SECURITY & DEFENCE QUARTERLY
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Nuclear power plants in war zones: Lessons learned from the war in Ukraine

Joanna Przybylak

j.przybylak@pracownik.akademia.mil.pl

https://orcid.org/0000-0001-9187-8588

Faculty of National Security, War Studies University, Aleja Generała Chruściela "Montera" 103, 00-910, Warsaw, Poland

Abstract

The aim of this paper is to examine the lessons learned till mid-2023 from the war in Ukraine to find out how attacking or seizing nuclear power plants (NPPs) can be utilised to advance military and political objectives during an armed conflict. The qualitative research approach has been applied to the study, focusing on an analysis of academic research and relevant acts of international law. In order to examine Russia's approach to the attacks against the Chernobyl and Zaporizhzhia NPPs, numerous reports, official statements by the authorities, press releases, and Internet sources have been analysed. For evaluation of nuclear security and safety standards in Ukraine, the "seven pillars" model proposed by the International Atomic Energy Agency has been adopted. The study indicates that strategically located NPPs can be used as "nuclear shields" for the occupying forces deployed at the plant or nearby. They may also become useful tools of "lawfare" waged with the use of flawed interpretations of international humanitarian law. Finally, nuclear security-related narrations analysed in the paper clearly prove that seized NPPs can be effectively used in information warfare. The research leads to the conclusion that civil NPPs in war zones can be weaponised and exploited by the hostile forces not only for impeding energy supplies (and thus shattering the public morale of the adversary) but also for blackmailing and coercing the decision-makers of the attacked state and their international allies with a vision of man-made nuclear disaster.

Keywords

nuclear power plants, international humanitarian law, war in Ukraine, nuclear security, nuclear blackmail

Article info:
Received: 16 September 2023
Revised: 3 November 2023
Accepted: 3 November 2023
Available online: 27 November 2023

Citation: Przybylak, J. (2024) 'Nuclear power plants in war zones: Lessons learned from the war in Ukraine', *Security and Defence Quarterly*, 46(2), pp. 84–103. doi: 10.35467/sdq/174810.

Introduction

On 22 June 2023, the President of Ukraine, Volodymyr Zelensky, released a video statement claiming that Russian forces were considering blowing up the Zaporizhzhia nuclear power plant (NPP) to induce a radiation leak (Office of the President of Ukraine, 2023). It was not the first time that the world had heard alarming reports about deteriorating nuclear security coming from Ukraine. The risk of a man-made disaster at occupied power plants has hit the headlines repeatedly since the beginning of the war, raising widespread international concerns about the unpredictable consequences of mismanagement or deliberate destruction of facilities containing nuclear materials. Although there have been several cases of military assault against nuclear research facilities in the past, Russia's shelling and subsequent seizure of a large operational NPP in Zaporizhzhia, as well as a 5-week-long occupation of the decommissioned Chernobyl NPP and its exclusion zone, are definitely unprecedented. Analysing lessons from this case is crucial for assessing the validity of international protection of nuclear installations and the role they may play in armed conflicts.

The research interest on the vulnerability of nuclear reactors as potential targets of military assault goes back to the 1980s, when a successful Israeli attack on the non-operational reactor at Osirak research facility in Iraq captured the attention of scholars (Mallison and Mallison, 1982; Ramberg, 1984, 1985). The protection of nuclear facilities during war attracted further interest after the First Gulf War, which sparked a debate on the legitimacy of allied bombings of Iraqi research reactors near Baghdad (Carnahan, 1992). Over the last two decades, research in this field has focused primarily on the legal and political aspects of pre-emptive strikes against nuclear facilities in the context of the North Korean and Iranian nuclear programmes (Malone, 2003; Reiter, 2005; Terry and Openshaw, 2014). Since there had been no history of a direct assault and military occupation of civil NPPs in densely populated areas until 2022, academic literature published up to this date devotes very little attention to the use of this type of aggression to achieve military and political goals by intimidating the attacked state and the international community.

As a consequence, experiences from the conflict in Ukraine are certain to add a new dimension to the research on nuclear security and safety in war zones. Current events in Ukraine have not been comprehensively studied yet due to the dynamic and unpredictable development of the situation on the frontlines; however, several academic studies on this topic have already been published. Among the most noteworthy papers published in scientific journals, the one by Duliba (2022) highlights the major violations of nuclear security principles carried out by Russian forces in the first months of the war and their implications for global security. Another contribution by Sokolski (2022) offers valuable insight into the problems arising from the seizure of NPPs by hostile military forces and makes recommendations for the US Army and the Pentagon concerning military measures and policies in this regard. Following that, studies by Solovian (2023) and Yaroshchuk (2023) introduced an interesting perspective on key Russian nuclear-related narratives as a part of its disinformation strategy. Several valuable reports have also been published by the authors associated with the leading European think tanks, such as the Royal United Services Institute (RUSI) and the Stockholm International Peace Research Institute (SIPRI) (Dolzikova and Watling, 2023; Fedchenko, 2023). Undoubtedly, there is still a need for further research that focuses on the status of NPPs in modern urban conflicts and the threats arising from them being captured and used for military purposes by hostile armies. This study aims to fill this gap while bearing in mind the existing limitations of the research on this ongoing, rapidly evolving conflict.

Therefore, the purpose of this study is to examine lessons from the war in Ukraine in order to determine how NPPs can be utilised by hostile forces to advance their military and political objectives. The paper attempts to answer the following research questions:

1. What are the major threats to the NPPs in Ukraine as a result of Russian military aggression?
2. How should the legitimacy of Russian attacks on NPPs in Ukraine be assessed in the light of international humanitarian law (IHL)?
3. Why did the seizure of the Chernobyl and Zaporizhzhia NPPs matter for Russia?
4. What is the role of the occupied NPPs in the Russian-Ukrainian information war?

As a research hypothesis, the author assumes that civil NPPs in war zones can be weaponised and used by hostile forces not only for impeding energy supplies but also for blackmailing and coercing the decision-makers of the attacked state and its international allies with a vision of man-made nuclear disaster. The author also argues that this effect can be achieved by the occupying forces regardless of the actual security situation at seized nuclear facilities.

