unless approved by the Atomic Energy Council and implemented in compliance with related laws, is not allowed."[178] This provision is very important. As a matter of fact, the IAEA held the Open-ended Meeting of Legal and Technical Experts on Implementation of the Guidance on the Import and Export of Radioactive Sources in June 2018 at Vienna.[179] From the fact that the IAEA held a meeting especially for the import and export issue, it is believed that this subject is of great concern. It is indeed worthy of recognition that the Atomic Energy Law in Taiwan already has the relevant provision; although some may argue that the Atomic Energy Law is too outdated that the last modification was almost 50 years ago, in the latest IAEA Open-ended Meeting of Legal and Technical Experts on Implementation of the Guidance on the Import and Export of Radioactive Sources, 155 attendant experts from 86 Member States "concluded that there is currently no need to revise the Guidance, and that efforts should be focused on the full and systematic implementation of its existing provisions."[180]

When it comes to quantitative regulations, Article 26.11 provides that "Radioactive materials within certain limited quantity may be exempted from control with the exact amount to be set forth by the Atomic Energy Council."[181] Article 24 also provides that "the Atomic Energy Council shall stipulate standards for protection against ionizing radiations."[182] These provisions are reasonable. In the IAEA technical guidelines, the radiological dose under a certain amount can be exempted from controls whilst the standards for protection in different levels must be strictly complied.[183]

3.1.2.3. Assisting Measures

In terms of information dissemination, the Atomic Energy Law has done an excellent job for preventing the potential crisis resulting from the secret modifications or unauthorized operations on the nuclear reactor facilities by the licensee. For instance, Article 21.2 regulates that "The commencement, alternation, stoppage or resumption of the production of nuclear source material shall be reported to the Atomic Energy Council for approval."[184]

When it comes to implementing assessment, under the framework of the Atomic Energy Law, the operation status of reactor facilities, usage of nuclear fuel, and the personnel's maneuver are all constantly monitored by the Atomic Energy Council. For example, Article 26.5 provides that "The Atomic Energy Council shall set forth safety regulations for equipment capable of ionizing radiation and dispatch personnel to conduct inspection from time to time."[185]

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[177] International Atomic Energy Agency, *supra* note 48, at 1.
[178] Atomic Energy Law, *supra* note 157, at Article 21.4.
[179] International Atomic Energy Agency, *supra* note 48, at 87.
[180] Ibid.
[181] Atomic Energy Law, *supra* note 157, at Article 26.11.
[182] Ibid., Article 24.
[183] International Atomic Energy Agency, *supra* note 59, at 101.
[184] Atomic Energy Law, *supra* note 157, at Article 21.2.
[185] Ibid., Article 26.5.

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Similarly, Article 26.10 regulates that "Any transfer and abandonment of radioactive material or of equipment capable of ionizing radiation as well as the disposal of radioactive waste are subject to approval of the Atomic Energy Council, and to audit, inspection may be made by the Atomic Energy Council."[186] The only concern is that the Atomic Energy Council might not be independent enough to reinforce its regulatory function,[187] but the regulatory framework itself is robust.

3.1.2.4. Equitable Measures

In accordance with Article 20, "All equipment that have to be imported for nuclear research, development, mining, production and protection, as well as for use relating to nuclear power generation shall, according to rules stipulated by the Executive Yuan, be reduced of or exempted from customs duties."[188] This is an excellent equitable measure because it takes into account the financial burden of the licensee. If there is no exemption of the custom duties, the licensee has to pay more for the import of the necessary nuclear safety equipment. This may give the stakeholders an incentive to compromise with the potential radioactive crisis.[189] It is believed that with the equitable measure provided in Article 20, nuclear safety in Taiwan is more secure.

3.1.3. The Nuclear Materials and Radioactive Waste Management Act

Table 9 categorizes the articles in the Nuclear Materials and Radioactive Waste Management Act into the four broad categories: objectives, implementing measures, assisting measures, and equitable measures based on the function of each article. Moreover, both the categories of implementing measures and assisting measures could be broken down into more detailed subsets as elaborated in Chapter 2.2.

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[186] Ibid., Article 26.10.
[187] Peng, *supra* note 162, at Abstract.
[188] Atomic Energy Law, *supra* note 157, at Article 20.
[189] Ramseyer, J. (2012). Why power companies build nuclear reactors on fault lines: The case of Japan. Theoretical Inquiries in Law, 13(2), 457-486.

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Objectives		Article 1
Implementing Measures	Prohibition	Articles 6, 9, 12, 15.1, 18, 19, and 25.1
	Quantitative Regulations	Articles 16 and 31
	Permission	Articles 8, 17.1, 23.1, and 23.2
	Compensation of Damage	
	Sanctions	Articles 13, 15.3, and Chapter 4
Assisting Measures	Information Dissemination	Articles 7, 8, 10, 13, 15.2, 17.2, and 20
	Implementation Assessment	Articles 7, 10, 13, 14, 15.3, 20, and 23.3
	Resolution of Disputes	
Equitable Measures		Articles 7, 24, 46, and 49

Table 9. The Nuclear Materials and Radioactive Waste Management Act

The table puts the articles of the Nuclear Materials and Radioactive Waste Management Act into different categories based on the specific function of each article.

Source:
The Nuclear Materials and Radioactive Waste Management Act (2002). (放射性物料管理法 (2002)。)
Yeh, J.-R. (1999). Global Environmental Issues—from the Viewpoint of Taiwan. Taipei, Taiwan: CHULIU PUBLISHER. (葉俊榮(1999)。全球環境議題:臺灣觀點。臺北市:巨流。)

The following sections will evaluate the adequacy and deficiency of the Nuclear Materials and Radioactive Waste Management Act with respect to its objectives, implementation, assisting approaches, and equity.

3.1.3.1. Objectives

In Article 1, it could be seen that the objectives of the law are "to administer radioactive material, prevent radioactive hazard and secure public safety."[190] Such objectives are clear and reasonable. In the latest IAEA Annual

[190] The Nuclear Materials and Radioactive Waste Management Act, *supra* note 158, at Article 1.

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Report, it was also mentioned that one of the most important tasks for nuclear reactor facilities is to let every country develop and apply the safety standards of spent fuel and radioactive wastes.[191]

3.1.3.2. Implementing Measures

When it comes to sanctions, Article 13 provides that "If there is anything not conforms to the prescription or if the public health, safety or environmental ecology may be hazarded, the competent authorities shall order the operator to improve the situation or take any other necessary measures within a limited time period. If the operator does not improve it in the limited time period or the situation is serious, the competent authorities may order the operator to cease construction or operation thereof or may revoke the license."[192] This is a very important provision on nuclear safety. As a matter of fact, the Three Mile Island nuclear disaster could have been prevented. Back then, before the Three Mile Island Nuclear Station experienced a major equipment failure on March 28th, 1979, similar situation already occurred in the Davis-Besse Nuclear Power Plant in Ohio and the Beznau Nuclear Power Plant in Switzerland.[193] If the authority timely obligated the licensee to stop the operation and go through a thorough inspection, the tragedy should have been prevented. Thus, it is good to see that Article 13 in the Management Act empowers the competent authorities in Taiwan to do just that.

As for prohibition, Article 18.2 provides that "when there is need to continue operation after the license is expired, an application shall be filed two years prior to expiration thereof with the competent authorities for renewing the license thereof. The operation thereof shall not be continued without the renewal of license as per the prescription."[194] This might not be a good provision considering the current nuclear waste disposal adversity in Taiwan. In fact, Taiwan is facing a severe issue that there is not enough space in the nuclear waste disposal facilities to store the excessive nuclear waste, so the nuclear waste ended up accumulated in the nuclear power plants. This is partially owing to the reason that the construction and operation of nuclear waste storage facilities have been "impeded by overwhelming political opposition fueled by public perceptions of risk."[195] When Article 18.2 in the Management Act makes it difficult for the licensee to continue the operation of the storage facilities, the lack of nuclear waste disposal space in Taiwan will get even worse. Thus, this provision shall be modified. It would be ideal if the legislation could strike a balance between environmental security and nuclear waste storage effectiveness.

Last but not least, in terms of quantitative regulations, Article 16 provides that the prescription of the law "shall not be applicable to nuclear source

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[191] International Atomic Energy Agency, *supra* note 48, at 89.
[192] The Nuclear Materials and Radioactive Waste Management Act, *supra* note 158, at Article 13.
[193] Burns, *supra* note 1, at 8-10.
[194] The Nuclear Materials and Radioactive Waste Management Act, *supra* note 158, at Article 18.2.
[195] Slovic, P., Flynn, J. H., and Layman, M. (1991). Perceived Risk, Trust, and the Politics of Nuclear Waste. *Science*, 254 (5038), 1603-1607.

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material or nuclear fuel which is below a specified weight or activity."[196] This is a good provision because it takes into account the principle of proportionality. If the competent authorities pertaining to the Management Act have to deal with all kinds of nuclear source material, they might not have enough time and effort to fulfill the governing duty of each task, and this would result in government waste due to "vanity of property rights subjects and responsibilities subjects."[197] From this point of view, Article 16 is a reasonable strategy because it empowers the specific sub laws to cope with the minor nuclear source materials while letting the Management Act focus only on the nuclear reactor facility issues.

3.1.3.3. Assisting Measures

When it comes to information dissemination, Article 10 provides that the operator of the nuclear waste storage facilities has to submit the reports "related to operation, radiation protection, environmental radiation monitoring, irregularity or emergency event, and any other reports designated by the competent authorities."[198] This is actually problematic because the reports must follow specific forms and formats; however, Taiwan has yet to establish a sub law that specifies the requirements of the reports on high-level radioactive waste. Instead, Taiwan only has the "Regulations on Final Disposal of Low Level Radioactive Waste and Safety Management of the Facilities"[199] that is authorized by Article 21 of the Management Act.[200]

On the other hand, as shown in Table 9, the Management Act lacks a resolution of disputes. Since "the siting of nuclear waste facilities has been very difficult in all countries,"[201] there are likely to be disputes in between the local people and competent authorities. Therefore, the Management Act has to be added with a resolution of disputes as soon as possible.

3.1.3.4. Equitable Measures

Article 24 regulates that "For the re-utilization or the exemption from institutional control of the land where final disposal facilities of radioactive waste are located, the operator shall submit to the competent authorities the materials as to environment assessment and the radiation safety assessment report approved by the competent authorities of environment protection and shall implement the same after approval."[202] This is an excellent provision

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[196] The Nuclear Materials and Radioactive Waste Management Act, *supra* note 158, at Article 16.

[197] Fan, B.-N. and Ban, P. (2008). Government Waste in China and Countermeasures. Journal of Zhejiang University, 38 (6), 49-56. (范柏乃、班鵬(2008)。政府浪費與治理對策研究。浙江大學學報, 38 (6), 49-56.)

[198] The Nuclear Materials and Radioactive Waste Management Act, *supra* note 158, at Article 10.

[199] Regulations on Final Disposal of Low Level Radioactive Waste and Safety Management of the Facilities (2012). Article 1. (低放射性廢棄物最終處置及其設施安全管理規則(2012)。第一條。)

[200] The Nuclear Materials and Radioactive Waste Management Act, *supra* note 158, at Article 21.

[201] Sjöberg, L. (2004). Local Acceptance of a High-Level Waste Repository. Risk Analysis, 24 (3), 1-30.

[202] The Nuclear Materials and Radioactive Waste Management Act, *supra* note 158, at Article 24.

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because otherwise the public would never know whether or not the place they live is under the exposure of harmful radioactive dose.

3.1.4. Nuclear Emergency Response Act

Table 10 categorizes the articles in the Nuclear Emergency Response Act into the four broad categories: objectives, implementing measures, assisting measures, and equitable measures based on the function of each article. Moreover, both the categories of implementing measures and assisting measures could be broken down into more detailed subsets as elaborated in Chapter 2.2.

Objectives		Article 1.1
Implementing Measures	Prohibition	
	Quantitative Regulations	Article 4
	Permission	Articles 6.3, 13.1, and 14.1
	Compensation of Damage	Article 30
	Sanctions	Chapter 6
Assisting Measures	Information Dissemination	Articles 7.5, 7.6, 8.2, 9.1.3, 11.4, 12.4, 13.1, 14.1, 22, 23, 25, 26.2, 29.2, and 31
	Implementation Assessment	Articles 11.2, 15-20, and 29.1
	Resolution of Disputes	
Equitable Measures		Article 43

Table 10. The Nuclear Emergency Response Act

The table puts the articles of the Nuclear Emergency Response Act into different categories based on the specific function of each article.

Source:

Nuclear Emergency Response Act (2003). (核子事故緊急應變法(2003)。)

Yeh, J.-R. (1999). Global Environmental Issues—from the Viewpoint of Taiwan. Taipei, Taiwan: CHULIU PUBLISHER. (葉俊榮(1999)。全球環境議題:臺灣觀點。臺北市:巨流。)

doi: 10.6342/NTU202000431

The following sections will evaluate the adequacy and deficiency of the Nuclear Emergency Response Act with respect to its objectives, implementation, assisting approaches, and equity.

3.1.4.1. Objectives

Article 1.1 provides that "The purpose of this Act is to establish an emergency response system in the event of a nuclear accident, and to strengthen the emergency response functions so as to ensure the safety and health of the public and to protect their properties."[203] In the latest IAEA Annual Report, Chapter 2.1 talks about "Incident and Emergency Preparedness and Response."[204] The IAEA says that the objective of this part is to further enhance the effective response to radiological incidents and to improve the exchange of information on nuclear incidents among different countries.[205] From this regard, the objectives of the Nuclear Emergency Response Act in Taiwan have already covered the first part of the IAEA objectives, which is to solidify the prompt response function. However, it has yet to include the second part, which is to notify other countries when a nuclear incident occurs in Taiwan. Indeed, out of the 45 articles in the Nuclear Emergency Response Act, there is no article specifying the specific notification procedures, obligations and competent authorities once a nuclear incident happens in Taiwan. Only Article 25 slightly mentions that "Upon occurrence of a nuclear accident, the government shall inform the neighboring countries and the associated international organizations at appropriate time, and shall ask their assistance when necessary."[206] Thus, the prompt notification to other countries is something that must be improved urgently in the Nuclear Emergency Response Act.

3.1.4.2. Implementing Measures

Figure 5 depicts the implementing measures under the framework of the law. Under the framework of the Response Act, there are five agencies. Two of them are central government agencies, and they are the Atomic Energy Council and the Ministry of National Defense. Also in the framework are the city and county governments where the emergency planning zones situate. Last but not least, the Dedicated Nuclear Emergency Response Unit is an obligatory agency under the licensee of the nuclear power plants—the Taipower Company—according to the law.[207]

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[203] Nuclear Emergency Response Act, *supra* note 159, at Article 1.1.
[204] International Atomic Energy Agency, *supra* note 48, at 75.
[205] Ibid.
[206] Nuclear Emergency Response Act, *supra* note 159, at Article 25.
[207] Ibid.

