

John Simon

Mr. Graham Rutherford

Oxford Scholars

12 November 2022

On the Russo-Ukrainian War and the Zaporizhzhia Nuclear Power Plant

Russia's invasion of Ukraine began on February 24, 2022. Just eight days later, Russia's advance reached the Zaporizhzhia nuclear power plant, the largest nuclear power plant in Europe. That night, intense fighting began around the site after Russian shelling set fire to one of the buildings. Although the fire was contained and radiation levels around the plant remained safe, the incident brought Zaporizhzhia to the forefront of the Russo-Ukrainian conversation. By the next day, control of the plant was firmly in the hands of the Russian military, and the Ukrainian operators of the plant were allegedly working "at gunpoint" (Waterhouse). By late August, shelling of electrical infrastructure caused the plant to lose external power for the first time, though it would regain and lose power again multiple times in the following weeks. In early September, The United Nations' authority on nuclear power, the International Atomic Energy Agency (IAEA), conducted a visit to the plant to assess the integrity of the site and its danger to the surrounding area. Their report concluded that the situation was "unprecedented" and "gravely concerning", noting that the plant failed all seven major safety tests for nuclear reactors. By mid-September, all six reactors at the plant had entered a cold shutdown, but by early November, two reactors partially resumed operation to provide limited energy for the plant's safety systems.

To better understand the potential danger, it's helpful to understand how nuclear reactors work. Nuclear reactors, like the ones in Zaporizhzhia, use the heat from controlled atomic

reactions to generate electricity. Rods of Uranium are brought into the reactor, where induced radioactive decay makes them very hot. This heat is used to boil water into steam, and that steam turns turbines which generate electricity. If there is too much heat, however, it can damage the reactor, potentially leaking dangerous radioactive material. This means that operating a nuclear reactor is a constant balancing act between keeping the fuel hot enough to generate electricity, and cooling it enough to avoid damage to the plant. To regulate the fuel in this way, a coolant is pumped into the core of the reactor, requiring energy. This electricity is usually supplied by multiple-redundant power lines that bring external electricity to the plant and are backed up by emergency diesel generators. If these cooling systems are cut off from electricity and fail, dangerous meltdowns can occur.

Nuclear plants also must deal with the dangers of nuclear waste, which is often stored temporarily at the site of the plant. While systems are in place to prevent the dangers of the waste from spreading to the outside world, they are not designed for war zones. A direct hit from a missile could potentially damage the fuel storage, spreading radioactive materials across a wide area. The chances of this happening, and the potential risk if it does, are both less than the danger posed by a coolant-system failure, but they are still important considerations for nuclear experts.

In addition to these dangers, there are major concerns about the personnel operating and maintaining the plant, who are working in hazardous warzone conditions. According to an IAEA report, military equipment and personnel are present at the plant at all times, which has led to “extremely stressful” conditions for workers. Some of the Ukrainian workers have escaped the plant’s conditions, but this has only led to staffing shortages. As of early September, only 3 of every four employees at Zaporizhzhia remained. Furthermore, many of the facilities at Zaporizhzhia have been damaged by shelling; workers are reportedly surrounded by broken

windows and damaged buildings. At least one worker at the plant has been seriously injured by the fighting on the outskirts of the plant. According to the IAEA, these deteriorating conditions for plant personnel likely cause “increased risk of human error,” exacerbating the other dangers present at the plant.

At the moment, the Zaporizhzhia nuclear power plant remains in an extremely precarious position. Four of the six reactors remain in the safe cold-shutdown state, but two of them are partially active, and therefore pose greater potential danger (IAEA). Most of the time the plant has access to external power, but between August and November power was cut off at least four times. A dangerously increasing amount of trust is being placed in the plant’s backup diesel generators, which are running out of fuel quickly as external power sources become less and less dependable. The Ukrainian state-run energy company estimates that the generators have about 15 days worth of fuel. If external power were denied to the plant for more than 15 days, nuclear disaster would be imminent. Russia and Ukraine have both expressed concern about the situation, but each country blames the other for damaging crucial infrastructure, and there is little hope for military cessations in the area any time soon.

