International Journal of Nuclear Security

Volume 8
Number 2 *IJNS and NSW Special Issue: Women in Nuclear Security*

Article 10

10-2023

Nuclear Security in Conflict Zones: The Dangerous Case of Zaporizhzhia

Maria Kurando
Odesa I.I. Mechnikov National University, Institute for Peace Research and Security Policy (IFSH) - University of Hamburg

International Journal of Nuclear Security, Vol. 8, No. 2, 2023—IJNS and NSW Special Issue: Women in Nuclear Security

Nuclear Security in Conflict Zones: The Dangerous Case of Zaporizhzhia

Maria Kurando
Odesa I. I. Mechnikov National University
Institute for Peace Research and Security Policy, University of Hamburg

Abstract

As critical components of a state's energy supply, nuclear power plants (NPPs) can become strategic and tactical targets in military conflicts—or can suffer collateral damage as a result of shelling in the vicinity. Military action jeopardizes the peaceful use of nuclear facilities and hinders their safe and secure operation, increasing the risks of dangerous forces releases. Nuclear security constitutes defense against a vast range of threats, such as theft and illicit trafficking of nuclear and other radioactive materials, their use by non-state actors, nuclear and radiological terrorism, and attacks on nuclear facilities. However, the case of hostilities around Zaporizhzhia NPP in Ukraine signals the emergence of a new, particularly dangerous threat that nuclear security has not explicitly addressed before—a threat from a state actor. Although this hazard has been considered in the framework of international humanitarian law, particularly in Additional Protocols I and II to the 1949 Geneva Conventions, the ongoing attacks on Ukrainian nuclear facilities reveal the absence of effective international mechanisms to mitigate critical incidents such as the one currently unfolding in Ukraine. This article explores the shortcomings of existing international mechanisms addressing the protection of civil nuclear installations during wartime and presents paths for their improvement. The article also emphasizes the necessity of developing multilateral and additional bilateral safety and security measures for times of conflict, as well as international standards to ensure the fulfillment of a state's nuclear security responsibilities.

Keywords: nuclear security, Zaporizhzhia, ZNPP, military action, state actor, IHL

DOI: 10.7290/ijns372553

International Journal of Nuclear Security, Vol. 8, No. 2, 2023—IJNS and NSW Special Issue: Women in Nuclear Security

1. Introduction

Russia's brutal attack on Ukraine, the takeover of the decommissioned Chornobyl nuclear power plant (NPP), and military activity in proximity to Ukrainian nuclear facilities revealed a lacuna in the international legal framework on the protection of nuclear installations in armed conflicts. Concerns intensified when the Russian forces took control over the Zaporizhzhia NPP (ZNPP) in early March 2022. The probability of a nuclear disaster occurring owing to military activity and hostilities near nuclear installations appeared to be closer to reality than just a hypothesis.

The nuclear domain is constantly faced with challenges—existing and emerging. One of the most concerning aspects is the nuclear security of nuclear installations, which can be severely impacted by a terrorist attack, criminals, and sabotage, leading to deadly consequences. Therefore, traditional approaches to nuclear security have been aimed at physical protection. However, new challenges are arising, signaling that the existing nuclear security scope is not enough to handle emerging threats [1]. The large-scale Russian invasion of Ukraine and the hazardous atmosphere around Ukrainian nuclear facilities are additional evidence of the need to develop mechanisms and instruments to deal with threats that military action poses to the secure and safe operation of NPPs.

Although frequently overlapping, nuclear safety and nuclear security have different objectives. Nuclear security focuses on anticipating and thwarting all deliberate malicious actions that can lead to radiological consequences [2], as well as the physical protection of nuclear materials and related facilities. Nuclear safety primarily addresses unintended risks caused by human errors, system failures, or natural disasters [3]. The crisis in Ukraine demonstrates how blurry these distinctions become in wartime [4].

Although nuclear facilities are not designed to withstand military action, several cases have occurred where such installations fell under attack (in Iraq [5] and Syria [6]) and were in the middle of war operations (in Slovenia [7]). Despite these cases, an international legal framework on protecting nuclear installations was not developed to effectively deal with incidents of this kind. The provisions of Additional Protocols I and II to the Geneva Conventions are criticized for ambiguity [8, 9, 10], and documents in the area of nuclear security either do not explicitly address threats from state actors [11] or do not provide comprehensive security recommendations for countries with war or conflict in their territories [12]. The mandate of the International Atomic Energy Agency (IAEA) is also limited in this regard.

The nuclear security regime requires immediate attention because of the unfolding crisis in Ukraine and the number of other potentially dangerous areas where nuclear installations are located and might be targeted in case of an armed conflict [8], including by state actors.

2. Legal Framework on Protection of Nuclear Installations in War Conditions

Attacks on nuclear facilities during wartime are outlined in several documents (i.e., provisions of international humanitarian law [notably, Additional Protocols I and II to the

DOI: 10.7290/ijns372553

1949 Geneva Conventions [13], resolutions of the IAEA General Conference [GC(XXVII)/RES/407 (1983) [14], GC(XXIX)/RES/444 (1985) [15], GC(XXXIV)/RES/533 (1990) [16], and Decision GC(53)/DEC/13 (2009) [17]]).

