

# Analysis of the Impact of Nuclear Radiation on Environment and Investigation of Safety Protection

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**Abstract:** As a potentially harmful environmental factor, nuclear radiation poses a serious threat to ecosystem and human health. With the wide application of nuclear energy technology, nuclear accidents and improper disposal of nuclear waste have aroused widespread public concern on the environmental impact of nuclear radiation. Therefore, it is of great significance to deeply analyze the impact of nuclear radiation on the environment and explore effective safety protection measures to ensure the safety of human beings and the environment. In order to assess the possible harm caused by nuclear radiation to the natural environment and human society, and formulate effective protective measures and emergency response strategies to reduce the negative impact of nuclear accidents on the ecosystem and public health, this paper explores the impact analysis and safety protection of nuclear radiation on the environment. This paper studies the potential impact of nuclear radiation on the environment by monitoring the release of radioactive materials, evaluating the law of the diffusion and migration of radioactive materials in the environment, and formulating corresponding protective measures. The effects of nuclear radiation on the environment are multifaceted, including direct damage to organisms, damage to ecosystems, and potential long-term genetic effects. Safety protection measures include physical shielding, distance protection, time protection and biological protection to reduce radiation exposure and protect humans and the environment from nuclear radiation hazards.

**Keywords:** Nuclear Radiation;

**Environment; Impact Analysis; Safety Protection**

## 1. Introduction

The impact of nuclear radiation on the environment has gradually aroused great attention from all walks of life, so the relevant departments continue to increase the research and analysis of nuclear radiation issues, and formulate scientific safety protection measures to minimize the adverse effects of nuclear radiation. China's nuclear technology is in the rapid development stage, the application scale is expanding day by day, strengthening the safety protection research is of great practical significance.

## 2. A Basic Overview of Nuclear Radiation

Nuclear radiation is a kind of energy emitted by radioactive substances in the form of waves and particles, which comes from nuclear energy facilities, nuclear accidents, natural and artificial radionuclides, etc., mainly including  $\alpha$ ,  $\beta$  and  $\gamma$  rays. For example, the earth's crust contains naturally radioactive elements such as potassium and uranium; In the production activities, human beings continue to develop the nuclear energy industry, apply nuclear technology to medical treatment, and carry out various types of nuclear weapons testing, etc., will produce a certain degree of nuclear radiation. For different types of nuclear radiation, gamma rays have greater harm, strong penetration, can quickly penetrate more types of materials, have a greater impact on the environment, and produce very serious radiation damage to the human body's internal tissues, organs, etc., thereby increasing the possibility of cancer, genetic mutations and other diseases. Nuclear radiation can cause irreversible damage to the environment, showing a high environmental harm, thus bringing great damage to the ecological

balance, and affecting biodiversity, seriously endangering the safety of the environment. Therefore, it is particularly critical to strengthen the impact of nuclear radiation on the environment and do a good job in monitoring and safety protection [1,2].

The impact of nuclear radiation on the environment is multifaceted, it can lead to air, water and soil pollution, and then affect the health of plants, animals and humans. Long-term exposure to nuclear radiation can lead to genetic mutations that increase the risk of cancer and other diseases. In order to reduce the harm of nuclear radiation, it is very important to take effective safety measures. This includes establishing strict safety standards for nuclear facilities, using appropriate shielding materials, and taking swift emergency measures in the event of a nuclear accident. Public education and training are also important means of raising awareness of nuclear safety and reducing radiation risks [3,4].

### **3. Analysis of the Impact of Nuclear Radiation on the Environment**

Nuclear radiation has a large impact on the environment, has serious damage to different organisms, and presents the characteristics of a long duration, difficult to deal with afterwards. For example, it has a great impact on the atmosphere, ocean, soil and other aspects. In the case that some areas are seriously contaminated by nuclear radiation, people cannot live normally in the area for a long period of time, and it has a great impact on animals and plants, which may cause mutations and other phenomena [5-7].

Trees in the vicinity of nuclear reactors do not grow normally and are generally devastated, while the survival rate of animals exposed to radiation is relatively low. Plants located a certain distance away from the nuclear reactor are also affected to varying degrees, and there is a phenomenon of leaf loss and wilt. In addition, the impact of nuclear fallout has a wide range, and it can spread to various places with the help of wind and rain, which has a greater impact on the environment. For example, after the Chernobyl event, nuclear radiation had a great impact on the pine forest in the isolated area, making its leaves all red, causing the plants to mutate and become mangroves. In the following six years, the

surrounding environment continued to return to normal, and various plants and animals slowly grew normally, but the mangrove still did not return to normal.

