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# Security Threats from Nuclear Power Plants in War

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## ABSTRACT

There are many factors that threaten human safety, and nuclear pollution is one of them. The Russian-Ukrainian war is still going on, and nuclear facilities such as Ukrainian nuclear power plants are inevitably attacked in the war. The security threat of war to nuclear power plants cannot be underestimated. This article will review the security threat of nuclear power plants to humans in war from two aspects: the threat of nuclear accidents to human safety and the impact of war on the safety of nuclear power plants. And look forward to how to respond to this security threat.

## KEYWORDS

Human Security; Nuclear Power Plants; Environmental Safety.

## 1. BACKGROUND AND INTRODUCTION

Today's era can be called the "World Energy Era". Due to various environmental pollution, energy crisis, and constant changes in the world's energy supply pattern and other related issues, the hot issues of the world's energy situation have received unprecedented attention. As a clean energy, nuclear energy can be regarded as the best hope to solve the crisis of consumption of fossil energy such as coal, oil and natural gas. Nuclear power plants are one of the important ways to realize the utilization of nuclear energy. Nuclear power plants are power plants with high energy and low material consumption. At present, the cost of generating electricity is lower than that of thermal power plants. Compared with other industries, nuclear power plants are relatively safe and reliable, and nuclear energy is a clean energy. In addition, a nuclear power plant is not only a power station, but also a special kind of nuclear fuel production plant.

Although compared with other industries, the probability of accidents in nuclear power plants is the lowest. However, once an accident occurs in a nuclear power plant, nuclear leakage will bring great harm. The most direct hazards caused by nuclear leaks come from nuclear radiation. Nuclear explosions and nuclear accidents will produce nuclear radiation. The most intuitive harm of nuclear radiation is to change genes and produce mutations. For living things, this is an extinct disaster. If there is a problem with the internal structure of the body, the survival time will be shortened, and the offspring of the living body will also be affected. With various diseases, which directly affect human safety [1]. What is difficult to control is that nuclear pollutants will flow and spread with carriers such as air and water, which means that once a nuclear accident occurs, it will not only have a devastating impact on the organisms and the environment at the location of the accident, but will also affect the surrounding areas and even the world. In addition, since the area where a nuclear accident occurs will no longer be inhabitable, a large amount of manpower and material resources will be required to deal with the accident, which will cause heavy damage to economic development. Even at the political level, the international influence of countries and regions where nuclear leaks occurred will change accordingly.

In addition to natural disasters and human error, at present, the biggest possibility of destroying nuclear power plants is military conflict in traditional warfare. The most distinctive feature of traditional warfare is the dominance of violence, so military weapons are the most direct means in warfare. For a nuclear power plant in a military conflict zone, the destruction of military weapons is its greatest security threat. The current Russo-Ukraine war has involved the safety of an abandoned Chernobyl nuclear power plant and another Zaporizhzhia nuclear power plant that has ceased to function due to the war [2]. In the early morning of February 24, 2022, the Russian army launched an offensive in Ukraine. On the same day, the airborne troops of the Russian Northern Group launched an assault on the Chernobyl nuclear power plant 16 kilometers away from the southern border of Belarus. After a gun battle with the garrisoned Ukrainian troops, the Russian army declared complete control of the Chernobyl area. Subsequently, the Russian army reached an agreement with the management of the nuclear power plant, announcing that they would jointly ensure the safety of the nuclear power plant. Russia's invasion of Ukraine first conquered Chernobyl because it was the only place to pass through when sending troops from Belarus to Kyiv. It is about 149 kilometers away from Kyiv and takes about 3 hours by car. In addition, the Chernobyl nuclear power plant had the most serious nuclear accident in the world, and was rated as a seventh-level (top-level) nuclear accident. If this nuclear power plant is damaged by artillery fire again during the Russia-Ukraine conflict, the consequences will not only be a military war between the two countries, but will trigger a global nuclear security crisis, with disastrous consequences. On March 9, 2022, the Russian National Guard took full control of the Zaporizhzhia nuclear power plant in southeastern Ukraine. Due to the fighting between the Russian and Ukrainian armies near the Zaporizhzhia nuclear power plant, the nuclear power plant was frequently shelled. Since September 11, 2022, the Ukrainian National Nuclear Energy Corporation announced its complete shutdown and has not resumed normal operations. Although the damage did not cause a nuclear leakage accident, no one can guarantee whether the nuclear power plant will be safe in the next exchange of fire. The issue of "establishing a nuclear safety zone at the Zaporizhzhia Nuclear Power Plant" is imminent.

