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Legislative Study on China's Compensation for Nuclear Damage Liability

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Abstract: The civil nuclear industry plays an important role in improving environmental quality and safeguarding energy security in China. Nevertheless, the industry is facing a huge risk of nuclear accident damage. The legal system of nuclear damage compensation is of vital importance for the industry to address potential risks. The Nuclear Safety Law, which has recently been published in China, stipulates two articles about nuclear damage compensation in principle. However, in general, the current nuclear damage compensation legal system in China has not yet been made systematic and there are still problems, such as a lack of maneuverability and details. This paper adopts qualitative and quantitative methodologies to summarize and analyze the current legislation and regulation pertaining to civil nuclear damage compensation liability in China and analyzes the shortages and deficiencies of these rules in detail by using legal analysis methods. Suggestions to establish and perfect China's legal system of nuclear damage compensation are proposed to safeguard the healthy development of the civil nuclear industry and remedy damages brought about by nuclear accidents. Such a legal system should contain the elements of clear legislative goals and objectives, a specific definition and scope of nuclear damage, strict and sole responsibility principles for operators, an appropriate liability amount, a stable financial guarantee for operators, and national supplementary liability.

Keywords: nuclear energy; nuclear damage; compensation; liability; legislation; nuclear safety law

1. Introduction

Given the way that coal fired power production has been challenged by continuous environmental haze and smog in China, China's developing civil nuclear energy has become one of the most significant ways to solve the energy shortage, improve energy structure, control environmental pollution, and ensure energy security [1]. The General Office of the State Council has named "Safe Development of Nuclear Energy and the Continuous Optimization of the Energy Structure" as the strategic plan for energy development in China between 2014 and 2020. By 2020, the scale of the civil nuclear industry in China will have been ranked second in the world [2]. However, just like in other energy industries, the development of the nuclear industry is facing various risks. Huge damage caused by nuclear accidents is due to several reasons, such as design problems, manufacturing defects, construction and installation errors, operation and maintenance negligence, equipment failures, natural disasters, terrorist attacks, and so on [3]. All of these problems can lead to nuclear accidents and cause significant damage. Since nuclear damage can lead to a lot of claims and influence, and general civil tort law does not provide a full responsibility system for particularity, legislators should provide rules for this kind of damage compensation liability [4].

The “Nuclear Safety and Radioactive Pollution Prevention 12th Five-Year Plan and the 2020 Vision” jointly issued by the Ministry of Environmental Protection (NNSA), the Ministry of Finance, the National Development and Reform Commission, the National Energy Bureau, and the National Defense Industry Bureau, emphasizes the importance of establishing a legal system for nuclear damage compensation liability and insurance in China. Moreover, China’s Nuclear Safety Law, which has the highest legal validity in the field of nuclear law, makes principled provisions on the scope of nuclear damage compensation, liability subject, financial guarantee arrangement, and other issues. However, under the existing laws and regulations in China, it is still difficult for nuclear accident victims to conveniently get nuclear damage compensation, resulting in difficulties in safeguarding the interests of communities and victims.

Consistent and comprehensive legislation is conducive to ensuring the safe and sustainable development of the civil nuclear industry. By examining the current nuclear legal system, the problems and deficiencies of China’s nuclear damage compensation legislation will be analyzed. This paper proposes the following research question: How can nuclear damage compensation legislation in China be improved to adapt to the development of the civil nuclear industry? In order to seek a solution for the future legislation of nuclear damage compensation liability in China, this paper adopts qualitative and quantitative methodologies to summarize and analyze the current legislation and regulation pertaining to civil nuclear damage compensation in China. The paper analyzes the shortages and deficiencies of this legislation and regulation and summarizes these rules in detail by using comparative legal analysis methods. By analyzing the existing legislation and policy framework and learning from the advanced legislative and practice experience of foreign countries and international conventions, this paper discusses the significance and importance of establishing specialized legislation on nuclear damage compensation and makes recommendations for future legislation.

2. Applicable Legal Provisions on Nuclear Damage Compensation in China

Generally speaking, specialized legislation on nuclear damage compensation is not currently enacted in China. Until now, only the Reply on Addressing the Issue of Third-Party Nuclear Liability issued by the State Council stipulates clauses on nuclear damage compensation. There have been two versions of the Reply, first the 1986 Reply, and then the 2007 Reply, which took the place of the 1986 Reply and is still implemented as the main legal source of nuclear damage compensation in China. Besides the 2007 State Council Reply, there are rules scattered in laws, such as the Nuclear Safety Law, the Prevention and Control of Radioactive Pollution Law, and the Tort Law, etc., as shown in Table 1 at the end of this section.