The qualitative research approach has been applied to this study, focusing mainly on a critical analysis of academic literature on nuclear security during armed conflicts and relevant acts of international law and its interpretations. In order to examine Russia's approach to using shelling and occupation of Ukrainian nuclear facilities for military and political purposes, numerous reports, official statements by the authorities, media releases, and selected Internet sources have been analysed with the use of the desk research technique. For evaluation of nuclear security and safety standards in Ukraine, the "seven pillars" model proposed by the International Atomic Energy Agency (IAEA, 2023a, pp. 6–8) is adopted. The study focuses on political and military aspects of the role of NPPs in war zones—technical details of nuclear safeguards in Ukraine are therefore not within the scope of this paper. Readers interested in this issue may refer to several comprehensive reports by IAEA, the most recent one issued in February 2023 (IAEA, 2023a).

Threats to nuclear power plants in Ukraine since 24 February 2022

In February 2022, there were five NPPs in Ukraine[1] with 15 operational reactors in total (Duliba, 2022, p. 2) and the share of electricity produced by NPPs was over 52%, making the country heavily dependent on this energy source (Chepeliev *et al.*, 2023, p. 1). As the continuity of energy supplies is undoubtedly critical for the state's capability of functioning under external threat, it should have come as no surprise that the NPPs became targets of Russia's military assault. And yet, Dolzikova and Watling (2023, pp. 3–4) point out that despite continuous efforts to enhance the physical protection of nuclear facilities against acts of sabotage and terrorism, much less was done by Ukraine to prepare an effective military defence of its NPPs against direct assault and occupation by the invading forces. The analysts of the United Kingdom's RUSI think tank seek partial explanation in a distorted risk assessment induced by a spy network associated with the energy sector that was exposed by the Security Service of Ukraine in June 2022 (Dolzikova and Watling, 2023, p. 5). However, the extraordinary vulnerability of such facilities and legitimate

[1] *Four operational power plants: Khmelnytskyi NPP, Rivne NPP, South-Ukrainian NPP, Zaporizhzhia NPP (operated by the National Nuclear Energy Generating Company "Energoatom") and the decommissioned Chernobyl NPP that shut down in December 2000.*

concerns over putting them in the line of fire during persistent defence should also be taken into consideration as another explanation for the rapid capture of two Ukraine's NPPs by Russian forces.

Despite its decommissioned status, control over the Chernobyl NPP and its exclusion zone was clearly of significant interest to Russia. As reported by the State Nuclear Regulatory Inspectorate of Ukraine, Russian troops crossed into Ukraine from Belarus, entered the Chernobyl NPP site at the very beginning of the offensive and took over the whole compound within a few hours on 24 February 2022 (Fedchenko, 2023, p. 3). Military activities within the uninhabited exclusion zone raised serious concerns over potential damage to the protective structures that confine the remains of the reactor damaged in 1986, or spreading radioactive material from the ground in the so-called "Red Forest". According to the IAEA report (2023a, p. 15),Ukrainian operating staff were held hostage to maintain the defunct power plant and pressured to work under armed guard without the possibility of being rotated. A command post and an ammunition depot were established in the vicinity of the NPP, most likely with the purpose of using the facility as a shield. There were also several reports of Russian soldiers mining the NPP's facilities, moving heavy military equipment, and digging trenches within the exclusion zone, which disturbed the upper layer of soil and resulted in an increased level of background radiation (Dolzikova and Watling, 2023, p. 6; Ivaniuta, 2022, p. 368, Jensen and Vasko, 2022, p. 306).

The occupation lasted for 5 weeks before the Russians withdrew on 31 March 2022, along with the broader pullback of troops from the area north of Kyiv, while the Ukrainian authorities formally regained control over Chernobyl. It should be pointed out that despite Russia deliberately keeping the threat of man-made disaster alive, no serious nuclear accident occurred throughout the entire occupation of the plant.

The consequences of the capture of the second NPP in south-eastern Ukraine have been more severe. On 4 March 2022, Russian troops seized Zaporizhzhia NPP—the largest NPP in Europe, which provided approximately 43% of all nuclear power and 20% of the total electricity used in Ukraine prior to the war (Gorchakov, 2023, p. 8). The NPP was reportedly fired at by Russian tanks (Duliba, 2022, p. 4; Ivaniuta, 2022, p. 371), while an administration, training centre, and laboratory buildings were damaged as a result of being hit by projectiles. The Ukrainian National Guard unit responsible for the defence of the NPP withdrew to avoid extremely hazardous fighting in the area of the power station (Dolzikova and Watling, 2023, pp. 6–7). Shortly afterwards, a Russian command post was set up within the immediate vicinity of the NPP and military equipment and weapons were brought to the plant. In February 2023, the IAEA (2023a, p. 11) inspectors stated that "military vehicles and stores were still present in the turbine halls of the unit 1 and 2 buildings."

Soon after the beginning of the occupation, representatives of the state-owned Rosatom Corporation arrived at Zaporizhzhia NPP and took over management, while the Ukrainian staff continued to operate the power plant and were constantly pressured to sign contracts with the new managing enterprise (Dolzikova and Watling, 2023, p. 16). It created a huge dilemma for the NPP employees, who were forced to sign contracts with Rosatom in order to keep their jobs and ensure their personal safety. On the other hand, by doing that, the employees could be accused of treason by the Ukrainian authorities—which actually happened when the mayor of the nearby Enerhodar called them "collaborators" in a comment to the media on 2 July 2023 (Datskevych, 2023). Since some of the Ukrainian staff refused to cooperate with the occupying forces, Rosatom brought additional operators from Russian NPPs. In October 2022, soon after the illegal annexation of

four Ukrainian regions,[2] Vladimir Putin signed a decree that declared Zaporizhzhia NPP "federal property" of Russia, which was aimed at transferring full supervision of the plant to Russian agencies. At the time of writing this paper (September 2023), it remains under Russian control, although in early July 2023, there were initial reports of some Rosatom employees leaving the NPP (Datskevych, 2023). Despite numerous calls from IAEA and the United Nations (UN) Secretary-General, the idea of establishing a demilitarised zone at the NPP and nearby has not been implemented so far (Burke 2022, p. 233; Gorchakov, 2023, p. 4).

