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Policy Brief

IMPLICATIONS OF THE RUSSIAN OCCUPATION OF CIVIL NUCLEAR SITES IN UKRAINE

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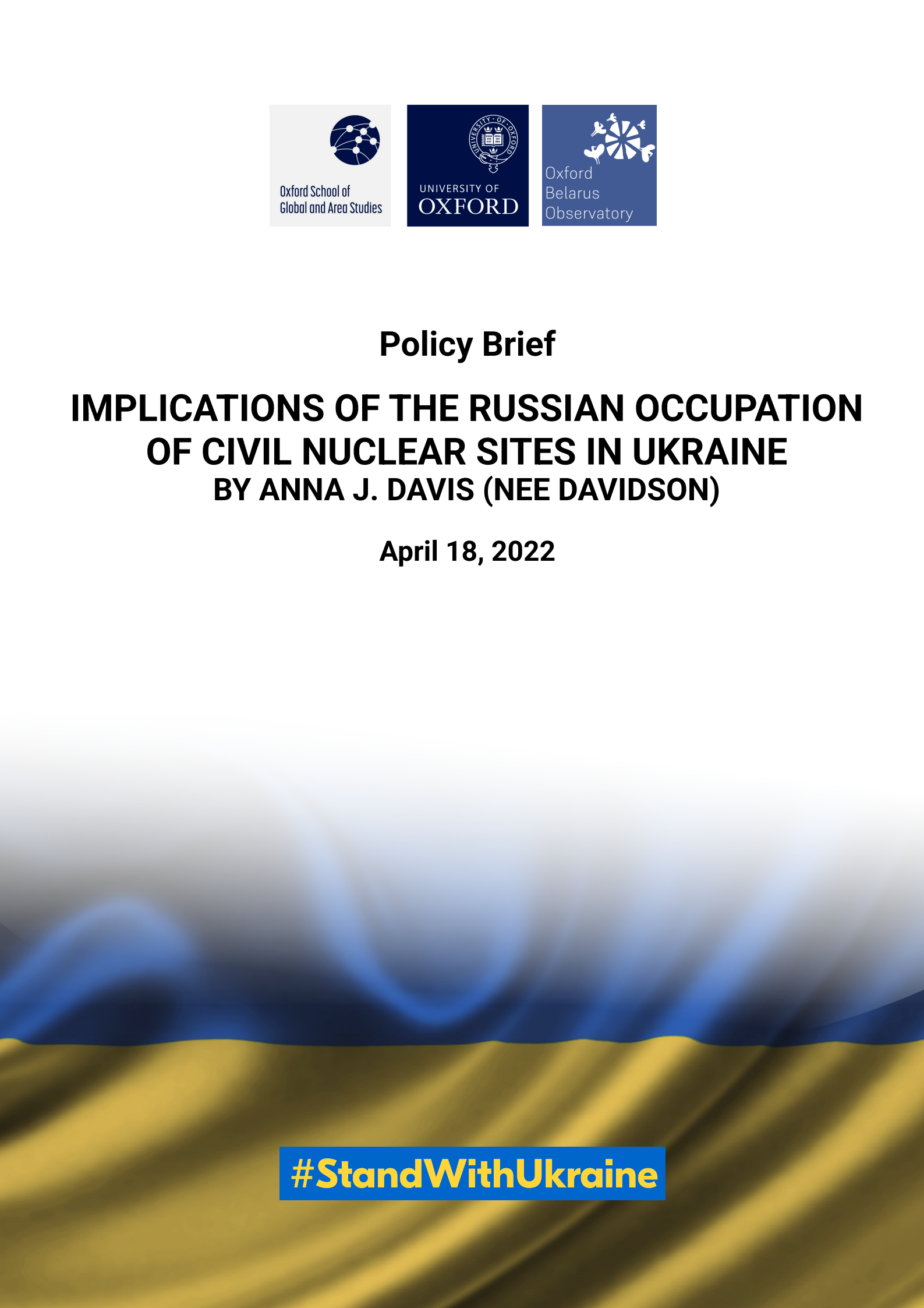

Table of Contents

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IMPLICATIONS OF THE RUSSIAN OCCUPATION OF CIVIL NUCLEAR SITES IN UKRAINE

