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No. 26|03 (March 2026)

Four Years of Nuclear Piracy: Zaporizhzhia and the Weaponisation of Civilian Nuclear Infrastructure

by **Ludovica Castelli and Ali Alkış**

The prolonged occupation of the Zaporizhzhia Nuclear Power Plant (ZNPP) during Russia's war against Ukraine marks the first sustained military control of an operational civilian nuclear power plant in an active interstate conflict. Over the past four years, the facility has been incorporated into the broader dynamics of territorial warfare, generating a hybrid nuclear safety and nuclear security crisis. Military presence at the plant, repeated disruptions of external power supply and interference with operations have embedded radiological risk within the conduct of war, transforming the latent possibility of nuclear catastrophe into a form of strategic leverage. This configuration can be understood as nuclear piracy: the coercive appropriation and instrumentalisation of civilian nuclear infrastructure by a state actor in order to exploit the threat of radiological release. Unlike earlier counter-proliferation strikes against nuclear facilities, which were episodic and destructive, the ZNPP illustrates a strategy based on prolonged occupation and the gradual normalisation of radiological vulnerability. The crisis exposes a significant gap in international humanitarian law and nuclear security governance, which remain poorly equipped to regulate the militarisation of civilian nuclear facilities in armed conflict.

On 24 February 2022, Russian President Vladimir Putin launched his full-scale invasion of Ukraine, hoping to seize Kyiv within a few days and install a pro-Russian government. A week later, Russian forces occupied the Zaporizhzhia Nuclear Power Plant (ZNPP), Europe's largest nuclear power station, and have remained in control of the site ever since. Four years on, the ZNPP represents the first sustained occupation and instrumentalisation of an operational nuclear power plant within an international armed conflict.

Over this period, the ZNPP crisis has simultaneously constituted a nuclear safety and a nuclear security crisis, stretching the limits of international humanitarian law, traditional nuclear security frameworks and the broader governance architecture surrounding civilian nuclear facilities and materials. In contrast to accidents such as Three Mile Island (the US, 1979), Chernobyl (Soviet Union, 1986) or Fukushima Daiichi (Japan, 2011) – each rooted primarily in technical failure, design flaws or natural hazards – the central danger at Zaporizhzhia has been the prospect of a nuclear security-induced nuclear safety catastrophe.[1] The risk is not a spontaneous systems

Ludovica Castelli *is Research Fellow in the 'Multilateralism and global governance' programme at the Istituto Affari Internazionali (IAI) and Project Manager within the EU Non-Proliferation and Disarmament Consortium (EUNPDC).*

Muhammed Ali Alkış *is a Junior Associate Fellow at NATO Defense College and a Ph.D candidate at the Hacettepe University.*

[1] While nuclear safety and nuclear security converge in the case of this specific

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malfunction, but a human-made emergency embedded in conditions of armed conflict. Military interference, repeated disruptions of off-site power supply and sustained psychological coercion of operating personnel have combined to push the plant toward conditions in which critical failure becomes conceivable.

In this respect, the ZNPP illustrates an emerging configuration in contemporary warfare in which civilian nuclear infrastructure and the radiological risk it inherently contains, can be deliberately manipulated as an instrument of military and political leverage. The plant has served not merely as symbol of territorial conquest, but as a strategic asset capable of constraining adversary action and shaping diplomatic dynamics. This represents an unprecedented and still largely unregulated front in conflict, one that existing legal prohibitions on attacks against nuclear facilities did not fully anticipate.

1. The last four years in the Zaporizhzhia occupation (2022–2026)

The occupation of Zaporizhzhia Oblast began in the earliest phase of Russia's full-scale invasion of Ukraine in February 2022. On 24 February, Kyiv notified the International Atomic Energy Agency (IAEA) that Russian forces had assumed control of the Chernobyl Nuclear Power Plant, a site subsequently returned to Ukrainian personnel on 31 March 2022.[2] A week later, the State Nuclear Regulatory Inspectorate of Ukraine (SNRIU) reported that Russian armoured units and infantry had breached defensive positions in Enerhodar, a satellite city located a few kilometres from the ZNPP.[3] In the early hours of 4 March 2022, the plant fell under Russian control.[4]

crisis, they refer to distinct but interrelated concepts. The International Atomic Energy Agency (IAEA) defines nuclear security as "the prevention of, detection of and response to criminal or intentional unauthorized acts involving or directed at nuclear material, other radioactive material, associated facilities or associated activities". See IAEA, "Developing Regulations and Associated Administrative Measures for Nuclear Security", in *IAEA Nuclear Security Series*, No. 29-G (2018), p. 1, https://www.iaea.org/publications/11169. Nuclear security focuses on protecting nuclear materials and facilities from unauthorised and malicious actions that could lead to unacceptable radiological consequences. In contrast, nuclear safety focuses on proper operating conditions and the prevention of nuclear accidents in order to protect both humans and the environment from possible radiation hazards.

