



# Russian Military Actions at Ukraine's Nuclear Power Plants

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Russia's ongoing military occupation of Ukraine's six-reactor Zaporizhzhia nuclear power plant (ZNPP)—the [largest in Europe](#)—has raised widespread alarm about the potential for damage to the plant that could cause large radioactive releases to the environment. Russian forces attacked and captured the plant on March 4, 2022, with reported [“heavy fighting and artillery shelling.”](#) Shelling around the plant resumed on August 5, 2022, prompting the International Atomic Energy Agency (IAEA) [to warn](#), “Any military firepower directed at or from the facility would amount to playing with fire, with potentially catastrophic consequences.” Shelling on August 25, 2022, disabled the plant's connections to the surrounding power grid. The loss of offsite power forced the two reactors that had been operating to shut down. The connections were restored and the units restarted [the following day](#). [Some analysts](#) argue that attacks on nuclear power plants could be considered a “war crime” under international law.

IAEA is negotiating with Russia and Ukraine to send an expert mission to ZNPP “in the next few days” to “assess the physical damage to the ZNPP's facilities, determine whether the main and back-up safety and security systems were functional and evaluate the staff's working conditions,” according to an August 28, 2022, [IAEA statement](#).

The two reactors operating at ZNPP are said to pose the highest risk of radioactive releases at the site, because they are running at full or nearly full pressure and heat output to generate electricity. Shutting down all the reactors at the plant would reduce that risk. When a reactor is shut down, its heat output immediately drops by about 94%, with the remaining heat continuing to be produced by the [radioactive decay](#) of nuclear materials in the reactor core. As the reactor core cools, it becomes less vulnerable to disruptions in plant cooling systems. Decay heat, even at reduced levels, must be constantly removed from the reactor core to prevent the nuclear fuel from melting. Such risks could be further reduced by transferring nuclear fuel from the plant's six reactors into [adjoining storage pools](#), although they still must be constantly cooled.

Russian military action at Ukrainian nuclear facilities has drawn high-level congressional concern. Senate Foreign Relations Committee Chairman Bob Menendez sent a [letter](#) on March 28, 2022, asking that “the IAEA take decisive actions to mitigate the risks from the Russian Federation army's incursion, attacks,

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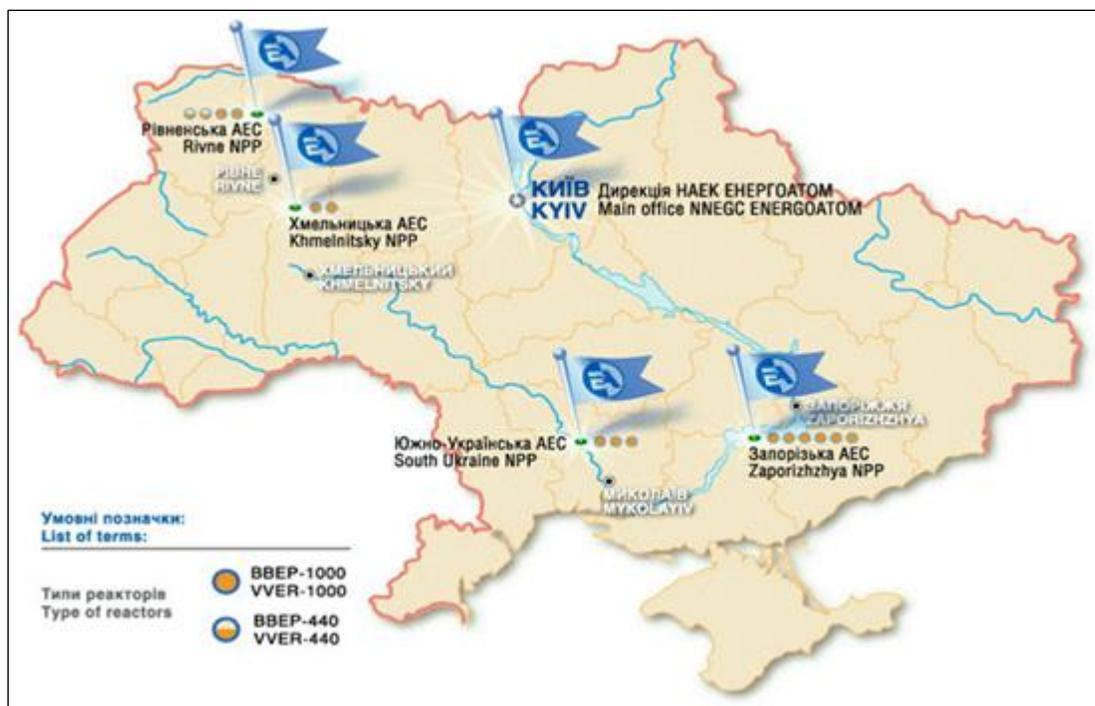
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and occupation of Ukraine's four nuclear power plants, national nuclear labs, and the Chernobyl Exclusion Zone.”