While it is important to understand the dangers facing the Zaporizhzhia nuclear power plant, it is equally important to understand what dangers it is *not* facing. As with all nuclear reactors, the ones at Zaporizhzhia cannot explode like a nuclear bomb. This is due to an atomic-level difference between the low-grade uranium used for nuclear power, and the bomb-grade uranium used for nuclear weapons. Similarly, control of Zaporizhzhia doesn’t impact Russia’s nuclear weapons development program in any significant way. Russia already has 38 nuclear reactors, so there is not much they could gain from Zaporizhzhia that they don’t already have.

Given its relatively close proximity to Chernobyl, many comparisons have been made between the Zaporizhzhia nuclear power plant and the site of the worst-ever nuclear meltdown. The chances of such a disaster are very low, however, because the reactors at Zaporizhzhia are of much safer design than the ones in Chernobyl (Paul). Between its outdated graphite-based cooling systems and lack of a concrete containment structure, the design of the Chernobyl nuclear power plant was fundamentally flawed from the beginning, so the modern Zaporizhzhia plant shouldn't be compared to it. A more apt comparison is to Fukushima, a deadly but much less devastating meltdown. In that case, an earthquake crippled the surrounding electrical grid, and a tsunami flooded the emergency backup generators, resulting in a coolant system failure that led to a meltdown. If that sounds familiar, it should: the primary danger in Zaporizhzhia is that power would be denied to the plant, resulting in a coolant system failure that leads to a meltdown.


Nuclear dangers aside, the Zaporizhzhia nuclear power plant is of great strategic importance. Zaporizhzhia has the largest nuclear power plant in Europe, which provides about 20% of Ukraine's electricity (The Guardian). Many experts believe that the primary reason Russia wants Zaporizhzhia is that it is a cornerstone of Ukrainian infrastructure – not that it is a volatile nuclear power plant. The Ukrainian Energy Minister believes that by taking away a vital source of Ukrainian energy, Russia hopes to eliminate competitors for its coal and gas industries (Kyiv Independent). In addition, as winter approaches, occupied Ukrainian civilians without energy may be more willing to turn to Russia for assistance. Russia has already taken steps to connect their newfound energy source to the Russian grid, annexing energy as well as land.

In addition to the strictly infrastructural importance of Zaporizhzhia, both sides accuse the other of using the volatile power plant as a tool for environmental terrorism. The plant is

currently within Russian-controlled territory, and the attacks putting the plant in danger are largely perpetrated by Ukraine. Much of the uncertainty and danger surrounding Zaporizhzhia has been caused by Ukrainian aggression towards the site. The situation is complex though, and should not be reduced to a single dimension of blame on Ukraine. The IAEA has reported significant damage done to external power lines leading to Zaporizhzhia within Ukrainian-controlled territory, suggesting that Russian shelling is at least partially at fault for the disrupted external power supply. In addition, Ukraine has alleged that Russia has been using the plant as a shield, taking advantage of Ukrainian hesitance to fire on the area by storing weapons and equipment at or near the plant. Russia, in turn, has alleged that Ukraine is intentionally targeting the plant to force Russian attention away from the frontline and onto protecting the plant (TASS). The truth most likely lies somewhere in the middle of these two claims, but it is only known to precious few for now.

Both Ukraine and Russia have done well cooperating with the IAEA, allowing them to gather the necessary information to make recommendations for the site. The three most pressing issues for Zaporizhzhia according to the IAEA are the unreliable power supply to the plant, the risk presented by nuclear waste storage, and the deteriorating conditions for workers. To address these issues, the IAEA has first and foremost called for a “nuclear safety and security protection zone” – essentially a local cease-fire in the region surrounding the plant – and has offered to help “facilitate the zone’s implementation.” In addition, they have called for the Russian military to return control of the plant to its regular management, which would relieve stress on the Ukrainian workers. The implementation of these measures would go a long way to ensuring the safety of Zaporizhzhia, Ukraine, and the world at large.