Table 1. China’s Applicable Legal Provisions on Nuclear Damage Compensation.

Laws	<ul style="list-style-type: none"> • Nuclear Safety Law (Article 11 and 90) • Prevention and Control of Radioactive Pollution Law (Article 12 and 59) • Tort Law (Article 70) • Principles of Civil Law (Article 123) • Product Quality Law (Article 73) • Maritime Law (Article 208)
Administrative Regulations and Rules	<ul style="list-style-type: none"> • Reply on Addressing the Issue of Third-Party Nuclear Liability in June 2007 (the 2007 Reply)
International Conventions	<ul style="list-style-type: none"> • None

2.1. Laws

Although there is currently no legislation that specializes in nuclear damage compensation, provisions scattered in laws, such as Nuclear Safety Law and Tort Law, have already provided

principles on nuclear damage compensation. China's Nuclear Safety Law, which was enacted on 1 January 2018, has the highest legal validity in the nuclear law system in China. Article 11 of the Nuclear Safety Law generally stipulates: "A citizen, a legal person or any other organization . . . if suffering nuclear damage, have the right to claim compensation under the law". As for the related specific issues, Article 90 provides operator liability, general liability scope of nuclear damage, exoneration from liability, and proper financial assurance responsibility of the operator. Specifically, according to Article 90, the nuclear facility operating entity that causes personal injury or death, loss of property, or environmental damage by reason of a nuclear accident shall be bound to make compensation unless it is able to prove that the damage resulted from such circumstances as war, armed conflict, or riot. This article also stipulates the sole liability and proper financial assurance responsibility of the operator, providing that "An entity which provides the nuclear facility operating entity with equipment, engineering or services, among others, has no responsibility for compensation for nuclear damage. Where the nuclear facility operating entity has an agreement with it, it may, upon making compensation, exercise its remedy against the nuclear facility operating entity as agreed". It also states: "A nuclear facility operating entity shall make appropriate financial guarantee arrangements by purchasing liability insurance, participating in mutual aid mechanism and other means in order to ensure the timely and effective performance of the obligation to compensate claims for nuclear damage". Since these two articles of the Nuclear Safety Law still lack feasibility, Article 90 also requires that "the operator shall be bound to make compensation according to the national nuclear damage liability system in China".

Before the Nuclear Safety Law was enacted in China, the only specialized legislation in the area of nuclear law was the Prevention and Control of Radioactive Pollution Law. Article 12 provides: "An entity running nuclear facilities, utilizing nuclear technology or developing and utilizing uranium (thorium) mines and associated radioactive mines shall . . . bear the liabilities in accordance with the law for the radioactive pollution it has caused". Article 59 also stipulates: "Whoever causes any damage to others due to radioactive pollution shall bear the civil liabilities in accordance with the law". However, this significant legislation has not made detailed provisions for nuclear damage compensation. Besides, Article 70 of Tort Law also stipulates: "Where a nuclear accident occurs to a civil nuclear facility and causes any harm to another person, the operator of the civil nuclear facility shall assume the tort liability unless it can prove that the harm is caused by a situation such as war or by the victim intentionally". Article 123 of the Principles of Civil Law provides: "If any person causes damage to other people by engaging in operations that are greatly hazardous to the surroundings, such as operations conducted . . . highly toxic or radioactive substances . . . , he shall bear civil liability; however, if it can be proven that the damage was deliberately caused by the victim, he shall not bear civil liability". In addition, Article 73 of the Product Quality Law and Article 208 of the Maritime Law have similar regulations.

2.2. Administrative Regulations and Rules

There are many administrative regulations in the civil nuclear industry in China nowadays, such as the Regulation on Supervision and Management of Civil Nuclear Facilities (1986), the Regulation on Nuclear Material Control (1987), and the Regulations on Safety Management of Radioactive Waste (2011). However, most of them stipulate the supervision and management of nuclear materials and facilities. Only the Reply on Addressing the Issue of Third-Party Nuclear Liability provides regulations on nuclear damage compensation. The Reply on Addressing the Issue of Third-Party Nuclear Liability (Guohan 1986 No. 44), issued by the State Council in March 1986, was the first administrative legislation on nuclear damage compensation in China. It provides the scope of operators, sole and absolute liability and maximum liability of operators, additional compensation liability of the government, and operators' rights for seeking recompensation and exoneration from liability.