[2] On 14 February 2025 a drone struck the roof of Chernobyl's New Safe Confinement (NSC). The IAEA said that both the outer and inner cladding of the NSC's arch had been breached, but that radiation levels were stable. See, "Ukraine State Nuclear Firm Says All Russian Forces Have Left Chernobyl Plant", in *Reuters*, 1 April 2022, https://www.reuters.com/world/europe/ukraine-state-nuclear-firm-says-most-russian-forces-have-left-chernobyl-nuclear-2022-03-31.

[3] The Soviet planners who founded Enerhodar in 1970 bestowed the city with a fitting name: "the gift of energy". For decades, the southern Ukrainian city was an affluent company town for power plant workers and their families.

[4] In Ukraine 15 pressurised water reactors of Russian water-water energetic reactor

What was designed as a civilian nuclear installation has been recast as a war hostage

Since then, the ZNPP has occupied a singular position in the history of civilian nuclear infrastructure. What was designed as a civilian nuclear installation has been recast as a war hostage, effectively enabling a form of coercion that blurs the line between military strategy and radiological risk manipulation.[5] Nuclear infrastructure, defined as physical systems that encompass various types of installations, including power reactors, fuel-reprocessing facilities and accelerators, which differ in mission, processes, design and radiation hazards, has long been treated as a technical substratum of international security. Yet the experience of Zaporizhzhia renders visible a more overtly political and instrumental dimension. Rather than passive objects to be safeguarded, protected, verified, checked for compliance and regulation, nuclear facilities may function as active sites through which authority and power are materially asserted and symbolically performed.

One central dimension of occupation has been the manipulation of radiological risk through the repeated disruption of offsite power, the shelling and drone strikes in the vicinity of the facility and the mining of surrounding territory.[6] High-voltage transmission lines connecting the station to Ukraine's grid have been severed on numerous occasions, at times leaving the facility dependent on a single remaining line and, in several instances, on emergency diesel generators. Although emergency diesel generators are specifically engineered to manage loss-of-power contingencies, their recurrent activation progressively undermined the redundancy that underpins nuclear safety doctrine. In response, reactors were progressively shifted into low-power or cold-shutdown states to minimise thermal loads and mitigate the risk of core damage.[7] The destruction by Russian forces of the Nova Kakhovka dam and the subsequent draining of the Kakhovka reservoir further compounded vulnerabilities and required alternative cooling arrangements through groundwater well construction.[8]

design are operated by the State enterprise national nuclear energy generating company Energoatom at four plants. These plants operate under nuclear safety regulations implemented by the State Nuclear Regulatory Inspectorate of Ukraine (SNRIU). Just one of the six reactors (unit 4) at the plant was producing electricity at the time of the attack. The statuses of unit 1 (maintenance outage) and units 5 and 6 (held in reserve, operating in low power mode) were initially unchanged as a result of the attack, whilst units 2 and 3 underwent a controlled shutdown. See SNRIU, *Current Situation on ZNPP*, 5 March 2022, https://snriu.gov.ua/en/news/current-situation-znpp.

5 Alkış, Ali, "From Zaporizhzhia to Natanz, Nuclear Piracy Is Equally Dangerous—and Illegal", in *Bulletin of the Atomic Scientists*, 1 October 2025, https://thebulletin.org/?p=126320.

6 IAEA, *Update 220 – IAEA Director General Statement on Situation in Ukraine*, 7 April 2024, https://www.iaea.org/node/158787.

7 Nuclear Energy Agency, *Ukraine: Current Status of Nuclear Power Installations*, 21 January 2026, https://www.oecd-nea.org/jcms/pl_66130.