Executive Summary

This policy brief assesses the risks and implications of the Russian occupation of the Chernobyl Nuclear Power Plant and the Zaporizhzhia Nuclear Power Plant in Ukraine during the ongoing invasion of Ukraine by Russian forces. A brief background is followed by an overview of the state of nuclear energy in Ukraine and the civil nuclear relationship with Russia to date. The policy brief then provides a few key safety considerations related to the transfer of nuclear safety knowledge from Russian leadership to troops on the ground and the risk of losing control of the security situation resulting in mistakes and confusion during conflict within the vicinity of reactors. The policy brief concludes with possible implications presented by the vulnerability of nuclear sites to hostile forces and what these implications mean for both Ukraine and for other states with nuclear sites, followed by four essential preliminary policy recommendations.

Background

On 24 February, Russian military vehicles were sighted at the Chernobyl Nuclear Power Plant (NPP) as the world quickly realised the severity of Russia's war in Ukraine. Russian forces were able to occupy Chernobyl after confrontation with Ukrainian National Guard soldiers,[1] whom they locked inside an underground bunker from the Cold War.[2] For five weeks Russian forces occupied the NPP and surrounding areas before finally withdrawing and returning control to Ukraine on 31 March. At the time of writing, the Zaporizhzhia NPP remains under Russian occupation and continues to operate. This plant has been occupied by Russian forces since 4 March, when a fire broke out after a projectile hit one of the training buildings outside of the main reactor complex.

Analysis of the Issue

Ukraine is highly skilled in nuclear technology with decades of experience operating their NPPs via the state-owned nuclear corporation Energoatom. Of all the countries in Europe, Ukraine operates the highest number of reactors next to France. Ukraine has four nuclear power plants operating a total of 15 reactors, as shown in *Figure 1*, whilst neighbouring Belarus has a newly commissioned nuclear power plant with one reactor currently operating and a second in construction. None of the operating reactors in Ukraine are RBMKs (the design of Chernobyl's reactor 4 whose core melted down). All of the reactors in both Ukraine and Belarus are Russian-designed VVER pressurised water reactors (PWRs). PWRs are the

[1] The exact number differs according to reports but was 169 as reported by CNN.
[2] Vasco Cotovio et al., "Ukrainians Shocked by 'crazy' Scene at Chernobyl after Russian Pullout Reveals Radioactive Contamination," CNN, April 9, 2022, https://edition.cnn.com/2022/04/08/europe/chernobyl-russian-withdrawal-intl-cmd/index.html.

most common type of reactors used today and Russia's state-owned nuclear energy corporation, Rosatom, is the leading exporter of reactors with about 35 construction projects happening around the world at present.[3] This means that it is not unusual for both Belarus and Ukraine, to have Russian-designed reactors. In addition to the reactors themselves, Russia's Rosatom provides an unrivalled, full package supporting 'the entire nuclear fuel cycle' including construction of the plants, reactor technology, professional training, and disposal of radioactive nuclear fuel for the lifetime operation of the reactor.[4] This means that Russian leadership is able to easily access the required expertise to safely occupy the NPPs that Rosatom (and previously, the Russian Federal Atomic Energy Agency) and its subsidiaries have constructed. Russian operations around NPPs will be and have been thus far very calculated and measured according to known risks.

Figure 1 Nuclear Power Plants in Ukraine

Associated Risks of Russia's Occupation of Ukraine's Nuclear Sites

The reactors at Chernobyl are in the decommissioning stage of their lifecycles, meaning that they do not actively produce energy to the electrical grid. However, the reactors at the

[3] Rosatom, "Projects," Rosatom, 2021, https://rosatom.ru/en/investors/projects/.
[4] Thomas P. Davis, "Could Generation IV Nuclear Reactors Strengthen Russia's Growing Sphere of Influence?'," *2019 UK PONI Papers, Royal United Services Institute*, 2019.