International humanitarian law is a set of rules that protect those who do not or have ceased to take a direct part in hostilities during an armed conflict and applies to international and non-international armed conflicts. Any conduct of hostilities must follow international humanitarian law; thus, the law applies to the war in Ukraine [18].

Article 56 of the Additional Protocol I to the Geneva Conventions [13] directly addresses the protection of installations containing dangerous forces, including "nuclear electrical generating stations" [13]. Sentence 1 of Article 56 stipulates that nuclear electrical-generating stations should not be attacked even in cases where they are military objectives. It is also later specified that the prohibition applies to attacks that may cause the release of dangerous forces and thus severely affect the civilian population [13]. However, since the Russian takeover of ZNPP, Article 56 has been criticized for contradictory interpretations [8, 9, 10] of when civil nuclear facilities require special protection against attacks based on facilities' military necessity, as well as a nonexhaustive list of facilities containing dangerous forces that should not be targeted in military action.

The ambiguity lies within the unclear definition of the terms *severe* and *dangerous* [13], as well as provisions of Article 56(2) of Additional Protocol I, which specifies cases when the special protection of a nuclear installation shall cease, in particular, "if it provides electric power in regular, significant and direct support of military operations and if such attack is the only feasible way to terminate such support" [13]. Such ambiguity might facilitate ill interpretations of the Article's provisions and can be exploited by combatants to consider nuclear facilities as a legitimate target in armed conflict [4].

The Article also does not include other facilities containing dangerous forces that should not be targeted in a military attack (i.e., research reactors, spent fuel storage, reprocessing plants, and transportation of nuclear materials) [11]. Although the reference to "nuclear electrical generating stations" was intended to serve as an illustration rather than a limitation, the aspect of extending the Protocols to other facilities should be revised [19].

The role of the IAEA General Conference resolutions and decisions should be considered within the boundaries of its authority. As an international organization with a technical mandate, the IAEA is unable to adopt legally binding resolutions [4, 11]. Similarly, despite the IAEA plea for the establishment of a nuclear safety and security protection zone [20] around Ukrainian nuclear facilities being the most prudent solution to the unfolding crisis, the IAEA cannot compel a country to cease military activities or impose a demilitarized zone [4].

DOI: 10.7290/ijns372553

The other document that seems to apply to the protection of nuclear facilities in war conditions is the IAEA Convention on the Physical Protection of Nuclear Material (CPPNM) [21]. However, similar to other legal instruments in the area of nuclear security, the CPPNM does not address threats from state actors and does not cover scenarios of nuclear facilities located in zones of armed conflict, frozen conflict, or war [12]. Moreover, the 2005 Amendment to the CPPNM clearly states, "The activities of armed forces during an armed conflict…are not governed by this Convention, and the activities undertaken by the military forces of a State in the exercise of their official duties, inasmuch as they are governed by other rules of international law, are not governed by this Convention" [22]. The shortcomings in the existing framework trigger debate on the need to establish new standards with unambiguous legal prohibitions against attacks on nuclear installations during wartime [8] or to adopt a new convention [11] in this regard. However, possibly aiming for a new international legal framework also has its shortcomings.

First, creating a new international legal framework could lead to more complexity, which starts with the commitment to a new convention [23]. The variety of instruments to choose will only lead to more legal questions—not regarding whether NPPs may be legally targeted but which rules to follow. Another question would pertain to the success of adopting such a convention and the future composition of signatories. The Russian occupation of ZNPP boosted debate on upgrading the international legal framework, but if a new convention took place, would Russia join? The same question applies to Israel, which has targeted nuclear installations before [5, 6], as well as other nuclear power states located in conflict-prone regions.

Second, it is not the ambiguity of the existing legal base that is a problem but compliance with it. Enforcement mechanisms are lacking in international law, but it is challenging to envision more profound international actions in this regard. The same lack of enforcement is true about the nuclear security regime. Nuclear security rests with each state, which implies a national responsibility to implement necessary measures to protect their nuclear installations. However, an international mechanism is needed to ensure states' adherence and fulfillment of their nuclear security responsibilities because the consequences of noncompliance are dangerous and extend beyond the affected state [11].

Adopting a new international legal framework would most likely be a cumbersome undertaking, which makes it more pressing to extend and strengthen the existing regime, especially on a bilateral or regional basis. Two examples of such mechanisms are the 1996 Pelindaba Treaty [24] and the 1988 Agreement on the Prohibition of Attack against Nuclear Installations and Facilities [25] concluded between India and Pakistan. These two agreements are the only treaties of their kind, lack ambiguity, and contain explicit prohibitions of the attack on nuclear installations. Despite the limited application area, these agreements can be particularly relevant, demonstrating a possible path for complementing the existing framework and preventing incidents such as the one unfolding in Ukraine.