8 IAEA, *Nuclear Safety, Security and Safeguards in Ukraine. Report by the Director General* (GC(67)/10), 14 September 2023, https://www.iaea.org/sites/default/files/

In October 2022, Russian President Vladimir Putin issued a decree transferring the plant to Russian jurisdiction under JSC Zaporizhzhia NPP, a Russian Federal State Unitary Enterprise affiliated with Rosenergoatom

A further dimension of occupation emerged in October 2022, when Russian President Vladimir Putin issued a decree transferring the plant to Russian jurisdiction under JSC Zaporizhzhia NPP, a Russian Federal State Unitary Enterprise affiliated with Rosenergoatom.[9] Ukraine rejected the decree as unlawful, thereby creating a contested framework of authority over licensing, regulatory compliance and operational command.[10] The plant's director was detained and replaced, and the IAEA observed an expanding role for Russian technical personnel in operational decision-making.[11] Although staff rotations gradually resumed after initial disruption, the IAEA repeatedly underscored the psychological and operational strain borne by personnel working under conditions of military occupation.[12]

This regime of control extended beyond technical oversight to encompass broader practices of social control. Russian occupation authorities imposed Russian legal frameworks, citizenship requirements and programmes of cultural assimilation, often accompanied by repression of dissent and systematic curtailment of civil liberties. Essential infrastructure – including water, heating, healthcare and housing – experienced chronic shortages and degradation, leaving residents in increasingly precarious conditions. In cooperation with the Federal Security Service (FSB), Russia's main intelligence service, Rosatom reportedly initiated processes described by local officials as "filtration", rendering collaboration with the new administration effectively compulsory.[13] Prior to the

gc/gc67-10.pdf; World Nuclear Association, *Ukraine: Russia-Ukraine War and Nuclear Energy*, updated 4 December 2025, https://world-nuclear.org/information-library/country-profiles/countries-t-z/ukraine-russia-war-and-nuclear-energy.aspx.

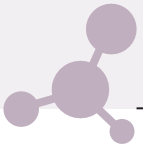
9 Rosenergoatom is one of the major subsidiaries of Rosatom, the central holding company for Russia's entire nuclear energy complex. See, World Nuclear Association, *Ukraine, Russia and Control of Zaporizhzhia Nuclear Power Plant*, updated 13 October 2022, https://world-nuclear.org/ukraine-information/wnn-ukraine/wnn-ukraine-russia-and-control-of-zaporizhzhia-nu.

10 "Putin Asserts Control over Ukraine Nuclear Plant, Kyiv Disagrees", in *Reuters*, 5 October 2022, https://www.reuters.com/world/europe/zaporizhzhia-plant-operate-under-russian-supervision-after-annexation-ria-2022-10-05.

11 According to the Ukrainian regulator, managerial and operational decisions required prior approval from the Russian commander. See, "Zaporizhzhia Plant Chief Will Not Return to Job After Detention, IAEA Says", in *Reuters*, 4 October 2022, https://www.reuters.com/world/recently-detained-head-zaporizhzhia-nuclear-plant-not-staying-iaea-2022-10-04; UN News, *Russian Military Control of Ukraine Nuclear Plants Cause for Grave Concern, Nuclear Energy Agency Warns*, 6 March 2022, https://news.un.org/en/node/1113382.

12 World Institute for Nuclear Security, *Voices of Ukraine Volume Two: Nuclear Security in Times of War*, July 2024, https://www.wins.org/?p=15465; "IAEA Staff Rotation at Zaporizhzhia Cancelled Due to Military Activity", in *World Nuclear News*, 13 February 2025, https://www.world-nuclear-news.org/articles/iaea-staff-rotation-at-zaporizhzhia-cancelled-due-to-military-activity.

13 Mykhailenko, Dariia, "Beneath Six Silent Reactors: Russia's Military Takeover of Europe's Largest Nuclear Plant", in *United24 Media*, 20 February 2026, https://united24media.com/war-in-ukraine/beneath-six-silent-reactors-inside-russias-military-takeover-of-europes-largest-nuclear-plant-16043.



Efforts to consolidate long-term control have also assumed an institutional and generational dimension

occupation, Enerhodar's population stood at approximately 50,000; it has since declined dramatically, with only a fraction of residents remaining.

