Regulatory of Nuclear Power Plant: Environmental Safety Aspect on Nuclear Power Plant Siting

Werdi Putra Daeng Beta
Directorate of Inspection for Radiation Facilities and Radioactive Materials
Indonesia Nuclear Energy Regulatory Agency (BAPETEN)
Jl. Gajah Mada No. 8 Jakarta 10120, Indonesia
d.beta@bapeten.go.id

Abstract

Nuclear Energy Regulatory Agency also called BAPETEN is a national regulatory authority for nuclear energy uses in Indonesia. Regulatory of Nuclear Power Plants (NPPs) is one of BAPETEN authorities for nuclear energy uses, including NPP siting. Regulatory of NPP consists of 5 (five) steps, there are siting, construction, commissioning, operation, and decommissioning. In this paper would be discussed regulatory of NPP siting, especially on environmental aspects. NPP site area is a geographical area that contains nuclear reactor, that is location in the land to be used for building, operation and decommissioning of one or more nuclear reactors for NPP facilities and all related systems, and within which the management of the authorized facility may directly initiate emergency actions. Site characteristics of NPP are very important to be considered in building and operating of NPP. One of some aspects to be considered is environmental safety of the site. This aspect should fulfill site criteria and requirement according to the regulation and reliable and in-depth studies, assessments related to environmental impact of nuclear reactors for power plants and the transfer of the released radioactive from nuclear reactor up to humans and the environment.

Keyword: BAPETEN, environmental safety, NPP site

Introduction

Nuclear Energy Regulatory Agency, also called BAPETEN is national regulatory agency for the use of nuclear energy in Indonesia. Nuclear Power Plant (NPP) is one BAPETEN scope of regulatory duties. Regulatory duties, in accordance with Law No. 10 Year 1997 on Nuclear Energy, Article 4 Paragraph (2) stated that the regulatory duties performed by Regulatory Agency held through regulation, licensing and inspection.

While one purpose of supervision is to ensure the safety and health of workers and the public and protection of the environment, in accordance with Article 15 item b of the Act. This causes BAPETEN role in nuclear energy programs are very significant and vital. BAPETEN obligation of regulating nuclear power through regulation, licensing, and inspection and supported by assessment of nuclear power plant system and technology. NPP is one of the utilization of nuclear energy for power generation. Licensing of nuclear reactors including regulation of NPP consists of NPP siting, construction, commissioning, operation, and decommissioning. This is synergized to one of Directorate of Inspection of Radiation Facilities and Radioactive Material mission, namely to set up the infrastructure of environmental and radiological inspection systems at the NPP which includes the siting, construction and operation.

Indonesia National energy policy has put nuclear energy as an option to meet the electricity demands of the people of Indonesia at present and in the future. This is reinforced by Government Regulation No. 5 of 2006 on National Energy Policy on Article 2 Paragraph 2 item b which states that national energy policy objective is the realization of energy (primary) optimal mix in 2025, namely the role of each type of energy to the consumer National energy is new and renewable energy, in particular Nuclear, be more than 5%.

Additionally, the main policy measures should be considered carefully to preserve the environment by applying principles of sustainable development, which includes sustainability of the environment. NPP in the dimension of sustainability of the environment means that the existence of NPPs must be able to maintain and preserve the environment. Risks and hazards of nuclear technology must be engineered and reduced so as not to disturb the environment as a whole. In this paper, it would be discussed regulatory of NPP, especially on environmental safety aspects in NPP siting.
Environmental safety requirements are important things to satisfy regulation, to propose for an NPP siting license and to be verified on inspection activity. The criteria/requirements are based on regulations and international standards. The problem statement of this paper is what the environmental safety requirements in NPP siting are. Environmental safety aspects in NPP site are the features that needed by the licensee to keep the site safe and secure for NPP lifecycle, especially in siting stage. The purpose of this study was to describe the environmental safety aspects of NPP site.

The scope of this research consists of environmental safety aspects of the nuclear power plant site; but not discuss about radiological safety aspects of nuclear power plant site and the type of nuclear reactor that will be built on the location of the site. Radiological safety aspects of the nuclear power plant site will discussed in a separate paper.