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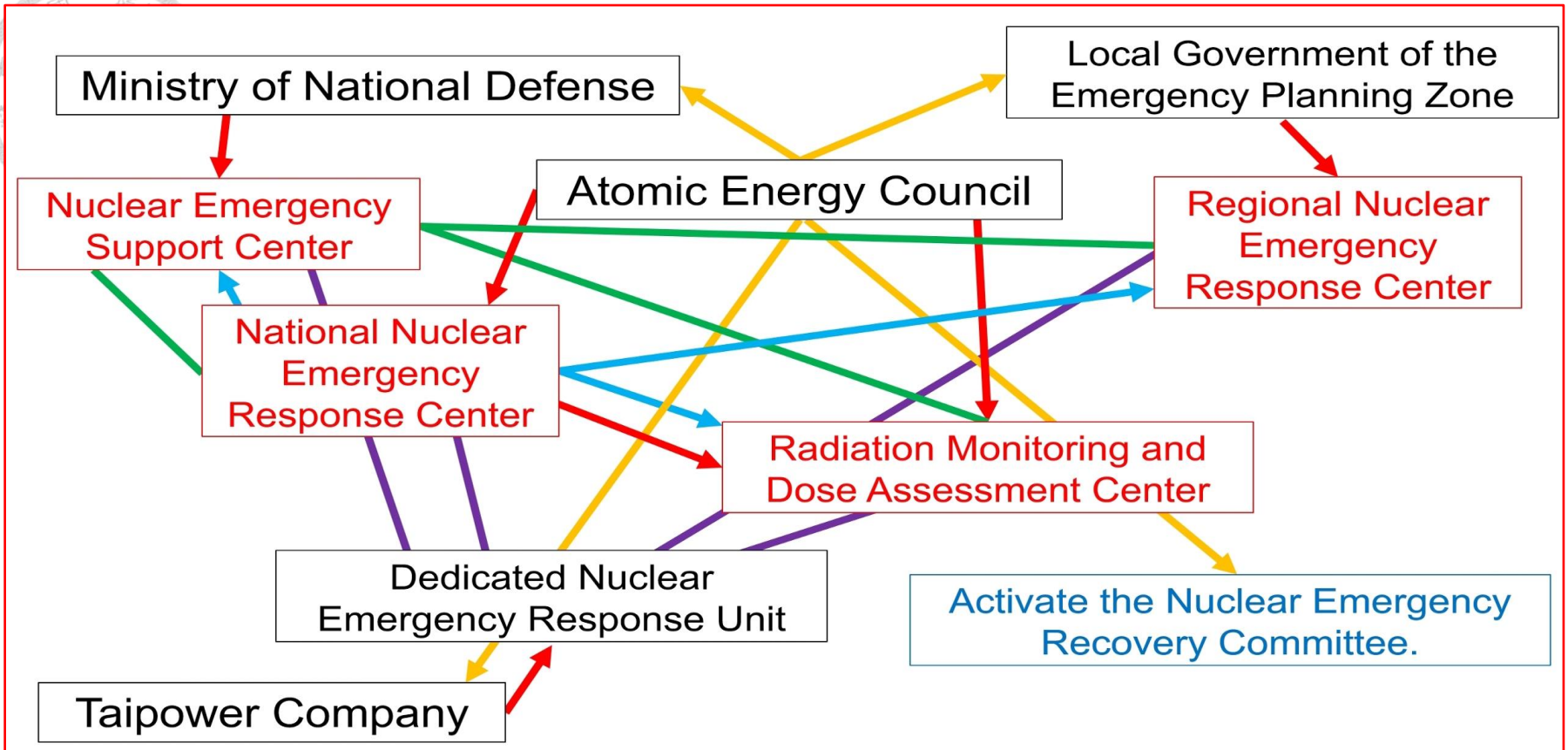

Figure 5. Operational Procedures of the Nuclear Emergency Response Act

Under the framework of the law, there are five fundamental agencies as shown in black, four temporary agencies as shown in red, and one temporary committee as shown in blue. The red arrows represent authorization, the yellow arrows represent the activation procedures of the recovery committee, the green lines represent assistance, the blue arrows represent the decommissioning procedures, and the purple lines represent the communication channels.

Source: Nuclear Emergency Response Act (2003). (核子事故緊急應變法(2003)。)

From Figure 5, it could be observed that the regulatory framework under the Response Act is clear and concise. It is indeed worthwhile for other countries to learn from. In normal days, the Taipower Company already defined the emergency planning zones near each nuclear power plant.[208] The emergency planning zone is to provide a shelter for the victims to fetch the medical treatment, food, water, iodine, and other necessary resources in case a nuclear incident occurs.[209] This is certainly an excellent provision because it prepares the crucial materials, equipment and facilities in normal days. Even if a nuclear incident suddenly occurs, such preparation can minimize the impact of the local people.

In addition, the Taipower Company has to draw up the emergency response plan for the nuclear reactor facilities and then submit the plan to the central authority—the Atomic Energy Council.[210] Upon approval, the Atomic Energy Council will exercise the emergency response plan in a certain frequency.[211] These regulations are reasonable; however, Article 15 only mentions that the central competent authority shall periodically conduct exercise.[212] It is believed that the awareness on nuclear safety will significantly increase every once in a while especially after a major accident such as the Fukushima Nuclear Disaster, but as time passes, the awareness is going to diminish. Therefore, it would be much better if Article 15 can define an exact interval between each exercise on the emergency response plan.

Meanwhile, the Taipower Company must provide the field, equipment and fund for the exercise, and the Dedicated Unit has to keep track of the exercise and send the professional personnel.[213] This is a good regulation because the licensee has the comparative advantage about the knowledge and technique, and they are the most suitable to provide the relevant professionals and resources for the exercise.

On the other hand, if a nuclear accident occurs, the Taipower Company has to immediately notify the Atomic Energy Council based on the format and standard operation procedures specified in the Emergency Response Plan.[214] Once the Atomic Energy Council receives the notification, it should promptly notify the Ministry of National Defense and the local governments in order that the Ministry of National Defense activates the Nuclear Emergency Support Center, and the local governments activate the Regional Nuclear Emergency Response Center.[215] Meanwhile, the Atomic Energy Council shall activate the National Nuclear Emergency Response Center and Nuclear Emergency Radiation Monitoring and Dose Assessment Center.[216] This notification mechanism is clear and concise. The structural design is excellent because it lets the Atomic Energy Council serves as the upstream regulator—it receives the emergency notification directly from the nuclear reactor operator and then

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[208] Ibid., Article 13.1.
[209] Ibid., Article 8.
[210] Ibid., Article 14.
[211] Ibid., Article 15.
[212] Ibid.
[213] Ibid., Article 12.
[214] Ibid., Article 23.
[215] Ibid., Articles 26 and 27.
[216] Ibid., Article 24.

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decides whether or not the situation is serious enough that further steps must be taken. If so, it then immediately notifies other competent authorities to activate all the relevant agencies. This design is effective and efficient. It avoids wasting governmental resources while securing the nuclear safety in terms of emergency response.

3.1.4.3. Assisting Measures

As for the interaction between the agencies, the purple lines in Figure 5 indicate the communication channels. In other words, the Dedicated Unit acts as the node of the message exchanges.[217] The green lines in Figure 5 represent assistance. In other words, the Support Center has to help other three Emergency Response Centers in the affairs pertaining to the law.[218] Last but not least, the Assessment Center has to follow the instructions of the National Response Center.[219] Such design is wonderful due to several reasons. First and foremost, both the National Response Center and the Radiological Assessment Center are the central emergency response agencies activated by the Atomic Energy Council. If the law authorizes both organizations with the same power, the situation will be complicated and inefficient once the two agencies declare contradictory policies. By making the Radiological Assessment Center follow the instructions of the National Response Center, Article 9.4 can effectively avoid this problem. Secondly, the Support Center is affiliated to the Ministry of National Defense, an agency with the absolute power to arrange all the domestic soldiers but with the lack of nuclear safety profession. By making the Support Center assist other three emergency response units, the soldiers can provide the manpower in terms of the distribution of resources, the decontamination of major roads, and the radiation measurements for the environment. Such design ideally maximizes the comparative advantages of each agency. Last but not least, the Dedicated Unit knows the best about the current status inside the nuclear power plant. Thus, it is the most suitable to serve as the communication center, for which it can prioritize the messages and retrieve the most crucial resources to resolve the urgent situations in the reactor facilities.

When the crisis is over, the regulatory framework will conduct the next procedure. First and foremost, the blue lines in Figure 5 are deactivation notifications. In other words, the National Response Center has the authority and shall deactivate other three Emergency Response Centers.[220] Meanwhile, the orange lines in Figure 5 are the necessary procedures of the activation of the Recovery Committee. To be more specific, the Atomic Energy Council has to put together the experts and resources of the relevant governmental agencies and Taipower Company to recover the influenced places as soon as possible.[221] These provisions have some room for improvements. It seems that the deactivation of the four emergency response units, as marked in red in Figure 5, happens too early, and the newly established Recovery Committee might not have enough capacity to conduct the quick restoration on the influenced areas. Thus, a better way to do it is to let the four emergency

[217] Ibid., Article 12.4.
[218] Ibid., Article 10.
[219] Ibid., Article 9.4.
[220] Ibid., Article 30.1.
[221] Ibid.

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response units do the work and do not deactivate them until all the recovery procedures are completed.

3.1.4.4. Equitable Measures

Article 43.1 provides that “the central Competent Authority shall collect a certain amount of money from the nuclear reactor facility licensee each year for every nuclear reactor facility to set up a Nuclear Emergency Response Fund.” [222] Such measure is fair and reasonable because the Taipower Company makes money from the operation of nuclear power plants while there is potential risk of radiological incidents. Thus, the power company should afford the expenditure on the nuclear emergency preparations.

3.2. Domestic Legislation in view of International Conventions

Chapter 2 and Chapter 3.1 have already elaborated the outlines of the international nuclear safety conventions and Taiwanese nuclear safety laws, respectively. Figure 6 shows the relationship between the international nuclear safety conventions and Taiwanese nuclear safety laws. In Figure 6, it can be seen that the Regulation Act is related to the Nuclear Safety Convention; the Atomic Energy Law is based on the Physical Protection Convention; the Management Act is in accordance with the Joint Convention and Marine Pollution Convention; finally, the Response Act is connected with the Notification Convention and Assistance Convention.

[222] Ibid., Article 43.1.

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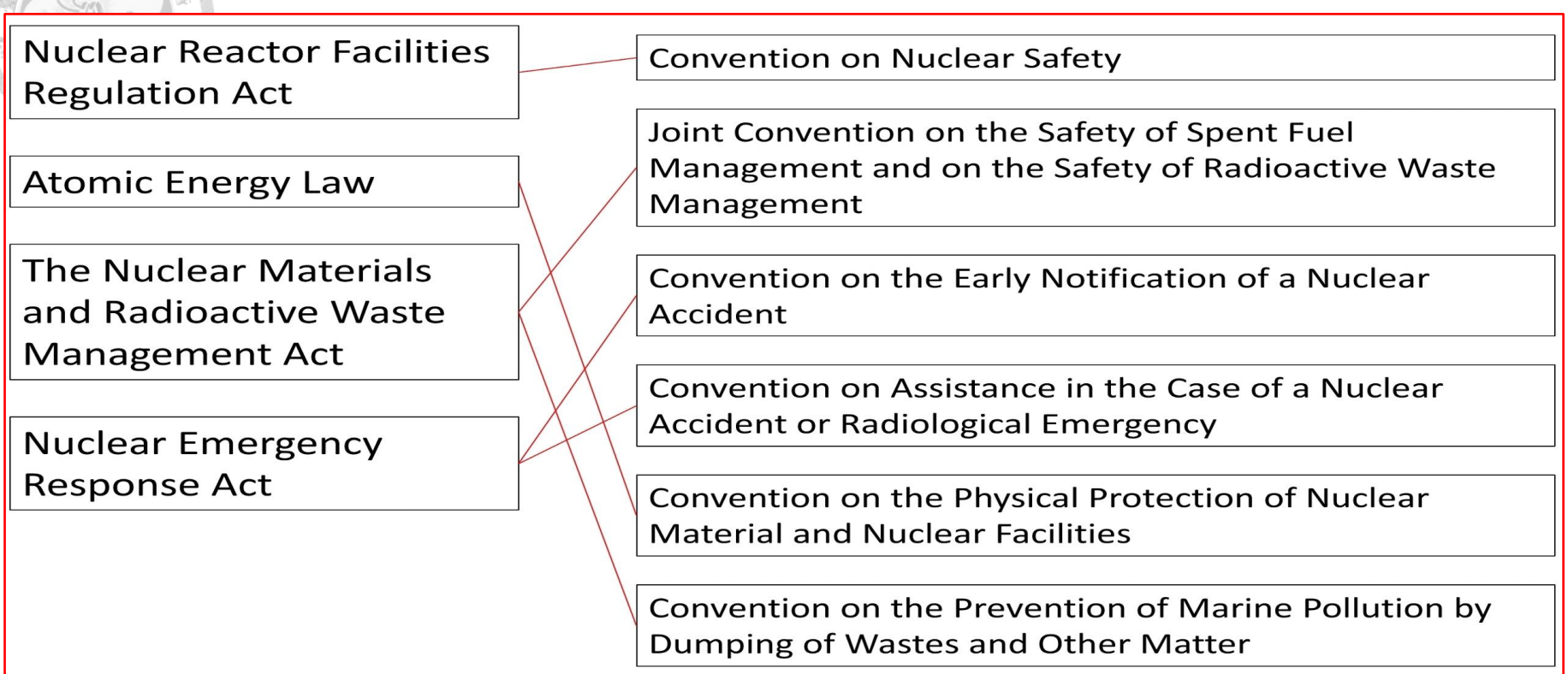

Figure 6. Relationship between International Nuclear Safety Conventions and Taiwanese Nuclear Safety Laws
Taiwanese nuclear safety laws are on the left, and the international nuclear safety conventions are on the right. The red lines link between the related laws and conventions based on their objectives.

Source: The figure was organized by the author.

In this section, there will be a comparison in between the international conventions and Taiwanese domestic laws with respect to the objectives, implementing measures, assisting measures and equitable measures.

3.2.1. Domestic Legislation in view of Nuclear Safety Convention

Table 11 compares the Nuclear Reactor Facilities Regulation Act with the Convention on Nuclear Safety in view of the objectives, implementation, assisting measures and equity.