DOI: 10.7290/ijns372553

3. The Dangerous Case of Zaporizhzhia

As essential components of a state's energy supply, NPPs can become strategic and tactical targets in armed conflict or suffer collateral damage. The destruction of such facilities may provide a military advantage by destabilizing an adversary's logistics and provisioning [4]. However, any advantage vanishes amid possible radiation releases and subsequent radioactive contamination affecting the civilian population of the attacked state and beyond.

During the first 6 months of combat, the nuclear safety and security of the ZNPP were a constant focus of the IAEA. The world witnessed worrisome news about the fires on the site, allegations of the Russian forces deploying heavy weapons at the facility and turning it into a military base, the hostile working environment for personnel of the ZNPP, and more [26].

In this regard, a huge step forward has been taken by allowing the IAEA team on-site at the beginning of September 2022 [27]. IAEA Director General Raphael Grossi personally led a mission of 13 experts who visited ZNPP. At the time, the largest NPP in Europe had already been under fire for weeks [28]. Not only was the team of experts able to assess the physical damage to the facilities and the operability of backup security and safety systems, but it also provided unbiased information on an actual situation at the site.

According to the IAEA report published as the result of the visit, all seven pillars of nuclear safety and security were violated at ZNPP: the physical integrity of the plant were compromised; the functionality of safety systems were disrupted; personnel were forced to work under difficult conditions and constant pressure; the power supply from the external grid was disrupted; supply chains were interrupted; problems occurred with scheduled radiation monitoring, emergency preparedness, and response measures; and communication with regulators was disrupted [29].

Although IAEA experts found no critical damage to the plant that could significantly affect radiation safety [29], continued shelling can escalate the situation quickly. One of the major concerns in this regard is access to the secure off-site power supply for all NPPs, which can easily be interrupted by military activity. Access to external electricity is vital for cooling the fuel rods and preventing the reactor core from overheating, even if shut down, as overheating can lead to a potential nuclear catastrophe [4].

Since the war began, ZNPP has suffered multiple connection losses to its external power line. The most prominent one, which happened in November 2022, was particularly dangerous for the ZNPP and all 15 power reactors at four nuclear power plants in Ukraine. IAEA Director General Grossi noted that it was the first time in history that all the plants had lost external power simultaneously [30].

Although the access to off-site power was restored on all previous occasions, the situation can change drastically, and the atmosphere at the site remains precautious. Director General Grossi repeatedly emphasizes the necessity of implementing a nuclear

DOI: 10.7290/ijns372553

safety and security protection zone around the facility. Despite the fact that consultations with Ukrainian and Russian officials in this regard continue [31], visible results have yet to be reached.

One of the main outcomes of the organization's September 2022 visit to ZNPP was the establishment of the IAEA Support and Assistance Mission to Zaporizhzhya. Permanent IAEA nuclear safety and security missions are currently present at all of Ukraine's nuclear facilities [32], which is an outstanding achievement but not enough to cease military activity and protect installations from shelling.

Currently, all six of the ZNPP's reactors are shut down, and one is in hot shutdown, supplying the plant and the city of Enerhodar. The plant is connected to the last operating 750 kV main external power line, which remains fragile, with one 330 kV backup line and 20 diesel generators available for electricity supply [33].

4. Lessons Learned

The case of hostilities at and around the ZNPP highlights existing threats that war poses to NPPs and signals the emergence of new challenges to nuclear security. First, nuclear facilities are not designed to withstand large-scale combat actions [34]. For the first time, we are witnessing a full-scale war around an NPP, as well as the occupation of it. Blackouts of Ukrainian power reactors emphasize the primary vulnerability of nuclear energy—the challenge of keeping reactors cooled when a secure connection to the power grid cannot be ensured.

Second, the Russian invasion and occupation of the ZNPP have jeopardized its safe and secure operation. However, nuclear security does not explicitly address threats from state actors. The preventive methods were designed in response to 9/11; thus, nuclear security is primarily focused on theft and illicit trafficking of nuclear and other radioactive materials, their use by non-state actors, nuclear and radiological terrorism, insider threats, and criminal attacks on nuclear facilities [35]. It does not cover threats from state actors in a state of war, thus making developing defense mechanisms and implementing protection measures problematic.

Third, no international mechanisms exist to effectively mitigate dangerous incidents such as the one unfolding in Ukraine. Although several international documents address attacks on nuclear installations during wartime, they lack enforcement mechanisms or are considered to contain ambiguous provisions.

Moreover, as the second largest source of low-emissions power, nuclear power provides approximately 10% of the world's electricity and will continue to play an indispensable role in global low-carbon energy production [36, 37]. Nuclear power capacity is constantly increasing, with approximately 60 reactors under construction, including in countries located in conflict-prone regions [36].

DOI: 10.7290/ijns372553

The lessons of Zaporizhzhia and the increasing use of nuclear power mark the need to revise the understanding of nuclear dangers and develop mechanisms to prevent dangerous incidents such as the one unfolding in Ukraine.