Since March 2022, there have been numerous violations of nuclear security and safety standards at Zaporizhzhia NPP. At least seven blackouts occurred due to grid power being cut off as a result of military activities in the nearby areas. Subsequently, cooling of the reactors and used nuclear fuel storages had to be conducted in an emergency mode, with the use of electricity produced by diesel generators (Gorchakov, 2023, p. 24–25, IAEA, 2023a, pp. 7–11). A decision to shut down all six reactors at Zaporizhzhia NPP was made due to the constantly deteriorating security conditions. The last operating reactor was put into cold shutdown in September 2022 (Energoatom, 2022).

As Fedchenko (2023, p. 5) points out, even after being shut down, a NPP still requires access to external sources of electricity and water to cool down nuclear fuel in the reactors' cores. Major concerns over cooling of the reactors and spent fuel pools arose when the Kahkovka Dam was ruptured on 6 June 2023, resulting in massive flooding of the nearby settlements and a drop in water levels in the Kakhovka reservoir, used as a primary source of water for the NPP's cooling pond. Nevertheless, continuously updated reports from the Ukrainian state-owned nuclear power operator confirmed that the water level in the cooling pond was stable and sufficient to meet the requirements of the shutdown plant, posing no immediate threat to the power station, despite significant water discharge from the reservoir itself (Energoatom, 2023).

Major threats to the NPPs in Ukraine that occurred during the Russian occupation may be assessed with the use of the "seven pillars" framework, as presented by the IAEA Director General in 2022. The model highlights the issues crucial for ensuring the safety and security of nuclear facilities during armed conflicts (IAEA, 2023a, p. 6). Table 1 includes a summary of the most significant threats to the Chernobyl and Zaporizhzhia NPPs, based on sources available at the time of writing this paper. It should be noted that there have been risks to other NPPs in Ukraine (Khmelnytsky, Rivne, and South Ukraine NPPs) as well, such as damage to power lines and disconnections from the power grid and shelling of nearby areas (Fedchenko, 2023, p. 2; IAEA, 2023a, p. 19), but they have been definitely less significant than the threats resulting from the occupation of Chernobyl and Zaporizhzhia NPPs. For this reason, they have been omitted from Table 1.

The reaction of the international community to the violations of nuclear security and safety standards in Ukraine has been clear and unambiguous—military assault and occupation of two NPPs have been widely condemned by international organisations and numerous governments (Dolzikova and Watling, 2023, pp. 18–26; European Union External Action [EUEAS], 2022; United Nations, 2022). The IAEA's board of governors adopted several resolutions, denouncing military activities in the vicinity of the plants and urging both sides of the conflict to refrain from attacks against civil nuclear installations (IAEA, 2023a, pp. 29–33). On-site expert missions of the UN's atomic watchdog agency are currently operating at all Ukraine's NPPs, including Zaporizhzhia (IAEA, 2023a, p. 23),

[2] *The annexed territories included Donetsk, Luhansk, Kherson and Zaporizhzhia Oblasts of Ukraine.*

Table 1. Major threats to nuclear safety and security of the Chernobyl NPP and Zaporizhzhia NPP according to IAEA's "seven pillars" model (based on Fedchenko, 2023, p. 2; Gorchakov, 2023, pp. 6–7; IAEA, 2023a, pp. 10–15; Ivaniuta, 2022, pp. 368–371).

Seven Pillars for ensuring nuclear safety and security	**Chernobyl NPP (decommissioned) and the Exclusion Zone** Occupation: 24 February 2022–31 March 2022	**Zaporizhzhia NPP (put into cold shutdown in September 2022)** Occupation: since 4 March 2022 Annexation: 4 October 2022
Physical integrity	Damaged infrastructure and laboratory equipment Archives of the NPP seized by the occupying forces Mining of the NPP and its surroundings Looting of an analytical laboratory	Direct shelling of the plant Training centre, laboratory, and administrative buildings damaged by projectiles Landmine explosions in the vicinity of the NPP Alleged mining of the NPP buildings (not confirmed)
Safety and security systems and equipment	Military equipment and troops present at the site Disrupted work of laboratories	Troops, military equipment, and weapons present at the site (including turbine halls)
Operating staff	Staff held hostage Detention of security guards Work under pressure, without personnel rotation, in close proximity to the frontlines Risk of human error	Detention of several staff members Staff shortage Pressure on Ukrainian operators to sign contracts with Rosatom Work under pressure, in close proximity to the frontlines Risk of human error
Off-site power supply	Interruptions to external power supply in March and November 2022	Damage to power lines Major interruptions to external power supply (at least seven cases of disconnection from external power grid)
Logistical supply chain	Temporary disruption to supply chain during occupation (destroyed roads and bridges, limited access to the materials required for maintenance of defunct reactors and fuel storages)	Damaged infrastructure surrounding the NPP site Key supplies provided by both Ukraine and Russia Non-critical maintenance works delayed due to the lack of spare parts Problems with delivering diesel fuel
Radiation monitoring and emergency preparedness and response	Monitoring system destroyed during the occupation Temporary increase of radiation level due to military activities in the exclusion zone Monitoring systems fully restored in June 2023	Unclear chain of command (due to the takeover of the NPP by Rosatom) Short-time disruptions to radiation monitoring systems
Communication	Lack of communication between NPP and Ukrainian regulatory authorities since 10 March 2022 Direct communication restored in April 2022	Limited communication with Ukrainian authorities, especially after annexation Limited access to information for Ukrainian state inspectors

although they have been so far denied access to parts of the NPP where alleged explosives or mines might be placed (IAEA, 2023c).

The continued presence of the IAEA's staff in the occupied NPP indisputably helps the monitoring of military activities within the facility's surroundings and the documenting of violations of safeguards at the plant itself. However, it can be argued that the presence of international inspectors had no significant impact on the Rosatom staff and Russian

military forces deployed at the power plant. As the IAEA's Director General Rafael Grossi emphasised, the organisation is able to offer technical assistance and expertise, but it cannot engage deeply in political and diplomatic operations that are within the competence of the UN Security Council (Duliba, 2022, p. 10). Although the director general has been personally engaged in diplomatic talks with the Russian and Ukrainian authorities concerning the establishment of a protection zone around Zaporizhzhia NPP (IAEA, 2023b), IAEA's inspectors and experts present on the site have no authority in this field. The international inspectors also have to rely on the goodwill of Russians to grant them access to specified areas of the power plant, so the results of their monitoring may be rightfully questioned as incomplete.