The damage of nuclear radiation to the surrounding environment is great, which makes the ecological balance greatly affected and easy to produce water pollution. In the case of nuclear contamination of water resources, the application of water resources to irrigate various crops will increase the radioactive substances in crops, and thus enter the human body, bringing great impact on human health [8]. At the same time, nuclear radiation has, to a large extent, produced serious air pollution, thereby releasing radioactive substances that have adverse effects on various plants and animals. The same is true of the soil environment, which is polluted to a certain extent by nuclear radiation, and continues to pollute the ecological environment in other regions with the continuous migration and change of the environment. For example, cesium-137 is a relatively common fission product with abundant content and portability, widely existing in soil environment, animals and plants, and has been distributed in the biosphere. After settling, the fission product quickly enters the surface, thus closely adsorbed organic matter and clay minerals in the soil environment, and is affected by other external environmental factors, and continues to migrate nuclear radiation into the surrounding surface space, resulting in large-scale soil pollution. According to the investigation and analysis of relevant data, some soil systems contain rich organic matter and have more clay minerals, and there are generally more cesium-137 circulating for a long time in the soil layer at a depth of 2-12cm. In addition, such fissionable materials can continuously enter various animals and plants through various methods such as atmospheric deposition and surface adsorption, thus destroying the ecological balance and affecting the natural environment [9].

### **4. Effective Measures for Nuclear Radiation Safety Protection**

#### **4.1 Shielded Nuclear Radiation**

In the process of nuclear radiation safety protection, the relevant departments can take

the way of shielding nuclear radiation to minimize the impact of nuclear radiation on the environment. For example, concrete materials are generally chosen in the construction and operation of nuclear power plant projects, mainly because of its low cost and good performance. Under normal circumstances, for the application of concrete materials, it is necessary to reasonably control its various structural properties, keep the density within  $3600\text{g/cm}^3$ , compressive strength below  $40\text{MPa}$ , tensile strength below  $3.2\text{MPa}$ . In the process of shielding concrete, the shielding layer mainly intercepts neutrons and  $\gamma$  rays. When the shielding performance has higher requirements, the density of concrete can be appropriately improved, and in the process of practical application, a certain amount of metal mineral aggregate is added in the preparation operation, but it will change the state of the concrete structure to a certain extent, and increase the cost. The appearance of new shielding concrete materials, in the preparation of magnet ore, steel ball as the aggregate, so as to effectively improve its  $\gamma$ -ray shielding performance. In addition, in the process of concrete mix design, the laboratory can be operated to incorporate appropriate carbon, steel fiber and other fiber materials, so as to improve the mechanical properties of concrete, and in the process of neutron shielding, more effectively prevent the appearance of secondary  $\gamma$  rays. In addition, the mobile reactor project will produce serious nuclear radiation contamination during operation. Most of these projects choose high-boron steel and other materials in the construction, but the boron content is mostly within  $0.5\%$ , and the overall shielding effect is not good. After that, nickel and molybdenum elements were appropriately added, so as to improve the high-boron steel and improve its impact toughness, thus meeting the requirements of nuclear radiation shielding. In order to further enhance the effect of nuclear radiation shielding, relevant personnel can improve the mechanical properties of high-boron steel materials with the help of heat treatment, rapid solidification and other methods. For example: The relevant personnel choose the rapid solidification technology, the high boron steel raw materials are appropriately mixed with a certain amount of titanium powder, boron powder mixture, and

the melt is quickly solidified in the mold, so that the prepared high boron steel has higher strength and better wear resistance, so that the mobile nuclear reactor project in the operation process, can give full play to the importance of the shielding layer, better shielding nuclear radiation. Reduce negative impact on the environment.

#### **4.2 Safety Protection of Nuclear Power Plants**

In the process of nuclear power plant safety protection, relevant personnel can combine the actual situation and reasonably introduce advanced technology within its coverage to build an intelligent alarm system, so as to carry out real-time monitoring of the daily operation and nuclear radiation of the nuclear power plant. In the event of an emergency, the intelligent alarm system can send an alarm signal in time to remind the radioactive substances in nuclear radiation that may exist in the natural environment. Therefore, the relevant government departments should give full play to their own guiding functions, do a good job of on-site security protection, and quickly transfer the people. Nuclear power units strengthen safety protection management, do a good job of regular inspection of relevant equipment, timely detect abnormal conditions, take relevant measures to properly deal with, and effectively avoid nuclear radiation risks. In this process, nuclear radiation and other problems have occurred, and relevant personnel need to take certain technical measures to deal with radioactive materials in depth [10].

#### **4.3 Control of Nuclear Radiation in the Workplace**

There are different degrees of nuclear radiation in the workplace of some nuclear projects, and relevant personnel need to develop scientific measures to strengthen control and effectively block the continued spread of nuclear radiation to the external environment through the air. For example, in the process of nuclear project construction, staff can choose ventilation filtration technology, air conditioning fans and other equipment in accordance with technical requirements, standardized installation in the nuclear project workplace, to further ensure that the frequency of air exchange meets the relevant requirements. In addition, relevant

personnel can use negative pressure and positive pressure dynamic shielding methods to shield and transform the conventional ventilation system, enhance its shielding function, and effectively avoid the continuous outward transmission and diffusion of nuclear radiation. For example, in the practical application of the negative pressure type dynamic shielding method, it is necessary to make the inlet air volume in the project workplace slightly lower than the boundary exhaust air volume, maintain the negative pressure air environment, and rationally configure the adsorber loop. In the process of putting the nuclear project into operation, in the case of nuclear radiation, nuclear radiation is effectively discharged through the adsorber circuit. At the same time, in order to improve the quality of nuclear radiation safety protection, it is necessary to install monitors and alarm interlocking devices. During the operation of the ventilation system, the radiation level of the discharged air is tested in all aspects. When the radiation value exceeds the preset safety range, the alarm chain device will automatically send a signal and suspend the exhaust air.

