International Journal of Environmental Sciences
ISSN: 2229-7359
Vol. 11 No. 1s, 2025
https://www.theaspd.com/ijes.php

The Role of Nuclear Accidents in Developing Civil Liability Rules for Nuclear Damage at the International and National Levels

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Abstract: *The study employs an analytical approach to examine the role of nuclear accidents in the evolution of civil liability frameworks for nuclear damage at both international and national levels. It highlights that, although rare, peaceful nuclear accidents cause significant concern among workers and the public. The Chernobyl incident notably prompted enhancements in nuclear legislation and the expansion of liability conventions. Furthermore, such accidents have led to the establishment of agreements for early notification and assistance in nuclear incidents, thereby strengthening nuclear safety and security. The study recommends the activation of all aspects of nuclear security and safety across nuclear facilities, urging each nation to fulfill its national and international obligations regarding the possession and use of nuclear energy. Additionally, it advocates for the accession of all countries to the Convention on Early Notification and the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency.*

Keywords: *Nuclear energy, nuclear accident, Chernobyl, liability, compensation.*

INTRODUCTION

Since the discovery of nuclear energy, humanity has harnessed it across various fields, leveraging its abundance and diverse properties to achieve remarkable outcomes that surpass many other energy forms. However, this energy also harbors a perilous aspect, manifesting in the catastrophic risks associated with its use.

This study addresses the issue of nuclear accidents, representing one of the most formidable challenges in the peaceful utilization of nuclear energy. These incidents are among the primary hazards arising from the operation of nuclear reactors and facilities. The research focuses on analyzing this problem due to its profound significance and substantial impact on public safety and the environment, making it a central concern in discussions about the future and security of nuclear energy.

The study aims to elucidate the influence of nuclear accidents on the development and modernization of civil liability rules pertaining to nuclear damage, both internationally and nationally. It seeks to analyze how these incidents have shaped and amended legislation governing liability for damages resulting from nuclear activities. Additionally, the research examines the historical progression of these rules and how nuclear accidents have contributed to reinforcing legal safeguards to protect those affected by such damages.

RESEARCH METHODOLOGY

The study employs an analytical method to assess and elucidate the impact of nuclear accidents on the development of civil liability frameworks for nuclear damage at both international and national levels. This involves examining key nuclear incidents and how nations and international organizations have adapted their legislation and systems to address and mitigate the risks associated with such accidents.

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RISKS OF NUCLEAR ENERGY

Despite the numerous advantages that nuclear energy offers to humanity and the significant benefits it brings to states and individuals through its peaceful applications, it inherently poses some of the greatest threats known to humankind. The dangers associated with its use surpass all other risks encountered throughout history. Some suggest that the atom contains the seeds of immense troubles, potentially leading to catastrophic consequences. This has instilled a perpetual fear of an ever-present and terrifying threat. Others argue that the rapid industrial development of atomic energy entails unparalleled risks. Undoubtedly, the inherent dangers of peaceful nuclear energy use have caused many countries to hesitate in investing in this energy, given its distinct nature compared to other conventional risks. These dangers are novel due to the extensive spatial and temporal scope of their harmful effects and, as a result of being a new science, many of these effects remain largely unknown.

The damages resulting from certain nuclear accidents can lead to the release of highly hazardous radiation, posing significant threats to human life and the environment. Therefore, while nuclear energy offers substantial benefits, its use carries inherent risks that must be carefully managed. These risks include:

1- Risks Associated with Nuclear Reactor Operation:

Danger accompanies all stages of the nuclear fuel cycle, from uranium extraction to the final storage of radioactive waste. During uranium mining, hazards include traditional mining risks and radiation exposure.

Uranium enrichment involves metallurgical processes with associated dangers, particularly during fuel fabrication. Reactor operation risks may arise from routine malfunctions or external factors like earthquakes and volcanic activity. Additionally, storing spent nuclear fuel poses ongoing risks, as it remains hazardous and requires secure storage to prevent environmental contamination.

2- Risks Associated with Nuclear-Powered Vessels:

These vessels derive power from onboard reactors, presenting risks that exceed those of stationary reactors due to their mobility and the need for refueling. Visits of nuclear-powered ships to foreign ports necessitate special agreements addressing safety measures and civil liability in case of accidents.

3- Risks Associated with Radioactive Waste Disposal:

Managing radioactive waste is one of the most complex challenges in the peaceful use of nuclear energy, given the legal issues arising from its disposal.

These multifaceted risks represent the darker side of nuclear energy, accompanying its use across various stages from mining and extraction through manufacturing and operation to waste disposal. These dangers are inseparable from nuclear energy production and application in diverse fields.