Zaporizhzhia NPP are operational and do supply electricity to Ukraine. Immediate safety concerns related to the release of radioactive materials at either of these nuclear power plants is a valid one for two main reasons. First is the transfer of nuclear safety knowledge from Russian leadership to troops on the ground. Second is the risk of losing control of the security situation resulting in mistakes and confusion during conflict within the vicinity of reactors at NPPs. This risk is always present in conflict despite any knowledge of nuclear safety that may be held by Russian forces. These two main safety concerns are examined in the subsequent paragraphs. Before moving on, though, it is important to address concerns about fuel supplies. Fuel for reactors is not considered a major issue at present. Although Ukraine receives the majority of its nuclear fuel supplies from Rosatom, the ongoing war has not significantly disrupted the electricity generation operations of its nuclear power plants. Receiving of fuel assemblies is not a common concern for NPPs as these remain inside a reactor for 18-36 months at a time; therefore, immediate fuel supplies for Ukraine's NPPs have not been necessary.[5] Ukraine has also been in the process of diversifying its sources of fuel to include Westinghouse's fuel services.[6]

The concern mentioned above regarding transfer of knowledge has already been realised during the occupation by Russian forces at the Chernobyl NPP. The access enjoyed by Russian state leadership via its state-owned nuclear energy complex to the knowledge of reactor safety and radioactive materials safety means that there would be an idea of just how closely Russian forces can maintain a threatening position without actually causing substantial harm or damage to the reactors. The Russian state has clearly leaned on Rosatom for such knowledge throughout the war. Rosatom's Director General, Alexey Likhachev, confirmed to IAEA Director General Rafael Mariano Grossi that Russian experts from the corporation were present at the Zaporizhzhia NPP.[7] In addition to this, the Russian government confirmed to IAEA that 'management and operation of the Zaporizhzhia and Chernobyl NPPs is carried out by the Ukrainian operating personnel. A group of several Russian experts provides them consultative assistance.'[8] It was also reported by one of the shift managers at Chernobyl that experts from Rosatom were onsite during the occupation.[9]

Although there is certainly no lack of expertise on the Russian side of how to safely operate a nuclear power plant, that expertise (or 'minimal intelligence', as put by Ukraine's Yaroslav Yemelianenko) is not necessarily guaranteed to be held by the individual Russian troops on the ground at both the Chernobyl and Zaporizhzhia NPPs.[10] This is evident in the reported trench digging by Russian troops without protective equipment in the Red Forest near the Chernobyl NPP, exposing them breathing in and coming into contact with

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[5] Chris Park and Michael Allaby, "Nuclear Fuel Cycle," in *A Dictionary of Environment and Conservation* (Oxford University Press, 2017).
[6] World Nuclear Association, "Nuclear Power in Ukraine," March 2021, https://world-nuclear.org/information-library/country-profiles/countries-t-z/ukraine.aspx#:~:text=Ukraine is heavily dependent on,by buying fuel from Westinghouse.
[7] IAEA, "Update 19 – IAEA Director General Statement on Situation in Ukraine," International Atomic Energy Agency, March 12, 2022, https://www.iaea.org/newscenter/pressreleases/update-19-iaea-director-general-statement-on-situation-in-ukraine.
[8] Ibid.
[9] Cotovio et al., "Ukrainians Shocked by 'crazy' Scene at Chernobyl after Russian Pullout Reveals Radioactive Contamination."
[10] Brendan Cole, "Russian Troops Sickened by Contaminated Chernobyl Soil: Official," Newsweek, March 31, 2022, https://www.newsweek.com/chernobyl-russia-troops-ukraine-yemelianenko-nuclear-1693714.

radioactive materials released into the environment.[11] The troops have now reportedly been taken to Belarus' Republican Scientific and Practical Center for Radiation Medicine and Human Ecology, according to the State Agency of Ukraine for Exclusion Zone Management.[12] However, the increase in radiation exposure caused by digging trenches must also be considered in light of the 36 years in which the radioactive materials have been decaying since the meltdown of reactor 4 at Chernobyl. On 25 February, as Russian military vehicles disturbed the soil in the Exclusion Zone, it was reported that radiation levels jumped to five times more than the normal dose that one would receive in the area to 65 microsieverts per hour (microSv/hr).[13] Microsieverts are one millionth of a sievert and millisieverts (mSv) are one thousandth of a sievert. Both are used as a way to measure radiation exposure.