Legality of Russian attacks and occupation of Ukraine's NPPs

Since the first weeks of Russian attacks on Ukraine, the legality of armed assault and occupation of NPPs has been a focus of intense debate. It is worth emphasising that contrary to the popular belief, NPPs are not entirely exempt from acts of war, even though IHL guarantees special protection of such facilities. According to Article 56 of the Protocol Additional I to the Geneva Conventions, military attacks on civilian nuclear facilities (and their surroundings) are generally prohibited. Such special protection might be lifted "only if it [the NPP] 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" (International Committee of the Red Cross, Humanitarian Law Databases, 1977a). Protocol Additional II contains further provisions that deal with targeting NPPs during an armed conflict. Its Article 15 prohibits all attacks on nuclear power stations "if such attacks could release dangerous forces causing severe losses among the civilian population," even if they are deemed legitimate military targets (International Committee of the Red Cross, Humanitarian Law Databases, 1997b). Additionally, recognising NPPs as civilian structures (unless unequivocally proven otherwise), that must not be attacked during an armed conflict is also considered to be a part of customary IHL, which means that all states are expected to follow this principle, regardless of whether they have ratified the said Protocols Additional to the Geneva Conventions or not (Fedchenko, 2023, p. 5; International Committee of the Red Cross [ICRC], 2005).

International law also refers to the issues of defence and occupation of NPPs. All parties to the conflict are equally obliged to exercise caution when planning and conducting any military activity within the vicinity of NPPs, whether in offence or in defence (Dienelt, 2022; ICRC, 2022). Additionally, military objectives should not be located in the vicinity of an NPP, unless they serve the sole purpose of defending the plant against armed assault and are not engaged in any other hostilities. The presence of military installations and the deployment of forces necessary to defend the facility against an attack are permitted under the provisions of IHL, and they cannot be seen as an excuse to consider such power station a military objective (International Committee of the Red Cross, Humanitarian Law Databases, 1977a, Article 56).

Interestingly, according to the International Committee of the Red Cross (ICRC, 1987) commentary to Article 56 of the Protocol Additional I, parties to the conflict may consider not defending such facilities at all, allowing them to be seized without fighting if there is a risk of dangerous forces being released. If an NPP is seized, occupying armed forces that are in actual control of an NPP at that moment have a duty to prevent nuclear incidents that might result in harm to the civilian population or the environment (Morgandi and Betin, 2022).

That being said, an NPP (or its surroundings) can become a legitimate objective of military assault only under very specific circumstances: it has to contribute significantly and directly to the military operations of the opponent, it has to be an absolute military necessity, and, at the same time, it must be certain that attacking the facility would not result in the release of dangerous forces (radioactive substances, radiation, etc.) that could harm the civilian population. It should be emphasised that these three conditions must occur simultaneously for the assault to be considered lawful. Of course, that leaves room for divergent interpretations, similarly to other provisions of IHL.

In view of the above, it's worth taking a closer look at the Russian attacks on the Chernobyl and Zaporizhzhia NPPs. First of all, it is unclear whether the provisions of IHL should refer only to operational power plants or defunct ones as well, as it is not directly indicated in the discussed legal acts. According to Morgandi and Betin (2022), the most reasonable interpretation would be to understand them as giving special protected status to all nuclear power stations, regardless of their current ability to produce electricity, as long as damaging them could lead to release of radioactive substances and radiation. The author of this paper agrees with this interpretation, as it is consistent with the general spirit of both Protocols Additional to the Geneva Conventions, which is to protect the civilian population from severe harm caused by the release of "dangerous forces," not to protect a specific type of infrastructure itself.

In light of these observations, attacks undertaken by Russian forces against the Chernobyl NPP and its subsequent seizure seem to meet none of the three indispensable conditions listed above. Firstly, there is no evidence that the defunct power plant could directly contribute to Ukraine's war effort in any way. Consequently, it would be impossible to prove a military necessity to cease this sort of support. The third condition (risk of severe harm to civilians as aconsequence of the release of "dangerous forces") seems to be the most disputable in this case, as there was indeed no significant release of radiation, although it could be argued whether the commanders of the attacking forces were able to guarantee the absence of such risk prior to military action. Nevertheless, all three provisions indicated above must occur simultaneously in order to lift the protected status of a nuclear facility. Therefore, the attack against the Chernobyl NPP should be considered a violation of the provisions of IHL, despite the fact that no significant accident occurred during the initial attack and its occupation (Duliba, 2022, p. 1).

When the assault on Zaporizhzhia NPP started, the UN Under-Secretary-General for Political and Peacebuilding Affairs stated in an address to the Security Council that it was a clear violation of Article 56 of the Protocol Additional I to the Geneva Conventions (United Nations, 2022). Similar opinions were expressed by several scholars, including Dannenbaum (2022), Dolzikova and Watling (2023, p. 17), Duliba (2022, p. 1) and Ivaniuta (2022, p. 367). The US Embassy in Kyiv went further and called the attack on Ukraine's largest NPP "a war crime," although Dannenbaum (2022) righty points out that not every violation of Article 56 satisfies strict conditions to be recognised as a war crime and, therefore, this term should be used with caution.

The legality of the shelling and occupation of the Zaporizhzhia power station can be assessed by referring to each of the three conditions required by IHL to end the special protection of an NPP. Firstly, the question is whether the analysed NPP provided electric power in "regular, significant and direct support" of Ukraine's military operations at the time when the Russian command made the decision to attack and seize it. As Dannenbaum (2022) and Zeith and Giorgou (2022) note, this criterion is highly questionable. Prior to the war, Zaporizhzhia NPP was the largest energy provider in the country, so it is very likely that the facilities belonging to the Ukrainian armed forces also benefited from it to

some extent. However, supplying electricity to the national power grid from which the military forces draw afterwards is definitely not sufficient to fulfil this provision of IHL. Such an argument could be made for any power generating station, nuclear or not, as most military facilities throughout the world naturally rely on electricity generated by civil power plants (Moore, 2022). Therefore, even if armed forces (or associated defence industries) use a small portion of electricity produced by a specific NPP, it still does not result in the plant losing its civilian objective status (Zeith and Giorgou, 2022).

