The Potential Hazards of Human Activity around the Nuclear Plant Site: Case Study of Nuclear Plant Site at Indonesia

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Abstract. *Studies of human activities around nuclear reactor installations that can trigger disasters have been carried out. This is related to BATAN's plan to develop nuclear facilities in Serpong, Banten. The aim of the research is to identify activities from stationary sources that have the potential to disrupt the safety of nuclear reactors and can trigger hazards such as releasing radioactive material into the environment. The methodology includes the collection of primary and secondary data from human activities around the prospective site, identification and mapping of these sources, screening with the Screening Distance Value (SDV) method. The results showed that until now there had been no chemical industry and oil refineries found around the study area, but there were 10 closest refueling activities within 3.0- 4.14 km, and 2 gas filling activities within 1.94 - 12.66 km. The results of screening and mapping indicate that the location of the nuclear reactor is in the SDV refueling and gas area so that it needs detailed evaluation using ALOHA software simulation. After detailed evaluation, there is no threat of explosion and fire hazards that need to be worried about nuclear reactor installations, so that they can be categorized as safe. This data is in accordance with the requirements of the International Atomic Energy Agency and the Indonesian Nuclear Energy Regulatory Agency.*

Keywords: human activity, hazards, SDV, nuclear plant

I. INTRODUCTION

The Chernobyl disaster caused by human error caused the release of a number of radioactive elements and provided a high enough dose of radiation exposure to the public, as well as the Fukushima disaster caused by natural disaster, namely high powered earthquakes and tsunamis which also triger the relesase of radioactive elements into the environment. In the case of Chernobyl nuclear accident with the International Nuclear Scales (INES) at level 7 and the focus of monitoring will be more on the release of noble gases I-131 and Cs-137 while the Fukushima accident is significantly around 10% of the Chernobyl accident[1].

According to Law No. 24 of 2007, disasters are events or series of events that threaten and disrupt the lives and livelihoods of people caused by natural factors and / or non-natural factors and human factors resulting in human casualties, environmental damage, loss of property objects, and psychological effects. In Law No. 24 of 2007, there is various types of disasters that caused by natural, non-natural, and social disasters (human factors). Nuclear explosion is one of the disasters that fall into the category of non-natural disasters[2].

Human activities that exist around the nuclear plant is an externality for the nuclear plant as human activities are generally difficult to control and have the potential to interfere with even hazardous to the nuclear plant because of the release of radioactive material into the environment. Based on this, the International Atomic Energy Agency (IAEA) and Badan Pengawas Tenaga Nuklir (BAPETEN) as a nuclear inspector in Indonesia have issued regulations relating to the construction of a nuclear plant.

At the stage before the construction of nuclear installations (including nuclear power plants), various aspects related to the security and safety of nuclear plants are usually reviewed and evaluated so that site survey activities are carried out. One important aspect of the site survey activity is "human-caused activities", which are described in detail in the IAEA Safety Standards Series, NS-R-3 (2003) and NS-G-3.1 (2002)), specifically for International Regulations and Chairman Regulation No. 6 (2008) as National Regulations[3,4,5].

According to IAEA (2003), facilities and human activities is called external human induced events and should be identified, evaluated of the possible resulting hazard phenomena to derive the appropriate design bases for the plant[3]. It should also be monitored and periodically assessed over the lifetime of the plant to ensure that consistency with the design assumptions is maintained. This is because some facilities and human activities in the area around nuclear plants can affect safety and threaten nuclear plant installations, especially in nuclear accidents[6]. As is known, nuclear plant safety includes internal safety (events in nuclear plants), proximity processes, and external safety (events outside nuclear plants) due to human activities or natural factors[4].

For this purpose the IAEA and BAPETEN provide guidance to meet safety requirements related to aspects caused by humans. The guide explains the types and dangers of various human facilities and activities around the site that can disrupt nuclear installations and can trigger the release of some radioactive substances into the environment due to fire and explosion[7].

