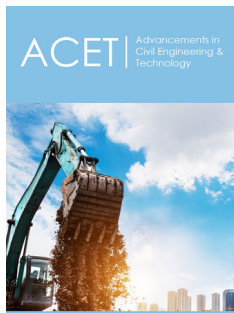


The Comparative Analysis of Coastal Site and Inland Site in Nuclear Power Plants

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Abstract

The paper investigates the distribution of nuclear power plants in the coast and the inland all over the world, and studies the focus of the disputes between supporters and opponents on inland construction of nuclear power plants. It is analysed that the construction of inland nuclear power plants refer to the factors such as population distribution, external events, hydrology, natural geographical environment, atmospheric diffusion, transportation and nuclear fuel supply and so on. The conclusion is that the safety of nuclear power plants in inland areas is guaranteed.

Keywords: Coast; Inland; Site; Nuclear power plant; Key factors

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Introduction

On December 15, 1991, China built its own Qinshan nuclear power plant to generate electricity. Since then, China has built a number of large-scale nuclear power bases in the coastal areas. Whether to develop inland nuclear power plants has been the focus of discussion in Chinese society, there are a large number of supporters and skeptics. From a global point of view, there is no contest between inland nuclear site and those in coastal site. Because the location of a nuclear power plant is only related to load demand, geology, earthquakes, hydrological conditions, meteorological conditions, population density, human activities and socio-economic factors and so on, the site in coast or inland is not the key factor. At present, most of the operating nuclear power units in the world are built inland. By the end of 2021, there were 53 nuclear power units in operation in China, and the construction of inland nuclear power units is the threshold that must be crossed for the development of nuclear power in China [1].

The Nature of the Nuclear Power Site Dispute in Coast or Inland

Chinese nuclear power plants are now built in the coastal region. The main arguments about whether China should build inland nuclear power units are from the perspective of natural conditions and the safety of nuclear power operation, supporters believed that in the 40 years of operation of Chinese nuclear power plants, there has never been a level 2 or higher nuclear safety event (accident), and nuclear power safety is guaranteed that similar Fukushima nuclear accident will not occur. The naysayers, in terms of nuclear accidents (Table 1), argue that the probability of nuclear safety is not 100% and that the impact of the event of a nuclear accident inland site would be much greater than that of the coastal site, with unacceptable disasters on downstream cities.

Table 1: The main reasons to opponents.

Risk Factors	Introduction
water safety	In the event of a nuclear accident, inland nuclear power plants may produce greater harm because of its radioactive substances into the water. Inland rivers or lakes dilution will be more difficult than ocean, which has a great impact on the water quality of the local area and some downstream areas.
Atmospheric diffusion	Once a nuclear accident happens, any direction of atmospheric diffusion will affect the downwind areas of human life.
Evacuation of personnel	Inland nuclear power plants are built along the large rivers or lakes, where are densely populated on all sides. In the event of an accident, evacuation of personnel and other emergency treatment is difficult.
Scientific site selection	The scientific layout of inland nuclear power plants may be affected by the interests of interference, resulting in scientific site selection, optimization and other considerations not enough.

As can be seen from the above discussion, the focus of both positive and negative view has become a mismatch: whether to build nuclear power plants, the core element is to ensure safety, not the acceptability of the impact of an accident. There is no question of sacrificing the coastal region to build nuclear power plant, so it is safety to build inland nuclear power. Therefore, the best way to resolve the dispute over inland sites is to improve the safety of nuclear power plants. <<The 12th five-year plan for nuclear safety and radioactive contamination and the long-term goals for 2020>>call for new nuclear power plants to be built in the future effectively eliminating the possibility of large releases of radioactive substances by design. High-temperature gas-cooled reactor [2] and HPR1000 are ideal reactors for China's inland nuclear power plants, which are technically capable of avoiding serious accidents such as core meltdowns and radioactive leaks under any circumstances.

International Nuclear Power Plant Site Analysis

The location of nuclear power plants abroad is mainly considered to coordinate with the power load distribution to meet the demand reasonably. More than two-thirds of the world's nuclear power plants in operation are along rivers and lakes. All countries adopt the same nuclear safety regulations and standards for inland nuclear power plants as those in coastal sites. Through long-term monitoring of inland nuclear power plants that are already in operation, it is proved that inland nuclear power plants are as safe, environmentally friendly and technically fully mature and feasible as those in coastal sites. France, which has the highest proportion of nuclear capacity, and the United States, which has the largest number of nuclear units, are typical.

Site analysis of coastal and inland nuclear power plants in France

The principle of nuclear power plant site selection and emergency planning in France are consistent with the basic requirements of coastal and inland sites, which are technical and economic criteria, safety criteria, and environmental criteria, social and economic criteria. Within this framework, the main difference between the coastal site and the inland site are priorities for cooling, site feasibility and safety evaluation due to different natural environments.

In general, nuclear power plant site selection is considered the power market demand, power supply layout conditions and the site of other conditions. Through the construction and long-term operation of dozens of nuclear power units, EDF had two important

conclusions: first, through detailed and rigorous research, the impact of nuclear power plants on the environment is negligible. Second, hydrobiology and radioecology studies confirm that there is no discernible evidence that nuclear power plants have an impact on the terrestrial and aquatic environment.

Site analysis of coastal and inland nuclear power plants in America

US criteria for nuclear sites in coast and inland are consistent, which is now the world's largest nuclear power installation capacity. U.S. National Atomic Energy Regulatory Commission (NRC) guidelines for nuclear plant site selection are geology and earthquake resistance, atmospheric conditions, population density, emergency response, hydrogeological conditions, military and transportation facilities, ecological protection, socio-economic principles, noise, etc. Years of experience in the operation of nuclear power plants in the United States have fully demonstrated that it is entirely feasible to build nuclear power plants inland areas without technical problems.