Russia has not put much effort into proving that Zaporizhzhia NPP provided support to the Armed Forces of Ukraine anyway. Instead, Russian diplomats focused on blaming the Ukrainians for firing at the approaching enemy forces from the buildings in the vicinity of the NPP "to provoke retaliation" (Nebenzia, 2022). Nevertheless, even if the Russian authorities managed to present evidence that the NPP supported the military operations of Ukraine, the assault would have to be "the only feasible way to terminate such support." As there were no reports of noticeable attempts to cut any direct supply lines from the Zaporizhzhia NPP to the Ukrainian military before the plant had been seized, it is extremely debatable whether the Russian forces discovered any form of such support, let alone tried to terminate it in any way other than by taking over the NPP site.

Finally, it seems that although the Russian narrative justifying the attack and occupation of Zaporizhzhia has been mostly focused on this particular provision of IHL, the third condition to lift the immunity of a nuclear power station has not been fully met either. There have been no reports of any significant leak of radioactive substances or higher level of radiation at Zaporizhzhia so far, which has been confirmed by independent inspectors (IAEA, 2023a) and frequently updated press releases from the UN's atomic watchdog. But it should be emphasised that Article 56 of the Protocol Additional I to the Geneva Conventions prohibits attacks against NPPs even if they may cause the release of dangerous substances and significant harm to the civilian population. The common legal interpretation of this provision indicates that even if military action does not ultimately result in such release and losses among civilians, an armed assault is still a violation of Article 56 if at the time of the attack the commanders were unable to determine with confidence that it would not lead to such consequences (Dannenbaum, 2022; Morgandi and Betin, 2022; Zeith and Giorgou, 2022).

As shown in Table 1, there have been confirmed reports of direct shelling of the plant, and some buildings in its vicinity got hit and destroyed. Moreover, international inspectors found evidence of Russian military equipment and weapons being stored inside the NPP's units. Several explosions have been reported in the proximity of the power station as well (Gorchakov, 2023, p. 6, IAEA, 2023a, p. 11). That makes the Russian position on the "very low" risk of a radioactive release extremely difficult to sustain (Dannenbaum, 2022). High risk of nuclear incidents or accidents—resulting from military activities, external power supply interruptions, human errors, and other consequences of occupation—has been expressed by the IAEA's inspectors as well who monitor on-the-spot situation (IAEA, 2023a, pp. 10–11).

The idea of deploying military forces and weapons inside the power plant's machine rooms is not in compliance with the obligations placed by IHL on the forces defending the NPP either. Even though such defensive activities are allowed, any military build-up in the vicinity of a nuclear power station must serve the sole purpose of repelling attacks against the facility itself, and cannot be used in any other hostilities (International Committee of the Red Cross, Humanitarian Law Databases, 1977a, Article 56). Furthermore, decision on the location of such defensive forces must take into account the requirement to minimise the risk of damage to the nuclear installations in the event of fighting. For this

reason, they should be placed as far as possible from reactors, spent fuel storages, cooling ponds, control rooms, and other installations critical for the proper functioning of an NPP (Zeith and Giorgou, 2022). Storing of Russian military equipment and weapons in turbine halls certainly does not fulfil this requirement. In view of the above, both initial shelling of Zaporizhzhia NPP and seizure and occupation of the plant may indeed be recognised as inconsistent with the IHL provisions.

Alkiş (2023, p. 6) points out that even if the situation is transparent enough to determine the illegitimacy of an attack against an NPP, the international nuclear security regime has no adequate enforcement mechanisms that could pressure the attacking forces to cease threatening actions. The problem appears to be more extensive and is not limited to the specific case of Ukrainian NPPs. It is therefore worth discussing it in the broader context of global nuclear order. As Budjeryn (2022, p. 344) points out, the institutions of international governance of the peaceful use of nuclear energy have not developed any effective solutions to respond to the weaponisation of civil NPPs so far—the crisis in Ukraine has only exposed the already existing weaknesses of the system. Since the beginning of the war, Russia's exploitation of nuclear power has directly challenged the international nuclear order in many ways—not only by undermining the principles of nuclear security and safety at occupied civilian NPPs but also by discrediting the idea of nuclear disarmament and threatening the world with the deployment and possible use of nuclear weapons (Bollfrass and Herzog, 2022).

Despite the diplomatic efforts of the IAEA's director general, there seems to be no prospect of any sustainable solution to this problem in the nearest future. It is therefore worth taking a closer look at how this crisis is handled by the parties to the conflict. For obvious reasons, the greatest emphasis should be put on the military and political decisions of the Russians, because they are still in actual control of Zaporizhzhia NPP and, in fact, have the most opportunities to exploit this unstable situation.

Why the occupied nuclear power plants matter for Russia?

Maintaining the activity of one's own critical infrastructure is crucial for a state's resilience during an armed conflict. Capturing and/or disrupting it is quite a predictable objective of most military operations, as it helps to reduce the defensive capabilities of the adversary in a significant way. Therefore, it should come as no surprise that Ukrainian NPPs became primary targets of the full-scale Russian invasion in 2022, despite their special status under IHL. That being the case, it should be determined what exactly makes the capture of the Zaporizhzhia and Chernobyl NPPs so important for the Russian war effort.