For the importation of advanced civil nuclear techniques from the United States and France, the State Council issued a new Reply on Addressing the Issue of Third-Party Nuclear Liability

in June 2007, which took the place of the 1986 Reply and became the main civil nuclear damage compensation legislation in China. The 2007 Reply (Guohan 2007 No. 64) can be summarized into several elements: (1) On the definition of “operator”, the 2007 Reply provides that “operator” refers to an entity in China that obtains the status of a legal person and operates a nuclear plant, civil research reactor, or civil engineering experimental reactor, or conducts the production or transport of civil nuclear fuel and the storage, transport, or reprocessing of spent fuel with its own nuclear facilities; (2) On the operator’s liability, the operator shall bear liability for personal injury and death, property losses, and environmental destruction caused by nuclear accidents. Where there are two or more operators whose liability cannot be clearly distinguished, operators shall bear joint liability. The maximum liability amount to operate a nuclear plant and conduct the storage, transport, or reprocessing of spent fuel is 300 million yuan, and the maximum liability amount of other operators is 100 million yuan. The operator can be exonerated from liability when nuclear damage is directly due to armed conflict or hostility, civil war, or riot; (3) On state liability, the state government should pay additional compensation, the maximum amount of which is RMB 800 million; (4) On financial guarantees, the operator should have proper financial arrangements to guarantee the prompt and effective performance of compensation liability for nuclear damage. This Reply required the operator to purchase adequate liability insurance before operating a nuclear plant or storing, transporting, or reprocessing spent fuel; (5) On transboundary pollution, transboundary nuclear damage shall be settled by the treaty or agreement signed by the People’s Republic of China (PRC) and relevant countries, and the principle of reciprocity shall be applied to countries that have no relevant treaty or agreement with China. Nevertheless, the detailed processes and approaches for compensation are not provided by the 2007 Reply.

2.3. International Conventions

China has actively participated in international communication in the area of nuclear issues for a long time and joined the International Atomic Energy Agency (IAEA) in 1984. Until now, eight international conventions on nuclear issues have been ratified and signed by China, including the Statute of the International Atomic Energy Agency, the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency, and the Convention on Nuclear Safety. However, none of these are on nuclear damage compensation. The current international nuclear damage compensation liability regime is well developed with two branches: the Paris Convention system and the Vienna Convention system. In spite of the similarities between the Paris and Vienna Conventions, their existence does not provide a uniform liability regime for all countries that are parties to either convention [5]. Thus, the adoption of the Joint Protocol Relating to the Application of the Vienna Convention and Paris Convention built a bridge with the Convention on Supplementary Compensation for Nuclear Damage, which established a worldwide liability regime, attracting more countries. Many European countries have joined the Paris Convention or the Vienna Convention, and the United States, Japan, and India have been parties to the Convention on Supplementary Compensation for Nuclear Damage. However, China, South Korea, South Africa, and Pakistan, as big civil nuclear industry countries, have not yet joined any nuclear damage compensation convention [6].

3. The Necessity to Establish Specialized Nuclear Damage Compensation Legislation in China

Considering the current deficiencies of China’s legal provisions on nuclear damage compensation and the potential advantages of establishing specialized legislation in this field, this section explains in detail the necessity to promote China’s future legislation on nuclear damage compensation.

3.1. Deficiencies of China’s Legal Provisions on Nuclear Damage Compensation

Although China has developed a certain amount of nuclear legislations and regulations, only the Nuclear Safety Law, the Prevention and Control of Radioactive Pollution Law, the Tort Law, and the 2007 Reply have clauses regarding nuclear damage compensation liability. However, the relevant

provisions of the above laws are too abstract to be implemented in practice. Specifically, the main shortages and deficiencies are described below.