To put this into context, humans receive on average about 2.4-3 mSv per year from natural exposure whilst, close to the Chernobyl NPP, a normal radiation dose is 3 microSv/hr and it is tolerable for limited periods of time, according to IAEA.[14] Permanent residents in the Exclusion Zone do not receive fatal levels of radiation poisoning despite being exposed to higher levels than those in the natural environment.[15] Similarly, those who work in the Exclusion Zone limit their annual dose of radiation by typically working for three weeks at a time followed by an off period of three weeks.[16] During the 1986 Chernobyl disaster, the average dose of radiation received by the liquidators was 100mSv. This is substantially more than the 65microSv/hr reportedly received by the Russian military forces who recently occupied Chernobyl (it takes 1,000microSv to equal 1mSv). However, it is impossible to say the exact dose that Russian forces have received given that the Chernobyl NPP was occupied for five weeks, and the rate of radiation exposure would have varied over time. Data is currently not available for radiation levels during the entire five weeks. At the time of writing, the IAEA is still working to verify the level of radiation exposure received by Russian forces.

The second safety issue can be observed in the situation that developed at the Zaporizhzhia NPP where Russian military forces took control. In the early hours of 4 March, fighting between forces caused a training building to be hit with a projectile and a fire to break out. It is important to remember that buildings housing reactors are built to withstand the impact of a commercial airliner.[17] So, although none of the actual reactors on site were damaged and no radioactive materials were released, there was some damage to one of the reactor compartment buildings that did not threaten the integrity of the structure. In addition to this, damage occurred to two of the five high-voltage off-site power lines (a single line

[11] The Moscow Times, "Russian Soldiers Dug Trenches in Chernobyl Zone's Radioactive Soil – Ukrainian Official," The Moscow Times, April 7, 2022, https://www.themoscowtimes.com/2022/04/07/russian-soldiers-dug-trenches-in-chernobyl-zones-radioactive-soil-ukrainian-official-a77255.
[12] Cole, "Russian Troops Sickened by Contaminated Chernobyl Soil: Official."
[13] Also referred to as uSv. Victoria Gill, "Chernobyl: Why Radiation Levels Spiked at Nuclear Plant," BBC, February 25, 2022, https://www.bbc.co.uk/news/science-environment-60528828.
[14] IAEA, "Frequently Asked Chernobyl," International Atomic Energy Agency, 2022, https://www.iaea.org/newscenter/focus/chernobyl/faqs.
[15] Ibid.
[16] The Chernobyl Gallery, "Radiation Levels," The Chernobyl Gallery, May 2021, http://www.chernobylgallery.com/chernobyl-disaster/radiation-levels/.
[17] World Nuclear Association, "Safety of Nuclear Power Reactors," World Nuclear Association, 2022, http://www.world-nuclear.org/info/Safety-and-Security/Safety-of-Plants/Safety-of-Nuclear-Power-Reactors/#.UghCSj92FvA.

needs to be in operation to provide power). Despite this, output of the reactors has not been substantially affected even by the occupation of an invading military force, aside from a brief 100 MWe reduction per reactor on 17 March when an onsite power line broke but was promptly repaired on the same day.[18] Communications have also been an ongoing problem between the nuclear regulator in Ukraine and the staff at the Zaporizhzhia NPP and the IAEA has expressed concerns over the staff's ability to 'fulfil their safety and security duties and have the capacity to make decisions free of undue pressure.'[19]

Repercussions of occupying nuclear sites in wartime

A major question arising from the occupation by Russian forces of two of Ukraine's nuclear sites is whether Ukraine is capable of ensuring its nuclear sites are secure, which in turn affects the credibility of Ukraine as a responsible nuclear energy state. This holds implications for Belarus as well at present given the balance in which the country hangs with a heavy Russian military presence and increasing agitation towards the Belarusian regime from the west. Similar to the Zaporizhzhia nuclear power plant being the closest Ukrainian NPP to the Russian border, Belarus' Ostrovets NPP is only 40km to the border of Lithuania. In light of these realities, we may ask ourselves whether it is possible for any state to ensure its nuclear sites do not fall into the hands of hostile forces, and this may very well be a futile effort. It is arguably more desirable from a public safety perspective to allow nuclear sites to come under occupation by foreign forces who understand the technology and science behind their operation rather than risk armed conflict at the sight which could lead to accidental damage to the reactors. In such cases, surrender may be safer than resistance. This means that both the international nuclear regulatory regime as well as states with civil nuclear sites will need to reassess the susceptibility of those sites to occupation by hostile forces. We can now be certain that the norm of respecting that nuclear sites are off limits during wartime no longer applies.