Site Selection Factors of Inland Nuclear Power Plant

The site selection is the primary problem and the key factor of the feasibility of nuclear power plant construction [3] and there is no such thing as an inland standard or a coastal standard. From the point of view of nuclear safety and economics, the site selection of a nuclear power plant must be to protect the public and the environment from the excessive radiation effects caused by a radioactive accident. It is important to study the influence of external natural or man-made events on the nuclear power plant and the influence of the normal release of radioactive substances on the density and distribution of people around the nuclear power plant.

The requirement for the distribution of the population

With the continuous improvement of nuclear power safety technology, nuclear power plant site selection requires near the load center and far possible away from residential areas. In view of the characteristics of inland nuclear power plants, the first consideration about the site selection of nuclear power plants should be given to the radiation exposure of the public and workers in case of a serious accident. The radiation risk to the public is mainly related to the location of the nuclear power plant, so it is necessary to evaluate the environmental characteristics. The

distance between a nuclear power plant and a large or medium-sized city depends on the time that it takes for people to evacuate or take emergency measures in the event of a nuclear accident.

Requirements for external events

Nuclear power plant site should be far away from dangerous goods production, storage and transport facilities and take necessarily external engineering protection measures. Nuclear power plants should also be kept away from civilian aircraft and reactor buildings need to be designed to prevent aircraft crashes. Locations close to military training airports and any military installations are not suitable for use as nuclear power plant sites. In order to prevent accidents such as intentional damage, fire and internal flooding, redundant series of safety systems should be placed in separate areas of physical isolation.

Requirements for hydrology

During the generation of nuclear power plant, a large amount of energy needs enough cooling water to carry which discharged in the form of heat energy. Inexhaustible sea water in coastal nuclear power plants take more advantages than that in rivers or lakes. The Hydrologic Requirements for inland nuclear power plant site selection are mainly based on the state of the water source nearby such as amount of water required, temperature of drainage and wastewater discharge.

A. Nuclear power plants need a large amount of circulating cooling water, necessary production and domestic water. Therefore, the choice of inland nuclear power plant site should give priority to the river areas.

B. Nuclear power plant needs to protect against natural flooding and flooding caused by damage of large upstream hydraulic engineering, as well as against risks from river navigation.

C. The protection of water supply and drainage structures and water delivery pipelines should consider the influence of flood scour, sediment deposition caused by dam break of natural flood and the long-distance water pipeline in floodplain area by river water and mountain torrents.

D. Considering the ecological impact of inland nuclear power plants, it is important to closely monitor the drainage temperature because of the cooling water warmer than the water from the river. In order to keep warm drainage from causing excessive environmental impacts, a permit is required and the main controls are the temperature difference between the intake and the outlet, the mixed water temperature, and the temperature of the drainage water.

E. The spray of cooling tower forms drizzle in a certain range, which may lead to the change of air humidity.

The requirements of physical geographical environment

The physical geographical environment affecting the construction of nuclear power plant mainly refers to flood, earthquake, ground subsidence or uplift, soil liquefaction, Tornado, tropical cyclone and so on. For earthquakes, the nuclear power

plant should be located away from active faults or in areas of lower earthquake intensity, which is designed to keep the reactor plant operating when an operational safety earthquake occurs that is one degree higher than the locally known maximum earthquake. For storms, the plant structure should be resistant to local design reference typhoons and tornadoes and the impact of their projectiles.

Atmospheric diffusion conditions

At the coastal site, the calm wind frequency is usually less than 10%, which is conducive to the radioactive contamination being dispersed. However, the calm wind frequency of some inland nuclear power plant sites is as high as 40%, so the atmospheric diffusion condition is the key content to be concerned in the inland nuclear power plant site selection.

The requirements of transportation

The nuclear power plant site needs good traffic conditions and meets the transportation requirements of special equipments. Therefore, the inland nuclear power plant site selection should pay attention to the traffic conditions near the rivers or lakes.

The sustainable supply of nuclear fuel

The sustainable supply of natural uranium is the precondition of large-scale development of nuclear power in the future. Some inland areas, such as Jiangxi, are priority areas for inland nuclear power development construction because of the sufficient uranium resource.

Conclusion

The idea that nuclear power can only be built on the coast is skewed. Many of the world's big nuclear powers have built more inland nuclear plants than that at coast and there's no date difference between them. The legal provisions are consistent with the basic requirements of inland and coastal areas in site selection. Decades of experience in the operation of nuclear power plants have demonstrated that the safety of nuclear power plants built inland areas can be fully guaranteed. It is not only feasible but also necessary in China's inland provinces to build nuclear power to meet energy needs, especially those with rapid development and a shortage of primary energy.

Author's Information

Mu Zhao, professor, He mainly engaged in nuclear energy and nuclear facilities decommissioning and radioactive waste management.

References

1. Mingqiang Song, Tao Zhou, Zhongyun Ju (2013) Feasibility and timing of nuclear power development inland in China. *Huadian Technology* 35(12): 1-3.
2. Zuoyi Zhang, Zongxin Wu, Dazhong Wang, Yuanhui Xu, Yuliang Sun, et al. (2009) Current status and technical description of Chinese 2×250MW_{th} HTR-PM demonstration plant. *Nuclear Engineering and Design* 239(7): 1212-1219.
3. Deming Tan (2009) Study on the key factor of Chinese inland nuclear power stations construction. *Jiangxi Energy* 2009(1): 16-18.