First and foremost, the seizure of Zaporizhzhia NPP has disrupted electricity supplies for Ukraine's civilian population in a considerable way. Assuming operation of the plant instead of shutting it down in the first months of the war allowed Russia to manipulate how much energy a millions of civilians in Ukraine might receive (Sokolski, 2022, p. 8), which resulted in repetitive blackouts, lasting from a few hours to several days (Rogoża, 2022). Once the plant entered a cold shutdown state, Ukraine lost a large part of its pre-war electricity-generating capabilities (Gorchakov, 2023, p. 8). Considering the fact that many other conventional power-generating stations in Ukraine have also been damaged heavily, the loss of power supplied by Zaporizhzhia NPP was of great importance to Ukraine's war efforts. The harsh consequences of limited electricity supplies could be seen especially in winter, when other critical services, such as supplies of heat and water, were

severely disrupted (Rogoża, 2022). Frequent energy outages (both planned and resulting from accidental damage to power lines) have been aimed at undermining Ukraine's military defence and damaging its economy, but at the same time, public morale on the Ukrainian home front has also been put to the test. This prolonged situation may result in further dangers to the operational integrity and resilience of the Ukrainian energy grid. It has forced Ukraine to reduce electricity consumption in a significant way as a result of unstable supply system. Additionally, prevalent transmission problems and frequently occurring blackouts have already forced Ukraine to request power from the electricity systems of Poland and Romania several times (Matuszak, 2023).

In August 2022, news circulating in international media claimed that Russia had planned to cut Zaporizhzhia NPP off from the Ukrainian power network and to connect it to the power grid of Crimea (Graham-Harrison, 2022). The plan failed for technical reasons (and alleged sabotage), although Yuri *et al.* (2022, p. 1) suggest that Russian authorities might be willing to connect the NPP to the Russian-controlled Crimean electricity grid in the future, which seems plausible, especially in the light of the recent federalisation announcement. If Russia ever gets this far, the consequences for Ukraine would be severe. Once the switch is permanent, it would be extremely difficult for Ukraine to link the plant back to its domestic grid if it is recaptured. Successful connection of Europe's largest NPP to the Russian power network would definitely benefit Vladimir Putin's annexation plans and increase the isolation of occupied territories from Ukraine. It can be assumed that such a symbolic success would also be used in Russian domestic politics to sustain support of the public for war.

The site of Zaporizhzhia NPP has also become a convenient base for storing Russian military equipment and supplies due to its strategic location on the southern bank of the Dnipro River and close to front lines (Dolzikova and Watling, 2023, p. 6). Special protection granted to NPPs under international law has not only been violated by the Russian forces but also deliberately used as a "shield" for weapons, vehicles, and troops. There appears to be a planned and intentional effort to provide cover to Russian forces and to create moral and legal dilemmas for the Ukrainians who might intend to attack them, although the Russian delegation to the UN repeatedly rejected claims that the plant had been turned into a military base (TASS, 2022). Such weaponisation of a functional nuclear facility is genuinely new and can be compared only to the concept of "human shields" in armed conflicts, defined by Schmitt (2009, p. 293) as "the use of persons protected by international humanitarian law, such as prisoners of war or civilians, to deter attacks on combatants and military objectives" (for fear of harming or killing them). In this case, the humans are replaced by a nuclear facility, but the main purpose remains the same: to discourage the opponent from attacking military objectives due to the fear of causing massive damage in violation of IHL. The fact that Zaporizhzhia NPP is located in a densely populated area (Sokolski, 2023, p. 9) that might be affected by release of radiation also makes it very useful as a "shield" for the Russian forces deployed at the plant's site.

When it comes to Chernobyl NPP, the reasons behind its seizure during the first day of the war are not clear-cut. Why would anyone prioritise capturing a defunct power plant over other objects of critical infrastructure, especially at the beginning of the operation? Taking over Chernobyl NPP definitely did not affect the Ukrainian energy sector, but it also did not present any practical value for the electricity needs of the invading Russian forces. The military significance of Chernobyl is also very questionable. One explanation could be the location of the plant on a direct route from Belarus to Kyiv. As Russian troops invaded Ukraine from the north, they used the fastest route, and securing the Chernobyl zone was simply another step in capturing the territories on the way to the

Ukrainian capital. This argument has been shared by many western experts, including Lt. Gen. Ben Hodges, former commander of the US Army Europe (Seitz-Wald, 2022).

This explanation seems logical, but yet there could be additional motivations behind the seizure of the decommissioned plant. As in the case of Zaporizhzhia NPP, the Russians established a supply base and a command post close to Chernobyl NPP and afterwards dug trenches in the exclusion zone (Dolzikova and Watling, 2023, p. 6). Given the planned and deliberate nature of these actions, it is likely that the plant served a similar purpose to Zaporizhzhia NPP: it was supposed to become a "shield" for the Russian troops and equipment deployed nearby. Especially when the symbolic, and often exaggerated, character of the Chernobyl disaster site is considered, it could have been anticipated that the Ukrainians might avoid heavy fighting, not to mention lack of international support for overly risky military activities in this area. It appears very plausible that Chernobyl was indeed intended to become a safe haven for the Russian forces securing the route from the Belarussian border to Kyiv. But above all, the capture of the iconic remains of Chernobyl NPP with its exclusion zone, as well as the largest operational NPP in Europe, allowed Russia to wage an information campaign, based on deep-rooted fear of nuclear catastrophe. As the nuclear-related narratives have been especially prevalent in the Russian-Ukrainian information war, it is worth analysing them in detail in a separate chapter.

Occupied NPPs in the information war

History contains several examples of armed assault against nuclear facilities, but they differ significantly from the Ukrainian case. Fedchenko (2023, p. 4) and Sokolski (2022, p. 8) point out that none of the previous attacks was directed at fully operational power plants. Most of them occurred in the Middle East and were directed against research centres or other non-operational nuclear facilities of ambiguous purpose, whose destruction did not pose a serious threat of radioactive material release. Additionally, all of the nuclear facilities that were bombed in the past in Iraq, Iran, and Syria were targeted with the aim of ending their operation or destroying them. No troops attempted to seize or occupy them. Zaporizhzhia and Chernobyl are the first NPPs in history to be occupied by enemy forces and, in case of Zaporizhzhia NPP, used for energy production under the adversaries' management (Sokolski, 2022, p. 8). There is no history of military assault against decommissioned NPPs or structures containing large amounts of spent radioactive fuel either. From the perspective of nuclear safety and security, the most similar case was perhaps the situation in Krško NPP, which found itself in the middle of a conflict, when Slovenia declared independence from Yugoslavia in 1991. Similar to Zaporizhzhia NPP, the Slovenian power plant was close to an area of military operations and it was brought to a cold shutdown due to fears of an air strike or long-term loss of external power supply (Stritar *et al.*, 1993, pp. 193–194). However, the intensity of the Slovenian war of independence was much lower than Ukraine, and Krško NPP never became a target of direct military assault. In view of the above, the seizure of two Ukraine's NPPs is definitely unprecedented. The fact that such a situation never occurred in the past allows Russian authorities to use speculations and fears of nuclear accident, regardless of the actual security situation at the occupied facilities. Additionally, it can be assumed that nuclear anxiety among the nations which support Ukraine may also be deliberately triggered to help Russia achieve its military and political goals.