Policy Recommendations

To Ukraine:

1. Lessons from occupations of the Chernobyl NPP and Zaporizhzhia NPP need to be applied to ensure the safe exit of Russian forces at the Zaporizhzhia NPP as well as mitigate any similar risks to occupation at Ukraine's other nuclear sites, including the Khmelnytskyi, Rivne, and South Ukraine NPPs as well as its research reactors at Sevastopol University, the institute for Nuclear Research (NASU) and Kharkiv Institute of Physics and Technology. First and foremost, personnel at these sites must be clear on the state's protocol for scenarios of Russian forces attempting to occupy the sites. Do they surrender management of the site in order to avert risk of releasing radioactive materials in the fog of war and confusion in conflict? Or do they maintain control of operations at the site at all cost? And then what? The answers to these

[18] World Nuclear Association, "Ukraine: Russia-Ukraine War and Nuclear Energy," World Nuclear Association, March 30, 2022, https://world-nuclear.org/information-library/country-profiles/countries-t-z/ukraine-russia-war-and-nuclear-energy.aspx.

[19] IAEA, "Update 42 – IAEA Director General Statement on Situation in Ukraine," International Atomic Energy Agency, 2022, https://www.iaea.org/newscenter/pressreleases/update-42-iaea-director-general-statement-on-situation-in-ukraine.

questions must be clearly communicated between the Ukrainian government and the personnel operating its nuclear sites during this conflict.

2. Ukraine's State Nuclear Regulatory Inspectorate must continue to ensure psychological and physical pressure to the personnel operating the Zaporizhzhia NPP are minimised whilst Russian occupation continues. At this point, integrity of nuclear safety is most important. At present, the situation at the Zaporizhzhia NPP is stable (i.e. there are no reports of conflict or gunfire since the Russian takeover), and, according to the most recent statement by IAEA, Ukraine reports 'no significant new developments related to nuclear safety and security…'[20] This means that, in order to avoid increased risk in nuclear safety, it would be ill advised for the Ukrainian armed forces to attempt to regain control of the NPP at present.

To states with nuclear power plants and nuclear sites, and to the international nuclear regulatory regime:

1. A reassessment, especially by the IAEA Office of Nuclear Security, of the protocol for security management of radioactive material and integrity of a nuclear site's operation by its owner, and communication with the state regulator, is needed. As far as is known, it appears that an unexpected decision point was faced by both the security forces at Ukraine's Chernobyl and Zaporizhzhia NPPs and by their respective personnel: surrender to the Russian forces or risk the possible release of radioactive materials if conflict with the Russian forces continued. This is a choice between preserving public safety in the immediate term and surrendering vital critical infrastructure to foreign forces. These two options should never be in opposition to one another, especially in wartime.
2. Related to point 2, a rethink by the international nuclear regulatory regime and states with nuclear sites is necessary regarding our appreciation of all possible motivations related to targeting nuclear sites. With the near loss of all reverence by Russian forces towards nuclear sites during wartime, it is important that states in conflict or in conflict-prone situations assess the integrity of their security infrastructures at these sites. This rethink must extend beyond motivations centred on the acquisition of radioactive materials and beyond potential hostile actions being terrorist groups and not military forces. Most nuclear safety protocols assume hostile forces towards nuclear sites would be motivated by the acquisition of radioactive and hazardous materials. Few mention the occupation of such sites in wartime as a motivation by hostile forces, and instead emphasise the risk presented by 'terrorists, other criminals and extremists who might seek to acquire and use nuclear material or other radioactive material…'[21] However, Russian forces have not exhibited the acquisition of nuclear material as an aim in occupying either Chernobyl or the Zaporizhzhia NPP

[20] IAEA, "Update 54 – IAEA Director General Statement on Situation in Ukraine," International Atomic Energy Agency (Vienna, Austria, April 16, 2022), https://www.iaea.org/newscenter/pressreleases/update-54-iaea-director-general-statement-on-situation-in-ukraine.

