

NUCLEAR SECURITY: A CASE STUDY OF ZAPORIZHZHIA

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A Russian soldier stands guard outside the Zaporizhzhia nuclear power plant after its capture. (Source: Al Jazeera)

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I. Introduction

Nuclear energy is an energy source with the lowest carbon footprint, and it offers solutions to the challenges of climate change and the energy crisis. This is why many states, committed to net-zero carbon goals, are expected to invest in nuclear technology to achieve their 2050 goals. However, nuclear technology has been a source of concern since the beginning of the Russian-Ukrainian War in 2022, either as nuclear weapons or nuclear power plants, which are not designed for war zones. In this vein, the article evaluates the situation in Ukraine, especially in Zaporizhzhia Nuclear Power Plant (NPP), from a nuclear security and safety perspective. The article also details the worst-case scenarios involving the conflict around the Zaporizhzhia NPP. It should be noted at the beginning that the article does not address any political concerns related to the Russian-Ukrainian War but focuses on its ramifications on nuclear security.

II. Nuclear Security and Nuclear Safety

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” while defining nuclear safety as “the protection of people and the environment against radiation risks, and the safety of facilities and activities that give rise to radiation risks.” [1]

In other words, nuclear security focuses on protecting nuclear materials, other radioactive materials, and related facilities to prevent negligent and/or malicious human actions. In contrast, nuclear safety focuses on proper operating conditions and the prevention of nuclear accidents to protect both humans and the environment from possible radiation hazards.

While nuclear security and safety have different dimensions, the aim is to protect people, society, and the environment from the harmful effects of ionizing radiation. Regardless of the cause, which might be an unsafe act or a security breach, all Member States should establish and implement a strong, sustainable, and effective nuclear safety and security regime to benefit from nuclear technology safely and securely.

However, nuclear facilities are not designed for war zones, even though the Design Basis Threat (DBT) requires states to implement a more substantial level of defence strategy compared to many other civilian structures. In other words, while NPPs have robust and resilient designs to withstand threats posed by terrorist groups, they are not designed to withstand military bombardment. [2]

And an NPP should not be only considered consisting of reactors when it comes to safety and security. Many auxiliary systems ensure the safe and secure operation of an NPP. Irrespective of reactor technologies, all NPPs have cooling and moderating systems. For example, water works as both coolant and moderator in light water reactors (LWR), while carbon dioxide and graphite are used as coolant and moderator in gas-cooled reactors (GSR). And in case of loss of reactor coolant flow, reactor core might take extreme damages resulting in melting down of reactor core and releasing radioactive substance. [3]

This is why several international documents address concerns related to the protection of NPPs during a military conflict. These include, but are not limited to, the Additional Protocol I to the Geneva Conventions, [4] Rule 42 of International Humanitarian Law (IHL), [5] rules within the Law of Armed Conflict (LOAC), [6] and several IAEA General Conference Resolutions [7] and Decisions. [8] These international instruments prohibit armed attacks on nuclear facilities as they would result in extreme damage to people, society, and the environment.

Similar to the existing international mechanism, the IAEA Director General Rafael Mariano Grossi argues that threats to the safety and security of nuclear facilities and materials, such as armed conflicts, violate the Seven Pillars of Nuclear Safety and Security in his speech to the IAEA Board of Governors meeting in March 2022. [9]

These seven pillars are as follows:

- (1) The physical integrity of the facilities – whether it is the reactors, fuel ponds or radioactive waste stores – must be maintained.
- (2) All safety and security systems and equipment must be fully functional at all times.
- (3) The operating staff must be able to fulfil their safety and security duties and have the capacity to make decisions free of undue pressure.
- (4) There must be a secure off-site power supply from the grid for all nuclear sites.
- (5) There must be uninterrupted logistical supply chains and transportation to and from the sites.
- (6) There must be effective on-site and off-site radiation monitoring systems and emergency preparedness and response measures.

(7) And finally, there must be reliable communications with the regulator and others. [10]

The existence of such different international mechanisms demonstrates the need to protect NPPs during a military conflict, as its effects would be beyond the warring parties.

