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Investigating the Environmental Impacts of Nuclear Power Plants.

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ABSTRACT

This paper investigates the environmental impacts of nuclear power plants such as air emission, water resources, water discharges, fuel and radioactive waste generation. The results of this study denotes the great effects of nuclear energy on the environment.

Keywords: Nuclear Energy, Nuclear Power Plants, Environmental Impacts, Pollution

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INTRODUCTION

Nuclear power activities involving the environment; mining, enrichment, generation and geological disposal. Nuclear power plants are mainly installed to serve the base load in electric power systems. This power plants produce reliable and low-cost power. Nuclear power plants have been widely reviewed and investigated in electric power systems [1-4]. Paper [4] presents an alternative off-site power supply improves nuclear power plant safety. This paper explains that a reliable power system is important for safe operation of the nuclear power plants. The station blackout event is of great importance for nuclear power plant safety. This event is caused by the loss of all alternating current power supply to the safety and non-safety buses of the nuclear power plant. In this study an independent electrical connection between a pumped-storage hydro power plant and a nuclear power plant is assumed as a standpoint for safety and reliability analysis. The pumped-storage hydro power plant is considered as an alternative power supply. The connection with conventional accumulation type of hydro power plant is analysed in addition. The objective of this paper is to investigate the improvement of nuclear power plant safety resulting from the consideration of the alternative power supplies. The safety of the nuclear power plant is analysed through the core damage frequency, a risk measure assess by the probabilistic safety assessment. The presented method upgrades the probabilistic safety assessment from its common traditional use in sense that it considers non-plant sited systems. The obtained results show significant decrease of the core damage frequency, indicating improvement of nuclear safety if hydro power plant is introduced as an alternative off-site power source. In paper [1], a new friction damper isolation system (FDIS) is suggested for isolated nuclear power plants (NPPs). Seismic responses of NPPs are accomplished by means of the finite element approach and setting up a representative multi-particle model of NPPs. Results in terms of time domain analysis show that response of structure supported by FDIS under small seismic are correspond to fixed structure, and perform similar properties as conventional isolated structure under large seismic. The yield force of friction damper is one of the important parameters which are related to responses and absorbing energy under seismic input energy in new isolated structures. Compared with cases of different yield level, responses of superstructures increase respectively with yield force, while displacements of isolation layer decrease effectively. The proposed new isolation system could be beneficial in enhancing the seismic safety of isolated NPPs. Nuclear energy originates from the splitting of uranium atoms in a process called fission. Fission releases energy that can be used to make steam, which is used in a turbine to generate electricity. Nuclear power accounts for approximately 20 percent of the United States' electricity production. More than 100 nuclear generating units are currently in operation in the United States. Uranium is a nonrenewable resource that cannot be replenished on a human time scale. Uranium is extracted from the earth through traditional mining techniques or chemical leaching. Once mined, the uranium ore is sent to a processing plant to be concentrated into enriched fuel (i.e., uranium oxide pellets). Enriched fuel is then transported to the nuclear power plant. In the plant’s nuclear reactor, neutrons from uranium atoms collide with each other, releasing heat and neutrons in a chain reaction. This heat is used to generate steam, which powers a turbine to generate electricity. Nuclear power generates a number of radioactive by-products, including tritium, cesium, krypton, neptunium and forms of iodine [5].

This paper investigates the environmental impacts of nuclear power plants such as air emission, water resources, water discharges, fuel and radioactive waste generation. The results of this study denotes the great effects of nuclear energy on the environment.

Environmental Impacts

Although power plants are regulated by federal and state laws to protect human health and the environment, there is a wide variation of environmental impacts associated with power generation technologies. The purpose of the following section is to give consumers a better idea of the specific air, water, land, and radioactive waste releases associated with nuclear power electricity generation.

Air Emissions

Nuclear power plants do not emit carbon dioxide, sulfur dioxide, or nitrogen oxides as part of the power generation process. However, fossil fuel emissions are associated with the uranium mining and uranium enrichment process as well as the transport of the uranium fuel to and from the nuclear plant [6].

Radioactive gases and effluents

Most commercial nuclear power plants release gaseous and liquid radiological effluents into the environment as a byproduct of the Chemical Volume Control System, which are monitored in the US by the EPA and the NRC. Civilians living within 50 miles (80 km) of a nuclear power plant typically receive about 0.1 µSv per year [6]. For comparison, the average person living at or above sea level receives at least 260 µSv from cosmic radiation [6]. The total amount of radioactivity released through this method depends on the power plant, the regulatory requirements, and the plant's performance. Atmospheric dispersion models combined with pathway models are employed to accurately approximate the dose to a member of the public from the effluents emitted. Effluent monitoring is conducted continuously at the plant [6].

Water Resource Use

Nuclear power plants use large quantities of water for steam production and for cooling. Some nuclear power plants remove large quantities of water from a lake or river, which could affect fish and other aquatic life [6].

Water Discharges

Heavy metals and salts build up in the water used in all power plant systems, including nuclear ones. These water pollutants, as well as the higher temperature of the water discharged from the power plant, can negatively affect water quality and aquatic life. Nuclear power plants sometimes discharge small amounts of tritium and other radioactive elements as allowed by their individual wastewater permits. Waste generated from uranium mining operations and rainwater runoff can contaminate groundwater and surface water resources with heavy metals and traces of radioactive uranium [6].

Spent Fuel

Every 18 to 24 months, nuclear power plants must shut down to remove and replace the "spent" uranium fuel. This spent fuel has released most of its energy as a result of the fission process and has become radioactive waste. Currently, the spent fuel is stored at the nuclear plants at which it is generated, either in steel-lined, concrete vaults filled with water or in above-ground steel or steel-reinforced concrete containers with steel inner canisters. In 2012, the President’s Blue Ribbon Commission on America’s Nuclear Future issued a report recommending the timely development of one or more permanent deep geological facilities for the safe disposal of spent fuel [6].

Radioactive Waste Generation

Enrichment of uranium ore into fuel and the operation of nuclear power plants generate wastes that contain low-levels of radioactivity. These wastes are shipped to a few specially designed and licensed disposal sites. When a nuclear power plant is closed, some equipment and structural materials become radioactive wastes. This type of radioactive waste is currently being stored at the closed plants until an appropriate disposal site is opened. Management, packaging, transport, and disposal of waste are strictly regulated and carefully controlled by the U.S. Nuclear Regulatory Commission and the U.S. Department of Transportation [6].

Reserves

In 2008, U.S. uranium ore reserves were estimated at one billion, 227 million pounds. These reserves are located primarily in Wyoming and New Mexico [6].

CONCLUSIONS

This paper studied the environmental impacts of nuclear power plants such as air emission, water resources, water discharges, fuel and radioactive waste generation. The results of this study showed the great effects of nuclear energy on the environment.

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