First, there is little legal authority with regard to the 2007 Reply. Since the relevant provisions of the Nuclear Safety Law, Tort Law, and other related laws lack feasibility, according to Article 90 of the Nuclear Safety Law, the operator should bear the compensation liability in accordance with the nuclear damage compensation legal system in China. Currently, the only legal regulation providing nuclear damage compensation is the 2007 Reply. Thus, the 2007 Reply can be seen as the main nuclear damage compensation legal source in China now. However, the 2007 Reply is just a letter from the State Council on compensation for nuclear damage. According to Article 89 of the Constitution of China, “the State Council . . . adopts administrative measures, enacts administrative rules and regulations and issues decisions and orders in accordance with the Constitution and the law”, and the enactment of administrative regulations must strictly follow legal procedures. Thus, the 2007 Reply is not an administrative regulation, but a State Council document established in accordance with the Procedures for Documents of the State Administrative Department. Law experts in China believe that the legal authority of such documents enacted by the State Council is lower than that of administrative regulations and higher than that of regulations made by ministries and provinces [7]. According to the General Office of the State Council’s Reply on the Questions about Implementation of the General Office of the State Council Issued 1993 No. 55 and State Reply 1996 No. 69 document, the relevant Notice and Reply issued by the State Council have the same effect as administrative regulation and can serve as the basis for administrative agencies to implement administrative penalties [8]. Therefore, the legal authority of the 2007 Reply is only equivalent to the administrative regulations. With the rapid development of the civil nuclear industry, this is not commensurate with the significance of the nuclear industry in China, and establishing nuclear damage compensation in the form of legislation is urgently needed.

Second, there are merely abstract provisions in the current nuclear damage compensation system and no specific liability mechanism in China. Articles 11 and 90 of the Nuclear Safety Law stipulate that victims of nuclear accidents (including citizens, legal persons, and other organizations) have the right to obtain compensation for nuclear damage. However, how the victims get the compensation is not stipulated. It provides the scope of compensation for damage, specifically personal injury, property loss, or environmental damage, but the definition and scope of nuclear damage are not clear. The financial obligation of operators is stipulated in principle, but it does not specify how to implement it. As for the 2007 Reply, there are also no explicit provisions on the liability-bearing mechanism and no method of financing for compensation liability. Without establishing and enacting specialized laws on nuclear damage compensation, all the legislations and regulations analyzed above will be difficult to apply in practice, which can affect the efficiency of compensation and injure the interests of victims when nuclear accidents happen.

3.2. Potential Advantages to Establish a Specialized Nuclear Damage Compensation Legal System

First, a specialized nuclear damage compensation legal system is conducive to the healthy and sustainable development of the civil nuclear industry. The consequences of nuclear accidents are uncertain. If an accident occurs, the operator may need to compensate for damage with a large amount of money and face bankruptcy, which is the main obstacle for operators to enter into the civil nuclear industry. Nuclear damage compensation legislation therefore emerged to address this issue. General Electric Corporation, the first major US nuclear reactor operator, had threatened to leave the nuclear industry on the grounds that “the risk of nuclear damage can cause a serious bankruptcy risk” [9]. To appease this important corporation and develop a civil nuclear industry, the United States Congress passed the Price–Anderson Act in 1957 to stipulate the liability limit of operators of nuclear facilities [10]. The development of nuclear damage compensation legislation, which stipulates the scope of operators, the operators’ liability, and the mode of financial guarantees, can not only

ensure compensation for the victims of nuclear damage, but also guarantee the healthy and sustainable development of the nuclear industry.

Second, a nuclear damage compensation legal system can also help to sufficiently compensate the victims of nuclear incidents. A nuclear damage compensation legal system can also help to sufficiently compensate the victims of nuclear incidents in accordance with legislation and regulation, which is conducive to remedying the consequences as far as possible. With the expansion of postwar energy development, potential hazards arise from nuclear accidents [11]. Nuclear catastrophe can not only cause losses to property, but can also pose long-term psychological burdens, life difficulties, and physical harm to injured residents. If compensation to injured residents cannot be properly addressed, it may cause social instability and have a profoundly negative impact on the entire nuclear industry. Therefore, whether to offer effective assistance and provide timely, efficient, and fair nuclear damage compensation to injured residents will be a great test for the credibility of the state and its government. Since Japan has a rather sound nuclear damage compensation legal system, Japan could quickly integrate various resources into compensation and make great efforts to provide victims with comprehensive compensation after the Fukushima nuclear accident to prevent serious social problems [12]. Therefore, a comprehensive legal system of nuclear damage compensation is an important project to protect the rights of residents.

4. Suggestions for China's Future Legislation on Nuclear Damage Compensation

Based on the principles stipulated in the newly established Nuclear Safety Law and the advanced legislative and practical experience of foreign countries and international conventions, China's future nuclear damage compensation legislation should contain clear legislative purposes and objectives, a specific definition and scope of nuclear damage, stipulation of operators' strict and sole liability, a stable financial guarantee, and national supplementary liability, etc. Some of the core contents are elaborated below.