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	Nuclear Reactor Facilities Regulation Act	Convention on Nuclear Safety
Objectives	Regulate nuclear reactor facilities. Protect public safety.	Enhance national measures on nuclear safety. Facilitate international technical cooperation on nuclear safety.
Implementing Measures	Prohibit any residence in the "exclusion area". The Atomic Energy Council regulates the nuclear material transportation. The Atomic Energy Council governs the decommissioning plans.	Let each country develop its own legislative and administrative regulations on reactor facilities. Let each country establish its own rules on nuclear waste.
Assisting Measures	The Atomic Energy Council conducts a major inspection on nuclear reactor facilities every ten years. Environmental radiation monitoring must be conducted 6 months after the completion of the decommissioning plan. The Atomic Energy Council would partially reveal the safety records to the public.	Review meetings would resolve any dispute between the Contracting Parties. The nuclear safety discussion in review meetings is confidential.
Equitable Measures	Special precautionary measures would be taken for the schools, hospitals and nursing homes that situate in the "low population zones".	It must be ensured that every nuclear reactor is provided with adequate fund and trained workers for its entire lifetime. However, any measure that aids the poor countries with the fund and trained staff have yet to be seen.

Table 11. Comparison between Nuclear Reactor Facilities Regulation Act and Convention on Nuclear Safety
The table compares the Regulation Act in Taiwan with the Nuclear Safety Convention in terms of the objectives, implementing measures, assisting measures, and equitable measures.

Source:
Nuclear Reactor Facilities Regulation Act (2003). (核子反應器設施管制法(2003)。)
International Atomic Energy Agency (1994). Convention on Nuclear Safety. Vienna, Austria: International Atomic Energy Agency.

The following sections will examine the four categories and distill the good practices from either side. Hopefully with the comparison, both the Regulation Act and the Nuclear Safety Convention could incorporate the good points from the counterpart and improve as a whole.

3.2.1.1. Objectives

In Table 11, it could be seen that the objectives of the Nuclear Safety Convention are to enhance national measures on the safety of the reactor facilities in each country, and to boost the international technical cooperation on the safety of reactor facilities.[223] Based on the Convention, Taiwan established the Nuclear Reactor Facilities Regulation Act with the objective to govern the safety of reactor facilities in order to protect the public from hazardous ionizing radiation.[224] However, it is obvious that the Regulation Act did not mention anything about the international technical cooperation, and this shall be added into the Act as soon as possible. This way, the specific implementing measures and assisting measures could be incorporated into the law and the affiliated sub laws in accordance with the newly added objective. Such measures would in turn facilitate the Taipower Company to obtain the state-of-the-art safety technology from other countries, and eventually securing the reactor facilities once and for all.

3.2.1.2. Implementing Measures

As Table 11 shows, there are two key points in the implementing measures of the Nuclear Safety Convention. First, each country is encouraged to establish the safety regulation on the domestic reactor facilities under its own administrative and legislative frameworks.[225] Secondly, each country is encouraged to define its domestic regulations on the spent fuel and radioactive waste.[226] The second key point is redundant because the spent fuel and radioactive waste regulations are already defined in the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management. On the other hand, the Regulation Act focuses on the implementing measures that the Atomic Energy Council shall govern the transportation of nuclear reactor materials,[227] operation of reactor facilities,[228] and decommissioning plans of nuclear power plants.[229] It even defines that "'Exclusion area' shall denote the area surrounding the nuclear reactor facilities, where an individual located at any point on its boundary for two hours immediately following onset of the postulated fission product release would not receive radiation dose in excess of the limits prescribed by the competent authorities,"[230] and that "Residence within the exclusion area which is unrelated to the operation, the maintenance or the security of nuclear reactor facilities, shall be prohibited."[231] From this regard, the Regulation Act in Taiwan is very clear and precise for which it defines the regulations on different

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[223] International Atomic Energy Agency, *supra* note 6, at Article 1.
[224] Nuclear Reactor Facilities Regulation Act, *supra* note 156, at Article 1.
[225] International Atomic Energy Agency, *supra* note 6, at Article 4.
[226] Ibid., Article 7.
[227] Nuclear Reactor Facilities Regulation Act, *supra* note 156, at Article 17.
[228] Ibid., Chapter 2.
[229] Ibid., Chapter 3.
[230] Ibid., Article 2.7.
[231] Ibid., Article 4.

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aspects of the nuclear reactor facilities; on the contrary, the Nuclear Safety Convention is a bit broad and ambiguous. As a result, the Convention shall learn from the Regulation Act and make the necessary modifications on the implementing measures.

3.2.1.3. Assisting Measures

When it comes to assisting measures, as illustrated in Table 11, the Nuclear Safety Convention provides that the disputes in between two or more Contracting Parties shall be discussed and resolved in a review meeting.[232] Moreover, in each review meeting, there is a debate on the nuclear safety report submitted by each country.[233] Unfortunately, the results of such nuclear safety discussions are confidential.[234] As for the Regulation Act, the assisting measures focus on three aspects. First and foremost, there is a major inspection on all the nuclear reactor facilities every ten years.[235] Secondly, "within six months of completion of the decommissioning plan of nuclear reactor facilities, the licensee shall submit to the competent authorities for review and examination the report on environmental radiation monitoring on the site."[236] At last but not least, the licensee must "submit the report(s) related to operation, radiation safety, environmental radiation monitoring, reportable or emergency event, or prompt notification, the generation record on radioactive waste and any other report(s)" to the Atomic Energy Council.[237] However, the Atomic Energy Council only reveals part of the report to the public while keeping the significant safety inspection records confidential.[238]

Thus, both the Nuclear Safety Convention and the Regulation Act need to improve in terms of information transparency. It is suggested that the confidentiality provided for the review meetings shall be abolished; meanwhile, the Atomic Energy Council in Taiwan shall not hide the significant safety reports on the reactor facilities. Additionally, the Convention assigns the review meetings as the only channel for dispute resolutions, but Taiwan is not one of the States Parties in the Convention due to its special international identity. Thus, the Regulation Act shall promptly add the provisions on how to deal with the disputes with other countries in case Taiwan might need to cope with some nuclear reactor conflicts in the future. Finally, the Regulation Act indeed did an excellent job on the specific safety standards on reactor facilities, but these specifications have yet to be seen in the Convention. Therefore, the Convention should be refined in the upcoming review meetings; at least the provisions on the environmental radiation monitoring after decommissioning must be added into the Convention.

3.2.1.4. Equitable Measures

As Table 11 describes, the Nuclear Safety Convention regulates that every single nuclear reactor facility, whether in the rich countries or in the developing countries, must be provided with adequate funds and trained staff

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[232] International Atomic Energy Agency, *supra* note 6, at 8-11.
[233] Ibid., Article 20.3.
[234] Ibid., Article 27.
[235] Nuclear Reactor Facilities Regulation Act, *supra* note 156, at Article 9.
[236] Ibid., Article 28.
[237] Ibid., Article 10.
[238] Peng, *supra* note 162, at Abstract.

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throughout its lifetime.[239] However, the Convention has yet to address how to help the poor countries on that. On the other hand, the Regulation Act not only includes the aforementioned requirements,[240] but also provides that "to newly establish school, works, jail, hospital, long term nursing institute, recuperation and convalescent institute (charity) for the aged" within the low population zone, "protective measures shall be provided."[241] This provision is very good because the vulnerable groups are more susceptible to the ionizing radiation, but such measures have yet to be seen in the Convention. Therefore, the Convention should take this provision into account, letting all the nuclear power countries around the world aware of this equitable measure.

3.2.2. Domestic Legislation in view of Physical Protection Convention

Table 12 compares the Atomic Energy Law with the Convention on the Physical Protection of Nuclear Material and Nuclear Facilities in view of the objectives, implementation, assisting measures and equity.

[239] International Atomic Energy Agency, *supra* note 6, at Article 19.
[240] Nuclear Reactor Facilities Regulation Act, *supra* note 156, at Article 5.4.
[241] Ibid., Article 4.

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	Atomic Energy Law	Convention on the Physical Protection of Nuclear Material and Nuclear Facilities
Objectives	Promote the research and development of nuclear science and technology, the exploitation of nuclear resources, and the peaceful utilization of nuclear energy.	Let each country recognize the potential benefits to be derived from the peaceful application of nuclear energy. Achieve and maintain worldwide effective physical protection of nuclear material used for peaceful purposes and of nuclear facilities used for peaceful purposes.
Implementing Measures	Any import or export of nuclear source material must be approved by the Atomic Energy Council. Materials within certain limited quantity may be exempted from control.	Each country shall maintain an appropriate physical protection regime to protect against theft and other unlawful taking of nuclear material in use, storage and transport.
Assisting Measures	The commencement, alternation, stoppage or resumption of the production of nuclear material shall be reported to the Atomic Energy Council for approval. Any transfer and abandonment of radioactive material or of equipment capable of ionizing radiation as well as the disposal of radioactive waste are subject to approval of the Atomic Energy Council.	Every country must immediately inform other countries any theft, robbery or other unlawful taking of nuclear material. This Convention has no right to require a State Party to provide the nuclear material criminal proceedings information.
Equitable Measures	All equipment that have to be imported for nuclear research, development, mining, production and protection shall be exempted from customs duties.	The criminals under this Convention shall be guaranteed fair treatment at all stages of the proceedings.

Table 12. Comparison between the Atomic Energy Law and the Convention on the Physical Protection of Nuclear Material and Nuclear Facilities
The table compares the Atomic Energy Law with the Convention on the Physical Protection of Nuclear Material and Nuclear Facilities in terms of the objectives, implementing measures, assisting measures, and equitable measures.

Source:
Atomic Energy Law (1971). (原子能法(1971)。)
International Atomic Energy Agency (1979). Convention on the Physical Protection of Nuclear Material and Nuclear Facilities. Vienna, Austria: International Atomic Energy Agency.

The following sections will examine the four categories and distill the good practices from either side. Hopefully with the comparison, both the Atomic Energy Law and the Physical Protection Convention could incorporate the good points from the counterpart and improve as a whole.

3.2.2.1. Objectives

As described in Table 12, the Physical Protection Convention aims to let each Contracting Party recognize "the potential benefits to be derived from the peaceful application of nuclear energy"[242] and to "achieve and maintain worldwide effective physical protection of nuclear material used for peaceful purposes and of nuclear facilities used for peaceful purposes."[243] On the other hand, the Atomic Energy Law aims to "promote the research and development of nuclear science and technology, the exploitation of nuclear resources, and the peaceful utilization of nuclear energy."[244] With the comparison, it is obvious that the objectives of the Physical Protection Convention are clear and reasonable, but the objectives of the Atomic Energy Law are too broad and impractical. Thus, it is suggested that in Article 1 of the Atomic Energy Law, the promotions on the "research and development of nuclear science and technology" and "exploitation of nuclear resources" shall be deleted because the Atomic Energy Law must focus on the protection of domestic nuclear materials and facilities.

3.2.2.2. Implementing Measures

In terms of the implementing measures, the Physical Protection Convention provides that each State Party shall establish, implement and maintain an appropriate physical protection regime applicable to nuclear material and nuclear facilities under its jurisdiction with the aim of protecting against theft and other unlawful taking of nuclear material in use, storage and transport.[245] Following this provision, the Atomic Energy Law regulates that "Import or export of nuclear source material, unless approved by the Atomic Energy Council and implemented in compliance with related laws, is not allowed."[246] In this aspect, there is good consistency in between the Convention and the Law because the Convention requires each country to prohibit the unauthorized retrieval of nuclear materials under the domestic framework while the Law provides just that. Even so, there is a potential threat under this framework because it is not suitable that the Convention encourages each country to develop its own regulatory framework. As a matter of fact, "Governments and international organizations, including the International Atomic Energy Agency (IAEA), were largely ignorant of Iraqi intentions and capabilities."[247] Moreover, "it is widely acknowledged that several states in the Middle East, notably Algeria, Iran and Libya, are moving toward nuclear weapons capability, as is North Korea."[248] Therefore, in addition to the regulatory framework of each country, there must be an inspection system incorporated into the Physical Protection Convention in the

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[242] International Atomic Energy Agency, *supra* note 120, at Preamble.
[243] Ibid., Article 1A.
[244] Atomic Energy Law, *supra* note 157, at Article 1.
[245] International Atomic Energy Agency, *supra* note 120, Article 2A.
[246] Atomic Energy Law, *supra* note 157, at Article 21.4.
[247] Deutch, J. M. (1992). The New Nuclear Threat. Foreign Affairs, 71 (4), 120-134.
[248] Ibid., 121.

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future. If a Member State does not comply with the inspection, there should also be sanctions defined in the Convention.

On the other hand, the Atomic Energy Law provides that "Radioactive materials within certain limited quantity may be exempted from control with the exact amount to be set forth by the Atomic Energy Council."[249] This is a good provision because if the competent authority needs to keep track of every bit of nuclear material, it may result in governmental wastes[250] and in turn compromise the ability of the Atomic Energy Council to effectively govern the nuclear reactor facilities. Even so, the quantitative regulations must be defined carefully by the authority based on scientific evidence. As for the states with nuclear proliferation concerns like Iraq, Iran, Algeria, Libya and North Korea,[251] such provisions are definitely inappropriate.

3.2.2.3. Assisting Measures

When it comes to the assisting measures, the Physical Protection Convention provides that "a State Party shall take appropriate steps to inform as soon as possible other States, which appear to it to be concerned, of any theft, robbery or other unlawful taking of nuclear material or credible threat thereof, and to inform, where appropriate, the IAEA and other relevant international organizations."[252] This is an important provision because a prompt notification will greatly enhance the chance of success through international cooperation. Unfortunately, the relevant provisions have yet to be seen in the Atomic Energy Law, so the competent authority in Taiwan should establish such reporting systems as soon as possible.

On the other hand, as Table 12 shows, the Atomic Energy Law provides that "The commencement, alternation, stoppage or resumption of the production of nuclear source material shall be reported to the Atomic Energy Council for approval."[253] Furthermore, "any transfer and abandonment of radioactive material or of equipment capable of ionizing radiation as well as the disposal of radioactive waste are subject to approval of the Atomic Energy Council, and to audit, inspection may be made by the Atomic Energy Council."[254] From this regard, although there is no reporting mechanism defined in the Law as mentioned earlier, the Law indeed clearly regulates that any physical protection issues related to nuclear materials must be strictly monitored by the competent authority. Moreover, taking into account that Taiwan is not facing the nuclear proliferation issue, the lack of international reporting system in the Atomic Energy Law as mentioned before shall not be an urgent problem.

3.2.2.4. Equitable Measures

As for the equitable measures, the Physical Protection Convention provides that "Any person regarding whom proceedings are being carried out in connection with any of the offences set forth in this Convention shall be guaranteed fair treatment at all stages of the proceedings."[255] With this

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[249] Atomic Energy Law, *supra* note 157, at Article 26.11.
[250] Fan and Ban, *supra* note 197.
[251] Deutch, *supra* note 247, at 121.
[252] International Atomic Energy Agency, *supra* note 120, at Article 5.
[253] Atomic Energy Law, *supra* note 157, at Article 21.2.
[254] Ibid., Article 26.5.
[255] International Atomic Energy Agency, *supra* note 120, at Article 12.