## 2. LITERATURE REVIEW

### 2.1. The Threat of Nuclear Power Plant Accidents to Human Safety

It is undeniable that nuclear power plants currently provide human beings with the highest level of energy, but the destructive impact of nuclear power plants that have had nuclear accidents on human safety is also extremely serious.

As far as the Chernobyl incident is concerned, the explosion of its nuclear power plant has the most serious impact range of 30 to 50 kilometers, and the relatively large range of impact is 200 kilometers to 500 kilometers [3]. There are also places beyond 500 kilometers. Radioactivity detected. However, the fire and high radiation caused by just one reactor explosion instantly burst out a large number of harmful substances, covering an area of 1,650 square kilometers. These radioactive substances are more than 400 times that of the Hiroshima atomic bomb explosion. Today, there are still deformed fetuses born under the influence [4]. At that time, half of the nuclear radiation dust fell on the three countries of Ukraine, Belarus and Russia, and even all parts of the world were affected to varying degrees, resulting in huge pollution. In the end, 270,000 people were diagnosed with cancer, and the death toll reached 93,000. Other potentially affected groups are still suffering from cancer, and it is difficult to estimate these accurate figures [5].

The Three Mile Island nuclear power plant in the United States suffered a nuclear accident in 1979. It is worth emphasizing that this accident did not produce a nuclear explosion, but only a nuclear leak. The farthest impact range was 16 kilometers. It was the most serious nuclear leak accident in the history of the United States. Afterwards, 400,000 Americans evacuated the area [6].

In the 2011 Fukushima nuclear power plant accident, the official announcement was that the evacuation range was 20 kilometers. However, due to the particularity of the location of the Fukushima nuclear power plant, as well as natural disasters such as floods caused by the earthquake at that time, the radiation range was not precise and controllable [7]. Once the nuclear wastewater flows into the sea, creatures on trillions of sea miles will be affected, and it is even less likely that residents in the surrounding sea areas will be immune to the cloud. From January to March 2015, 16 new cancer cases were diagnosed in the examination of the effects of nuclear radiation on the thyroid gland of teenagers under the age of 18 at the time of the accident. Today, 103 of the 385,000 adolescents in Fukushima Prefecture have been diagnosed with thyroid cancer [8].

## 2.2. Security Threats of Conventional Warfare to Nuclear Power Plants

### 2.2.1. Direct Security Threats of Military Weapons to Nuclear Power Plants

Undoubtedly, large civilian nuclear power plants are not nuclear weapons, and there is an essential difference between the two. However, if a large-scale nuclear power plant is completely destroyed due to a violent attack on a nuclear power plant during a war, the actual harm will be even greater than detonating some small and medium-yield nuclear weapons in situ. One of the important reasons is that the nuclear materials of large civilian nuclear power plants, or the total amount of nuclear materials used for power generation, is huge, which is completely incomparable to all modern single nuclear weapons [9]. Although the nuclear materials used in the operation of large-scale nuclear power plants are enough to make thousands of nuclear bombs, their abundance is very low and they cannot reach the level of nuclear explosion under normal safe operation. However, if there is a man-made conventional weapon attack on the nuclear power plant reactor, and finally detonates or explodes the outer casing of the core reactor, it will inevitably lead to a huge catastrophic nuclear accident [10].

At present, the large nuclear power plants exposed to military conflicts are mainly Zaporizhzhia Nuclear Power Plant and Chernobyl Nuclear Power Plant (abandoned). The area where the Zaporizhzhia nuclear power plant is located is even more conflicted. Zaporizhzhia Nuclear Power Plant is located in Energodar, Zaporizhzhia State, Ukraine. It is the largest nuclear power plant in Europe and one of the top ten nuclear power plants in the world. The nuclear power plant generates half of Ukraine's nuclear power generation and accounts for 25% of Ukraine's total electricity generation. Nuclear power plants are not ordinary targets, but facilities with important strategic attributes. Because of the particularity of the nuclear facility, not long after the Russian-Ukrainian conflict broke out, the Zaporizhzhia nuclear power plant was controlled by a special force of the Russian army in early March, and it is still occupied and guarded by the Russian army. The Russian Ministry of Foreign Affairs stated that in order to prevent the leakage of nuclear and radioactive materials, it is necessary to send Russian soldiers to defend the nuclear power plant [11]. At the same time, the Russian side agreed to continue the operation and management of the nuclear power plant by the employees of the State Nuclear Power Company of Ukraine. Due to the war situation, since the Russian-Ukrainian conflict entered July, the largest nuclear power plant in Europe has been repeatedly shelled. The nuclear nitrogen and oxygen devices and radiation detection equipment of the nuclear power plant have been damaged successively. The storage facility with 174 spent fuel containers was hit by rockets. Only one of the six reactors remains operational. In August, the nuclear power plant suffered another wave of intensive bombardment, and the Russian side counted more than 50 bombs falling [12]; The backup line supplied power to the grid; the external supply line was also interrupted by the explosion, but was later restored. In mid-to-late November, the facilities and power supply lines of the Zaporizhzhia nuclear power plant were bombarded again. In less than 30 minutes, a total of 12 missiles were attacked, 6 missiles fell into the reactor cooling pool, 2 missiles fell into the nuclear waste dry storage area, nuclear power plant radioactive waste storage facilities, cooling pool spray systems, cables, Bridges and other parts were damaged, and the nuclear power plant can be said to be "hanging by a thread" [13].