DEFINITION OF NUCLEAR ACCIDENTS AND NOTABLE EXAMPLES

The definition of nuclear incidents or accidents has garnered significant attention at both the local and international regulatory levels. Legislations and international agreements have sought to address the concept of a nuclear accident and define it using a nearly unified terminology. The Saudi regulator defines a nuclear accident in Article (1) of the Civil Liability for Nuclear Damage Law as: "any incident, or series of incidents having the same origin, that causes nuclear damage, or creates a grave and imminent threat of such damage."

Similarly, the UAE law defines a nuclear incident in Article (1) of the Federal Decree-Law No. (4) of 2012 on Civil Liability for Nuclear Damage as: "any event, or series of events having the same origin, that causes nuclear damage, or creates a grave and imminent threat of such damage, solely in relation to preventive measures."

The Saudi definition aligns with that found in the Vienna Convention and its 1997 amending Protocol, as well as with the definition in Article I of the 1997 Convention on Supplementary

Compensation for Nuclear Damage, with the addition of the phrase "solely in relation to preventive measures."

This statutory definition does not differ substantially from that found in legal doctrine, where a nuclear accident is described as an act or series of acts having a common origin, resulting in the uncontrolled release of nuclear radiation leading to nuclear damage (Fath Al-Bab, 2016). Others have defined it as any act or series of acts stemming from the malfunctioning of operational systems in a nuclear facility or loss of control over nuclear materials, resulting in nuclear damage.

Nuclear accidents are closely tied to the nuclear energy industry and nuclear reactors and can take various forms. These may include explosions, fires, or the physical destruction and release of nuclear fuel rods from their containment. Additionally, the triggering acts may occur either within the facility—intentionally or unintentionally—or from external sources, such as attacks on the facility or natural disasters like earthquakes or hurricanes. Some scholars argue that most nuclear accidents have not been caused by equipment or system failures but rather by human error (Al-Jarallah, 1995; No'man, 2001; Al-Baroudi, 2012; Naderman, 2021).

Since the advent of nuclear energy, a number of nuclear accidents have occurred. However, their frequency has gradually decreased due to advancements in nuclear technology and improvements in both technical and regulatory nuclear safety and security standards.

In this context, it is important to discuss the most significant of these incidents. The Three Mile Island accident in Pennsylvania, USA, on March 28, 1979, was the first major crisis experienced by the nuclear industry. It served as a serious warning regarding the dangers of nuclear facilities if not operated under reliable safety protocols. The accident occurred due to a malfunction in the reactor's cooling system, resulting in the partial meltdown of the core and the release of radioactive materials into the environment. Approximately two million people were exposed to radiation, and cleanup costs were estimated to exceed $100 million.

This was followed by the Chernobyl disaster in 1986 in the former Soviet Union—the worst nuclear accident to date and the first major incident in a civilian nuclear facility. It resulted in the core meltdown and the emission of large quantities of radioactive materials that spread across vast areas of Eastern and Western Europe. The surrounding environment was severely contaminated, rendering large swathes uninhabitable and forcing the evacuation of around 115,000 people. The causes were attributed to human error and the absence of effective safety systems.

In 2011, the Fukushima Daiichi nuclear disaster in Japan was primarily triggered by overwhelming natural forces and is considered an exceptional event. However, human factors also contributed, as detailed in the 2015 report by the Director General of the International Atomic Energy Agency (Riyahi, 2016; Salam, 2017; Abu Basel, 2019).

These were not the only nuclear incidents. The world has witnessed numerous serious nuclear accidents over the years, spanning both civilian and military domains. On the civilian side, accidents have occurred in nuclear reactors and power plants. On the military side, nuclear testing by various countries has caused environmental and human disasters. Repeated nuclear tests have exacerbated the issue, leading to numerous accidents, some with severe consequences for both the environment and human health. In some cases, negligence or poor planning turned these tests into nuclear crimes, resulting in widespread contamination and human suffering. The world continues to suffer from the lasting impacts of some of these accidents, which have left deep scars on the affected regions.

The Impact of Nuclear Accidents on the International and National Regulation of Civil Liability for Nuclear Damage:

Despite the rarity of nuclear accidents resulting from the peaceful use of nuclear energy, such incidents continue to evoke significant concern among workers in nuclear facilities and the public alike. Over the

past fifty years, a limited number of major nuclear accidents—approximately fifteen—have occurred, most of which had no environmental impact beyond the immediate site and were effectively contained without any significant adverse effects on humans or the environment. However, four incidents—Windscale in the UK (1957), Three Mile Island in the US (1979), Chernobyl in Ukraine (1986), and Fukushima in Japan (2011)—posed substantial challenges in terms of liability and compensation due to their catastrophic scale and severity (Al-Baroudi, 2012; Salam, 2017; Al-Hilli, 2019).