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foundation, Article 14.3 of this Convention, specifying that "nothing in this Convention shall be interpreted as requiring that State Party to provide information concerning criminal proceedings arising out of such an offence,"[256] shall be abolished. That is because the provision that allows a State Party not to provide the criminal proceedings information could be understood as a resolution to avoid disputes, letting the signatories more willing to approve this Convention. Even so, since the human rights of the suspects during the proceedings have already been guaranteed, such resolution would be redundant. Instead, the uncovering of the criminal proceedings information is likely to make the Convention more effective.

On the other hand, the Atomic Energy Law provides that "All equipment that have to be imported for nuclear research, development, mining, production and protection, as well as for use relating to nuclear power generation shall, according to rules stipulated by the Executive Yuan, be reduced of or exempted from customs duties."[257] This measure has yet to be seen in the Convention, but it is indeed a good method to enhance nuclear safety as elaborated in Chapter 3.1.2.4. Thus, the Physical Protection Convention is suggested to take this approach into consideration.

3.2.3. Domestic Legislation in view of Joint Convention and Marine Dumping Convention

Table 13 compares the Nuclear Materials and Radioactive Waste Management Act in Taiwan with the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management and Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter in view of the objectives, implementation, assisting measures and equity.

[256] Ibid., Article 14.3.
[257] Atomic Energy Law, *supra* note 157, at Article 20.

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	Nuclear Materials and Radioactive Waste Management Act	Joint Convention and Marine Dumping Convention
Objectives	Administer radioactive material, prevent radioactive hazard and secure public safety.	Secure the spent fuel and radioactive waste management through the enhancement of national measures and international cooperation. Ensure that the needs and aspirations of the present generation are met without compromising the ability of future generations to meet their needs and aspirations. Let each country recognize the importance of the marine environment to human beings and all living creatures. Make each country comply with the Charter of the United Nations when developing its own environmental policies.
Implementing Measures	If there is anything not conform to the prescription, the licensee has to cease operation. An application shall be filed two years prior to expiration of the spent fuel or radioactive waste facility.	Within the national law, each country shall take the necessary measures to implement the obligations on site selection, construction and operation of the spent fuel or radioactive waste facility specified in the Convention. Any dumping of radioactive waste, organohalogen compounds, mercury, cadmium, or persistent plastic into the ocean is prohibited. For arsenic, lead, copper, zinc, organosilicon, cyanides, fluorides, and pesticides, only trace amount of dumping into the ocean is allowed.
Assisting Measures	Nuclear waste storage facilities have to submit the reports of operation, radiation protection, environmental radiation monitoring, and irregularity, but the report format of high level radioactive waste has yet to be defined. Atomic Energy Council may execute various inspections and monitorings according to the relevant nuclear safeguard treaties or agreements executed by the IAEA.	The States Parties determined the structure, submission deadline, and reviewing process of the national reports in the preparatory meeting. The national reports must include the management practices, the location and essential features of each management facility, a specific inventory of the domestic spent fuel and radioactive waste, and a specific list of the domestic decommissioning nuclear installations. Every Contracting Party shall report the nature and quantities of all matter permitted by the domestic competent authority to be dumped as well as the location, time and method of dumping.
Equitable Measures	The radiation safety assessment report must be approved by the competent authorities of environmental protection before the land where final disposal facilities of radioactive waste are located could be utilized again.	Each country has the duty to support the vulnerable states which request it for the trained personnel, monitoring equipment, and the treatment technique to mitigate the pollution of marine dumping.

Table 13. Comparison between Management Act, Joint Convention and Marine Dumping Convention

The table compares the Nuclear Materials and Radioactive Waste Management Act in Taiwan with the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management and the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter in terms of the objectives, implementing measures, assisting measures, and equitable measures.

Source:

The Nuclear Materials and Radioactive Waste Management Act (2002). (放射性物料管理法(2002)。)

International Atomic Energy Agency (1997). Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management. Vienna, Austria: International Atomic Energy Agency.

International Atomic Energy Agency (1972). Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter. Vienna, Austria: International Atomic Energy Agency.

The following sections will examine the four categories and distill the good practices from either side. Hopefully with the comparison, all the three laws could incorporate the good points from the others and improve as a whole.

3.2.3.1. Objectives

As Table 13 shows, the objective of the Management Act is "to administer radioactive material, prevent radioactive hazard and secure public safety."[258] Meanwhile, the Joint Convention aims to "achieve and maintain a high level of safety worldwide in spent fuel and radioactive waste management through the enhancement of national measures and international cooperation."[259] In this aspect, there is good consistency in between the Joint Convention and the Management Act because the Joint Convention encourages each country to improve its domestic safety measures while the Management Act could reach its objective of securing public safety by the enhancement of domestic measures. It would be even better if the Management Act could add the provision about international technical cooperation in order to better comply with the Joint Convention.

However, in addition to the above provisions, the Joint Convention also aims at ensuring that during all stages of radioactive waste and spent fuel management, "the needs and aspirations of the present generation are met without compromising the ability of future generations to meet their needs and aspirations."[260] This is an important provision, but it has yet to be seen in the Management Act, and it is believed that such deficit results in the fact that the licensee and competent authorities in Taiwan did not work hard enough to think about how to manage the radioactive wastes; instead, they tend to leave the issue to the future generations. Thus, the Management Act shall add the provision about the intergenerational justice into the objective part as soon as practicable.

At last but not least, the Marine Dumping Convention aims to let each country "recognize the importance of the marine environment to human beings and all living creatures,"[261] and to let the environmental policies of each country comply with the Charter of the United Nations.[262] These provisions are crucial and shall be incorporated into the Management Act as well. This way, the tragedies of coral bleaching near the Third Nuclear Power Plant in Taiwan and the mutation of snappers near the Second Nuclear Power Plant in Taiwan would never happen again.[263]

3.2.3.2. Implementing Measures

In terms of the implementing measures, the Joint Convention provides that "Within the national law, each Contracting Party shall take the legislative, regulatory and administrative measures necessary for implementing its

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[258] The Nuclear Materials and Radioactive Waste Management Act, *supra* note 158, at Article 1.

[259] International Atomic Energy Agency, *supra* note 5, at Article 1.1.

[260] Ibid., Article 1.2.

[261] International Atomic Energy Agency, *supra* note 135, at Preamble.

[262] Ibid.

[263] Wu, R.-J. (2004). Environmental costs Analysis of thermal discharge from power plant. Taipei, Taiwan: Graduate Institute of Environmental Engineering, National Taiwan University. (吳任潔(2004)。發電廠溫排水之環境成本分析。國立臺灣大學環境工程學研究所:臺北市。)

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obligations under this Convention." [264] Following this provision, the Management Act in Taiwan regulates that "the competent authorities may order the operator to cease construction or operation thereof or may revoke the license"[265] if there is safety concern that may seriously threaten "the public health, safety or environmental ecology."[266] Moreover, as Table 13 shows, "When there is need to continue operation after the license is expired, an application shall be filed two years prior to expiration."[267] From this regard, the Management Act is consistent with the Joint Convention—As the Convention requires each country to develop the domestic legislation so as to fulfill the obligations of the Convention, the Management Act does so accordingly. The only deficit is that the IAEA Annual Reports indeed highlighted some good points on the practices of spent fuel and radioactive waste management,[268] but these good practices have yet to be incorporated into the Joint Convention. If the Joint Convention could add these things such as the software package for radioactive waste management registry[269] and the document for the long term storage of radioactive waste,[270] each country can in turn craft the domestic laws that comply with the international safety specifications in an even better way.

On the other hand, as illustrated in Table 13, the Marine Dumping Convention provides that "the high-level radioactive wastes or other high-level radioactive matter" generated by nuclear reactor facilities are prohibited to be dumped into the ocean.[271] Even so, this Convention was not crafted specifically to govern the dumping of nuclear wastes. Instead, it also provides that the organohalogen compounds; mercury and mercury compounds; cadmium and cadmium compounds; persistent plastic; and so forth are prohibited to be dumped into the sea.[272] Furthermore, arsenic, lead, copper, zinc, organosilicon, cyanides, fluorides, and pesticides could only be disposed in a trace amount[273] whereas beryllium, chromium, nickel, vanadium, and scrap metal could be disposed at a larger amount.[274] From this regard, it is believed that the Marine Dumping Convention is too broad and general, and there is not much help on the governance of nuclear reactor radioactive wastes. As a result, in Preamble, Paragraph (xiii) of the Joint Convention—each country shall keep in mind "the Convention on Nuclear Safety (1994), the Convention on Early Notification of a Nuclear Accident (1986), the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency (1986), the Convention on the Physical Protection of Nuclear Material (1980), the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter as amended (1994) and other

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[264] International Atomic Energy Agency, *supra* note 5, at Article 18.
[265] The Nuclear Materials and Radioactive Waste Management Act, *supra* note 158, at Article 13.
[266] Ibid.
[267] Ibid., Article 18.2.
[268] International Atomic Energy Agency, *supra* note 43, at 59.
[269] Ibid.
[270] International Atomic Energy Agency, *supra* note 50.
[271] International Atomic Energy Agency, *supra* note 135, at Annex 1.
[272] Ibid.
[273] Ibid., Annex 2.
[274] Ibid., Annex 3.

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relevant international instruments"—the "Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter as amended (1994)" shall be ignored. Instead, it is much more efficient simply by adding a new article in the Joint Convention, specifying that "All the radioactive wastes generated by nuclear reactor facilities are not allowed to be dumped into the ocean."

3.2.3.3. Assisting Measures

As for the assisting measures, the Joint Convention provides that the Contracting Parties have already determined the structure, submission deadline, and reviewing process of the national reports in the preparatory meeting.[275] In addition, the national reports must include the management practices, the location and essential features of each management facility, a specific inventory of the domestic spent fuel and radioactive waste, and a specific list of the domestic decommissioning nuclear installations.[276] These provisions are extremely worthwhile for the Management Act to take into consideration because it only defines the report format of the low-level radioactive wastes so far.[277] It is highly suggested that the Management Act shall refer to the national reports of other countries and see how they define the high level radioactive wastes in terms of the management practices, the essential features of each management facility, and the inventory of the domestic spent fuel and radioactive waste.

Furthermore, as shown in Table 13, the Management Act provides that the Atomic Energy Council "may execute various inspections and monitoring according to the relevant nuclear safeguard treaties or agreements" executed by the IAEA and "the inspection fees for nuclear safeguard to be paid to the IAEA shall be borne by the operator of facilities."[278] Although it is a good equitable measure to let the licensee pay the fee of the IAEA inspections, such assisting measures of nuclear safeguard reviews shall not be defined in the Management Act. Instead, nuclear safeguard is within the domain of the Physical Protection Convention as elaborated in Chapter 2.7. Since the Atomic Energy Law was established based on the Physical Protection Convention, as illustrated in Chapter 3.2.2., this provision shall be moved from the Management Act to the Atomic Energy Law in order to avoid ambiguity.

Finally, the Marine Dumping Convention regulates that every Contracting Party shall report the nature and quantities of all matter permitted by the domestic competent authority to be dumped as well as the location, time and method of dumping.[279] Ideally, each country should do exactly just that; however, if a country secretly dumps the radioactive wastes into the ocean, it is very unlikely that the competent authority of that country will honestly report such maneuver to the IAEA. Thus, in addition to the existing provision, an international inspection network must be established.

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[275] International Atomic Energy Agency, *supra* note 5, at Article 29.
[276] Ibid., Article 32.
[277] Regulations on Final Disposal of Low Level Radioactive Waste and Safety Management of the Facilities, *supra* note 199, at Article 17.
[278] The Nuclear Materials and Radioactive Waste Management Act, *supra* note 158, at Article 7.
[279] International Atomic Energy Agency, *supra* note 135, at Article 6.4.

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3.2.3.4. Equitable Measures

When it comes to the equitable measures, the Management Act provides that "For the re-utilization or the exemption from institutional control of the land where final disposal facilities of radioactive waste are located, the operator shall submit to the competent authorities the materials as to environment assessment and the radiation safety assessment report approved by the competent authorities of environment protection and shall implement the same after approval."[280] This is an excellent equitable measure because it ensures that the future generations would not be influenced by the radiation of the existing nuclear waste disposal facilities, but it has yet to be seen in the Joint Convention. Thus, the Joint Convention shall quickly take this good practice into account. This way, not only in Taiwan, but also in other countries around the world, the intergenerational fairness and justice would be realized.

On the other hand, the Marine Dumping Convention regulates that each country shall provide the "support for those Parties which request it for the training of scientific and technical personnel; the supply of necessary equipment and facilities for research and monitoring; and the disposal and treatment of waste and other measures to prevent or mitigate pollution caused by dumping."[281] This is a good provision, but it would not work for the nuclear reactor facilities because any dumping of radioactive wastes is not allowed.[282] Even so, such equitable measures are worthwhile for the Joint Convention to take into account. After all, the Joint Convention has no explicit equitable measure. Although the IAEA did conduct a pilot course to teach the developing countries on how to manage the radioactive wastes[283] and dispose the wastes into the borehole where the ionizing radiation is isolated,[284] these equitable measures are not obligatory, and they are not defined in the Joint Convention, either. As new scientific evidences and technology are being discovered and invented, such equitable measures shall be conducted continually in order to make sure that the treatment of radioactive wastes in the vulnerable states are kept up-to-date. Therefore, the Joint Convention shall be added that "each country shall support those Parties which request it for the transfer of the state-of-the-art radioactive wastes treatment technology," which is similar to what was already provided in the Marine Dumping Convention.[285] This way, the worldwide management of radioactive wastes will be improved as a whole.

3.2.4. Domestic Legislation in view of Early Notification Convention and Assistance Convention

Table 14 compares the Nuclear Emergency Response Act in Taiwan with the Convention on Early Notification of a Nuclear Accident and the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency in view of the objectives, implementation, assisting measures and equity.

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[280] The Nuclear Materials and Radioactive Waste Management Act, *supra* note 158, at Article 24.
[281] International Atomic Energy Agency, *supra* note 135, at Article 9.
[282] Ibid., Annex 1.
[283] International Atomic Energy Agency, *supra* note 63, at 71.
[284] Ibid., 72.
[285] International Atomic Energy Agency, *supra* note 135, at Article 9.