5. International Experience and Ways Out

Ukraine is not the first example of attacks on nuclear facilities conducted by state actors. Iran, Iraq, Israel, and the United States have previously launched attacks on nuclear facilities. In 1980, while still under construction, the Osirak research reactor in Iraq was targeted by Iran. Only a year later, in 1981, the same reactor was destroyed by Israel [38], with claims that it was a part of Iraq's nuclear weapons program. The same reasoning was used by the United States during the First Gulf War when two research reactors were destroyed at the Iraqi Tuwaitha Center [39]. Iraq itself launched attacks on Iran's two Bushehr power reactors. Other incidents include the Krško NPP in Slovenia [7], which was in the middle of a war operation in 1991, and the al-Kibar reactor in Syria in 2007, destroyed by Israeli air force [6].

Notably, the taboo on bombing live reactors was established after the 1981 operation on Osirak, so the subsequent attacks generally adhered to this informal norm [40]. However, the concern about nuclear safety and security in the Middle East prevails. Considering the region is prone to high conflict and has numerous examples of past crisis incidents, the future of nuclear facilities amid an intensification of conflicts is worrisome.

In this vein, the potentially dangerous cases include Israel's Dimona military reactor, portrayed as a target during Iran's extensive military simulation [41], which was a concern for Israel; Iran's Bushehr reactor; and Taiwanese Kuosheng and Longmen NPPs, which are also insecure because of possible military invasion plans by China [42]. Moreover, Ukraine's reactor fleet will be expanded with the construction of nine new AP1000 units as a part of the recent Westinghouse deal [43].

All these cases require separate solutions, which are not easily reached. However, there are possible paths for improvement. For instance, because tensions in the Middle East represent a regional problem, the security of nuclear installations could be facilitated through negotiations on a Middle East nuclear weapon–free zone treaty. Specifically, by the inclusion of the same provision as in Article 11 of the Pelindaba Treaty on the prohibition of armed attacks on nuclear installations, "Each Party undertakes not to take, or assist, or encourage any action aimed at an armed attack by conventional or other means against nuclear installations in the African Nuclear-Weapon-Free Zone" [24].

Another example of instability comes from Indian–Pakistani relations. Considering Pakistan's precarious security situation because of its rivalry with India, its experience might be particularly relevant for Ukraine and other cases where interstate tensions and the looming threat of military conflict severely affect nuclear security. Existing in a volatile and distrustful atmosphere and being one of the most terror-prone and politically unstable countries in the world [44], Pakistan is facing massive challenges to nuclear

DOI: 10.7290/ijns372553

security [45]. One of the most pressing concerns is the security of Pakistan's nuclear facilities in case of a military conflict with India.

By the early 1980s, Pakistan already had three wars with India. In late 1986–early 1987, the relations between the two countries were particularly tense because of Operation Brasstacks [46], a military exercise held by India. A massive number of Indian Army personnel, including the Navy and Air Force, were mobilized and deployed at the border. Such actions urged Pakistan to begin countermobilization with claims that India would allegedly attempt to strike Pakistan's nuclear installations [46].

Notably, in 1981, there were allegations that India, following the Israeli example, would launch an attack at the nuclear enrichment site at Kahuta [47]. The concern that allegedly prevented India from such action included the fear of Pakistan's retaliatory air strike on the Bhabha Atomic Research Center, which was possible because of the earlier Pakistan's acquisition of the US F-16 fighter jets—the same type that the Israeli used during the attack on Osirak reactor in Iraq [47]. The operation and the tension it brought resulted in negotiations between the two countries and an essential confidence-building measure—the signing of the Agreement on Prohibition of Attacks on Nuclear Installations and Facilities in 1988 [25]. The relevance of the Agreement derives from the clear and comprehensive prohibition of the attacks and the extensive list of facilities that shall not be impacted:

> i. Each party shall refrain from undertaking, encouraging or participating in, directly or indirectly, any action aimed at causing the destruction of, or damage to, any nuclear installation or facility in the other country.
>
> ii. The term 'nuclear installation or facility' includes nuclear power and research reactors, fuel fabrication, uranium enrichment, iso-topes separation and reprocessing facilities as well as any other installations with fresh or irradiated nuclear fuel and materials in any form and establishments storing significant quantities of radioactive materials [25].

Another essential detail is stated in the second clause and requires the parties to provide an annual information report on "the latitude and longitude of nuclear installations and facilities and whenever there is any change" [25]. The most recent exchange of the nuclear installations lists took place on January 1, 2023 [48]. Notably, for the 32 years since the practice was established, no interruption of exchanges has occurred, despite the intensification of tension, such as during the Kargil war or border skirmishes on the Line of Control in 2020–2021.

A combination of two factors influenced Pakistan's national nuclear security policy: a recognition of mutual vulnerabilities, which facilitated the agreement with India, and Pakistan's assessing India as a threat to its very existence. Following the Indian–Pakistani experience, threats from state actors could be addressed during states' national nuclear security threat assessment [2]. This address can be particularly relevant for nuclear-generating countries located in conflict zones and would facilitate

DOI: 10.7290/ijns372553

the adoption of bilateral agreements on an attack prohibition between potential adversaries.