Due to the armed conflict between Russia and Ukraine at the Zaporizhzhia Nuclear Power Plant, the risk of nuclear leakage has increased step by step, which has aroused worldwide concern. According to the International Nuclear Event Scale (INES), the Chernobyl nuclear accident mentioned above and the Fukushima nuclear accident are both major nuclear accidents with the highest level at 7. In dealing with the Chernobyl nuclear accident, the Soviet Union invested a lot of manpower, material and financial resources, finally built a sarcophagus on the reactor to prevent nuclear radiation leakage and the entire city was abandoned. The Fukushima nuclear power plant has been exposed to leaks of radioactive material since the explosion in 2011. Since there is nowhere to put more than one million tons of nuclear wastewater, the Japanese government decided to discharge nuclear wastewater into the Pacific Ocean, which may cause huge damage to human health and the ecological environment [14]. However, the possible nuclear accident caused by the attack on the Zaporizhzhia nuclear power plant will be more serious than Chernobyl and Fukushima. Because almost all previous nuclear accidents occurred in a state of non-war, but the Zaporizhzhia Nuclear Power Plant is at the front line of the conflict. And the uncertainties and risks it faces are extremely high. According to the prediction of Ukrainian nuclear energy experts, Once a catastrophic accident occurs at the Zaporizhzhia nuclear power plant, the severity may be 10 times that of the Chernobyl nuclear accident [15]. At present, international experts have made several scenarios surrounding the attack on the Zaporizhzhia nuclear power plant and triggering a nuclear safety accident. Firstly, the power supply to the nuclear power plant was cut off due to the fighting. As a result, the nuclear fuel may not be able to be cooled, and there is a risk of a reactor fire and a nuclear leak. The second is that various artillery shells and missiles directly hit the nuclear power plant during the battle. Whether it is a deliberate attack or an accidental bombing of a nuclear power plant, the consequences are unimaginable. Since nuclear power plants store a large amount of nuclear fuel, in extreme cases of violent attacks, it is tantamount to directly detonating nuclear weapons, and even the destructive power is far greater than that of ordinary nuclear weapons. The third is that cyber-attacks may lead to nuclear power plant accidents. Since the Russia-Ukraine conflict, there have been multiple large-scale cyberwarfare that have spread to many critical infrastructures. Since the "Stuxnet" virus was revealed to have destroyed Iran's nuclear facilities in 2010, cyber-attacks have also been regarded as one of the defense weaknesses of nuclear power plants [16].

### 2.2.2. Safety Threat to Nuclear Power Plant by Workers under High Voltage

In addition to the direct attack of artillery fire, the working status of the staff who operate and maintain the nuclear power plant is also one of the security threats to the nuclear power plant. Due to the special nature of the work of nuclear power plants, the staff of nuclear power plants cannot make any mistakes in their work, and high-precision and high-intensity work is already a kind of pressure [17]. Secondly, many positions in nuclear power plants generally require 24-hour monitoring and maintenance. Although the work system is based on a rotation system, the inability to work and rest regularly is a challenge to the physical and psychological conditions of the staff. In comparison, under normal working conditions, the pressure of nuclear power plant staff has exceeded that of other general types of work. Under war conditions, due to the influence of more external factors, the probability of forced work is extremely high, which cannot guarantee a good working condition and increases the risk of errors in the work. This is the nature of the work of nuclear power plants with almost zero fault tolerance rate is undoubtedly another security threat.