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	Nuclear Emergency Response Act	Notification Convention and Assistance Convention
Objectives	Establish an emergency response system and strengthen the emergency response functions against a nuclear accident.	Minimize the transboundary radiological consequences of a nuclear accident through information exchange. Minimize the loss of a nuclear accident through the prompt assistance provided by the States Parties.
Implementing Measures	The Atomic Energy Council shall supervise the implementation of response measures, analyze the nuclear accident, and carry out radiation measurements for personnel, vehicles, and the environment. The local government of the emergency planning zone shall carry out traffic control, arrange accommodations, and provide emergency medical aid for the evacuees. The nuclear reactor operator shall conduct exercise planning, exercise the response plan in normal days, and notify the Atomic Energy Council once a nuclear accident occurs.	The IAEA must promptly inform the countries which may be affected by a nuclear accident, and the notification must include the nature, occurrence time, exact location, and methods to minimize the radiological consequences. The State Party where the nuclear accident occurs could ask for help and direct the resources sent by other countries, but at the end of the event, the equipment and materials must be unaffected and returned.
Assisting Measures	The Atomic Energy Council shall notify the relevant agencies to activate the emergency response plan. The Atomic Energy Council shall issue press release and activate public notification systems. The local government of the emergency planning zone shall assist in issuing press release and activating public notification systems. The operator of the nuclear reactor facilities shall provide the information about the current status inside the nuclear power plant and communicate with other agencies to obtain the necessary assistance.	The nuclear accident State must tell other countries the foreseeable transboundary release of the radioactive materials based on the information of current and forecast meteorological and hydrological conditions. Each State Party shall make known to other countries its competent authorities and point of contact authorized to make and receive requests for and to accept offers of assistance. States are responsible for identifying expertise, equipment and materials that can be made available to help another State in a nuclear accident. To request for assistance, a Member State must provide the name and e-mail of its competent authority and assistance coordinator, the event description, the actions taken or planned, and the type of assistance requested.
Equitable Measures	Every nuclear reactor facility must pay the Atomic Energy Agency the fee for the Nuclear Emergency Response Fund each year.	The IAEA shall construct the radiation monitoring system in a country which does not have nuclear activities itself and borders on a State having an active nuclear program but did not sign this Convention. When the assisting country asks for the reimbursement of costs, it shall consider the need of the developing countries.

Table 14. Comparison between Response Act, Notification Convention and Assistance Convention

The table compares the Nuclear Emergency Response Act in Taiwan with the Convention on Early Notification of a Nuclear Accident and Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency in terms of the objectives, implementing measures, assisting measures, and equitable measures.

Source:

Nuclear Emergency Response Act (2003). (核子事故緊急應變法(2003)。)

International Atomic Energy Agency (1986). Convention on Early Notification of a Nuclear Accident. Vienna, Austria: International Atomic Energy Agency.

International Atomic Energy Agency (1986). Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency. Vienna, Austria: International Atomic Energy Agency.

The following sections will examine the four categories and distill the good practices from either side. Hopefully with the comparison, all the three laws could incorporate the good points from the others and improve as a whole.

3.2.4.1. Objectives

As described in Table 14, the Response Act aims to "establish an emergency response system in the event of a nuclear accident, and to strengthen the emergency response functions so as to ensure the safety and health of the public and to protect their properties."[286] On the other hand, the Notification Convention aims to minimize the transboundary radiological consequences due to a nuclear accident by obligating each State Party to provide relevant information as early as possible.[287] Meanwhile, the Assistance Convention aims to facilitate prompt assistance in the event of a nuclear accident so as to minimize its consequences and to protect life, property and the environment from the effects of radioactive releases.[288] In the discussion of Chapter 3.1.4., it is clear that the emergency response network in Taiwan is robust enough that ideally fulfills the objective of the Response Act. However, the Act did not mention anything about how Taiwan could provide assistance to other countries when a nuclear accident takes place, and it did not address the early warning to the neighboring countries once a nuclear accident happens in Taiwan, either. As a matter of fact, in addition to the domestic response framework, the mitigation of a nuclear accident must rely on international cooperation. Therefore, the Response Act has to incorporate those two factors into its objectives as early as possible.

3.2.4.2. Implementing Measures

As shown in Table 14, pursuant to the Response Act, the Atomic Energy Council is in charge of supervising the "implementation of response measures,"[289] analyzing the nuclear accident,[290] and carrying out "radiation measurements for personnel, vehicles, and the environment."[291] On the other hand, the local government of the emergency planning zone shall carry out traffic control, arrange accommodations, and provide emergency medical aid for the evacuees.[292] Last but not least, the operator of the nuclear power plant has to draft the emergency response plan, exercise the plan in normal days, and report to the Atomic Energy Council once a nuclear accident happens.[293] From this regard, the Response Act is perfect because it makes the most of the expertise in each agency. By letting the Atomic Energy Council controls the implementation of the emergency response plan, it can avoid the ambiguity caused by inconsistent and simultaneous policies issued by different agencies.[294] On the other hand, the local government is more suitable than the central government to conduct traffic control in the areas surrounding the

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[286] Nuclear Emergency Response Act, *supra* note 159, at Article 1.1.
[287] International Atomic Energy Agency, *supra* note 68, at Preamble.
[288] International Atomic Energy Agency, *supra* note 90, at Article 1.
[289] Nuclear Emergency Response Act, *supra* note 159, at Article 7.
[290] Ibid.
[291] Ibid., Article 9.
[292] Ibid., Article 8.
[293] Ibid., Article 11.
[294] Chang, M.-C. and Hu, J.-L. (2011). Inconsistent preferences in environmental protection investment and the central government's optimal policy. Applied Economics, 43 (6), 767-772.

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problematic nuclear reactor facility—it is believed that the regional traffic optimization could be done if the local authority uses online detector measurements to optimize signal timings.[295]

As for the Notification Convention, as shown in Table 14, it provides that the IAEA shall promptly inform the States Parties which are or may be physically affected. The notification includes the nature, the occurrence time, and the exact location of the nuclear accident. Moreover, the IAEA shall also provide the available information relevant to minimizing the radiological consequences in those States Parties.[296] Due to the special international identity, Taiwan is not one of the States Parties of the Convention; even so, it is believed that the IAEA is going to provide the relevant information upon the request of the Atomic Energy Council owing to the customary international humanitarian law.[297] After all, the "widespread, long-term and severe damage to the natural environment is prohibited,"[298] so the IAEA has the duty to provide the related information of the nuclear accident upon request, including the requests that were made by the countries that are not Member States of the Convention. However, in the Response Act, there is no relevant provision, so it should be added as soon as possible that "Once a nuclear accident happens in other countries, which may cause transboundary effect in Taiwan, the Atomic Energy Council shall actively consult the IAEA the relevant information of the nature, occurrence time, exact location, and mitigation methods of the nuclear accident."

Furthermore, the Assistance Convention regulates that the State Party where the nuclear disaster occurs could ask the international society for help, and the personnel and instruments from other countries would be sent to that State Party. Additionally, the overall direction, control, coordination and supervision of the assistance shall be the responsibility within its territory of the requesting State. As a result, the ownership of equipment and materials provided by either Party during the periods of assistance shall be unaffected, and their return shall be ensured.[299] As mentioned in Chapter 3.1.4.2., under the framework of the Response Act, there are a lot of agencies, including the Atomic Energy Council, Ministry of National Defense, local government of the emergency planning zone, operator of the reactor facilities, and so forth. In order to avoid the ambiguity that different agencies request for international assistance at the same time, it is crucial that Article 25 of the Response Act shall be modified. Originally, Article 25 provides that "Upon occurrence of a nuclear accident, the government shall inform the neighboring countries and the associated international organizations at appropriate time, and shall ask their assistance when necessary."[300] This study suggests that Article 25 should be modified into "Upon occurrence of a nuclear accident, the Atomic

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[295] Hamilton, A., Waterson, B., Cherrett, T., Robinson, A., and Snell, I. (2013). The evolution of urban traffic control: changing policy and technology, Transportation, Planning and Technology, 36 (1), 24-43.

[296] International Atomic Energy Agency, *supra* note 68, at Article 4.

[297] Henckaerts, J. M., Doswald-Beck, L., and Alvermann, C. (Eds.). (2005). Customary international humanitarian law. Cambridge University Press.

[298] Ibid., Rule 45.

[299] International Atomic Energy Agency, *supra* note 90, at Article 3.

[300] Nuclear Emergency Response Act, *supra* note 159, at Article 25.

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Energy Council must inform the International Atomic Energy Agency (IAEA) and the neighboring countries that may be affected as soon as possible, and the notification must include the nature, exact location, occurrence time, and the suggested measures to minimize the harm of ionizing radiation. Moreover, the Atomic Energy Council shall ask for international assistance when necessary."

3.2.4.3. Assisting Measures

In terms of the assisting measures, the Response Act provides that the Atomic Energy Council shall notify the relevant agencies to activate each of its own emergency response plans. The Atomic Energy Council also needs to "issue press release and activate public notification systems."[301] Meanwhile, the local government of the emergency planning zone shall "assist in issuing press release and activating public notification systems,"[302] and the operator of the reactor facilities must "notify, communicate, and coordinate with competent authorities of various levels and seek outside support."[303] These are all reasonable provisions, but they have yet to cover the assisting measure provided by the Notification Convention, stating that the nuclear accident country must tell other countries the foreseeable development of the transboundary release of the radioactive materials based on current and forecast meteorological and hydrological conditions.[304] As mentioned in Chapter 3.2.4.1., such deficit may result from the lack of international responsibility defined in the objective part of the Response Act. Thus, in addition to the necessary modifications that were suggested in Chapter 3.2.4.1., the Response Act also needs to be added with a new article, regulating that "Once a nuclear accident happens in Taiwan, the Atomic Energy Council shall discuss with the central weather bureau and the Nuclear Emergency Response Organization within the Facility[305] in order to notify the International Atomic Energy Agency (IAEA) and the countries that may be influenced the foreseeable transboundary release of radioactive materials."

On the other hand, as Table 14 shows, the Assistance Convention requires each Member State to provide the competent authority and the point of contact.[306] Since Taiwan is not one of the Member States due to the special international identity, the Atomic Energy Council shall attend the international conference of the Convention as an observer and provide the relevant information. Finally, as elaborated in Chapter 2.6.3., based on the RANET manual, each State Party shall identify expertise, equipment and materials that can be made available to help another State in a nuclear accident[307] whereas the country that requests for international assistance must provide the name and e-mail of its competent authority, the name and e-mail of its assistance coordinator, the event description, the actions taken or planned, and the type of assistance requested.[308] This study highly suggests that the key points of

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[301] Ibid., Article 7.5.
[302] Ibid., Article 8.2.
[303] Ibid., Article 11.4.
[304] International Atomic Energy Agency, *supra* note 68, at Article 5.
[305] Nuclear Emergency Response Act, *supra* note 159, at Article 12.
[306] International Atomic Energy Agency, *supra* note 90, at Article 4.
[307] International Atomic Energy Agency, *supra* note 106, at 10.
[308] Ibid., Appendix I.

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the RANET manual shall be incorporated into the Assistance Convention as soon as practicable. This way, the domestic nuclear emergency response laws around the world, including the Response Act in Taiwan, could be designed to better comply with the international framework and enhance the function of the Convention.

3.2.4.4. Equitable Measures

As for the equitable measures, as shown in Table 14, the Response Act suggests that the Atomic Energy Council "collects a certain amount of money from the nuclear reactor facility licensee each year for every nuclear reactor facility to set up a Nuclear Emergency Response Fund."[309] This is a good measure, but it has yet to be seen in the Notification Convention, and it was not included in the Assistance Convention, either. Thus, the two Conventions shall incorporate the relevant provisions of such measure in the future.

On the other hand, the Notification Convention provides that the IAEA should conduct investigations into the feasibility and establishment of an appropriate radiation monitoring system to a country which does not have nuclear activities itself and borders on a State having an active nuclear program but did not sign this Convention.[310] This is a good equitable measure, but just like what was mentioned in Chapter 2.5.4., this provision has yet to be put into practice because every nuclear power country has already signed the Convention. Meanwhile, the Assistance Convention provides that when the assisting Party asks for the reimbursement of costs, it shall consider the need of the developing countries.[311] This is also an excellent equitable measure because it takes into account that some vulnerable states may hardly afford the fee of the sophisticated instruments and professional personnel brought in by other countries. Since this measure has not been provided by the Response Act yet, the Response Act could be added that "When asking for the reimbursement of costs for the nuclear accident assistance provided by Taiwan, the financial hardship of the vulnerable countries shall be taken into consideration."

3.3. Merits and Flaws of Taiwan's Nuclear Safety Laws

To summarize the main findings in Chapters 3.1. and 3.2., there are indeed a number of merits and flaws in each of the nuclear safety law in Taiwan. To begin with, Taiwanese legislation readily did an excellent job following the provisions of all the six international nuclear safety conventions. Basically, the objectives, implementing measures, assisting measures and equitable measures provided by the conventions were already defined in Taiwanese nuclear safety laws in a more detailed manner. For instance, the Convention on Nuclear Safety authorized each signatory to develop its own legislative and administrative framework so as to govern nuclear activities, so the Regulation Act in Taiwan in turn assigned the Atomic Energy Council to supervise the licensee of the reactor facilities. Another example is that the Early Notification Convention encouraged each State Party to take protective measures in order to minimize the consequence of a nuclear accident, so the Response Act in Taiwan formulated a dedicated and sophisticated framework

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[309] Nuclear Emergency Response Act, *supra* note 159, at Article 43.1.
[310] International Atomic Energy Agency, *supra* note 68, at Article 8.
[311] International Atomic Energy Agency, *supra* note 90, at Article 7.3.

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to let the country be well prepared in normal days in case a nuclear incident suddenly breaks out. In spite of such merits, it is hard to find out whether or not the administrative function could work properly so as to reinforce the nuclear safety laws in Taiwan unless detailed case study is done in the future.

Although Taiwanese nuclear safety laws generally followed the guidelines of the international nuclear safety conventions, there are several important points missing. Among them, the most critical issue is the intergenerational justice. The Joint Convention clearly defined the intergenerational justice in its objectives that the needs and aspirations of present generation shall be met without compromising the environment of our descendants, but such provision has yet to be seen in any one of the objectives among all four Taiwanese nuclear safety laws. Another flaw is that although the Response Act clearly crafted a comprehensive framework to cope with a nuclear accident, it has yet to follow the guidelines of the Early Notification Convention to obligate the Atomic Energy Council to promptly notify the neighboring countries about the occurrence time, exact location and nature of the incident, and it has yet to require the competent authority to tell other states about the expected transboundary release of radiological materials based on the weather and hydrological forecasts, either. Finally, while the Convention on Nuclear Safety requires a clear separation in between the nuclear station licensee and the regulatory agency in each country, the degree of separation in between the Taipower Company and the Atomic Energy Council in Taiwan remains not sufficient because the Atomic Energy Council cannot fulfill its regulatory duties independently of the political and economic pressures. All in all, despite the high consistency between the conventions and Taiwanese nuclear safety laws, the intergenerational justice, early warning systems and the independence of the regulatory agency in Taiwan need to be improved. As a result, this thesis concluded that the nuclear safety laws in Taiwan are generally good and comprehensive with only a few points that must be added or modified; however, it requires future studies to find out whether or not the administrative function in Taiwan could completely reinforce the articles provided by the nuclear safety laws.