6. Design Basis Threat and Its Role in the Protection of Nuclear Installations during Armed Conflicts

After the 9/11 terrorist attacks, the urgent need to enhance nuclear security was promoted, bringing attention to issues related to all malicious actions, which could lead to radiological consequences [49]. However, nuclear security faces challenges. The absence of international standards and mechanisms to ensure the fulfillment of states' nuclear security responsibilities, as well as the lack of consensus among states on the significance of nuclear security and threats credibility [50], creates vulnerabilities that could be exploited in conflicts by state and non-state actors.

National governments are responsible for the security of their nuclear facilities and the implementation of necessary protection measures. According to Fundamental Principle G of the Amendment to the CPPNM, "The State's physical protection should be based on the State's current evaluation of the threat" [22]. In this regard, the IAEA advises national authorities on best practices in the IAEA Nuclear Security Series, namely in the implementation guide, *National Nuclear Security Threat Assessment, Design Basis Threats and Representative Threat Statements* [51].

The evaluation outlines the credible threats to the state's nuclear installations and activities involving nuclear materials. Further action requires the state to create threat scenarios, known as design basis threats (DBTs), from which nuclear facilities should be protected [51].

A DBT provides detailed characteristics of potential adversaries with consideration of specificities of protected nuclear facilities and radioactive materials. Such adversaries include external actors (e.g., individuals attempting sabotage on nuclear facilities and/or theft) and insider threats (e.g., those with authorized access to nuclear materials and/or sensitive data, who may act together with the external actors). The main risk is considered to come from various sources, including extremists, criminals, and terrorists [51]. The operator's nuclear security systems are designed and tested based on the DBT.

The national nuclear security threat assessment usually echoes national security. For instance, Ukraine has constantly updated its legal framework based on threat evaluation, and the war in the Donbas region had major implications on the state's national nuclear security policy after 2014 [12]. The first revised *DBT for Nuclear Installations, Nuclear Materials, Radioactive Waste and Other Sources of Ionizing Radiation in Ukraine* was issued in August 2015. The report included a DBT assessment with a view on military aggression, the potential deployment of Russian tactical nuclear weapons in the Autonomous Republic of Crimea, and the presence of armed groups in the eastern part of the country aimed at destabilizing the internal situation [12].

DOI: 10.7290/ijns372553

Ukrainian officials took appropriate measures to protect nuclear facilities according to the *Action Plan of Energoatom on the Realization Concept of Combating Terrorism in NPPs from 2014 through 2020* [12]. However, the protection measures were not developed to mitigate risks from a possible large-scale military conflict at or in the vicinity of nuclear installations. The latest edition of the *DBT for Nuclear Installations, Nuclear Materials, Radioactive Waste and Other Sources of Ionizing Radiation in Ukraine* was adopted in 2019 and is being revised considering threats from the Russian invasion [52].

Because military battles and state actors hinder the nuclear security regime, viewing nuclear security as closely related to intrastate and interstate conflict may be relevant. The existing threat assessment mechanisms could be used to enhance the security of nuclear installations in war conditions. On the basis of threat evaluation, states could then gradually implement corresponding legal and regulatory frameworks at bilateral or regional levels. These frameworks are vital for the states with nuclear facilities and radioactive materials located in conflict-prone regions.

After threat evaluation with a view on national security objectives, an agreement on the prohibition of attacks on nuclear facilities, similar to the one India and Pakistan have in place, could be adopted between Ukraine and Russia. That agreement might have given a chance to prevent the hostilities around Ukrainian NPPs and facilitate the establishment of the demilitarized zone. The same example can be followed in other potentially dangerous zones, as well.

7. Conclusion

The Russian large-scale military invasion of Ukraine and the dangerous case of Zaporizhzhia showed how a state actor can jeopardize the national nuclear security regime and reveal its weaknesses. Existing international instruments on protecting nuclear installations and radioactive materials are not complete and sufficient enough for such incidents and require the instruments to be complemented and updated.

Given the disastrous implications of nuclear accidents, states should focus on reaching a consensus and fostering the development of a legal framework for the strict prohibition of attacks on nuclear facilities. Such an agreement should also include instruments of control on the state's compliance and definition of transparency level in sharing information to promote nuclear security. To facilitate such paths, the IAEA should consider issuing practical recommendations for developing DBT in countries with armed conflict on their territories (possibly involving a state-actor) in its information circulars, possibly as a part of the Nuclear Security Series.

It is fair to state that no bilateral or regional instruments can prevent attacks on nuclear facilities; however, the experience suggests that international humanitarian law cannot do it either. On a world map, plenty of nuclear-generating countries are located in conflict-prone zones that are likely to remain tense for years ahead. This reality adds value to the creation of adequate national nuclear security threat assessments and

DOI: 10.7290/ijns372553

understanding vulnerabilities, leading to mutual peace-preserving actions or implementing a code of conduct in military planning based on formal agreements.