Efforts to consolidate long-term control have also assumed an institutional and generational dimension, with ZNPP becoming a key instrument in Russia's broader project of Russifying occupied Ukrainian territory. On 12 February 2026, the ZNPP occupation administration announced that one hundred secondary-school students from occupied Enerhodar and other towns in the oblast had participated in a career guidance forum entitled "The Path of a Nuclear Worker. Enerhodar 2026", hosted at Sevastopol State University in occupied Sevastopol. Organised and financed jointly by occupation authorities and Rosenergoatom, the event sought to immerse students in the professional pathways of Russia's nuclear sector and to assist them in making "informed career choices".[14] Sevastopol State University has previously convened comparable programmes aimed at integrating Ukrainian students into Russian nuclear educational tracks. Occupation authorities presented the February 2026 forum as an effort to cultivate a dedicated "talent pool" for the ZNPP. Independent assessments suggest that these programmes exceed the remit of conventional educational outreach, instead constituting elements of a longer-term strategy to embed the plant within Russia's nuclear-industrial ecosystem.[15] By training young Ukrainians in Russian operational standards and institutional practices, Moscow advances its objective of entrenching durable control over the facility through the reshaping of its future workforce and organisational culture.

Over time, the ZNPP has come to symbolise the evolving role of civilian nuclear infrastructure within contemporary warfare. While military actions involving nuclear facilities are not without precedent, the protracted occupation and recurrent militarised incidents at Zaporizhzhia mark a departure from earlier, episodic strikes against nuclear sites. The plant's trajectory illustrates how such installations may become deeply embedded within broader strategic, territorial and symbolic contests, serving simultaneously as material assets, instruments of coercion and socio-political resources in an ongoing conflict.

[14] Zaporizhzhya NPP Official, "Forum 'The Path of a Nuclear Worker. Enerhodar 2026' Launched in Sevastopol" [in Russian], Telegram post, 12 February 2026, https://t.me/znppofficial/1675.
[15] Mykhailenko, Dariia, "Beneath Six Silent Reactors", cit.

2. What is new: The paradigm of nuclear piracy

Although Russia's invasion of Ukraine marks the first time that a full-scale interstate war has unfolded in a country with an extensive and operational nuclear energy sector, military action against nuclear facilities is not without precedent. Earlier episodes include the 1943 Allied attack on the Norsk Hydro plant, the Iranian strike in 1980 and Israel's 1981 attack on the Osiraq reactor at Iraq's Tuwaitha research centre, Iraqi attacks on Iran's Bushehr reactor during the Iran–Iraq War, US strikes on Iraqi nuclear-related facilities in 1991 and 1993, and Israel's 2007 operation against the Al-Kibar site in Syria.[16] More recently, coordinated Israeli–US strikes on Iran's enrichment facilities at Natanz, Fordow and Esfahan during the June 2025 "12-day war" followed the same preventive counter-proliferation logic.[17]

The situation at the ZNPP differs not merely in scale, but in structure and strategic logic. Earlier cases were episodic, time-limited kinetic operations aimed at neutralising specific facilities in order to eliminate perceived proliferation risks. By contrast, the ZNPP has been subjected to prolonged military occupation and incorporated into the broader framework of territorial control.[18]

This development signals a departure from the conceptual framework that has historically shaped international responses to attacks on nuclear facilities. Efforts undertaken at the Conference on Disarmament between 1980 and 1992 in the context of negotiations on a Radiological Weapons Convention sought to codify prohibitions on armed attacks against civilian nuclear installations. These initiatives were informed primarily by the experience of aerial strikes, particularly the Osiraq precedent, and were premised on the assumption that the principal risk stemmed from the deliberate destruction of nuclear infrastructure. In contrast, the ZNPP crisis demonstrates that sustained control and operational interference can generate a prolonged condition of radiological vulnerability.

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This phenomenon may be conceptualised as nuclear piracy, defined as the coercive appropriation and instrumentalisation of civilian nuclear infrastructure by a state actor during armed conflict in order to exploit the latent risk of radiological release as a strategic constraint on adversary behaviour.[19] In the case of Zaporizhzhia,

[16] Castelli, Ludovica and Olamide Samuel, "Justifying Attacks on Nuclear Facilities", in *The Nonproliferation Review*, Vol. 30, No. 1-3 (2023), p. 83-105, https://doi.org/10.1080/10736700.2024.2301883.