Methods

The methodology of this study is descriptive analytic, that is assessment of all kind of data and parameters on environmental aspect in NPP siting. The data and parameters to be considered are in the environmental impact of nuclear reactors for power plants and the transfer of the released radioactive nuclear reactor up to humans and the environment.

Author refers to reference [6], in this case, "Reactor Site Criteria," requires that the population density; use of the site environs, including proximity to man-made hazards; and the physical characteristics of the site, including seismology, meteorology, geology, and hydrology, be taken into account in determining the acceptability of a site for a nuclear power reactor.

Then, parameters analyzed and describe its sufficient requirements for the acceptability of the site. The approach will be carried out in this paper is to describe the eligibility criteria of the site for environmental safety in the nuclear power plant, namely characteristics of the site related to the evaluation of risks to public and the feasibility of implementation of emergency response plans.

All kind of data is to be obtained from literature study of relevant sources. Study materials are laws and regulations related to nuclear energy, nuclear reactor siting, and other material from the competent international organizations.

Result and Discussion

NPP is a nuclear reactor that serves as a power reactor used for electricity generation. Nuclear reactor is a device or installation that is run with the nuclear fuel core could generate a chain reaction controlled and used for power generation, or research, and / or the production of radioisotopes. Nuclear power reactor is in the form of nuclear power plants that utilize thermal energy for power generation both for commercial and non-commercial interests [7].

Site definition

According to the author, and according to BAPETEN Chairman Regulation No. 5 Year 2007 [8] on the Safety Requirements of Nuclear Reactor Site Evaluation noted that the site area is the geographic area that contains the nuclear reactor, in which the management of nuclear reactor emergency authority to take action. This is consistent with the definition of the IAEA [8] (Site Evaluation for Nuclear Installation, Safety Requirements, Safety Standard Series No. NS-R-3, IAEA Vienna, 2003) and USNRC (U.S. Nuclear Regulatory Commission) [10] which states that: "site area is a geographical area that contains an authorized facility, and within which the management of the authorized facility may directly initiate emergency actions".

Meanwhile, according to the IAEA [9] stated that "the siting is the process of selecting a suitable site for a facility, including appropriate assessment and definition of the related design bases." Site Evaluation is an activity analysis of each source of incident on the site and surrounding area that may impact the safety of nuclear reactors (NPP). According to Indonesia Government Regulation No. 43 Year 2006 on Nuclear Reactor Licensing [7] stated that: Site is a location on land used for the construction, operation, and decommissioning of, one or more nuclear reactors and their related systems. The author believes that, if the site is assigned for nuclear power plants, so the nuclear power plant site is geographic area containing nuclear plant, which is the location on land used for the construction, operation, and
decommissioning of, one or more nuclear reactors and their related systems are in it authorized the management of nuclear reactor emergency action.

**Site Evaluation**

Environmental safety aspects of site evaluation are vital and must be considered, as this will affect the acceptability of the site whether it is appropriate or not to build nuclear power plants. In BAPETEN Chairman Regulation No. 5 Year 2007 [8] on the Safety Requirements of Nuclear Reactor Site Evaluation, Section 4 stated that: In the site evaluation, applicant should consider the following aspects (in term of environmental safety):

a. Characteristics of the site and the environmental impact of nuclear reactors and the transfer of the released radioactive nuclear reactor up to humans and the environment, and;

b. Population demographics and other characteristics of the site related to the evaluation of risks to members of the public and the feasibility of implementation of emergency response plans.

Furthermore, the following will be discussed in detail the things mentioned above related to the environmental safety of the NPP site [6,9,10-13].

**Site Characteristics**

Characteristics of the nuclear power plant site are very important to consider in the development and operation of nuclear power plants. Aspects to be considered include the environmental safety of nuclear power plant site. Characteristics of the site consists of the characteristics of geology, seismology, hydrology, oceanography and meteorology of the site and surrounding area, which is related to the distribution of the existing population in the present and the future, land use, site activities and supervision of the planning is done [6,11]. Also, It aims to determine the effect of site characteristics on facility design and operating criteria, and to show a review of the site characteristics in terms of safety [9,10,11,12], especially environmental safety.