8. References

1. Dewey, K.; Foster, G.; Hobbs, C.; Salisbury, D. *Nuclear Security Culture in Practice: A Handbook of UK Case Studies*; Centre for Science and Security Studies, King's College London: London, UK, 2021. https://www.kcl.ac.uk/csss/assets/nuclear-security-culture-in-practice-2021.pdf (accessed 2023-02-28).
2. International Atomic Energy Agency. *Design Basis Threat (DBT).* https://www.iaea.org/topics/security-of-nuclear-and-other-radioactive-material/design-basis-threat (accessed 2023-02-28).
3. Khripunov, I. *Nuclear safety vs. security: Can the two cultures be harmonized?*, 2018. Bulletin of the Atomic Scientists. https://thebulletin.org/2018/07/nuclear-safety-vs-security-can-the-two-cultures-be-harmonized/ (accessed 2023-02-28).
4. Kurando, M. *The Case of Zaporizhzhia: Making International Nuclear Safety and Security Fit for Conflict*, 2022. Institute for Peace Research and Security Policy at the University of Hamburg. https://ifsh.de/en/news-detail/the-case-of-zaporizhzhia-making-international-nuclear-safety-and-security-fit-for-conflict (accessed 2023-02-28).
5. Shipler, D. Israeli Jets Destroy Iraqi Atomic Reactor; Attack condemned by U.S. and Arab Nations. *The New York Times,* June 9, 1981. https://www.nytimes.com/1981/06/09/world/israeli-jets-destroy-iraqi-atomic-reactor-attack-condemned-us-arab-nations.html (accessed 2023-02-28).
6. Bateman, T. Israel Admits Striking Suspected Syrian Nuclear Reactor in 2007. *BBC News*, March 21, 2018. https://www.bbc.com/news/world-middle-east-43481803 (accessed 2023-02-28).
7. Stritar, A.; Mavko, B. Vulnerability of the Nuclear Power Plant in War Conditions. In First Meeting of the Nuclear Society of Slovenia, Bovec, Slovenia, June 11–12, 1992. https://www.osti.gov/etdeweb/servlets/purl/20892171.
8. Rodriguez, L.; Sukin, L. *Russian actions at Zaporizhzhia show need for better legal protections of nuclear installations*, 2022. Bulletin of the Atomic Scientists. https://thebulletin.org/2022/10/russian-actions-at-zaporizhzhia-show-need-for-better-legal-protections-of-nuclear-installations/ (accessed 2023-02-28).
9. Carlson, J. *Prohibition of Military Attacks on Nuclear Facilities*, 2022. Vienna Center for Disarmament and Non-Proliferation. https://vcdnp.org/wp-content/uploads/2022/09/Attacks-on-nuclear-facilities.pdf (accessed 2023-02-28).
10. Dienelt, A. How Are Nuclear Power Plants Protected by Law during War? *Völkerrechtsblog* **2022**. DOI: 10.17176/20220308-000934-0.
11. Alkış, A. *Nuclear security during armed conflict*, 2022. Stimson. https://www.stimson.org/2022/nuclear-security-during-armed-conflict/ (accessed 2023-02-28).
12. Chumak, D. The implications of the Ukraine conflict for national nuclear security policy. *EU Non-Proliferation Consortium Non-Proliferation Papers*, November 2016, 53, 1–14. https://www.sipri.org/sites/default/files/Implications-Ukraine-conflict-national-nuclear-security-policy.pdf.

DOI: 10.7290/ijns372553

13. International Committee of the Red Cross. *Protocols Additional to the Geneva Conventions of 12 August 1949*; International Committee of the Red Cross: Geneva, 2010. https://www.icrc.org/en/doc/assets/files/other/icrc_002_0321.pdf (accessed 2023-02-28).
14. International Atomic Energy Agency General Conference. *Resolution Adopted during the 256th Plenary Meeting on 14 October 1983*; 1983; Vol. GC(XXVII)/RES/407. https://www.iaea.org/sites/default/files/gc/gc27res-407_en.pdf (accessed 2023-08-01)
15. International Atomic Energy Agency General Conference. *Protection of nuclear installations devoted to peaceful purposes against armed attacks*; 1985; Vol. GC(XXIX)/RES/444. https://www.iaea.org/sites/default/files/gc/gc29res-444_en.pdf (accessed 2023-08-01).
16. International Atomic Energy Agency General Conference. *Resolution Adopted during the 332nd Plenary Meeting on 21 September 1990*; 1990; Vol. GC(XXXIV)/RES/533. https://www.iaea.org/sites/default/files/gc/gc34res-533_en.pdf (accessed 2023-08-01).
17. International Atomic Energy Agency General Conference. *Decision Adopted on 18 September 2009 during the eleventh Plenary Meeting*; 2009; Vol. GC(53)/DEC/13. https://www.iaea.org/sites/default/files/gc/gc53dec-13_en.pdf (accessed 2023-08-01).
18. International Committee of the Red Cross. *What is international humanitarian law?*, 2022. International Committee of the Red Cross. https://www.icrc.org/en/document/what-international-humanitarian-law (accessed 2023-02-28).
19. Lamm, V. *Protection of civilian nuclear installations in time of armed conflict*. https://www.oecd-nea.org/law/nlb/nlb-72/029_038.pdf (accessed 2023-02-28).
20. Marais, E.; Madsen, M. *UN Security Council: IAEA Grossi Calls for Establishment of Nuclear Safety and Security Protection Zone at Zaporizhzhya NPP*, 2022. International Atomic Energy Agency. https://www.iaea.org/newscenter/news/un-security-council-iaea-grossi-calls-for-establishment-of-nuclear-safety-and-security-protection-zone-at-zaporizhzhya-npp (accessed 2023-02-28).
21. International Atomic Energy Agency. *Convention on the Physical Protection of Nuclear Material*; INFCIRC/274/Rev. 1; International Atomic Energy Agency: Vienna, 1980. https://www.iaea.org/sites/default/files/infcirc274r1.pdf.
22. International Atomic Energy Agency. *Amendment to the Convention on the Physical Protection of Nuclear Material*; INFCIRC/274/Rev.1/Mod.1 (Corrected); International Atomic Energy Agency: Vienna, 2005. https://www.iaea.org/sites/default/files/publications/documents/infcircs/1979/infcirc274r1m1c.pdf.
23. Onderco, M.; Egger, C. *Why a new convention to protect nuclear installations in war is a bad idea*, 2022. Bulletin of the Atomic Scientists. https://thebulletin.org/2022/12/why-a-new-convention-to-protect-nuclear-installations-in-war-is-a-bad-idea/ (accessed 2023-02-28).
24. International Atomic Energy Agency. *The African Nuclear-Weapon-Free Zone Treaty (The Treaty of Pelindaba)*, 2009. International Atomic Energy Agency.