[17] Alkış, Ali, "From Zaporizhzhia to Natanz, Nuclear Piracy Is Equally Dangerous—and Illegal", cit.

[18] Budjeryn, Mariana, "Distressing a System in Distress: Global Nuclear Order and Russia's War against Ukraine", in *Bulletin of the Atomic Scientists*, Vol. 78, No. 6 (2022), p. 339-346, DOI 10.1080/00963402.2022.2132742.

[19] Alkış, Ali and Bethany Goldblum, "Lessons from Zaporizhzhia: How to Protect Reactors against 'Nuclear Piracy'", in *Bulletin of the Atomic Scientists*, 20 September

Russian forces have occupied an operational nuclear power plant and effectively transformed it into a site of geopolitical leverage. The presence of multiple large-scale reactors and significant inventories of irradiated fuel means that the consequences of a severe accident would likely extend beyond the immediate conflict zone. Radiological release, depending on meteorological and hydrological conditions, could affect neighbouring states, including territories under Russian control. The strategic value of the occupation therefore lies in the continuous generation of transboundary risk, which alters military calculations and diplomatic dynamics alike.

3. The IAEA role and ad hoc normative frameworks

The emergence of the nuclear piracy paradigm posed an immediate and profound challenge to the global nuclear governance architecture and to the IAEA. Established in 1957 with a dual mandate – to promote the peaceful uses of nuclear energy and to apply safeguards against nuclear proliferation – the IAEA's founding Statute contains no explicit reference to physical protection or nuclear security. In its early decades, the protection of civilian nuclear infrastructure was conceptualised narrowly as "physical protection", understood as a technical offshoot to the safeguards system.[20]

Only in the post-Cold War era – and particularly after the terrorist attacks of 11 September 2001 – did nuclear security evolve into a more distinct, comprehensive framework aimed at combating illicit trafficking, sabotage and non-state terrorism. Yet even as the concept expanded, the normative regime remained anchored in the principle that nuclear security is the exclusive, sovereign responsibility of individual member states. International cooperation relied primarily on voluntary guidelines and best practices rather than intrusive, legally binding inspection authorities.[21]

IAEA had to adapt its operational and diplomatic posture in real time, bridging the gap between its peacetime guidance and the wartime realities

The weaponisation of the ZNPP disrupted this equilibrium. For the first time, the IAEA confronted a nuclear security crisis unfolding within an active international armed conflict and involving the prolonged occupation of a civilian nuclear power plant. As a result, the Agency had to adapt its operational and diplomatic posture in real time, bridging the gap between its peacetime guidance and the wartime realities.

In fact, the IAEA moved beyond its standard guidance and

2023, https://thebulletin.org/?p=107317.

[20] de Klerk, Piet, "How Nuclear Security Arrived at the IAEA", in Joseph F. Pilat (ed.), *The International Atomic Energy Agency. Historical Reflections, Current Challenges and Future Prospects*, London/New York, Routledge, 2022, p. 189-201.

[21] Findlay, Trevor, "The IAEA's Critical Role in Nuclear Security", in Christopher Hobbs et al. (eds), *The Oxford Handbook of Nuclear Security*, Oxford, Oxford University Press, 2024, p. 178-196.

The IAEA moved beyond its standard guidance and articulated a new, ad hoc normative framework

articulated a new, ad hoc normative framework. Director General Rafael Mariano Grossi introduced the "Seven Indispensable Pillars of Nuclear Safety and Security"[22] as a concise set of operational conditions intended to safeguard the ZNPP amid active hostilities. Rather than introducing legal obligations, the Pillars distilled fundamental safety and security requirements into a conflict-specific framework: the protection of the plant's physical structures; the uninterrupted functioning of safety and security systems; assured and redundant access to off-site power; stable supply chains and maintenance capabilities; effective radiation monitoring and emergency response arrangements; and the freedom of plant personnel to perform their duties without coercion or interference. While the last pillar addresses the humanitarian conditions of the workforce, it is fundamentally a nuclear safety requirement; stressed or coerced operators are significantly more prone to making the kind of critical operational errors that lead to reactor meltdowns. In doing so, the Agency sought to define the minimum threshold below which nuclear safety in wartime could not be sustained.