Works Cited

- “Country Nuclear Power Profiles: Russian Federation.” *International Atomic Energy Agency (IAEA)*, 2021,
<https://cnpp.iaea.org/countryprofiles/Russia/Russia.htm#:~:text=Currently%2C%20the%20country%20operates%2038,the%20export%20of%20nuclear%20services>
- “Director General’s Statement on Serious Situation at Ukraine’s Zaporizhzhya Nuclear Power Plant.” *International Atomic Energy Agency (IAEA)*, 9 September 2022,
<https://www.iaea.org/newscenter/statements/director-generals-statement-on-serious-situation-at-ukraines-zaporizhzhya-nuclear-power-plant>
- “Energoatom: Russia tries to connect Zaporizhzhia nuclear plant to occupied territories.” *The Kyiv Independent*, 3 November 2022,
<https://kyivindependent.com/news-feed/energoatom-russia-to-connect-zaporizhzhia-nuclear-plant-to-occupied-territories>
- Energy atom , [@energoatom_ua]. *Telegram*. https://t.me/s/energoatom_ua
- “Intelligence: Russian troops install military equipment on Zaporizhzhia power plant’s rooftop.” *The Kyiv Independent*, 1 November 2022,
<https://kyivindependent.com/news-feed/intelligence-russian-troops-install-military-equipment-on-zaporizhzhia-power-plants-rooftop>
- “Kiev’s attacks on Zaporozhye NPP put nuclear security of entire Europe at risk – diplomats.” *TASS Russian News Agency*, 7 August 2022, <https://tass.com/politics/1490595>
- “Kiev raising stakes for confrontation by attacking Zaporozhye NPP – regional official.” *TASS Russian News Agency*, 10 August 2022, <https://tass.com/politics/1492161>

Kirby, Paul. “Ukraine nuclear plant: How risky is the standoff in Zaporizhzhia?” *BBC News*, 1 September 2022, <https://www.bbc.com/news/world-europe-62602367>

Kramer, Andrew. “Using Nuclear Reactors for Cover, Russians Lob Rockets at Ukrainians.” *The New York Times*, 1 August 2022, <https://www.nytimes.com/2022/08/01/world/europe/ukraine-south-counteroffensive-nuclear.html>

“Nuclear Safety and Security in Ukraine.” *International Atomic Energy Agency (IAEA)*, <https://www.iaea.org/nuclear-safety-and-security-in-ukraine>

“Nuclear Safety, Security and Safeguards in Ukraine: 2nd Summary Report by the Director General.” *International Atomic Energy Agency (IAEA)*, 5 September 2022, https://www.iaea.org/sites/default/files/22/09/ukraine-2ndsummaryreport_sept2022.pdf

Petersson, Henrik. “Zaporizhzhia nuclear power plant: History, control, and key developments.” *CNN News*, 2 September 2022, <https://www.cnn.com/2022/09/02/europe/ukraine-zaporizhzhia-nuclear-plant-visual-guide-intl-dg>

“Two ZNPP reactors switched to hot shutdown mode – Rosenergoatom.” *TASS Russian News Agency*, 2 November 2022, <https://tass.com/world/1531669>

“Ukraine: Current status of nuclear power installations.” *Nuclear Energy Agency (NEA)*, 3 November 2022, https://www.oecd-nea.org/jcms/pl_66130/ukraine-current-status-of-nuclear-power-installations

“Ukraine sees Zaporozhye plant only as an instrument of nuclear blackmail – Rosenergoatom.” *TASS Russian News Agency*, 11 October 2022, <https://tass.com/economy/1521189>

“Ukraine’s Zaporizhzhya Nuclear Power Plant lost off-site power again, diesel generators providing back-up electricity.” *International Atomic Energy Agency (IAEA)*, 12

November 2022,

<https://www.iaea.org/newscenter/pressreleases/ukraines-zaporizhzhya-nuclear-power-plant-lost-off-site-power-again-diesel-generators-providing-back-up-electricity>

Waterhouse, James. “Zaporizhzhia nuclear workers: We’re kept at gunpoint by the Russians.”

BBC News, 11 August 2022, <https://www.bbc.com/news/world-europe-62509638>

“Zaporizhzhia nuclear power plant: everything you need to know.” *The Guardian*, 4 March 2022,

<https://www.theguardian.com/world/2022/mar/04/zaporizhzhia-nuclear-power-plant-everything-you-need-to-know>