DOI: 10.7290/ijns372553

https://www.iaea.org/publications/documents/treaties/african-nuclear-weapon-free-zone-treaty-pelindaba-treaty (accessed 2023-02-28).
25. Center for Non-Proliferation Studies. Agreement Between India and Pakistan on the Prohibition of Attack Against Nuclear Installations and Facilities (India-Pakistan Non-Attack Agreement, 1988), 2023. Center for Non-Proliferation Studies. https://www.nti.org/wp-content/uploads/2021/09/india_pakistan_non_attack_agreement.pdf (accessed 2023-02-28).
26. Tobias, B.; Peter, L. Zaporizhzhia: Russian Rockets Damaged Part of Nuclear Plant, Ukraine Says. *BBC*, August 5, 2022. https://www.bbc.com/news/world-europe-62432873 (accessed 2023-02-28).
27. Madsen, M. *IAEA Support and Assistance Mission Sets Out to Zaporizhzhya Nuclear Power Plant in Ukraine*, 2022. International Atomic Energy Agency. https://www.iaea.org/newscenter/news/iaea-support-and-assistance-mission-sets-out-to-zaporizhzhya-nuclear-power-plant-in-ukraine (accessed 2023-02-28).
28. International Atomic Energy Agency. *Update 96—IAEA Director General Statement on Situation in Ukraine*, 2022. International Atomic Energy Agency. https://www.iaea.org/newscenter/pressreleases/update-96-iaea-director-general-statement-on-situation-in-ukraine (accessed 2023-02-28).
29. International Atomic Energy Agency. *Nuclear Safety, Security and Safeguards in Ukraine. 2nd Summary report by the Director General, 28 April–5 September 2022*. International Atomic Energy Agency: Vienna, 2022. https://www.iaea.org/sites/default/files/22/09/ukraine-2ndsummaryreport_sept2022.pdf (accessed 2023-02-28).
30. International Atomic Energy Agency. *Update 132—IAEA Director General Statement on Situation in Ukraine*, 2022. International Atomic Energy Agency. https://www.iaea.org/newscenter/pressreleases/update-132-iaea-director-general-statement-on-situation-in-ukraine (accessed 2023-02-28).
31. International Atomic Energy Agency. *Update 146—IAEA Director General Statement on Situation in Ukraine*, 2023. International Atomic Energy Agency. https://www.iaea.org/newscenter/pressreleases/update-146-iaea-director-general-statement-on-situation-in-ukraine (accessed 2023-02-28).
32. International Atomic Energy Agency. *IAEA Missions Established at All Nuclear Power Plants Across Ukraine*, 2023. International Atomic Energy Agency. https://www.iaea.org/newscenter/multimedia/videos/iaea-missions-established-at-all-nuclear-power-plants-across-ukraine (accessed 2023-02-28).
33. International Atomic Energy Agency. *Update 175—IAEA Director General Statement on Situation in Ukraine*, 2023. International Atomic Energy Agency. https://www.iaea.org/newscenter/pressreleases/update-175-iaea-director-general-statement-on-situation-in-ukraine (accessed 2023-08-01).
34. Acton, J. *The Most Immediate Nuclear Danger in Ukraine Isn't Chernobyl*, 2022. Carnegie Endowment for International Peace. https://carnegieendowment.org/2022/02/24/most-immediate-nuclear-danger-in-ukraine-isn-t-chernobyl-pub-86521 accessed 2023-02-28).
35. *Nuclear Security Conventions.* International Atomic Energy Agency. https://www.iaea.org/topics/nuclear-security-conventions (accessed 2023-02-28).