As the crisis deepened into prolonged occupation, however, these general standards proved insufficient to deter the deteriorating conditions at the site. In May 2023, Grossi established Five Concrete Principles, specifically tailored to avert a catastrophic incident at the ZNPP.[23] These principles explicitly demanded that the plant not be subject to attack or used as a base for heavy weapons and military personnel; that off-site power be preserved; and that all structures, systems and components essential to safe operation be protected from sabotage. Together, the Seven Pillars and Five Principles represented an ad hoc normative architecture – an attempt to draw red lines in a conflict zone.

Implementing this framework required navigating severe institutional and political frictions. The IAEA's 35-member Board of Governors became the primary political arena for diplomatic contestation. Since 2022, the Board has passed successive resolutions condemning the Russian Federation's actions and demanding the immediate withdrawal of its military and other personnel from the ZNPP.[24] Yet the Board's authority is declaratory rather than coercive as it lacks the enforcement mechanisms required to alter the realities on the ground.

[22] IAEA, *IAEA Director General's Introductory Statement to the Board of Governors*, 2 March 2022, https://www.iaea.org/node/101849.
[23] UN News, *IAEA Chief Outlines Five Principles to Avert Nuclear 'Catastrophe' in Ukraine*, 30 May 2023, https://news.un.org/en/node/1137172.
[24] Ukraine Ministry of Energy, *IAEA General Conference Adopted a Resolution Demanding the Immediate De-Occupation of Zaporizhzhia NPP*, 18 September 2025, https://www.mev.gov.ua/en/news/iaea-general-conference-adopted-resolution-demanding-immediate-de-occupation-zaporizhzhia-npp.

In September 2022, Grossi personally led a mission across the active frontline to establish the IAEA Support and Assistance Mission to Zaporizhzhia, embedding a permanent team of international inspectors at the occupied facility

Facing a human-made crisis that blurred the lines between military strategy and radiological disaster, Director General Grossi assumed an unprecedented proactive role, effectively transforming the Agency from a purely technical advisory body into an active diplomatic intermediary. In September 2022, Grossi personally led a mission across the active frontline to establish the IAEA Support and Assistance Mission to Zaporizhzhia (ISAMZ), embedding a permanent team of international inspectors at the occupied facility.[25] This continuous presence represented a radical departure from standard IAEA protocols, serving as an improvised yet vital mechanism for documenting, deterring and preventing the gradual normalisation of radiological risk under conditions of military occupation.

As the plant's operational resilience eroded, particularly through repeated disruptions of external power lines that forced recurrent reliance on emergency diesel generators, the IAEA's engagement evolved further.[26] The IAEA began actively brokering localised, tactical ceasefires to enable repairs to critical infrastructure. In early 2026, for example, consultations facilitated by the Director General led to the establishment of a "temporary ceasefire zone", approximately 10 kilometres from the nearby thermal power plant's open switchyard, to allow technicians to restore a damaged 330 kV line.[27] These micro-arrangements, negotiated solely to preserve nuclear safety, illustrate what might be defined as the "Grossi doctrine", namely the pragmatic fusion of technical oversight and conflict mediation.

Yet the recourse to such improvised solutions underscores the profound structural limitations of the global nuclear governance architecture. The core assumption that nuclear security rests exclusively with the host state creates a legal paradox in contexts of contested sovereignty. At Zaporizhzhia, operational authority is violently disputed between the occupying Russian forces and the sovereign Ukrainian government.[28] The existing regime provides guidance for peacetime cooperation and for preventing non-state threats, but it offers no robust mechanism for managing the militarisation or occupation of civilian nuclear facilities by a state actor. The ZNPP crisis therefore suggests that, if the IAEA is to address

[25] Madsen, Michael Amdi, "IAEA Support and Assistance Mission Sets Out to Zaporizhzhya Nuclear Power Plant in Ukraine", in *IAEA News*, 29 August 2022, https://www.iaea.org/node/108490.

[26] The facility consistently lost access to its main 750 kilovolt (kV) external power line and its 330 kV back-up line, plunging the station into blackout conditions that forced reliance on emergency diesel generators on a near-monthly basis. See, Nuclear Energy Agency, Ukraine: Current Status of Nuclear Power Installations, cit.

[27] IAEA, *Update 336 – IAEA Director General Statement on Situation in Ukraine*, 9 January 2026, https://www.iaea.org/node/288123.