Usually, nuclear projects include different workplaces such as personnel, logistics channels, and waste storage areas, and there are large differences in the amount of radiation. Therefore, for different radioactive sites, relevant personnel need to develop targeted safety protection measures, achieve zoning control, and improve the quality and effectiveness of nuclear radiation safety protection. For example, by isolating and controlling personnel and logistics channels, workers can avoid the discharge of radioactive substances to affect the environment and endanger human health. In the logistics channel, reasonably install shielding materials to prevent radioactive substances from producing more nuclear radiation during transportation, penetrating the shielding layer, entering the external ecosystem, and polluting the environment. At the same time, in the waste loading and unloading sites, warehouses, etc., equipped with detectors, effective detection of nuclear radiation dose rate, packaging materials surface nuclear radiation pollution degree, do a good job in the analysis of the test results, after it meets the relevant requirements, can be exported to the

warehouse. When the relevant personnel need to enter the nuclear radiation control site, they need to wear special work clothes in accordance with the requirements, and take off the work clothes when leaving the locker room with strong tightness, and do a good job of decontamination treatment, cleaning the trace nuclear radiation attached to the surface of the clothing.

#### 4.4 Auxiliary Protective Measures

Nuclear radiation has a great impact on the environment, and widely exists in People's Daily production and life, it is necessary to strengthen safety protection, and do a good job of follow-up nuclear radiation pollution treatment, so as to reduce the harm of nuclear radiation to the environment and human health, and ensure the harmonious and healthy development of society. In the process of nuclear radiation safety protection, auxiliary measures need to be adopted, in the case of nuclear radiation and other safety accidents, the relevant personnel should carry out reasonable investigation and handling work, do a good job in the safe transfer of personnel, and take scientific protective measures to adjust the ecological environment. The planting of green plants can alleviate the impact of nuclear radiation on the environment and maintain the balance of ecological environment. By improving the greening effect and adjusting the ecological environment, the absorption of nuclear radiation can be achieved with the help of green belt and forest land, so as to protect the ecological environment and reduce the impact of nuclear radiation on the environment.

#### 5. Conclusion

Nuclear energy is widely used in People's Daily life, so it is very important to strengthen the safety protection of nuclear radiation. Nuclear radiation has a great impact on the environment, it is necessary for relevant departments to pay more attention to nuclear radiation safety protection, and take a series of effective measures to reduce the impact of nuclear radiation on the environment. Personnel of relevant departments can enhance the effect of nuclear radiation safety protection and better protect the ecological environment by shielding nuclear radiation, nuclear power plant safety protection, control nuclear

radiation in the workplace, auxiliary protection and other measures.

The impact of nuclear radiation on the environment is profound and complex, which not only causes direct damage to organisms, such as acute radiation sickness and long-term genetic mutations, but also may lead to long-term damage to ecosystems. For example, the pollution of soil and water will make these natural resources lose the original ecological balance, affect the growth of plants and animals, and then have a chain reaction on the entire biological chain. In addition, radiation can accumulate through the food chain, posing long-term threats to human health, such as an increased risk of cancer and genetic diseases. Therefore, the use of nuclear energy and the prevention of nuclear accidents need to be extremely careful in order to reduce the potential harm to the environment and human society. This involves not only strict control and management at the technical level, but also the improvement of public awareness and the improvement of emergency response mechanisms. Only in this way can we enjoy the convenience of nuclear energy while minimizing its negative impact on the environment and human health.

Nuclear radiation safety protection is an important measure to ensure the safety of personnel and environment in the peaceful use of nuclear energy and the application of nuclear technology. The effects of nuclear radiation on human health and the environment can be minimized through strict compliance with national and international radiation protection standards, effective radiation monitoring and management, and the use of advanced shielding technologies and personal protective equipment. In addition, public education and emergency preparedness are integral parts of nuclear radiation safety. Radiation protection not only involves the technical level, but also includes many aspects such as policy formulation, law enforcement, education and training, and emergency response. In all aspects of the peaceful use of nuclear energy and the application of nuclear technology, from the design, construction, operation and decommissioning of nuclear power plants, from the transport of radioactive materials to medical, industrial, scientific and other applications, strict safety protection measures are needed. These measures include

but are not limited to: establishing a sound radiation protection system, formulating scientific and reasonable radiation protection standards and norms, conducting regular radiation safety training and exercises, and establishing a sound radiation monitoring and accident early warning system. Through these comprehensive measures, the health and safety of the public and workers can be effectively protected, while protecting the environment from unnecessary radiation pollution.

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