DOI: 10.7290/ijns372553

36. *Plans for New Nuclear Reactors Worldwide.* World Nuclear Association, 2023. https://world-nuclear.org/information-library/current-and-future-generation/plans-for-new-reactors-worldwide.aspx (accessed 2023-02-28).
37. International Atomic Energy Agency. *IAEA Projections for Nuclear Power Growth Increase for Second Year Amid Climate, Energy Security Concerns*, 2022. International Atomic Energy Agency. https://www.iaea.org/newscenter/pressreleases/iaea-projections-for-nuclear-power-growth-increase-for-second-year-amid-climate-energy-security-concerns (accessed 2023-02-28).
38. Boudreau, D. G. The Bombing of the Osirak Reactor. *International Journal on World Peace* **1993**, *10* (2), 21–37. http://www.jstor.org/stable/20751886.
39. *Gulf War Air Power Survey*, *Vol. 1: Planning and Command and Control*; US Government Printing Office: Washington, DC, 1993; Vol. 1.
40. Ramberg, B. *The danger of nuclear reactors in war*, 2022. Project Syndicate. https://www.project-syndicate.org/onpoint/ukraine-shows-nuclear-reactors-at-risk-during-war-by-bennett-ramberg-2022-08 (accessed 2023-02-28).
41. Frantzman, S. Why Iran's threat to attack Israel's Dimona matters—analysis. *The Jerusalem Post*, December 26, 2021. https://www.jpost.com/middle-east/article-689777 (accessed 2023-02-28).
42. Easton, I. Ian Easton On Taiwan: Are Taiwan's nuclear plants safe from Beijing? *Taipei Times*, April 12, 2021. https://www.taipeitimes.com/News/editorials/archives/2021/04/12/2003755509 (accessed 2023-02-28).
43. Westinghouse to supply all fuel for Ukraine fleet, plus more AP1000 units. *Nuclear Newswire*, June 6, 2022. https://www.ans.org/news/article-4022/westinghouse-to-supply-all-fuel-for-ukraine-fleet-plus-more-ap1000-units/ (accessed 2023-04-19).
44. Institute for Economics and Peace. *Global Terrorism Index 2022: Measuring the Impact of Terrorism.* Institute for Economics and Peace: Sydney, 2022. https://www.visionofhumanity.org/wp-content/uploads/2022/03/GTI-2022-web-04112022.pdf (accessed 2023-02-28).
45. Azad, T. M. *Pakistan's Evolving Nuclear Security Culture*, 2021. Stimson. https://www.stimson.org/2021/pakistans-evolving-nuclear-security-culture/ (accessed 2023-02-28).
46. Center for Arms Control and Non-Proliferation. *The Brasstacks Crisis*, 2022. Center for Arms Control and Non-Proliferation. https://armscontrolcenter.org/the-brasstacks-crisis/ (accessed 2023-02-28).
47. Benjamin, M. India Said to Eye Raid on Pakistani A-Plants. *The Washington Post*, December 20, 1982. https://www.washingtonpost.com/archive/politics/1982/12/20/india-said-to-eye-raid-on-pakistani-a-plants/7e30dde5-e97c-45dc-82bb-521dee37a6ac/ (accessed 2023-02-28).
48. India, Pakistan exchange lists of nuclear facilities, prisoners. *Al Jazeera*, January 1, 2023. https://www.aljazeera.com/news/2023/1/1/india-pakistan-exchange-list-of-nuclear-facilities (accessed 2023-02-28).

DOI: 10.7290/ijns372553

49. Bunn, M. Reducing the Greatest Risks of Nuclear Theft and Terrorism. *Daedalus* **2009**, *138* (4), 112–123. DOI:10.1162/daed.2009.138.4.112.
50. Kibaroglu, M. The Threat of Nuclear Terrorism Requires Concerted Action. *Strategic Analysis* **2014**, *38*, 209–216. DOI:10.1080/09700161.2014.884440.
51. International Atomic Energy Agency. *National Nuclear Security Threat Assessment, Design Basis Threats and Representative Threat Statements*; IAEA Nuclear Security Series No. 10-G (Rev. 1); International Atomic Energy Agency: Vienna, 2021. https://www-pub.iaea.org/MTCD/Publications/PDF/P1926_web.pdf (accessed 2023-02-28).
52. Cabinet of Ministers of Ukraine. The Government Determined the Need to Review the Design Basis Threat to Nuclear Installations, Nuclear Materials, Radioactive Waste and Other Sources of Ionizing Radiation in Ukraine (in Ukrainian), 2022. State Nuclear Regulatory Inspectorate of Ukraine. https://www.kmu.gov.ua/news/pryiniato-postanovu-shchodo-orhanizatsii-roboty-z-vyznachennia-proektnoi-zahrozy-dlia-iadernykh-ustanovok-iadernykh-materialiv-radioaktyvnykh-vidkhodiv-ta-inshykh-dzherel-ionizuiuchoho-vyprominiuvannia-v-ukraini (accessed 2023-02-28).

DOI: 10.7290/ijns372553