4.1. Establish Clear Legislative Purposes and Objectives

As the foundation and core of the law, legislative objectives must be followed and cannot be conflicted by implementation, interpretation, and improvement of the legislation. In addition, the legislative purposes are always written in such legislation, such as Article One. Section One of Japan's Act on Compensation for Nuclear Damage states the purpose of this law. It stipulates: "The purpose of this Act is to protect persons suffering from nuclear damage and to contribute to the sound development of the nuclear industry by establishing the basic system regarding compensation in case of a nuclear damage caused by reactor operation, etc.". Also, Article One of the Act on Compensation for Nuclear Damage in South Korea states the objective of this Act: "The purpose of this Act is to protect victims and to contribute to the sound development of the nuclear industry by establishing matters relating to compensation in the event of nuclear damage arising during the operation of a nuclear reactor". The beginning of the Convention on Third-Party Liability in the Field of Nuclear Energy (Paris Convention) also clarifies the purposes of this convention, and regards "ensuring adequate and equitable compensation for persons who suffer damage caused by nuclear incidents whilst taking the necessary steps to ensure that the development of the production and uses of nuclear energy for peaceful purposes" as one of the most significant purposes. Considering that the 2007 Reply did not provide the legislative purposes or objectives of nuclear damage compensation liability legislation, and the current situation of developing the civil nuclear industry rapidly and energetically in China, the legislative purposes and objectives of China's future nuclear damage compensation legislation could be made "to clarify the division of compensation liability, ensure prompt and adequate compensation of damages caused to persons and property by the nuclear accident; control, mitigate and eliminate the damages caused by nuclear accidents, protect lives, property and environment; and contribute to the sound development and public acceptance of civil nuclear industry".

4.2. Explicitly Define the Definition and Scope of Nuclear Damage Compensation

China's 2007 Reply and Nuclear Safety Law merely provide "personal injury and death, loss of property and environmental damages caused by nuclear damages" as the scope of nuclear damage compensation in general. No legislation and regulation in China, including the Nuclear Safety Law, the Prevention and Control of Radioactive Pollution Law, the Tort Law, and the 2007 Reply, provides the definition and specific scope of nuclear damage compensation. It is therefore necessary for future legislation of nuclear damage compensation in China to stipulate the definition and specific scope of nuclear damage compensation in detail.

According to Article 3 of the Convention on Third-Party Liability in the Field of Nuclear Energy of 1960, as amended by the Additional Protocol of 1964 and the Protocol of 1982, the scope of nuclear damages that the operator of a nuclear installation shall be liable for includes: "(i) damage to or loss of life of any person; and (ii) damage to or loss of any property other than (1) the nuclear installation itself and any other nuclear installation, including a nuclear installation under construction, on the site where that installation is located; and (2) any property on that same site which is used or to be used in connection with any such installation; (3) upon proof that such damage or loss (hereinafter referred to as 'damage') was caused by a nuclear incident in such installation or involving nuclear substances coming from such installation, except as otherwise provided for in Article 4". The Vienna Convention on Civil Liability for Nuclear Damage of 1963 provides a similar scope of nuclear damage as the Paris Convention. Thus, before the late 1980s, both of the original international conventions and legislation from countries on nuclear damage compensation liability defined the scope of nuclear damage as (i) loss of lives and personal injury; and (ii) loss of or damage to property, except on-site property damage.

As a consequence and due to the influence of the Three Mile Island and Chernobyl nuclear accidents attracting more and more attention, there was a new trend to add "environmental related damage" to the scope of "nuclear damages". Article 2 of the Protocol to Amend the Vienna Convention on Civil Liability for Nuclear Damage of 1997 amended the nuclear damage scope of the 1963 Vienna Convention to add the following aspects: "(iv) the costs of measures of reinstatement of impaired environment, unless such impairment is insignificant, if such measures are actually taken or to be taken, and insofar as not included in sub-paragraph (ii); (v) loss of income deriving from an economic interest in any use or enjoyment of the environment, incurred as a result of a significant impairment of that environment, and insofar as not included in sub-paragraph (ii); (vi) the costs of preventive measures, and further loss or damage caused by such measures; (vii) any other economic loss, other than any caused by the impairment of the environment, if permitted by the general law on civil liability of the competent court". The 2004 Protocol to Amend the Paris Convention and the Brussels Supplementary Convention (not yet in force) also cover a broader range of damage [13]. In addition to personal injury and property damage, the 2004 Protocol includes certain types of economic loss, the cost of measures to reinstate a significantly impaired environment, loss of income resulting from that impaired environment, and the cost of preventive measures, including loss or damage caused by such measures [14]. Moreover, the Convention on Supplementary Compensation for Nuclear Damage defines "nuclear damage" as "(i) loss of life or personal injury; (ii) loss of or damage to property; and each of the following to the extent determined by the law of the competent court: (iii) economic loss arising from loss or damage referred to in sub-paragraph (i) or (ii), insofar as not included in those sub-paragraphs, if incurred by a person entitled to claim in respect of such loss or damage; (iv) the costs of measures of reinstatement of impaired environment, unless such impairment is insignificant, if such measures are actually taken or to be taken, and insofar as not included in sub-paragraph (ii); (v) loss of income deriving from an economic interest in any use or enjoyment of the environment, incurred as a result of a significant impairment of that environment, and insofar as not included in sub-paragraph (ii); (vi) the costs of preventive measures, and further loss or damage caused by such measures; (vii) any other economic loss, other than any caused by the impairment of the environment, if permitted by the general law on civil liability of the competent court". Thus, it is a new trend to

