Nuclear Risks at the Ukrainian Zaporizhzhia Nuclear Power Plant (ZNPP)

The Zaporizhzhia Nuclear Power Plant (ZNPP) is the largest nuclear power plant in Europe, and one of the ten largest in the world.

Since Russia first took over the ZNPP on March 4, 2022, there has been major concern over the safety of the plant and the risk of a potential nuclear incident that could result in the release of radiation in Ukraine and elsewhere.

Key Takeaways

- IAEA plans to stay and establish a permanent presence at the plant.
- Energoatom said that power lines had been restored to the Zaporizhzhia plant but that they were powering down Reactor No. 6, preparing it to be cooled and transitioned to a safer state.
- At ZNPP, the power is normally supplied by four high-voltage lines, which connect the nuclear complex to Ukraine’s electricity grid, but the conflict has seen those lines systematically cut.
- Ukrainian Intelligence believes Russia is intentionally targeting the plant in an act of nuclear terrorism.
- If the plant goes offline again, it will need to switch to backup emergency diesel generators to keep the reactors cool: Generators have about 10 days worth of fuel.
- There is enough reserve water to maintain cooling at normal rates for the months to come but damage to the dam is causing the crucial water source, the Kakhovka Dam, to deplete continuously.
- If that fuel is depleted, the generators are damaged in further fighting, or the water cooling systems fail it could trigger a meltdown in a matter of hours.

Assessing the Damage

There has been repeated shelling at the ZNPP in the past months that has been cause for serious concern.

Most importantly, there has been repeated damage and interference to the power lines connecting the ZNPP to the Ukrainian power grid. For some time, the plant was disconnected from all four high-voltage lines connecting the plant to the national power grid, relying on a backup line to provide power. On September 11, Energoatom, Ukraine’s nuclear power company, announced that while the power lines were restored to the ZNPP, they were shutting down unit 6, allowing it to cool down. However, the danger remains.

A loss of power to the plant is perhaps one of the most dangerous scenarios, as it needs constant energy from the very same electric grid it powers in order to function. In particular, it requires this power for its safety and cooling systems that cool the reactor cores and the spent fuel ponds that host the spent (used) nuclear fuel. If shelling continues in and around the plant, it could re-disconnect the plant from the power grid. Though the last reactor went offline and is cooling down, it is still very hot and requires power to continue the cooling process. If power is lost, it could potentially trigger a meltdown. While the reactor is housed in a building reinforced to withstand major impact and thus would likely limit radiation released into the environment, we cannot concretely predict the damage such a scenario would cause.

The bigger threat lies with the spent fuel ponds. If the water filling these ponds and cooling the spent fuel rods evaporates, the zirconium cladding will heat up, and could potentially catch fire and cause a significant amount of radiation to be released. As well, these spent fuel ponds are not safeguarded by any reinforced building - they are out in the open - meaning any artillery or projectiles could also threaten the stability of the spent fuel. Further, the dry spent fuel cooling facility requires constant airflow to cool down spent fuel, and if power is lost that facility’s stability is also jeopardized.
The collapse of the Nova Kakhovka Dam causes long-term logistical challenges for cooling the fuel rods. Since the collapse of the dam at the beginning of June the Kahkova reservoir level has been dropping for 10cm per day. Between the large cooling pond, the smaller ponds, and the discharge channel there is enough water for cooling for several months. However, a long-term solution will need to be found as water continues to drain from the reservoir.

On top of physical damage, the Ukrainian operational staff have been working under immense pressure since the ZNPP was taken over by Russian military forces. In a report following the International Atomic Energy Agency’s visit in September, they stated that the “morale and the emotional state” of staff “were very low.”

Adding to this extremely stressful situation, staff reported not having unrestricted access to some areas of the plant, including the cooling ponds. Combining the reduced ability to perform their responsibilities ensuring the safety and security of the plant, severely reduced staffing creating immense workloads for existing staff, and the constant stress weighing on the staff, the concern for human error resulting in a nuclear incident is considerable.

Assessing the Risks

Since its visit on September 2, the IAEA has continued to monitor the site with the hope of establishing a permanent presence. However, there has been no progress on calls for a demilitarised zone with missiles landing as close as 300 metres from the plant. On June 22, 2023, Ukrainian intelligence services claimed Russian forces are planning an act of nuclear terror, specifically in the form of a targeted radiation leak from the plant. The Kremlin denies the reports outright and the exact situation remains unclear. The IAEA completed another round of inspections as recently as June 21, and though they note the perimeter mines and select mines inside the plant are in clear violation of international safety protocols, they found no evidence of explosives that threaten the critical infrastructure of the plant.

President Zelensky has put increased pressure on the international community to act against Russia, noting both that “radiation knows no borders” and claiming that those who sit in indifference are not only “contributing to Russian evil but to terror in general.”

On June 22 Senators Lindsey Graham and Richard Blumenthal introduced a bipartisan resolution declaring any attack on the plant would be seen as an attack on NATO and would invoke an Article 5 response. Senator Graham emphasised the need for clarity in effective deterrence. The message was clear: attack the plant, face war with NATO.

PSR supports efforts to implement a nuclear safety and security protection zone at the ZNPP.

Sign the International Physicians for the Prevention of Nuclear War (IPPNW) Avaaz petition calling to ban all fighting around nuclear power plants.