After Russia took control of the Zaporizhzhia nuclear power plant, according to the IAEA report, a Russian commander took control of Zaporizhzhia's site management, including operations related to technical operations, and the technical team has started working on three eight-hour shifts rotation. Russian forces shut down some mobile networks and internet access, disrupting communications between staff and Ukraine's nuclear regulator. Russian forces shut down some mobile networks and internet access, disrupting communications between staff and Ukraine's nuclear regulator. "The station's employees are under intense psychological pressure from the occupiers. All employees arriving at the station are carefully checked by armed terrorists," the Ukrainian state nuclear company

said. The staff of the Chernobyl nuclear power plant in Ukraine are also facing the dual challenges of personal safety and high-intensity and high-stress work. Since Russia occupied the Chernobyl nuclear power plant on February 24, after 25 days of non-stop work, more than 200 Chernobyl workers were allowed to go home after a shift. There are also reports that workers responsible for protecting spent nuclear fuel and radioactive waste in parts of the plant spent nearly 600 hours at the gunpoint of the Russian army, sleeping as much as possible at their workstations, surviving on a severely reduced diet, and having their cell phones hacked. Confiscation [18]. Due to psychological pressure and physical fatigue, it is already a great challenge for the staff to be able to complete normal work tasks. However, due to various pressures, they have to overwork under the condition of physical and mental exhaustion. Once a mistake occurs, the consequences will be unimaginable.

### 2.2.3. The Horrible Dirty Bomb

A dirty bomb, also known as a radioactive bomb, is a weapon that spreads radioactive material over a wide area. Unlike conventional nuclear weapons, dirty bombs do not produce a nuclear explosion. However, it can cause dust pollution equivalent to nuclear radioactivity, and the spread of radioactive particles caused by it will cause harm to the human body and cause catastrophic ecological damage. Dirty bombs are not “weapons of mass destruction” but “weapons of mass destruction” [19]. The main purpose of those who make dirty bombs, such as terrorists, is to cause panic. In addition, it is designed to coerce or intimidate a government or society to pursue general political or ideological goals.

Nuclear power plants in war are the preferred "raw material pool" for making dirty bombs. The first is whether the procurement, transportation, use and disposal of radioactive sources can be carried out under the strict supervision of regulatory agencies due to complex reasons such as war, and whether they can abide by the prescribed guidelines until the radioactive sources are safely disposed of, so that they will not be used by terrorists. or misused by others [20]. Second, after an accident at a nuclear power plant, the ruptured and leaked reactor core became an absolute super dirty bomb, and this man-made dirty bomb contained a lot of nuclear fuel. Because the nuclear reaction of ordinary nuclear bombs is relatively complete and rapid, after several years of continuous rain, the environmental radioactivity can basically be restored to the standard that allows humans and other organisms to develop and reproduce normally. However, after hundreds of tons of fuel in a large reactor burst and leaked, because there are so many reaction substances, they will not explode instantly but "burn" slowly, and will produce a large amount of strong radiation new substances with a half-life ranging from hundreds of years to tens of millions of years. Not only can it pollute millions of square kilometers of land and the global atmosphere, but its polluted core area of thousands of square kilometers will become a wasteland for thousands of years. Therefore, it can be seen how reckless it is to actively attack and destroy large nuclear power plants.

## 2.3. Why Take Huge Risks to Attack a Nuclear Power Plant

Ukraine's economic strength is not strong, but its geographical location is very special. It is a transportation hub connecting various plates in Europe, with well-developed water and land transportation. Moreover, Ukraine is very rich in minerals and is still the granary of Europe. Therefore, the Soviet Union put a large number of heavy industries and military industries in Ukraine. These industries require a huge energy supply, so supporting nuclear power plants came into being. The Zaporizhzhia Nuclear Power Plant accounts for one-fifth of Ukraine's national power generation and one-half of the country's nuclear power generation. Half of eastern Ukraine is almost entirely dependent on this nuclear power plant for power. Moreover, nuclear power is particularly important to Ukraine's agricultural production. A large number of agricultural machineries needs electric drive, and a large number of farmlands in southern Ukraine are also equipped with electric irrigation equipment [21]. It can be said that whoever controls Ukraine's nuclear power plants controls the country's economy and people's livelihood.