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Chapter 4. Taiwan's Case Studies

In this chapter, there are two case studies in Taiwan. The first one is the license renewal application, and the second one is the decommissioning of the reactor facilities. After that, there will be a reflection on the case studies that summarizes the limitations and difficulties of this research.

4.1. License Renewal Application

Nearly all the operating nuclear reactors in Taiwan are close to their license expiration dates, and the operator, the Taipower Company, must apply for license renewal as soon as practicable. However, there are two major issues for the license renewal application in Taiwan—the lack of public hearing and insufficient environmental reviews. Thus, in the following sections, this study will first discuss the need of abolishing the confidentiality provided in the laws, and then elaborate the importance of incorporating the provisions for international technical cooperation into the Regulation Act in Taiwan.

4.1.1. Confidentiality shall be abolished

As discussed in Chapter 3.2.1.3., the nuclear safety reports under the Nuclear Safety Convention are confidential.[312] Since the Regulation Act in Taiwan was established in accordance with the Nuclear Safety Convention, it is believed that the confidentiality provided in the Regulation Act[313] was derived from the Convention. Considering the lack of public hearing in the license renewal application of the Jinshan Nuclear Power Plant in Taiwan, this study suggests that the confidentiality provided in both the Nuclear Safety Convention and the Regulation Act shall be abolished. Hopefully in this way, the public hearing in future license renewal applications will be more robust.

As a matter of fact, Taiwan has only faced the license renewal application once. In that case, the Taipower Company eventually retrieved the application. From July 27th, 2009, when the Atomic Energy Council first received the license renewal application of the Jinshan Nuclear Power Plant from the Taipower Company, to July 7th, 2016, when the Taipower Company automatically withdrew the application, there were almost 7 years of investigation. Within the 7 years, there was only one public hearing on November 25th, 2009.[314] By comparing the case in Taiwan with the standard operation procedure in the United States as shown in Figure 7, it is very clear that the public hearing in Taiwan is insufficient.

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[312] International Atomic Energy Agency, *supra* note 6, at Article 27.

[313] Peng, *supra* note 162.

[314] Atomic Energy Council (2018). License Renewal of the Jinshan Nuclear Power Plant. Retrieved from: https://www.aec.gov.tw/核能管制/運轉中電廠管制/核能電廠運轉執照換發[台電公司於 105 年 7 月 7 日撤回核一廠延役申請案，原能會已終止審查作業] (行政院原子能委員會 (2018)。核能一廠運轉執照換發。檢自: https://www.aec.gov.tw/核能管制/運轉中電廠管制/核能電廠運轉執照換發[台電公司於 105 年 7 月 7 日撤回核一廠延役申請案,原能會已終止審查作業])

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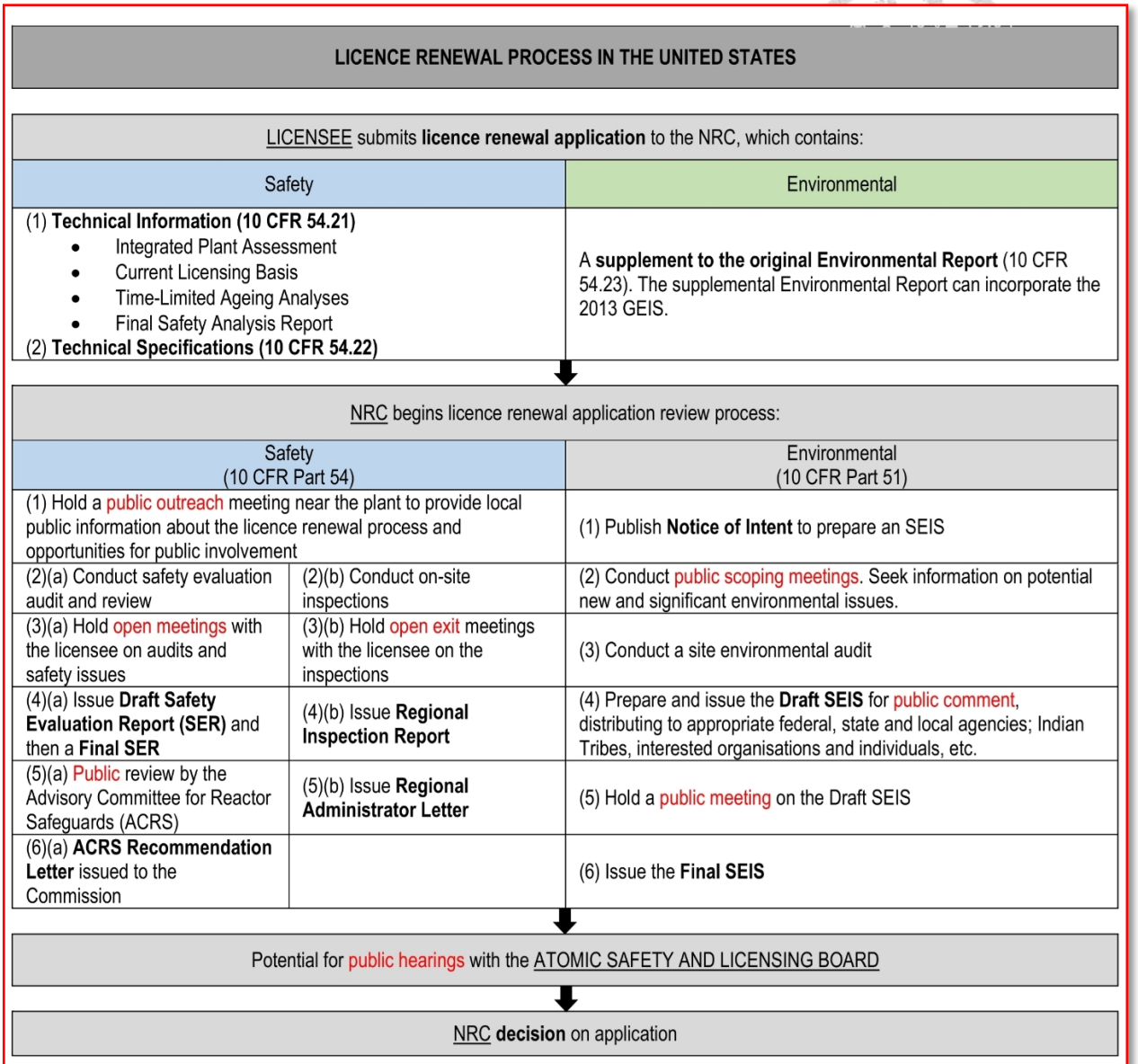

Figure 7. License Renewal Application in the United States

Under the framework of the United States Nuclear Regulatory Commission (USNRC), the license renewal application could be divided into safety review and environmental review. The red words are public hearings, and the bold black words are the necessary documents that must be submitted by the licensee.

Source: Nick, S. K. (2018). Today is yesterday's pupil: Reactor license renewal in the United States. In Nuclear Law Bulletin No. 101 (Nuclear Energy Agency, Organization for Economic Co-operation and Development Ed., pp. 31-61). (Nuclear Law Bulletin, No. 101). Boulogne-Billancourt, France: OECD/NEA.

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In Figure 7, it could be observed that under the framework of the United States Nuclear Regulatory Commission (USNRC), there are a total of 8 public hearings. Four of them are specifically for the safety review, three of them are specifically for the environmental review, and the last one is an integral public hearing that covers both the safety and environmental aspects.[315] On the other hand, as mentioned earlier, during the 7-year license renewal application review process of the Jinshan Nuclear Power Plant in Taiwan, there was only one public hearing. It is obvious that only one public hearing is definitely not enough to cover all the details on every single important attribute of the nuclear power plant depicted in Figure 7. Thus, the Regulation Act shall be modified in a way that strengthens the transparency of information.

4.1.2. International technical cooperation in the Regulation Act

As described in Chapter 3.2.1.1., the Regulation Act did not mention anything about international technical cooperation on nuclear safety, but this is a very important point in the Nuclear Safety Convention. If the regulatory framework in Taiwan could incorporate the international technical cooperation, the Atomic Energy Council might be able to provide adequate authenticity, and the license renewal review of the Jinshan Nuclear Power Plant would have ended up with a better consensus in between the local residents and the competent authority.

As a matter of fact, the license renewal application of the Jinshan Nuclear Power Plant ended up with a furious protest of the local residents because they thought the competent authority failed to address several critical environmental issues that they were concerned about. First and foremost, the local people were concerned about the environmental pollution of the ionizing radiation. As reported by Citizen of the Earth, Taiwan (地球公民基金會)[316] in the conference that took place in Kaohsiung, Taiwan on May 17th, 2019, some radioactive wastes from the nuclear power plant were treated as household garbage and were buried at the sites for household garbage. Moreover, some radiological tubes in the nuclear reactors were stolen and sold as scrap iron. In addition to that, it was also reported that the cooling system of the nuclear reactors sucked in a lot of fish, approximately 8 kilograms per minute, and the fish were secretly transported and buried in the local mountain by the nuclear reactor operators. As described by a former local high school teacher, the cooling systems continuously suck in a lot of marine creatures, and those creatures end up stuck on the filter of the cooling system and never have a chance to return to the sea alive again.[317] It is even believed that the ecological impact at the entrance of the cooling system is more serious than the thermal pollution at the exit of the cooling system in a nuclear reactor facility.[318] Aside from the environmental concerns, the local people fight

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[315] Nick, *supra* note 169, at page 53.

[316] Citizen of the Earth, Taiwan (2019). About Us. Retrieved from: http://www.cet-taiwan.org/about (地球公民基金會(2019)。關於我們。檢自: http://www.cet-taiwan.org/about)

[317] Jiang, Y.-M. (2018). Opinions of the Local Residents who live near the Jinshan Nuclear Station. Retrieved from: https://www.twreporter.org/a/opinion-living-near-nuclear-power-plants (江櫻梅(2018)。家離核電廠那麼近:一位金山人的無奈。檢自: https://www.twreporter.org/a/opinion-living-near-nuclear-power-plants)

[318] Ibid., page 2.

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strongly against the license renewal mainly due to the safety issues of the nuclear power plant. In December 2014, when the Taipower Company was conducting a major inspection in Unit 1 of the Jinshan Nuclear Power Plant, it was discovered that the handlebar of the fuel rods was broken, and that case was unprecedented throughout the history of all the commercial nuclear reactors around the world. Although it was concluded after inspections by the Atomic Energy Council that the issue resulted from the manufacturing defect of the German company,[319] this incident would certainly make the local residents become more fearful on the license renewal of the nuclear power plant. Another major safety concern results from the Kuosheng Nuclear Power Plant, less than 20 kilometers away from the Jinshan Nuclear Power Plant. Since the wet spent fuel pool of the Unit 1 reactor in the Kuosheng Nuclear Power Plant was already full, the Taipower Company transformed the cask loading pool into additional spent fuel pool in order to store the excessive spent fuel so that the nuclear reactor could keep operating.[320] Even though such maneuver has already been applied by a number of nuclear power plants in the United States such as the Cooper Nuclear Power Plant in 2007, the Diablo Canyon Nuclear Power Plant in 2005, and so forth,[321] this is certainly not the best practice, and the local residents are worried that such maneuver may pose a potential crisis of ionizing radiation accidents.[322]

In fact, nearly all the safety and environmental concerns mentioned above could be resolved in a better way through the international technical cooperation as illustrated in Table 15. Thus, this study highly recommends that the Regulation Act shall incorporate the international technical cooperation provision into its objectives, hoping that such measure would in turn boost the implementing measures and assisting measures of the law to be crafted in a way that distill the best practices of other countries to enhance the nuclear safety in Taiwan.

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[319] Chinese Television Service (2015). The Broken Fuel Handlebar in the Jinshan Nuclear Station already cost 1.5 Billion NT Dollars. Retrieved from: https://news.cts.com.tw/cts/politics/201503/201503081590429.html (華視新聞(2015)。核一廠燃料把手鬆脫，已花 15 億。檢自: https://news.cts.com.tw/cts/politics/201503/201503081590429.html)

[320] Chen, W.-Z. (2017). Unit 1 of Kuosheng Nuclear Station would Restart in Early June. Retrieved from: https://e-info.org.tw/node/205325 (陳文姿(2017)。核二廠一號機預計六月上旬重啟。檢自: https://e-info.org.tw/node/205325)

[321] Atomic Energy Council (2015). Q and A for the Transformation of Cask Loading Pool into Spent Fuel Pool in the Kuosheng Nuclear Station. Retrieved from: https://www.aec.gov.tw/webpage/control/nuclear/files/index_20_5-01.pdf (行政院原子能委員會(2015)。「核二廠燃料廠房三樓裝載池設備修改及安裝工作」申請案常見問答集。檢自: https://www.aec.gov.tw/webpage/control/nuclear/files/index_20_5-01.pdf)

[322] Chen, W.-Z. (2017). Procedural Defect—Environmental Groups would File a Petition against the Transformation of Cask Loading Pool into Spent Fuel Pool in the Kuosheng Nuclear Station. Retrieved from: https://e-info.org.tw/node/205327 (陳文姿(2017)。未審先發包-核二廠「裝載池」改裝放用過核燃料，環團將提訴願。檢自: https://e-info.org.tw/node/205327)

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Problems	Solutions
Some radioactive wastes were buried at the sites for household garbage.	Transfer the technique from the USNRC Draft Safety Evaluation Report.
Some radiological tubes were stolen and sold as scrap iron.	Apply the technique from the USNRC Regional Inspection Report.
The cooling systems continuously suck in huge amounts of marine creatures.	Hire the USNRC Draft SEIS experts.
The cask loading pool was transformed into spent fuel pool.	Transfer the nuclear waste storage technology from France.

Table 15. International Technical Cooperation as a Solution

This table puts together the safety and environmental concerns on the license renewal application of the Jinshan Nuclear Power Plant. Meanwhile, the table provides the solutions that would improve the situations based on international technical cooperation.