III. Zaporizhzhia Nuclear Power Plant

The Russian-Ukrainian War has many important aspects to discuss. Nevertheless, as mentioned in the beginning, the article approaches the war from nuclear security and nuclear safety perspective. In this vein, for the first time in history, the war takes place in a country with such a large and advanced nuclear power infrastructure. [11]

Although there has been one other NPP, Krško Nuclear Power Plant in Slovenia, located in an active war zone while being operational during the dissolution of Yugoslavia in 1991, it was not directly targeted during the war. [12]



The Zaporizhzhia Nuclear Power Plant after coming under attack by Russian troops (Source: NBC News)

This increases the importance of the Zaporizhzhia NPP as it is now taken over by Russian military officers, and there has been continuous shelling on the NPP, which caused panic both in and beyond Ukraine because this is the largest NPP in continental Europe. [13]

There are significant risks both inside and outside the Zaporizhzhia NPP. However, a Chornobyl-like explosion is not one of them. Because the Chornobyl accident was caused by insufficient understanding and respect on the part of the operators concerning the safety aspects of operational and test procedures, in addition to serious design deficiencies. [14]

While the Zaporizhzhia NPP has pressurized water reactors known as a VVER model, the Chornobyl NPP had a graphite-moderated RBMK model, which did not have a containment building. It is believed that the design of the VVER is inherently safer and better protected than the Chornobyl RBMK systems. Thus, it is safe to state that the design is very different from the Chornobyl reactors, reducing the risk of a Chornobyl-like explosion. [15]

Despite being well protected against certain types of strikes, the Zaporizhzhia NPP is not designed to withstand a military strike, as mentioned earlier. Although there are still concerns that a missile could hit a reactor and cause a severe release of radiation, there is stored spent fuel in the dry casks outside of those reactors. Missile strikes or shelling would cause a fire to catch as either the spent fuel pools or dry casks or cause some kind of damage to the reactors themselves, causing a radiological release.

Similarly, if a missile were to hit one of the six nuclear reactors at the facility, these reactors, despite having improved structure, could not withstand such an impact, resulting in radiation release. It is also believed that spent fuel in dry casks is much more vulnerable to a hit; if it were to be hit, it could spread radiation over a wide area. [16]

There are also other possible consequences from shelling or fires at the site. It has been reported that Russian military officers are in and around the facility and are using it for launching strikes on nearby cities. [17]

It would result in the loss of off-site power to the nuclear reactor, while nuclear power plants depend on off-site power to operate safely and securely. If all external power to the facility goes down, the site would have to run on its backup diesel generators, and at the moment, the condition of those generators is unknown. It should be remembered that, even though the public thinks the tsunami caused the accident in Fukushima, it was coolant systems, including emergency ones, that could not operate without the electricity cut off by the tsunami and caused the melting down of fuel rods. [18]

Similarly, as the Chernobyl accident had human error as one of the causes, what is happening inside the Zaporizhzhia NPP is also a very significant concern. Because the Ukrainian operators in the plant have been operating that facility under duress and their conditions are not known, which violates the Seven Pillars of Safety and Security, expressed the DG Grossi. [19]

This causes an ongoing safety and security crisis at the facility since the pressure the Ukrainian operators are under might lead to human error. Without an organizational safety and security culture, it becomes nearly impossible to operate a nuclear power plant safely and securely, and it is hard to imagine that there is a strong safety and security culture at a nuclear power plant that is being occupied by an adversary force. [20]

If there is radiation release due to the aforementioned reasons, the consequences will depend on several factors such as the quantity of radiation released, the weather and various factors that impact how radiation spreads. However, it cannot be ignored that the consequences could also spread internationally, from East Europe to the Middle East. [21]

In this vein, it is fundamental for the IAEA to visit the Zaporizhzhia NPP, which will help stabilize the nuclear safety and security situation at the facility and reduce the risk of a severe nuclear accident and possible radiation release. However, it is a challenging mission for the IAEA to visit the Zaporizhzhia NPP. Because if the IAEA concludes negotiations for the mission with a positive outcome, the IAEA personnel will be entering an active conflict under much potential risk. [22]

IV. Conclusion

Nuclear technology has much to offer to the challenges that the whole world faces. Instead of focusing on how it could be beneficial, the focus on nuclear technology has been diverted from its peaceful use since the beginning of the Russian-Ukrainian War, either as with a threat of nuclear

weapons or possible radiation release due to the active armed conflict around the Zaporizhzhia NPP. The consequences have been either under or over-estimated according to the political stances. In this regard, the article offered an unpolitical perspective on the situation in the Zaporizhzhia NPP and detailed what possible consequences would be if nuclear safety and security measures continued to be violated.

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