add to the original nuclear damage scope: (i) the cost of reinstatement measures for the impaired environment; (ii) costs of preventive measures; and (iii) different forms of economic loss to the extent determined by the law of the competent court. However, as this trend will increase the burden of the civil nuclear industry, it has been accepted by very few nations in their own legislation.

As a responsible power, China can and ought to regard “environmental damage” as a significant part of “nuclear damage compensation”. China has already taken “personal injury and death, loss of property or environmental damages caused by nuclear damages” as the scope of nuclear damage compensation in principle. However, compared with the scope of the above international conventions, the definition and specific scope of nuclear damage compensation provided in current legislation and regulations in China is far too abstract and principled. The future specialized legislation on nuclear damage compensation should follow the developed legislative experience of international conventions to define nuclear damage compensation in detail. In future nuclear damage compensation legislation in China, the detailed definition and scope of nuclear damage compensation could cover the following aspects: (i) loss of life and personal injury; (ii) loss of or damage to property, except on-site property damage; (iii) cost of reinstatement measures for the impaired environment; (iv) cost of preventive measures; and (v) different forms of economic loss to the extent determined by the law of the competent court, from ionizing radiation emitted by any source of radiation inside a nuclear installation, or emitted from nuclear fuel or radioactive products or waste in or nuclear material coming from, originating in, or sent to, a nuclear installation, whether arising from the radioactive properties of such matter or from a combination of radioactive properties with toxic, explosive, or other hazardous properties of such matter.

4.3. Provide Strict Liability and Sole Liability Principles

Principles of liability are vital to identify and assume operators’ liability. Both the Vienna Convention on Civil Liability for Nuclear Damage and Convention on Supplementary Compensation for Nuclear Damage state that the, “The liability of the operator for nuclear damage shall be absolute”, which requires that the operator should assume not only strict liability, but also sole liability, for nuclear accident damages.

A strict liability principle means that the operator of a nuclear installation is held liable regardless of fault. Given the special dangers involved in civil industry activities and the difficulty of establishing negligence in particular cases, this principle has been adopted for nuclear damage compensation liability [15]. The strict liability principle assumes that the liability results from the risk, without considering fault. This principle greatly facilitates the process of bringing claims on behalf of the victims of a nuclear accident; and stipulating that the operator of the nuclear installation is liable for compensation regardless of any fault on his part, the claimant is only required to prove the relationship of cause and effect between the nuclear accident and the damage for which compensation is sought, and the operator cannot escape liability by proving diligence on his part [16]. A strict liability principle already existed in the People’s Supreme Court Prescriptions on Civil Evidence. Both the Nuclear Safety Law and the 2007 Reply stipulate that for personal injury and death, loss of property, and environmental damage caused by nuclear accidents, the operator of a nuclear installation shall bear compensation liability, unless the damage is caused by war, an armed conflict, or insurrection, etc. This is also the manifest of strict liability of nuclear operators in China. Therefore, future nuclear damage compensation legislation in China could elaborate a strict liability principle by adopting the following definition: The operator of the nuclear installation is liable for compensation regardless of any fault on his part; the claimant of a nuclear accident is only required to prove the causation of the nuclear accident and the damage for which compensation is claimed, and the operator cannot avoid liability by proving his diligence.