Source:

Nick, S. K. (2018). Today is yesterday's pupil: Reactor license renewal in the United States. In Nuclear Law Bulletin No. 101 (Nuclear Energy Agency, Organization for Economic Co-operation and Development Ed., pp. 31-61). (Nuclear Law Bulletin, No. 101). Boulogne-Billancourt, France: OECD/NEA.
International Atomic Energy Agency (1999). Survey of wet and dry spent fuel storage. Vienna, Austria: International Atomic Energy Agency.
Jiang, Y.-M. (2018). Opinions of the Local Residents who live near the Jinshan Nuclear Station. Retrieved from: https://www.twreporter.org/a/opinion-living-near-nuclear-power-plants (江櫻梅(2018)。家離核電廠那麼近:一位金山人的無奈。檢自: https://www.twreporter.org/a/opinion-living-near-nuclear-power-plants)
Chen, W.-Z. (2017). Procedural Defect—Environmental Groups would File a Petition against the Transformation of Cask Loading Pool into Spent Fuel Pool in the Kuosheng Nuclear Station. Retrieved from: https://e-info.org.tw/node/205327 (陳文姿(2017)。未審先發包-核二廠「裝載池」改裝放用過核燃料，環團將提訴願。檢自: https://e-info.org.tw/node/205327)

As shown in Table 15, the USNRC "Draft Safety Evaluation Report", one of the safety review documents described in Figure 7, could readily resolve the issue mentioned earlier that some radioactive wastes from the nuclear power plant were treated as household garbage. This is because in the United States, the "Draft Safety Evaluation Report" is made by the staff of the USNRC, and it provides "the technical and legal basis for the USNRC's conclusions on whether or not the license renewal application satisfies the standards for issuance of a renewed license."[323] Thus, the Atomic Energy Council in Taiwan can proactively ask some of the USNRC members for help, and let the Taipower Company pay for the fee of safety inspection, similar to the measure mentioned in Chapter 3.2.3.3.—The Atomic Energy Council "may execute various inspections and monitoring according to the relevant nuclear safeguard treaties or agreements" executed by the IAEA, and "the inspection fees for nuclear safeguard to be paid to the IAEA shall be borne by the operator of facilities."[324] In other words, in current Taiwanese nuclear safety laws, the Atomic Energy Council could only ask the IAEA for help on the inspection of nuclear security,[325] but this study recommends that a new article shall be added into the Regulation Act, specifying that during the license renewal application, the Atomic Energy Council could hire some USNRC staff members to do the "Safety Evaluation Report". Through this international technical cooperation, the Taipower Company workers who operate the nuclear reactor facilities could learn how to treat the trivial radioactive wastes that they used to dump as household garbage in the past. Once they acquire the advanced technique from the USNRC, the nuclear reactor could qualify the Safety Evaluation Report, and the license renewal application could be passed. Meanwhile, owing to the technical cooperation from the USNRC, the opposition from the local residents would likely diminish.

Similarly, as mentioned in Table 15, the concern of the theft of the radiological tubes could be resolved as long as the Atomic Energy Council lets some USNRC staff members do the "Regional Inspection Report" for the nuclear power plant in Taiwan that is in the procedure of license renewal application. As shown in Figure 7, the USNRC staff members could conduct on-site inspections in the nuclear power plant in Taiwan that is about to renew its license. It is believed that the well-experienced USNRC staff members could find out the reason why some radiological tubes were stolen, and they would mention the structural weakness within the nuclear station in the "Regional Inspection Report". Next, the Atomic Energy Council shall require the Taipower Company to fix the problems mentioned in the "Regional Inspection Report" and not to renew the operating license until all of the issues are already solved.

As for the issue of the cooling system described in Table 15, the international technical cooperation from the USNRC would definitely help. As a matter of fact, the Nine Mile Point nuclear power plant on Lake Ontario in New York was reported to kill millions of fish in past decades because its cooling

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[323] Nick, *supra* note 169, at page 56.
[324] The Nuclear Materials and Radioactive Waste Management Act, *supra* note 158, at Article 7.
[325] Ibid.

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systems continuously sucked in the fish from the Ontario Lake.[326] On May 26th, 2004, the licensee submitted applications to the USNRC to renew the Nine Mile Point Nuclear Power Plant Units 1 and 2 for an additional 20 years of license.[327] It is believed that the USNRC staff has required the licensee to improve the environmental impact of the cooling system through the drafting of the "site-specific Supplement to the Generic Environmental Impact Statement (SEIS)."[328] Thus, in May 2006, the Nine Mile Point Nuclear Station was already equipped with the cooling system that can "remove any accumulation of impinged organisms or other material into a sluiceway, which empties into an impingement collection basket during impingement monitoring." [329] Furthermore, "under normal operating conditions, wash water, fish, and debris are discharged via the Unit 1 discharge tunnel back to Lake Ontario."[330] Thus, the Atomic Energy Council shall invite the international technical cooperation from the USNRC to learn how to construct the system so as to resolve the problem that the cooling systems in Taiwanese nuclear reactors continuously suck in a lot of fish. The relevant measure shall be incorporated into the Regulation Act in Taiwan as soon as practicable.

Even though the solution provided by the SEIS of the Nine Mile Point Nuclear Station license renewal application seems ideal, there are still some potential concerns. For example, it was revealed that despite the separation design that prevents the marine creatures from entering the cooling system, there are some even smaller organisms that might accidentally enter the cooling system. As reported by Hawthorne and Tribune Reporter (2011), "Billions more eggs, larvae and juvenile fish that are small enough to pass through the screens are cooked to death by intense heat and high pressure inside the coal, gas and nuclear plants."[331] Thus, while the Atomic Energy Council is asking for the technical cooperation from the USNRC, the USNRC shall do the research to address the issue mentioned above.

4.2. Decommissioning Procedures

When it comes to the license renewal application, people are concerned about the safety of the nuclear reactor facilities just like what was mentioned in Chapter 4.1. On the other hand, if it was decided that the nuclear reactor would not undergo the license renewal application, and it is going to be decommissioned, then the local residents start to worry about the nuclear waste disposal issues. After all, nobody wants the nuclear waste disposal site to situate in the backyard, and those who live near the nuclear station are afraid that the power plant itself might become the permanent nuclear waste

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[326] Hawthorne, M. and Tribune Reporter. (2011). Millions of Great Lakes fish killed in power plant intakes. Retrieved from: https://www.chicagotribune.com/news/ct-met-great-lakes-fish-kills-20110614-story.html?outputType=amp

[327] U.S. Nuclear Regulatory Commission Office of Nuclear Reactor Regulation (2006). Generic Environmental Impact Statement for License Renewal of Nuclear Power Plants (Supplement 24-Regarding Nine Mile Point Nuclear Station, Units 1 and 2). District of Columbia, DC: United States Nuclear Regulatory Commission.

[328] Nick, *supra* note 169, at page 47.

[329] U.S. Nuclear Regulatory Commission Office of Nuclear Reactor Regulation, *supra* note 327, at 2.1.3. Cooling and Auxiliary Water Systems.

[330] Ibid.

[331] Hawthorne, M. and Tribune Reporter, *supra* note 326, at page 1.

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disposal site. Thus, just like what was mentioned in Table 15, Taiwan shall learn from France in terms of the state-of-the-art nuclear waste treatment technology. Moreover, just like what was elaborated in Chapter 3.2.3.1., the Nuclear Materials and Radioactive Waste Management Act in Taiwan shall be modified in order to incorporate the intergenerational justice into its objectives.

4.2.1. International Technical Cooperation

In Chapter 4.1.2., it was mentioned that by adding international technical cooperation into the Regulation Act, the problems of license renewal application would likely be resolved. In fact, this approach could also work for the decommissioning of nuclear reactor facilities.

The toughest issue of the decommissioning in Taiwanese nuclear reactors, as emphasized by Citizen of the Earth, Taiwan,[332] is the disposal of nuclear waste. In June 2017, the Atomic Energy Council approved the decommissioning plan of the Jinshan Nuclear Power Plant submitted by the Taipower Company. On May 15th, 2019, the Environmental Protection Agency completed the second stage environmental impact assessment. After the Taipower Company reports to the Atomic Energy Council the modifications of the decommissioning plan based on the environmental impact assessment, the decommissioning procedures will begin, and the entire process will be completed in the year of 2043. However, just like what was mentioned in 3.2.3.3., under the framework of the Nuclear Materials and Radioactive Waste Management Act, the specifications on the disposal of high-level radioactive wastes have yet to be defined, so all the high-level radioactive wastes have nowhere to go—They are stuck in the nuclear power plants, and the first disposal facility of high-level radioactive wastes in Taiwan could not be completed at least until 2023.[333] Moreover, as elaborated in Chapter 4.1.2., some of the nuclear reactors in Taiwan already had no more space to store the excessive radioactive wastes, so they had to undergo structural modifications to transform the cask loading pool into the storage of radioactive wastes,[334] and the environmental groups are very concerned about the safety of this maneuver.[335] If the nuclear power plant itself become the final disposal facility of the high-level nuclear waste after decommissioning—as concerned by the environmental group Citizen of the Earth, Taiwan—then the ionizing radioactive release might be critical as earthquakes create structural damage to the decommissioned nuclear reactor facilities.[336] As a result, this study sincerely suggests that Taiwan shall learn from the good practices of how other countries manage their radioactive wastes through the international technical cooperation.

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[332] Citizen of the Earth, Taiwan, *supra* note 316.

[333] Atomic Energy Council (2019). Final Disposal of High-level Radioactive Wastes. Retrieved from: https://www.aec.gov.tw/便民專區/民眾常見問答集/放射性物料管理/放射性廢棄物最終處置--220_237_2275_362.html (行政院原子能委員會(2019)。高放射性廢棄物最終處置。檢自: https://www.aec.gov.tw/便民專區/民眾常見問答集/放射性物料管理/放射性廢棄物最終處置--220_237_2275_362.html)

[334] Chen, *supra* note 320, at page 2.

[335] Chen, *supra* note 322, at pages 4-5.

[336] Jhang, D.-P. (2014). Nuclear Stations on Fault Lines. Retrieved from: https://ourisland.pts.org.tw/content/地震帶上的核電廠 (張岱屏(2014)。地震帶上的核電廠。檢自: https://ourisland.pts.org.tw/content/地震帶上的核電廠)

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In France, about 75% of its electricity is derived from nuclear energy as of October 2019.[337] With tremendous amounts of nuclear power plants and radioactive wastes, it is very likely that France has already developed advanced technology for nuclear waste disposal and reasonable management strategies.[338] Thus, Taiwan shall actively seek for international technical cooperation in order to better deal with the excessive radioactive wastes in Taiwanese nuclear stations.

As a matter of fact, France has 6 facilities in support of reprocessing activities.[339] Through the reprocessing of nuclear wastes, 93~95% radioactive wastes can be recycled and utilized again in the commercial nuclear stations,[340] so the problems of excessive nuclear wastes could be resolved. Unfortunately, due to the potential risk of nuclear proliferation, currently there are only four countries that can reprocess the radioactive wastes—France, United Kingdom, Japan and China.[341] Therefore, Taiwan shall actively hire the professional personnel from France to acquire the reprocessing technique in order to tackle the issue of the excessive radioactive wastes. In other words, the incorporation of "international technical cooperation" into the objectives of the Regulation Act in Taiwan, as illustrated in Chapter 3.2.1.1., could not only resolve the license renewal application concerns mentioned in Chapter 4.1.2., but also tackle the decommissioning adversity elaborated in this section.

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[337] World Nuclear Association (2019). Nuclear Power in France. Retrieved from: https://www.world-nuclear.org/information-library/country-profiles/ckuntries-a-f/france.aspx

[338] Ibid., pages 2-4.

[339] International Atomic Energy Agency (1999). Survey of wet and dry spent fuel storage. Vienna, Austria: International Atomic Energy Agency.

[340] Jiang, R.-T. (2013). Three Antidotes for Nuclear Waste Management. Retrieved from: https://nuke.wikia.org/zh/wiki/核廢料處理的三大大法寶 (江仁台(2013)。核廢料處理的三大法寶。檢自: https://nuke.wikia.org/zh/wiki/核廢料處理的三大大法寶)

[341] Ibid., page 2.

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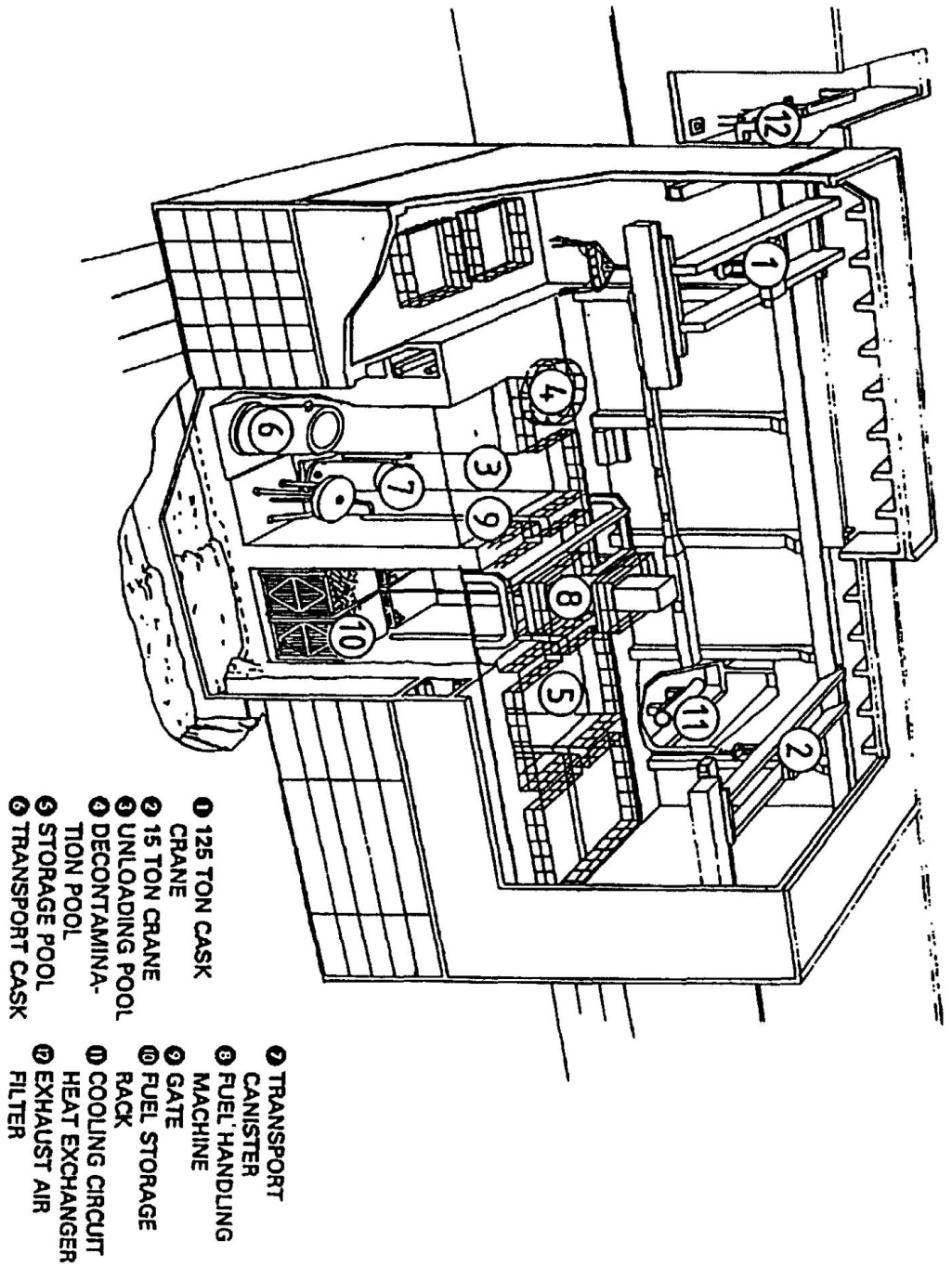

Figure 8. Nuclear Waste Management Technique in France
Before reprocessing the radioactive wastes, the French management facilities pour the hot spent fuel into the decontamination pool, and then use the cooling circuit to cool down the spent fuel.