[28] Alkış, Ali and Aşkın İnci Sökmen Alaca, "IAEA and Nuclear Security: An Evolutionary Perspective", in *Journal of Nuclear Sciences*, Vol. 9, No. 2 (December 2022), p. 17-22, https://doi.org/10.59474/nuclear.2023.63.

nuclear security effectively in the context of armed conflict, member states will need to move beyond a strictly state-centric model and toward a more coherent and enforceable international framework capable of operating where sovereignty itself is under dispute.

4. Implications for Nuclear Security

Four years into the occupation of the ZNPP, the present situation may be understood through three interrelated dimensions: (1) the enduring manipulation and normalisation of radiological risk; (2) a diplomatic stalemate centred on the management and status of the facility; and (3) a broader normative paralysis concerning the evolution of legal frameworks governing nuclear installations in armed conflict.

4.1 The enduring manipulation and normalisation of radiological risk

By 2024 and early 2025, episodes of large-scale external power loss at the ZNPP had become less frequent

By 2024 and early 2025, episodes of large-scale external power loss at the ZNPP had become less frequent. Yet episodic drone strikes, explosions in proximity to reactor buildings and cooling infrastructure, and recurrent military activity around critical switchyards have underscored the persistence of a militarised risk environment. Civilian communities, both in the regional centre of Zaporizhzhia and in smaller towns across Zaporizhzhia Oblast, continue to endure shelling and drone attacks. The frontline remains fluid, with Ukrainian forces and Russian-aligned troops contesting positions along key axes, particularly near the administrative boundaries of Zaporizhzhia, Dnipropetrovsk and Donetsk regions. Significant strikes in 2025 and early 2026 resulted in civilian casualties and damage to residential infrastructure, reinforcing the cumulative human toll of a conflict now entrenched in its fourth year.

Although all six reactors at ZNPP have been maintained in cold shutdown for more than three years, nuclear safety concerns endure. Even in shutdown status, continuous electricity supply is indispensable to operate pumps that cool reactor cores and spent fuel pools. Backup transmission lines have repeatedly gone offline due to military activity near the 330 kV switchyard operated by the Zaporizhzhya Thermal Power Plant, compelling the facility at times to rely predominantly on the remaining 750 kV Dniprovska line.[29] The recurrence of such disruptions has gradually transformed what would once have been considered an extraordinary nuclear emergency into a recurrent contingency. In effect, radiological vulnerability has

[29] IAEA, *Update 341 – IAEA Director General Statement on Situation in Ukraine*, 19 February 2026, https://www.iaea.org/node/288313.

been routinised.

This gradual normalisation poses a profound challenge to the existing international normative architecture. Current legal regimes, primarily rooted in international humanitarian law and nuclear safety conventions, presume that nuclear facilities are exceptional objects warranting heightened protection. Yet they offer limited operational guidance or enforcement mechanisms in circumstances of prolonged occupation and sustained low-intensity attacks.

4.2 Diplomatic stalemate and the future of ZNPP

The second dimension concerns the diplomatic impasse surrounding the plant's legal status, operational control and future management. Russia has moved incrementally to consolidate regulatory and institutional authority over the facility, including the issuance of long-term operating licences by its nuclear regulator and integration efforts under Rosatom. These measures are evidence of a broader strategy to normalise *de facto* control through administrative and technical absorption.

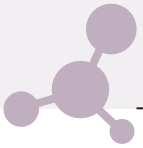
Ukraine categorically rejects these steps as unlawful, maintaining that the plant remains sovereign Ukrainian territory under occupation. President Volodymyr Zelensky has placed the ZNPP's future at the centre of ongoing United States–brokered negotiations in Geneva. Now in their third round, the Geneva talks extend beyond ceasefire modalities to encompass territorial disputes, economic arrangements, humanitarian issues and the management of strategic infrastructure. Proposals have ranged from electricity-sharing mechanisms to forms of international oversight intended to depoliticise operational control. None, however, has secured mutual consent.

The plant's status thus remains suspended between incompatible legal claims and strategic calculations

The plant's status thus remains suspended between incompatible legal claims and strategic calculations. It functions simultaneously as a bargaining chip, a symbol of sovereignty and a node in broader territorial negotiations. The diplomatic arena, rather than resolving the plant's ambiguity, has reproduced it. As long as competing visions of sovereignty and territorial settlement remain irreconcilable, the governance of ZNPP will continue to mirror the wider deadlock.