The sole liability of operators means that the operator of a nuclear installation is solely liable or exclusively liable for nuclear damage. No other person may be held liable, and the operator cannot be held liable under other legal provisions (e.g., tort law or product quality law), so liability is

legally channeled solely to the operator of the nuclear installation. As the sole liability principle for operators can balance the relationship of operators and victims, avoid difficult and lengthy questions of complicated legal cross-actions for victims, and help victims obtain their compensation quickly and conveniently, it has already become the most significant rule of nuclear damage compensation legislation for almost all states and international conventions on nuclear liability. With the exception of Austria and the US, all states that have enacted nuclear liability laws have accepted the sole liability principle, and the US has a system that produces substantially the same result as the sole liability principle. The international conventions also support this principle. For example, Article Two of the Vienna Convention on Civil Liability for Nuclear Damage provides: "Except as otherwise provided in this Convention, no person other than the operator shall be liable for nuclear damage". Similar to the international conventions, both China's 2007 Reply and Nuclear Safety Law provide a sole liability principle for operators. This has been the prerequisite for the introduction of foreign advanced nuclear technology to China since the 1980s. As the most important and unique rule in China's future nuclear damage compensation legislation, the sole liability principle is suggested to be stipulated as: The operator of a nuclear installation bears sole and exclusive liability in nuclear damage compensation, which means no person other than the operator can be held liable for nuclear damage.

4.4. Increase Current Liability Limitation of the Operator

The nuclear liability conventions permit contracting states to limit the liability amount of the operator of a nuclear installation. Only a few states, such as Austria, Germany, Japan, and Switzerland, apply the concept of unlimited liability of the operator, while most states limit the liability of the operator. The earliest nuclear damage compensation legislation, the Price–Anderson Act of 1957 in the US, emphasized this limited liability principle in order to appease the first major US nuclear operator. With improvements in technology and the commercialization of the nuclear industry, more and more energy corporations became nuclear installation operators and the operators have not been protected as before. Thus, the liability limit of the operator has been increasing all these years. The minimum liability amount under the 1997 Vienna Convention and the Convention on Supplementary Compensation for Nuclear Damage is 300 million Special Drawing Rights (SDRs) of the International Monetary Fund (IMF), and the minimum amount under the 2004 Protocol of the Paris Convention (not yet in force) is 700 million euros. The maximum liability amount differs in different countries and regions. Spain stipulates a nuclear damage compensation limit up to 1.2 billion euros. In 2005, Canada's New Energy and Security Act raised the limit on civil nuclear damage liability of operators from 75 million to 1 billion CAD [17]. As Japan provides unlimited liability for operators in "the Act on Compensation for Nuclear Damage" (1961), TEPCO and other power companies had already paid 7.9 trillion yen as compensation by the end of 2016.

However, according to China's 2007 Reply, the liability limitation of the operator for nuclear damage in China is only 300 million yuan, which is almost 2.6% of the requirement in the Convention on Supplementary Compensation for Nuclear Damage and much less than that in other countries [18]. This is not commensurate with China's social economy and the status of the nuclear industry, and is also contrary to relevant international development trends. Therefore, future legislation should refine such provisions and increase the maximum limitation of compensation liability. With development of the economy and the nuclear industry in China, compared with the legislative experience of foreign countries, it is suggested that the liability limit of the operator for nuclear damage can be stipulated as 1500 million yuan for one nuclear accident now, which should be increased every 15 years gradually until the limit reaches the international standard provided by international conventions. This can not only protect the rights of nuclear pollution affected victims, but also help China's civil nuclear industry better adapt to the increase of liability limitation.

4.5. Develop Nuclear Damage Insurance and Complementary Compensation Liability of National Government as Two Tiers of Stable Financial Guarantee

Due to the strict and sole liability principle, operators need insurance to sustain the development of the nuclear industry once nuclear accidents occur. If neither the insurer nor the operator can afford the compensation, the national government should bear the complementary compensation liability. These rules are for the benefit of both victims and operators. Tiers of stable financial guarantee were thus established. The Price–Anderson Act of the United States provides two tiers of financial guarantee in the case of nuclear damage compensation: The first tier is where each nuclear operator should pay for the damage, so the operator is required to purchase 450 million USD liability coverage for each reactor, and reactors under 100 MWe have a lower primary insurance requirement, which is provided by a private insurance pool, American Nuclear Insurers. The second tier is jointly provided by all US reactor operators and is funded through retrospective payments, if required, of up to 121 million USD per reactor per accident collected in annual installments of 19 million USD (and adjusted for inflation). Article 3 of the Convention on Supplementary Compensation for Nuclear Damage also stipulates two tiers of compensation with respect to nuclear damage per nuclear incident: on the first tier, the installation state shall ensure the availability of 300 million SDRs, or a greater amount that it may have specified, to the depositary at any time prior to the nuclear incident, or a transitional amount pursuant to sub-paragraph (ii); and on the second tier, beyond the amount made available under sub-paragraph (a), the contracting parties shall make available public funds according to the formula specified in Article IV.