[21] Ibid.

and instead appear to have been tasked with gaining control of the sites and holding that control until further orders are given.[22]

References

Cole, Brendan. "Russian Troops Sickened by Contaminated Chernobyl Soil: Official." Newsweek, March 31, 2022. https://www.newsweek.com/chernobyl-russia-troops-ukraine-yemelianenko-nuclear-1693714.

Cotovio, Vasco, Frederik Pleitgen, Byron Blunt, and Darla Markina. "Ukrainians Shocked by 'crazy' Scene at Chernobyl after Russian Pullout Reveals Radioactive Contamination." CNN, April 9, 2022. https://edition.cnn.com/2022/04/08/europe/chernobyl-russian-withdrawal-intl-cmd/index.html.

Davis, Thomas P. "Could Generation IV Nuclear Reactors Strengthen Russia's Growing Sphere of Influence?'." *2019 UK PONI Papers, Royal United Services Institute*, 2019.

Gill, Victoria. "Chernobyl: Why Radiation Levels Spiked at Nuclear Plant." BBC, February 25, 2022. https://www.bbc.co.uk/news/science-environment-60528828.

IAEA. "Frequently Asked Chernobyl." International Atomic Energy Agency, 2022. https://www.iaea.org/newscenter/focus/chernobyl/faqs.

———. "National Nuclear Security Threat Assessment, Design Basis Threats and Representative Threat Statements." IAEA Nuclear Security Series No. 27-G Implementing Guide. Vienna, Austria, 2021. https://www-pub.iaea.org/MTCD/Publications/PDF/PUB1760_web.pdf.

———. "Update 19 – IAEA Director General Statement on Situation in Ukraine." International Atomic Energy Agency, March 12, 2022. https://www.iaea.org/newscenter/pressreleases/update-19-iaea-director-general-statement-on-situation-in-ukraine.

———. "Update 42 – IAEA Director General Statement on Situation in Ukraine." International Atomic Energy Agency, 2022. https://www.iaea.org/newscenter/pressreleases/update-42-iaea-director-general-statement-on-situation-in-ukraine.

———. "Update 54 – IAEA Director General Statement on Situation in Ukraine." International Atomic Energy Agency. Vienna, Austria, April 16, 2022. https://www.iaea.org/newscenter/pressreleases/update-54-iaea-director-general-statement-on-situation-in-ukraine.

Park, Chris, and Michael Allaby. "Nuclear Fuel Cycle." In *A Dictionary of Environment and Conservation*. Oxford University Press, 2017.

Rosatom. "Projects." Rosatom, 2021. https://rosatom.ru/en/investors/projects/.

[22] Despite reports of theft by Russian forces of radioactive material from laboratories at Chernobyl, this appears to have been carried out by individual soldiers as 'souvenirs' and does not appear to be the primary aim of the Russian state in occupying Chernobyl.

The Chernobyl Gallery. “Radiation Levels.” The Chernobyl Gallery, May 2021. http://www.chernobylgallery.com/chernobyl-disaster/radiation-levels/.

The Moscow Times. “Russian Soldiers Dug Trenches in Chernobyl Zone’s Radioactive Soil – Ukrainian Official.” The Moscow Times, April 7, 2022. https://www.themoscowtimes.com/2022/04/07/russian-soldiers-dug-trenches-in-chernobyl-zones-radioactive-soil-ukrainian-official-a77255.

World Nuclear Association. “Nuclear Power in Ukraine,” March 2021. https://world-nuclear.org/information-library/country-profiles/countries-t-z/ukraine.aspx#:~:text=Ukraine is heavily dependent on,by buying fuel from Westinghouse.

———. “Safety of Nuclear Power Reactors.” World Nuclear Association, 2022. http://www.world-nuclear.org/info/Safety-and-Security/Safety-of-Plants/Safety-of-Nuclear-Power-Reactors/#.UghCSj92FvA.

———. “Ukraine: Russia-Ukraine War and Nuclear Energy.” World Nuclear Association, March 30, 2022. https://world-nuclear.org/information-library/country-profiles/countries-t-z/ukraine-russia-war-and-nuclear-energy.aspx.