4.3 The limits of normative evolution

The third dimension is more structural and concerns the apparent paralysis of the international legal and normative apparatus tasked with protecting nuclear facilities in wartime. Historically, catastrophic nuclear events have catalysed institutional development. The accident at the Chernobyl Nuclear Power Plant accelerated the strengthening of international safety standards under the auspices of the IAEA, while the 2011 disaster at the Fukushima Daiichi Nuclear



The militarisation and prolonged occupation of an operational nuclear power plant have not yet generated a normative leap

Power Plant prompted comprehensive safety action plans at both international and regional levels.

By contrast, the militarisation and prolonged occupation of an operational nuclear power plant have not yet generated an equivalent normative leap. The IAEA has maintained a continuous presence at ZNPP and articulated essential safety principles, yet its mandate, derived from United Nations instruments, does not explicitly extend to the enforcement of binding standards tailored to active armed conflict. International humanitarian law contains provisions concerning works and installations containing dangerous forces, but these appear loose and completely irrelevant to the contemporary scenario. The unprecedented nature of the ZNPP case is widely acknowledged, yet institutional adaptation remains incremental and politically constrained.

Taken together, these three dimensions – normalised radiological risk, diplomatic stalemate and normative inertia – define the contemporary status of Zaporizhzhia. They illustrate not only the fragility of nuclear safety in wartime, but also the structural limits of the current international order in confronting the strategic instrumentalisation of civilian nuclear infrastructure.

Conclusions

The ongoing occupation of the ZNPP confronts the international community with a qualitatively distinct form of strategic coercion. The paradigm of nuclear piracy exposes structural vulnerabilities within a global nuclear governance architecture that was never designed to regulate the prolonged military control and instrumentalisation of civilian nuclear infrastructure. Whereas the contemporary nuclear security regime evolved primarily to counter non-state terrorism, and international humanitarian law affords only limited and conditional protection against attacks on works and installations containing dangerous forces, neither framework adequately addresses situations of sustained occupation, coercive manipulation and the normalisation of radiological risk. A normative and institutional lacuna therefore persists.

Addressing this gap requires a reconsideration of both international humanitarian law and nuclear security governance. First, the normative ambiguity surrounding Article 56 of Additional Protocol I must be addressed. The "military necessity" exception – historically invoked in debates over strikes against nuclear installations – provides little conceptual guidance for contexts characterised not by singular attacks, but by prolonged occupation and strategic exploitation.[30] The

[30] Castelli, Ludovica "Europe, Nuclear Risks, and the Politics of Restraint", in *IAI Papers*,

absence of clear legal parameters risks rendering civilian nuclear facilities vulnerable to instrumentalisation in future conflicts. A more comprehensive prohibition on the targeting, occupation and strategic manipulation of civilian nuclear infrastructure would close the interpretive space within which nuclear piracy operates.

Second, the IAEA's crisis response during the ZNPP emergency, though operationally significant, has remained largely improvised. The practice of establishing continuous physical presence and brokering localised ceasefire arrangements, also known as "Grossi doctrine", demonstrates the indispensability of independent, technical oversight in active conflict environments. Yet the sustainability of such arrangements cannot rest on diplomatic contingency alone. Member states should therefore consider formalising *de jure* mechanisms that grant the Agency timely and unimpeded access to facilities under threat, even where sovereignty is violently contested. Such reform would mark a necessary evolution beyond the strictly state-centric premises upon which nuclear security governance has historically relied.

Finally, the longstanding pattern of normative deferral in multilateral disarmament fora is increasingly untenable. The events at Zaporizhzhia signal not an aberration, but a potential precedent in the strategic use of civilian nuclear risk. Renewed engagement within the Conference on Disarmament and the IAEA Board of Governors to clarify, codify and penalise the weaponisation of civilian nuclear sites would constitute an essential step toward reinforcing the legal and institutional boundaries that underpin nuclear order. Absent such efforts, the normalisation of nuclear piracy risks reshaping the landscape of contemporary conflict.

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Via dei Montecatini, 17
I-00186 Rome, Italy
T +39 06 6976831
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ISSN 2610-9603 | ISBN 978-88-9368-400-2

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