The Chernobyl disaster, in particular, prompted legislative improvements and transformations in nuclear law. It became increasingly evident that international treaties and conventions—whose implementation relies on national legislation—played a central role. The incident served as a driving force, compelling countries to reassess their existing legal frameworks and introduce amendments as necessary based on the lessons of Chernobyl. Legal systems began operating with heightened rigor to reduce nuclear risks and prevent future accidents (Ahmed, 2016; Al-Baroudi, 2012).

The Chernobyl accident also prompted the international community to evaluate whether existing liability and compensation regimes effectively protected nuclear accident victims, particularly given the potential transboundary impacts on populations, property, and natural resources. Regulators acknowledged the need to maximize the geographical coverage of liability conventions by establishing a unified international liability regime for neighboring states (Al-Hajj, 2013). This incident motivated parties to the Paris and Vienna Conventions to update their provisions to ensure adequate protection for victims of nuclear accidents (Abu Amro, 2016). Consequently, the International Atomic Energy Agency (IAEA) convened a series of expanded meetings and conferences involving numerous member states and specialized international organizations. These efforts culminated in the adoption of two international agreements: the Convention on Early Notification of a Nuclear Accident and the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency (Abdul Latif, 2016).

The Fukushima incident, triggered by a magnitude 8.9 earthquake off eastern Japan on March 11, 2011, also prompted a strong response from the IAEA. In cooperation with Japan and relevant stakeholders, the agency organized a ministerial conference on nuclear safety and dispatched eight expert missions to Japan between 2011 and 2015 to support collaboration, monitoring, and improvements to the global nuclear safety framework (Abdel Qader, 2011; Boukarita, 2017).

Notably, civil liability rules for nuclear damage were applied under Japanese domestic law in the Fukushima case, as Japan is not a party to any international convention on nuclear civil liability. However, Japan's national legal framework is notably comprehensive. Law No. 147 of 2009 concerning compensation for nuclear damage and Law No. 148 of 2009 concerning compensation agreements, along with Executive Decrees No. 44 and No. 45 implementing those laws, place liability squarely on the nuclear operator. As of June 20, 2014, the operating company had received approximately 2.2 million compensation claims from both individuals and businesses (Abdul Latif, 2019).

These developments indicate a stabilization of international principles governing civil liability for nuclear damage and a clear trend toward enhancing nuclear safety, security, and peaceful use.

At the national level, most domestic nuclear liability laws were enacted after the establishment of international nuclear agreements. A common characteristic of these national systems is their strong influence by the principles and concepts established by international conventions, which have come to form the general framework for nuclear civil liability both internally and externally. Consequently, national regulations, particularly regarding fundamental principles and core rules, have come to mirror the international regime (Abd Al-Aal, 2008).

In conclusion, the catastrophic risks and legal challenges posed by nuclear accidents have compelled both international and national regulators to work in parallel to develop and modernize nuclear liability frameworks. These efforts aim to ensure that such frameworks are appropriately tailored to the unique

and exceptional nature of nuclear risks, which differ fundamentally from conventional hazards. Moreover, they seek to address legal gaps revealed by previous nuclear incidents and to establish comprehensive rules covering all aspects of liability and compensation in this sensitive domain. This approach reflects a pressing need for an integrated legal framework capable of addressing the unprecedented challenges posed by the nuclear industry at both the national and international levels.

FINDINGS

The findings of this study highlight the role of nuclear accidents in shaping and advancing the rules governing civil liability for nuclear damage at both the international and national levels. The key findings are as follows:

1. Nuclear accidents resulting from the peaceful use of nuclear energy are rare and infrequent, yet they remain a significant source of concern for both workers in nuclear facilities and the general public.
2. The Chernobyl disaster played a major role in driving changes and improvements in nuclear legislation, serving as a catalyst for countries to reassess their nuclear energy laws and regulations.
3. Nuclear accidents have led to the broadening of the geographical scope of liability conventions to the greatest extent possible, through the establishment of an international liability framework covering all neighboring countries.
4. These incidents were instrumental in the adoption of the Convention on Early Notification of a Nuclear Accident and the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency.
5. Nuclear accidents contributed to an accelerated focus on strengthening nuclear usage, security, safety, and protection measures.

RECOMMENDATIONS

Based on the findings derived from the study on the role of nuclear accidents in the development of civil liability rules for nuclear damage at both the international and national levels, the following recommendations can be proposed:

1. It is essential to fully implement all aspects of nuclear security and safety across all nuclear facilities.
2. Every state must fulfill its national and international obligations concerning the possession and use of nuclear energy.
3. All countries should accede to the Convention on Early Notification of a Nuclear Accident and the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency.
4. Nuclear reactors and power plants should be established in locations that are remote from populated and vital areas.

ACKNOWLEDGMENT

The authors are thankful to the Deanship of Graduate Studies and Scientific Research at Najran University for funding this work under the Growth Funding Program grant code (NU/GP/SEHRC/13/121-1)

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