The four-unit Chernobyl nuclear plant, whose last operating reactor permanently closed in 2000, was occupied on the first day of the Russian invasion of Ukraine, on February 24, 2022. Russian troops [left the plant by April 1](#) as part of a general withdrawal from northern Ukraine.

## Nuclear Power Plants Operating in Ukraine

Ukraine has four operating [nuclear power plant sites](#) with a total of 15 reactors, which in recent years have provided about half of Ukraine's total [electricity generation](#). All the operating Ukrainian reactors are light water reactors (cooled by ordinary water), using designs from the Soviet Union similar in concept to most of the world's commercial power reactors. Ukraine's operating nuclear plants are located throughout the country, as shown by the following IAEA [map](#):



Source: IAEA, 2020

The operable Ukrainian reactors are fundamentally different from those at the [Chernobyl plant](#), which suffered a major explosion in 1986.

## Reactor Safety Systems

The core of a light water reactor consists of about 100 tons of highly radioactive nuclear fuel producing tremendous heat through a nuclear [chain reaction](#).

To slow or shut down the chain reaction, control rods are inserted into the reactor core. Although shutdown happens very quickly during an emergency, substantial amounts of heat continue to be produced from radioactive decay of the nuclear materials in the reactor core after the chain reaction stops. If water does not continue to circulate through the core, decay heat can build up enough to melt the

nuclear fuel and breach the steel pressure vessel that holds the core. The heat and pressure could also eventually escape the concrete containment structure that surrounds the pressure vessel and associated pumps and piping. This occurred during the [Fukushima Daiichi accident](#) in Japan at reactors built with a different type of containment from [those in Ukraine](#).

## Reactor Safety Risks from Russian Attacks

Russian forces have seized control of ZNPP and its management, but the plant's operational personnel have remained on duty "under constant psychological pressure," according to the [Ukrainian nuclear regulatory agency](#).

The ongoing Russian military action poses a range of potential threats to Ukrainian nuclear plant safety:

- *Direct military damage to one or more reactors.* Nuclear power plants are not designed to withstand military munitions, which could directly penetrate the concrete reactor containment and steel pressure vessel, allowing release of highly radioactive material.
- *Military damage to reactor safety systems.* Even if a military attack did not damage the reactor containment, explosions and fires could disable safety systems vital to avoiding core overheating.
- *Station blackout: loss of electric power.* Nuclear plants rely on electricity to run cooling pumps and control systems. If [power from the electric grid is lost](#), diesel generators produce backup power and are intended to operate long enough for grid power to be restored. Loss of power from both the grid and the diesel generators results in station blackout, the condition that caused the radioactive releases at Fukushima, even though the reactors there had shut down.
- *Disruption of plant personnel.* Plant safety could be at risk if military action hindered or blocked the hundreds of workers needed to operate, maintain, and manage a nuclear power plant.
- *Damage to spent fuel pool or cooling systems.* If damage to a spent fuel pool allowed its water to drain, or if its cooling systems were disabled, the spent fuel could overheat and release large amounts of radioactive material to the environment.

## Author Information

Mark Holt  
Specialist in Energy Policy

Mary Beth D. Nikitin  
Specialist in Nonproliferation

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