**General Description of the Site**

Facility site locations should be determined and equipped with adequate scale map that shows:

1. The area belongs to the facilities and its borders;
2. The location and orientation of buildings and major equipment;
3. Location of the industrial, commercial, educational, recreational or residential;
4. Roads, highways, waterways and the nearby railway line;
5. Boundary areas controlled by the operating organization, and
6. Limit the discharge of effluents.

A description of the applicant's legal authority relating to all areas located within a specified area of the control should be noted. All activities that are not related to the operation of the facility will be done in the control area.

**Meteorology**

Meteorological contain descriptions of the meteorological site and its environment, including wind speed and direction, air temperature, precipitation, humidity, and atmospheric stability parameter inversion continued. It is also given the frequency of seasonal and annual weather phenomena including storms, hurricanes, lightning and tornado.

**External Event**

External event is a phenomenon and the characteristics of the site whether caused by nature or by human, which should be considered in assessing the adequacy of the site for a nuclear reactor facility. Describe the methods used for determining outbreaks and incidents that are part of the design basis for the effects of natural phenomena and man-made effects that are important. Information on the design criteria for protection against these effects are also described.
Geology and Seismology

Geology of the site and its surroundings should be described in detail to identify the effects that can harm the nuclear reactor facility. The information is used to determine the seismic design basis, such as the frequency of occurrence of repeated earthquakes and ground motion, presented in this section, including information on:

1. Assessment of the potential for surface fault at the site;
2. Definition of the technical nature of the condition and the soil and / or rock the foundations of the reactor, and
3. Assessment of potential volcanic activity.

Hydrology and Oceanography

Surface and underground hydrology of the site and its surroundings include location, size, flow, water use and characteristics of drinking water sources. The location and characteristics of man-made structures must be shown, including dams and canals flow modifiers, and flood control structures.

A description of the groundwater hydrology surrounding nuclear facilities should also be given, including the main characteristics of the local water and its interaction with surface water, and the data on the use of groundwater in the region.

If the reactors are built near the coast, it has to be given oceanographic and hydrographic information, including a map of the bathymetry of the area near the beach in front of the reactor site. Natural phenomena that need to be considered in the safety report may include:

1. Flood;
2. Currents, waves, waves, and
3. Phenomena like the tsunami caused by seismic and dam failure.

Closest Industrial, Transportation and Military Facilities

All industrial facilities, transportation and the military that exist now and in the future that could harm the reactor facility shall be described here, as examples, chemical plants, oil refineries, storage facilities, mining and mineral collection, military bases, transportation (air, land, water), transport facilities (railways, shipyards, ports, airports), pipelines, drilling operations and oil and gas wells, and underground storage facilities. The potential adverse effects of these facilities belonging to the reactor building, such as aircraft collision or other accident should be described. Expected significant changes in land use must be considered, including the expansion of existing facilities or activities, or the development of high-risk facilities.

Land Utility, Water and Natural Environment

Regional ecological characteristics and the use of water and land must be described in a nuclear power plant site, which includes:

1. Land and water bodies that sustain life;
2. Land devoted to agriculture;
3. Land designated for farm or ranch;
4. The land earmarked for commercial purposes, residential and recreation;
5. Water bodies used for ponds and sport fishing;
6. Body of water that is used for commercial and recreational purposes;
7. The direct and indirect pathways of radioactive contamination of the food chain.

Atmospheric Distribution of Radioactive Substances

The atmospheric distribution of radioactive studies should be done and described the methods for distributing atmospheric radioactive substances released during normal operation and accident conditions in the reactor, according to the policy of the operating organization and the regulatory body. It must also be explained forecast dispersion based on actual meteorological data or data...
conservatively based on the worst weather assumption. The scope of the model should include the characteristics of the topography of the site and the specific regional, and facility characteristics that may affect the distribution of the atmosphere. The accuracy and validity of the method, including the adequacy of input parameters, source configuration and topography, should be discussed. It should be pointed computational results on atmospheric diffusion parameters onsite and off-site location of NPP, or refer to the concentration of radionuclide in the atmosphere, and radiation dose calculations.