Bouvier (2020) observes that nuclear anxiety in western societies has a long history—it emerged primarily from the memories of the 1986 accident at Chernobyl and the echoes of the Cold War era fear of nuclear war. In many cases, it is linked to poor understanding of the differences between nuclear energy used for military and civilian purposes. The

Fukushima accident of 2011 also influenced several European countries, such as Germany, leading to a decline in public support for nuclear power and changes to long-term energy policy (Grossi *et al.*, 2017, p. 451). This deep-rooted nuclear anxiety has been exploited noticeably by Russian propaganda since the first days of the war and it seems to be one of the leading frameworks for Russian information warfare and psychological operations. Four major narratives around nuclear security and NPPs in Ukraine can be identified and these include the following:

1. Claims that Ukraine is building nuclear weapons and/or "dirty bombs" at the defunct Chernobyl NPP (along with the narrative of alleged biological and chemical weapons being built in clandestine laboratories with the support of the United States). This narrative was especially prevalent at the beginning of the full-scale invasion (Bruck, 2023, p. 1; Yaroshchuk, 2023, pp. 28–30). On the eve of the war, denuclearisation of Ukraine was presented to the public as one of the key tasks of the "special military operation" (Watling *et al.*, 2023, p. 7).
2. Presenting Ukraine as an extremely irresponsible user of nuclear energy that puts its NPPs on the verge of nuclear catastrophe, similar to the Chernobyl disaster (Yaroshchuk, 2023, pp. 32–33). This narrative also includes accusations of Ukraine storing nuclear waste from other countries in violation of safety standards and against the will of the local population. International assistance missions of IAEA to Ukraine are discredited and accused of provocations (Solovian, 2023, p. 42).
3. Nuclear terrorism narrative, aimed at presenting Ukrainian military operations as violations of the protected status of NPPs, and Russia as the only one able to ensure their safety and security under Ukrainian shelling. The forces deployed at Zaporizhzhia NPP are presented as serving purely defensive purposes. At the same time, Russian authorities deny the deployment of military equipment inside the power plant's units and accuse Ukraine of storing western-supplied weapons in its power plants (Solovian, 2023, p. 43; Yaroshchuk, 2023, pp. 33–34).
4. Ambiguity surrounding the real intentions of Russian forces regarding the fate of occupied power plants once they are forced to withdraw. This narrative focuses primarily on Zaporizhzhia NPP and is based on a covert threat of blowing up or mining NPP's units in order to cause the release of radiation if there is an imminent Ukrainian counteroffensive.

It can be seen that the first three narratives serve the purpose of justifying the "special military operation" as well as the following capture and annexation of Ukraine's nuclear power facilities. Their aim is to present Ukraine as an untrustworthy party to the Treaty on the Non-Proliferation of Nuclear Weapons, which attempts to use nuclear energy for military purposes and disregards international standards of nuclear safety and security. These three nuclear-related narratives can also be analysed with regard to the concept of "lawfare," defined by Tropin (2021, p. 17) as "the use of law aimed at delegitimising the actions of an opponent (or legitimising one's own) and to tie up the time and resources of the opponent and achieve advantages in military activity or in any sphere of social relations." As indicated in the preceding section of this paper, Russian attacks and the seizure of Chernobyl and Zaporizhzhia NPPs cannot be considered as compliant with the provisions of IHL. For this reason, delegitimising the opponent seems a logical solution to divert attention from Russia's own unlawful actions. Examples of such "accusations in a mirror" include claims that Ukraine was shelling Zaporizhzhia NPP in violation of the Protocols Additional to the Geneva Conventions (Hunder, 2022), planning to hit the plant with nuclear waste-filled warheads (Smith, 2023), or conspiring to carry out a false-flag operation with the use of illegally built radioactive "dirty bombs" (Dolzikova and Watling, 2023, p. 20; Lendon, 2022). According to Yaroshchuk (2023, pp. 27–28, 35), all these narratives add up to the general Russian metanarrative depicting Ukraine

as a dangerous terrorist state that disobeys international law and is incapable of effective self-governance.

The available evidence suggests that the fourth analysed narrative (ambiguity surrounding the fate of occupied NPPs once the Russian troops are forced to withdraw) serves a different purpose. It can be assumed that its main objective is to convey the impression that decisive military actions of the armed forces of Ukraine or extensive western arms deliveries could result in an irrational, desperate move of the occupying troops, such as blowing up or mining the most vulnerable sections of the nuclear facilities. Preventing (or limiting) supplies of foreign weapons to Ukraine has been one of Russia's key goals since the beginning of the conflict. Therefore, indirect ambiguous threats of a man-made nuclear disaster are used along with other forms of blackmail targeting western societies and policymakers, such as intimidating remarks on the possible use of nuclear weapons or "global catastrophe" threats in response to new weapons being delivered to Kyiv (Kelly and Kerry, 2023).