In addition, on the one hand, from the perspective of great power competition, the Russia-Uzbekistan war was ultimately a proxy war. If any nuclear power plant in Ukraine is severely damaged and a nuclear accident occurs, not only Ukraine, but most of Europe and Russia will be severely affected by nuclear radiation. This will cause serious damage to Russia and the whole of Europe. Adversary countries that do not directly participate in the war on the surface can become the biggest beneficiaries of the war. On the other hand, from the perspective of the "psychology" of the two countries in combat, the analysis of the battlefield situation combined with the conflict between Russia and Ukraine shows that once the battlefield situation is unfavorable to Ukraine, the Zaporizhzhia Nuclear Power Plant will be bombarded. It seems that someone deliberately let the Russians see the madness of the Ukrainians and see Ukraine's determination and will to die with Russia, so as to deter the fierce offensive of the Russian army and reverse the passive situation.

## 3. HOW TO RESPOND TO THIS SECURITY THREAT

In a state of non-war, the international community has formed a set of basic consensus and rules on how to ensure nuclear safety. Every country has a specialized nuclear safety regulatory department, and adopts a complete legal system to take various safety measures for nuclear facilities, nuclear activities and nuclear materials, so as to avoid nuclear accidents caused by natural disasters or man-made reasons. Internationally, the International Atomic Energy Agency is responsible for providing technical assistance to countries in the peaceful use of nuclear energy, and has presided over the formulation of a series of international conventions and standards on nuclear safety and nuclear accident disposal. However, in a state of conflict, especially on the front line of firefights, domestic regulation and laws are likely to be ineffective due to the actual control of the area. The protective design of nuclear power plants may also be destroyed by war, making it more difficult for staff to maintain a daily safe operating mode. Without the joint support of the warring parties, the International Atomic Energy Agency would not be able to send an expert team to conduct on-site investigations on the nuclear safety, security and safeguards of nuclear power plants and provide corresponding support and assistance. Therefore, no matter what the conflict is, in the face of the possible nuclear safety crisis caused by nuclear power plants, all parties should clearly realize that nuclear safety is a common challenge faced by all mankind, and no one can stay out of it.

For nuclear power plants that are already under the threat of war, it is very urgent and necessary to first demarcate the nuclear power plant and its surrounding area as a demilitarized zone or list the nuclear power plant as a target that prohibits military strikes, and give specific security guarantees. At the same time, it is also crucial to ensure that experts from the International Atomic Energy Agency can continuously and effectively conduct on-site investigations and monitor radioactivity data and the nuclear security environment in real time. Secondly, for residents living within the influence area of nuclear power plants where nuclear accidents may occur, relevant measures to prevent radioactive hazards can be implemented in advance, such as distributing iodine tablets and holding nuclear disaster evacuation drills. In addition, in the relevant regulations of the "Geneva Convention" prohibiting attacks on nuclear power plants, according to its first protocol in 1949, attacks on dams, dikes and nuclear power plants are restricted if they may cause floods or nuclear radiation causing "serious" civilian losses. It is also possible to use international public opinion to put pressure on all parties to the conflict, calling for an end to military acts against humanity and preventing one party from committing war crimes.

From the long-term perspective of the peaceful use of nuclear energy, whether it is the Fukushima nuclear explosion or the Chernobyl nuclear leak, the scope of influence has transcended the borders of nation-states and become global problems. Since nuclear energy safety cannot be completely guaranteed by domestic law alone, it is therefore important to regulate nuclear energy safety from the perspective of international law. According to the development of science and technology and the changes of the global situation, it is very necessary to revise the nuclear energy safety treaty and

supplement the nuclear safety standards in time. Secondly, the initiative of the International Atomic Energy Agency in international nuclear energy safety emergencies should be strengthened, and the enforcement and operability of international treaties on nuclear energy safety should be enhanced. For example, Grossi, Director General of the International Atomic Energy Agency, personally led a working group to the Zaporizhzhia Nuclear Power Plant to carry out assessment and safeguard activities. This move gave the outside world more confidence in the safety of the nuclear power plant. Third, it is difficult for the international community to guarantee the safety of nuclear energy by relying solely on the power of one country. Therefore, strengthening international cooperation in the field of nuclear energy safety is also one of the effective measures. Finally, as far as the nature of nuclear power plants is concerned, on the one hand, science and technology should be developed to reduce the risk of accidents and improve protection means; Areas of strategic value, so that the threat of nuclear accidents can be minimized in the event of abnormal conditions, making the best use of nuclear energy from a safety point of view.

Even though there are still many problems and contradictions to be solved in the development and utilization of nuclear technology, human beings will not stop the development and utilization of nuclear energy because of nuclear wars and nuclear accidents in history. We firmly believe in the peaceful future of nuclear energy Exploitation is possible.

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