Source:
International Atomic Energy Agency (1999). Survey of wet and dry spent fuel storage. Vienna, Austria: International Atomic Energy Agency.

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Figure 8 is a good example that the Atomic Energy Council shall learn from France through the international technical cooperation in order to tackle the radioactive wastes. To be more specific, Figure 8 depicts the necessary management facility before the reprocessing of radioactive wastes. First, when the facility receives the fresh spent fuel from the nuclear reactor, the cranes (labeled as "1" and "2" in Figure 8) can move the dangerous spent fuel around different instruments in the facility in a safe and stable way.[342] In the first step, the spent fuel will be moved to the unloading pool (labeled as "3" in Figure 8), where the shield plug will be removed and the radioactive wastes would be poured into the transport cask and canister (labeled as "6" and "7" in Figure 8).[343] Then, the radioactive wastes will go through the integrity check by the krypton monitors; when necessary, the wastes will be purified by the decontamination pool (labeled as "4" in Figure 8).[344] Eventually, the spent fuel is going to be cooled by the heat exchanger (labeled as "11" in Figure 8), and the steam generated therein will be purified by the exhaust air filter (labeled as "12" in Figure 8).[345]

It is highly recommended that Taiwan shall learn from the good practice in Figure 8 for several reasons. First and foremost, as illustrated in Chapter 4.1.2., there are a number of radiological concerns in Taiwanese nuclear reactors, and one of the concerns is that the workers of the nuclear waste storage facility in Taiwan are exposed under extraordinary and hazardous ionizing radiation.[346] With the technology illustrated in Figure 8, the trolley can be "remotely moved around the facility" from the outside,[347] so the workers no longer need to be exposed under the harmful radiation inside the radiological compartment. On the other hand, in Chapter 4.1.1., Figure 7 clearly pointed out the lack of environmental review in Taiwan due to the confidentiality provided by the Regulation Act.[348] The lack of environmental inspection may result in excessive radiation emitted by the nuclear stations. Thus, the operator in Taiwan shall invite the international technical cooperation from France in order to establish the "exhaust air filter systems" denoted as "12" in Figure 8. Hopefully in this way, the impact of the defective environmental review process could be mitigated. To sum up, all the measures could not be done unless the provision of international technical cooperation is added into the objectives of the Management Act, as elaborated in Chapter 3.2.3.1. Thus, the provision must be incorporated in to the law, and the relevant articles shall be provided in accordance with the provision as soon as practicable.

4.2.2. Intergenerational Justice

In addition to international technical cooperation, the intergenerational justice is also a necessary component so as to resolve the decommissioning

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[342] International Atomic Energy Agency, *supra* note 339, at 3.3.3.
[343] Ibid., at page 16.
[344] Ibid., 3.3.3.1. TO.
[345] Ibid., FIG 1. Loviisa pool.
[346] Association for Employment Injuries in Taiwan (2012). Nuclear Waste Storage Facility in Orchid Island, Taitung, Taiwan Threatens the Health of Workers and Tao People. Retrieved from: https://www.coolloud.org.tw/node/67091 (中華民國工作傷害受害人協會(2012)。蘭嶼核廢料儲存廠迫害作業工人、達悟族人生命健康。檢自: https://www.coolloud.org.tw/node/67091)
[347] International Atomic Energy Agency, *supra* note 339, at page 15.
[348] Peng, *supra* note 162, at Abstract.

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issues. As mentioned in Chapter 3.2.3.1., the Nuclear Materials and Radioactive Waste Management Act in Taiwan failed to address the most important objective provided by the matching Joint Convention—"the needs and aspirations of the present generation must be met without compromising the ability of future generations to meet their needs and aspirations."[349] This is believed to be the main reason why Taiwan has yet to define the safety requirements for the long-term disposal of high-level radioactive wastes, as illustrated in Chapter 3.2.3.3.

In fact, there are already many countries around the world that follow the guidelines of the Joint Convention to ensure the usage of nuclear power would not compromise the environment and health for future generations. For example, Finland has already established the laboratory for the disposal of high-level radioactive wastes in 2004. The laboratory was constructed at Olkiluoto, Finland by the Posiva Institution, an institution that specifies in the investigation and treatment of nuclear wastes.[350] After detailed and comprehensive experiments, it has been proven that by storing the high-level nuclear wastes in the depth of 300 to 1,000 meters underground in the geologically stable areas, it will be perfectly safe for both the environment and the health of all living creatures because even if the radiation accidentally leaks out from the containers, it would have decayed to harmless value before reaching the ground.[351] Posiva Institution in turn applied for the commissioning of the high-level nuclear wastes final disposal facility, and the application was passed by the Finland Government in November, 2015.[352] This is a good example of securing the intergenerational justice, and it is indeed urgent for the Atomic Energy Council in Taiwan to learn from the good practice in order to realize the intergenerational justice.

As a result, this study strongly suggests that the modifications mentioned in Chapter 3.2.3.1. must be made as soon as possible. In other words, Article 1 in the Nuclear Materials and Radioactive Waste Management Act shall be added that "The Atomic Energy Council and nuclear facility operator in Taiwan must do the research, refer to the good practices worldwide, and commission the safe final disposal facilities for the high-level radioactive wastes as soon as possible in order that the nuclear power operations carried out by the present generation would not compromise the ability of future generations to meet their needs and aspirations." Hopefully in this way, Taiwan can catch up with the pace of other countries and decommission the nuclear stations in an ideal manner.

4.3. Reflection on the Case Studies

Although this thesis made a number of suggestions for Taiwan's nuclear safety laws to improve based on the comparison with the international nuclear safety conventions, it still requires future works to examine each of the recommendations in details due to the limitation of this research. After all, it is worthwhile to note that even though the analytical tool itself that was introduced in Chapter 2.2. is effective enough to break down the complicated

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[349] International Atomic Energy Agency, *supra* note 5, at Article 1.2.
[350] Atomic Energy Council, *supra* note 333, at page 3.
[351] Ibid., page 2.
[352] Ibid., page 3.

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conventions, when this thesis tried to make suggestions to improve Taiwanese nuclear safety laws based on the existing international nuclear safety conventions, there were a number of uncertainties. First, this thesis could only recommend the nuclear safety laws in Taiwan to improve in the legislative aspect such as adding the intergenerational justice; however, when it comes to the administrative aspect, this thesis could not investigate whether or not the provisions of the nuclear safety laws could be reinforced thoroughly unless specific case study is done in details in the future. Secondly, as shown in Figures 1, 2 and 3, all the nuclear safety conventions were adopted in 1970s, 1980s and 1990s with very few amendments. Thus, even if Taiwan's nuclear safety laws readily comply with the conventions, it does not necessarily mean that such provisions are adequate and up-to-date enough. Last but not least, the nuclear safety conventions were adapted to allow each Contracting Party to develop its own legislative and regulatory frameworks accordingly. Therefore, the articles in each convention only provide a general direction, but the domestic nuclear safety laws in every country would clearly define each aspect of nuclear activities in details based on the special conditions of each country. As a result, it is difficult to compare Taiwanese laws with the international nuclear safety conventions, and this study could only try the best to see if there are some important components that should be but have yet to be included in either the international conventions or Taiwanese nuclear safety laws.

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Chapter 5. Conclusion

Before the Fukushima Nuclear Disaster, the Three Mile Island and Chernobyl Accidents already triggered the international society to adopt all six of the nuclear safety conventions, as elaborated in Chapter 2.1. However, the Fukushima Disaster still occurred, indicating that the existing legal framework needs to be improved.

In terms of the recommended improvements, in Chapter 2.3., this thesis found out that there was no equitable measure in the Nuclear Safety Convention. While the Nuclear Safety Convention authorized each State Party to develop its own regulatory framework on domestic nuclear safety, the countries with the lack of fund and technique might not be able to ensure the safe operation and the prevention of radioactive pollution from the reactor facilities. However, each country had the right and freedom to build nuclear power plants due to state sovereignty. Thus, this thesis suggested that equitable measures must be added into the Nuclear Safety Convention so as to secure the nuclear safety in those vulnerable countries as early as practicable. In Chapter 2.4., this thesis found out that the resolution of disputes defined in the Joint Convention was ambiguous. It only provided that any dispute shall be resolved in the international conference, but it did not explain how to do that. Therefore, this thesis suggested that the liability should be defined based on whether or not the package design matches the radionuclides that are being transported as well as whether or not the packages have been held until equilibrium conditions have been approached closely enough to demonstrate compliance with the requirements for temperature and pressure. By clearly defining the liability, compensation in between States Parties could be facilitated accordingly, and each Member State would comply with the safety requirements more seriously. In Chapter 2.5., this thesis noticed that the IAEA already provided detailed guidance on the emergency response, but the guidance had yet to be seen in the Notification Convention. Thus, this thesis recommended that in the next international conference, the Contracting Parties shall modify the Notification Convention to obligate that in a nuclear accident, before any significant release of radioactive material, the competent authority of the country must make arrangements for taking protective actions. In Chapter 2.6., this thesis found out that after Fukushima, the reported nuclear incidents worldwide showed an increasing trend, but the assistance provided by the Member States was very limited. As a result, this thesis recommended that the Incident and Emergency Center under the IAEA shall be provided with more resource and personnel in order to build the bridge in between the nuclear incident countries and the States Parties that could yield the specific assistance. Meanwhile, this thesis suggested that the Assistance Convention shall provide more incentives for the Member States to provide support. In Chapter 2.7., this thesis realized that the objectives of the Physical Protection Convention were too redundant, so the provisions other than nuclear nonproliferation shall be deleted. Last but not least, in Chapter 2.8., this thesis found out that the Marine Dumping Convention categorized the dumping danger of nuclear wastes into the same annex along with organohalogen, mercury, cadmium, and persistent plastic. Such categorization was misleading, so this thesis recommended that nuclear wastes shall be specially emphasized by the Marine Dumping Convention as

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the extremely harmful material that is not allowed to be disposed into the ocean.

To sum up, the six international nuclear safety conventions generally did an excellent job to cover a comprehensive range of aspects in terms of the nuclear activities worldwide. It is worthy of recognition that these conventions as a whole already defined the intergenerational justice, the isolation in between reactor licensee and regulatory agency, and the international monitoring and warning system against any radiological incidents. If the assistant missions could be increased and the equitable measures could be better defined, the international nuclear safety regime would certainly become even better.

While Chapter 2 provided suggestions on the main findings for each nuclear safety convention, Chapter 3 investigated the nuclear safety laws in Taiwan to see if they could catch up with the progress on the international legal framework. To be more specific, in Chapter 3.1., this thesis analyzed the four nuclear safety laws in Taiwan and then compared each law with the matching convention in Chapter 3.2. It is important to bear in mind that "the matching convention and law" does not mean that the Taiwanese law and international convention that were put together to compare in Chapter 3.2. were ideally corresponded with each other; instead, the scope and density of the articles vary significantly in between the international conventions and domestic laws, and this thesis could only try its best to put together the relevant convention and law in accordance with their special traits such as the objectives and the aspect of nuclear activity that they both want to cover.

The main findings of Chapter 3 included the lack of international technical cooperation provisions in the Regulation Act, the deficit of international reporting system in the Atomic Energy Law, the inadequacy of the intergenerational justice in the Management Act, and the necessity to establish an early notification system to the neighboring countries in the Response Act. To solve each of the issue, this thesis suggested that the Regulation Act shall refer to the Nuclear Safety Convention to incorporate the international technical cooperation provision into its objectives, the Atomic Energy Law should take the Physical Protection Convention into account and add the international reporting system against any nuclear proliferation concerns into its assisting measures, the Management Act must comply with the Joint Convention to include the intergenerational justice in its objective part, and the Response Act needs to follow the guidelines of the Early Notification Convention and Assistance Convention so as to obligate the competent authority in Taiwan to notify other countries with the comprehensive report format once a nuclear incident occurs.

All in all, Taiwanese nuclear safety laws did an excellent job following the guidelines of the international nuclear safety conventions, but it requires future works to find out whether or not the provisions of those laws could be carried out completely by the administrative branch in Taiwan. Moreover, despite the good compliance with the international conventions, the intergenerational justice and early warning system to the neighboring countries once a nuclear accident happens shall be incorporated into Taiwanese nuclear safety laws as soon as possible.

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After the comparison in between the international nuclear safety conventions and Taiwanese laws, Chapter 4 analyzed two case studies in Taiwan. In Chapter 4.1., this thesis discussed the license renewal application of the Jinshan Nuclear Power Plant. The main finding was that although Taiwanese nuclear power plants followed the instructions of the USNRC, unlike the license renewal application process in the US, both the public hearing and the environmental review were inadequate in Taiwan. While the license expiration dates are approaching, the Taiwanese Atomic Energy Council should urgently tackle this issue. This thesis suggested that the confidentiality provided in both the Nuclear Safety Convention and the Regulation Act in Taiwan shall be abolished so that there would be adequate public hearings to review the potential safety and environmental threats before the operating license is renewed. Meanwhile, this thesis recommended that Taiwan should seek for the international technical cooperation to deal with the nuclear proliferation issues, radiological concerns, and environmental impacts of the domestic reactor facilities. In addition to the license renewal problems, Chapter 4.2. discussed the decommissioning of nuclear stations since Taiwan is now facing its first ever decommissioning of the earliest reactor facility. Despite the existing laws and procedures, many urgent issues have yet to be resolved such as the disposal of high-level radioactive wastes, the prevention of complex natural disasters, and the potential radiological release to the environment. In order to cope with the issues, this thesis suggested that Taiwan could learn from the advanced nuclear waste treatment technique from France through the channel of international technical cooperation. Rather than transforming the cask loading pool into additional storage pool for radioactive wastes, it would be much better to apply the French technique which reused and recycled 94% of spent fuel and reduced significant amount of high-level radioactive wastes. Moreover, by adding the intergenerational justice into the Management Act, the competent authority and operating licensee in Taiwan would both seriously do the research and come up with the policy that focuses on the preservation of the environment.

To sum up, this thesis highly appreciates that the international nuclear safety conventions have already covered a comprehensive scope of nuclear activities, and the nuclear safety laws in Taiwan show excellent compliance with the conventions. However, the research sincerely recommends that the international nuclear safety conventions shall be increased with the number of assistant missions while better defining the equitable measures, the nuclear safety laws in Taiwan must be promptly enhanced in terms of intergenerational justice and the early warning systems to the neighboring countries, and the issues revealed by the case studies should be resolved according to the recommendations of this study on the conventions and domestic laws. Hopefully in this way, the nuclear safety regime worldwide could be effectively improved and permanently secured once and for all.

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