It seems unlikely that the Russian decision-makers would go as far as deliberately causing a large-scale nuclear accident. As Dolzikova and Watling (2023, p. 20) point out, the consequences of any major act of sabotage against Zaporizhzhia NPP would most probably affect the territory of Russia or the territories under Russian occupation. But nevertheless, narratives of this type still prey on nuclear anxiety and the common perception of Russia as a violent and unpredictable actor in international relations. Noticeable results of such "nuclear fear-mongering" were seen in Ukraine and in several neighbouring countries. For example, in Spring 2022, the authorities of Ukraine, Moldova, and Romania started to distribute iodine pills in order to prepare their citizens for a possible radioactive leak (Sokolski, 2022, p. 6). A few months later, the government of Poland also announced that it had increased its stockpile of potassium iodide pills and allocated them to local distribution points (Polskie Radio, 2022). This prevalent insecurity has been continuously exacerbated by accompanying measures undertaken by the Russian occupation authorities, such as the unexpected evacuation of the area surrounding the Zaporizhzhia power plant in May 2023 (Davenport, 2023). There is no evidence of this sort of nuclear blackmail having a direct impact on the western military assistance to Kyiv so far. However, it can be assumed that an actual man-made nuclear disaster—possibly blamed on the Ukrainian forces—could deter certain governments from further support and force Ukraine to the negotiating table.

It is also worth noting that the last of the analysed narratives has been utilised not only by Russia but also by Ukraine, obviously with a different purpose. The President of Ukraine has frequently sparked concerns around the world, accusing Russia of planning to blow up Zaporizhzhia NPP, mining the reactors in preparation for withdrawal, or preparing other acts of sabotage aimed at releasing radiation (Edwards, 2023; Office of the President of Ukraine, 2023). Despite President Zelensky's declaration that these accusations were based on reliable intelligence data (supported by public statements by the military intelligence chief), the IAEA mission has not managed to confirm mining of reactor buildings and no acts of nuclear sabotage or terrorism have occurred so far. Therefore, it seems fair to analyse such claims as part of the information warfare as well.

Similar to the narrative of the adversary, Ukraine seeks to depict Russian decision-makers as ruthless and unpredictable characters, who might be capable of crossing the red line and deliberately causing a nuclear catastrophe. However, in this case, the ultimate goal appears to be opposite to the intended outcome of the Russian propaganda. With the frequent use of nuclear-related arguments in its calls for military assistance, Ukraine aims to present Russia as a threat to international security and order, and one that must be neutralised by

providing Ukraine with further arms deliveries and helping it to regain full sovereignty over the occupied territories. Interestingly, both parties to the conflict contribute to the prevalence of this common narrative but seem to expect different outcomes, which suggest a significantly different assessment of the targeted western recipients.

Conclusions

The Russian occupation of two Ukrainian NPPs undeniably poses one of the greatest challenges to the global nuclear security regime. International safety and security standards, developed for the mutual benefit of all actors in international relations, have been compromised in a considerable way. The war in Ukraine has exposed problems with effective enforcement of the provisions of IHL as well as their interpretation. The results of this research clearly show that basic standards of safe maintenance have been neglected by occupation forces at both Chernobyl and Zaporizhzhia NPPs, which has been verified and proved by independent inspections. Failed attempts to create a demilitarised zone around Zaporizhzhia NPP confirm the assumption that international institutions lack proper mechanisms to deal with the risk posed by military operations in the vicinity of vulnerable nuclear facilities. It may be argued whether the world needs new legal solutions in order to make all NPPs entirely exempt from acts of war. Although there have been several examples of such non-attack agreements in bilateral and multilateral relations (such as the 1988 India-Pakistan Agreement or certain provisions of the African Nuclear Weapon-Free-Zone Treaty of Pelindaba), it does not seem likely that such compromise could be achieved on a global scale.

Using Ukraine as a study case allows preliminary conclusions to be drawn regarding the way NPPs in a war zone can be exploited to advance military and political goals of a hostile state. First of all, capturing them is crucial for impeding energy supplies, especially if the adversary is as dependent on nuclear energy as Ukraine. It may cause significant loses to the economy of the attacked state and, above all, put the civilian front at huge risk (or even lead to a humanitarian crisis in extreme cases) as a consequence of electricity shortages. Additionally, it may result in deteriorating the morale of the affected population, unless effective countermeasures are taken by the attacked state. Under some circumstances, seized NPPs can be used to fulfil the electricity needs of the occupying state—that is what Russia failed to achieve while trying to connect Zaporizhzhia NPP to the Crimean grid.

The second major finding of this paper is that strategically located NPPs can be used by the occupying forces as "nuclear shields" for their own supplies and equipment deployed at the plant or nearby. Such actions definitely contravene the basic provisions of IHL and violate the protected status of nuclear power stations, although, as this research proves, they cannot be ruled out, especially if the parties to the conflict are powerful enough to disregard international law without fear of severe consequences. The lessons learned from Ukraine also clearly indicate that the concept of "lawfare" is very likely to be utilised by the occupying forces in order to justify their attacks and seizure of NPPs, and to discredit the forces defending or trying to recapture them. This study has shown that by exploiting the invalid interpretations of IHL or using outright manipulation, the party in actual control of an NPP can easily blame the adversary for putting it at risk if there is any attempt to regain control over the plant using military means.

Lessons learned so far from the war in Ukraine also allow preliminary conclusions to be drawn on the role of NPPs in information warfare and to verify the main hypothesis of this study. As the analysis of the Russian narratives has proven, NPPs in war zones can in

fact be used by hostile forces to blackmail and coerce the decision-makers of the attacked state, as well as their international allies, with a vision of man-made nuclear disaster. It is worth emphasising that such intimidating narratives prey on common nuclear anxiety and have very little to do with the actual security situation at occupied power plants. In fact, the evidence from this study suggests that sensational "fake news" concerning NPPs often takes on a life of its own, regardless of less thrilling, but real security problems frequently occurring in Zaporizhzhia or previously occupied Chernobyl. Finally, it should be noted that both Russia and Ukraine have used nuclear-threat rhetoric to some extent in their communication addressed to western nations, although their goals differ significantly. The effectiveness of both Ukrainian and Russian nuclear security-related narratives remains a question to be answered. More research is needed to assess it in the broader context of information warfare and strategic communication theory. A greater focus on this issue could definitely provide valuable findings for further research on the weaponisation of occupied NPPs initiated by this paper.

Funding

This research received no external funding.

Data Availability Statement

Not applicable.

Disclosure Statement

The author is an editor of Security and Defence Quarterly and was excluded from the peer review and editorial decision-making process.

The author read and agreed to the published version of the manuscript.

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