**Distribution of Radioactive Substances through Surface Water and Groundwater**

On the distribution of radioactive substances through surface water and ground water should be outlined that despite the location and distribution of radionuclides entering surface water or groundwater near the facility. The results of hydrological and hydrogeological investigations were used to assess the characteristics of the dilution and distribution of water bodies should be presented.

The method used to evaluate the possible effects of contamination of surface and ground water of the population should be described. If necessary, the calculation of off-site dose should be given and the reference to the calculation should be made.

**Mitigation**

Mitigation should discuss the results of a study conducted to assess the need for, or scope of, mitigation efforts such as accident management or emergency response efforts may be required in the event of an accident at the facility, in accordance with the Regulatory Agency policy. Mitigation should consider:

1. Distribution of population and projected population changes in the area around the facility;
2. Land use and water current and projected in the region;
3. Potential forms of radioactive sources, and the population dose from direct radiation field and the route of the air / water;
4. Potential contamination of the food chain;
5. The potential radiation doses to onsite personals;
6. The need to control the activities that are not related to the operation of nuclear power facilities in the area of control or evacuate the people involved in these activities;
7. The ability of authorities concerned to implement the necessary emergency efforts, and
8. Feasibility of emergency plans by considering the distribution of population, national and international boundaries, special groups (such as hospitals), special geographical characteristics (such as islands, communication and transport facilities).

After all it is laid out clearly; the next step is to draw conclusions about the acceptability of the site, for a conviction of certain considerations. If further analysis is needed to support this conclusion, the characteristics of the site should be identified. In this case should be stated also that the risk of radiation to the population in accident conditions, including the implementation of mitigation measures, is quite low and in accordance with applicable requirements.

**Examples of NPP Site Study**

Apart from the prospective NPP site in Muria Peninsula, BATAN as operational organization is currently doing research in other areas as a response to the request of some local governments that have proposed the area as the location of the prospective NPP site. BATAN is conducting prospective studies on nuclear power plant site based on safety requirement, including environmental safety. The activity was held in the Province of Banten, Kalimantan Island, and Bangka Belitung. The study was also to get an alternative site to obtain prospective NPP site several options that meet environmental safety requirements.

The results of the study site \(^{(14)}\) are:
1. Banten Province: Studies of Status site in Kramatwatu-Bojonegara until now is at the stage of screening. Currently, BATAN Teams and local government are performing the Spatial and Regional Planning on Banten where prospective site Kramatwatu-Bojonegara and Pulo Panjang considered as a strategic area. Studies and activities remain to be done on candidates’ site of Kramatwatu-Bojonegara.

2. Kalimantan island:
   From the aspect of geology and seismicity, Kalimantan is good for plant location. West Kalimantan is an area of granite stones suitable for the foundation of NPP. Central Kalimantan (Pangkalan Bun) and South Kalimantan are very good Sediments. Also, early survey has been done in East Kalimantan.

3. Bangka Belitung Province (BABEL):
   Literature study result showed that for Babel:
   a) There is no potential for tsunami.
   b) Population is relatively rare, with a total population of 1,074,775 people.
   c) The focus of demographic and strategic archipelago (13 km from the island of Sumatra, 330 km from the island of Java, 210 km from the island of Borneo and 380 km from Singapore)

   Pre-site survey at Babel showed two areas of interest, namely:
   a) Ingris Coast, Tanah Merah, District Muntok, West Bangka Regency.
   b) Berdaun Coast, Simpang Rimba District, West Bangka Regency, South Bangka.

**Conclusion**
Regulatory of NPP is one of BAPETEN authority in the utilization of nuclear energy. Environmental safety aspects of nuclear power plant site must meet the criteria and requirements in accordance with the legislation, assessments and in-depth and reliable studies related to environmental impact of nuclear reactors for power plants and the transfer of the released radioactive from nuclear reactor up to humans and the environment.
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