Therefore, learning from the legislative experience of international conventions and developed countries, in order to compensate victims sufficiently and on time after nuclear damage accidents, future legislation of China should establish two tiers of financial guarantee. The first tier can be compulsory commercial insurance bought by the operators, and the second tier can be national government complementary compensation. The history of China's nuclear damage insurance, which is the most significant element of the first tier, can be traced back to 1987. In order to meet the demand of nuclear insurance in China's civil nuclear industry development, this can be approved by China Insurance Regulatory Commission, China's Nuclear Insurance Community, which was jointly established by China Reinsurance Company, People's Insurance Company of China, China Pacific Insurance Company, and China Ping An Insurance Company in 1999. At present, the China Nuclear Community includes 25 domestic property insurance companies and reinsurance companies. It brings together more than 90% of the domestic property insurance market, and provides nuclear property insurance and third party liability insurance for all nuclear power operations in China. Therefore, all civil nuclear reactors are covered by commercial insurance at present. The 2007 Reply provides: "The operator shall make proper financial arrangement to guarantee the prompt and effective performance of the compensation liability for nuclear damage caused by nuclear accident. Thus, the operator shall purchase adequate liability insurance before operating nuclear plant, or storing, transporting or reprocessing spent fuel". The Nuclear Safety Law also stipulates: "A nuclear facility operating entity shall make appropriate financial guarantee arrangements by purchasing liability insurance, participating in mutual aid mechanism and other means". However, these regulations are too abstract for operation in practice, and do not provide the coverage and premium of the insurance. Therefore, the compulsory liability of purchasing nuclear damage insurance for operators as the first tier must be provided with systematic and feasible rules in future legislation in China. Based on the 1500 million yuan suggested as the liability limit, the commercial insurance the operator must buy before his installation operates should also cover 1500 million yuan or more.

The second tier can be national government complementary compensation. Normally, it is the national government that takes charge of bearing the complementary compensation liability for nuclear damage. China has provided this national complementary liability since as early as the 1986 Reply. The 1986 Reply stipulates that the "Chinese government should provide the necessary and limited complementary compensation, with a maximum limitation of RMB 300 million yuan, if the required

compensation exceeds the compensation limitation of the operator". Additionally, the 2007 Reply provides that the "State Government should pay additional compensation, and the maximum amount of compensation is RMB 800 million yuan". However, there are no rules about which agency of the national government should assume the compensation liability and how the agency should fulfill liability. Moreover, the maximum amount is not high enough to be commensurate with economic development in China today. Thus, future legislation should refine such provisions, appoint the agency to pay for the complementary compensation, and increase the maximum amount of complimentary compensation to as high as the operator's future liability limitation, 1500 million yuan.

5. Conclusions and Further Research

China's existing legislation, including the 2007 State Council Reply and the Nuclear Safety Law, merely provides nuclear damage compensation liability in principle. The current nuclear damage compensation legal system is not systematic and several problems exist, such as a lack of maneuverability and weak legal authority. Two requirements for establishing specialized nuclear damage compensation legislation are therefore presented in this paper: establishing a nuclear damage compensation legal system is conducive to the healthy and sustainable development of the nuclear industry; it can also sufficiently compensate victims after nuclear accidents. Therefore, China should, without delay, develop specialized legislation on nuclear damage compensation that contains clear legislative goals and objectives, not only in the interest of the victims, but also for the healthy development of the civil nuclear industry; a specific definition and scope of nuclear damage, including the cost of measures to repair the environment; strict and sole liability of the operator regardless of fault on his part; a liability compensation amount as high as 1500 million yuan; and two tiers of stable financial guarantee, including commercial insurance and national government supplementary liability.

This paper provides general research pertaining to China's nuclear damage compensation legislation. Other specific issues, such as the operator's (the insurer's) exoneration from liability, and whether China should join the Convention on Supplementary Compensation for Nuclear Damage, merit further research. Moreover, as a vital element of China's nuclear damage compensation legislation, further research is also needed to explore the actual impact and implementation of the nuclear damage compensation mechanism.

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