In this study several facilities and human activities will be discussed which can cause indirect disasters, such as the chemical industry, refineries, gas and fuel depot stations at the research sites. These sources have the potential to cause the release of dangerous substances (including radioactive materials), explosions and fires. Based on this reason, a potential source of human activity around the survey of the location of a nuclear plant has been carried out.

The purpose of the research is to identify several human activities that exist around nuclear installations that have the potential to cause disasters, including the release of a number of environmental radioactive materials. The results obtained are expected to be used as a reference in site selection and determining the basic design in the site evaluation of nuclear power plants in Indonesia.

1.1 The Hazardous Potential Sources to Nuclear Installation

The potential sources of the external human induced evens to nuclear may be classified as stationary sources and mobile sources. Stationary sources for which the location of the initiating mechanism (explosion center, point of release of explosive or toxic gases) is fixed, such as chemical industry, oil refineries, storage depots of gas or fuel, etc. While mobile sources for which the location of the initiating mechanism is not totally constrained, such as transport for hazardous materials or potential projectile (by road, rail, waterways, air, pipelines)[8]. In this study discusses some stationary source of potential external hazards from the nuclear plant.

1.2 The Screening Distance Value (SDV)

The Screening Distance Value (SDV) criterion is a criterion based on the value of the screening distance, is the distance between the potential hazard source of an external occurrence to the nuclear installation. In the IAEA Safety Series NS-G-3.1 document, Screening Distance Value (SDV) does not mention explicitly for some potential sources, but the determination of the SDV is done through an approach and is fully submitted to IAEA member countries including Indonesia [4,5]. If the potential hazard of distance value of an external event in the direction of SDV, then the presence of the source should not be considered the potential hazards.

II. METODOLOGY

Research activities include secondary and primary data collection, such as oil refineries, chemical industry, fuel and gas station (filling, storage and distribution depots) at around the nuclear site till 25 km radius. Study was conducted in December 2015 to December 2016. Secondary data were obtained from government agencies and resource persons in the study locations, while the primary data were from field confirmation. Furthermore, identifying and mapping their distribution of each source, and screening using the SDV[4,5]. The detailed evaluation of potential hazards was using ALOHA software[9].

III. RESULT AND DISCUSSION

3.1 Oil Refinery

Oil refineries are industries that process oil crude into petroleum products, such as naphtha oil, gasoline, diesel fuel, kerosene and LPG which can be used directly and other products produced into raw materials for the petrochemical industry[10]. The oil refinery are very complex installation with various types of process equipment and supporting facilities and can provide potential for explosions and fires so that it is harmful to the surrounding environment. According to the IAEA and BAPETEN, these sources should be identified and evaluated for potential hazards. The result of research shows that in the research location there is no oil refinery so in this case not considered as a hazard[4,5].

3.2 Chemical Industry

The hazards that occur in the operation of chemical process plant can be separated conveniently into two groups, such as chemical reaction hazards (thermal instability, runaway reaction, gas evolution, etc.), and what can be termed operational hazards. Operational Hazards are risks that arise from the nature of the materials involved in the process, and the manner in which they are handled[11]. Operational Hazards are concerned primarily with the possible occurrence of fires and explosions in plant, and the procedures that can be used to avoid them or prevent damage to plant or personnel. Operational hazards can occur in virtually

For this purpose, IAEA and BAPETEN have required that resources be identified and evaluated against their potential hazards. The result of shows that there is no chemical industry in the location of research but there are only one of industries that use chemicals (dyes), namely pulp and paper industry which is 12.46 km from the nuclear reactor site. Based on this data the reactor site is in outside of the chemical industry SDV (5 km) so it is not considered a hazard.

3.3 Gas Station

Gas stations (LPG) (filling, storage, and distribution depots) provide the same potential hazards as fuel depot stations, such as explosions, fires, release of combustible materials, explosives, asphyxial materials, corrosive materials and hazardous and toxic materials [4, 5]. Gas (LPG) belongs to the category of flammable, colorless, non-corrosive and odorless gas. LPG contains 30% propane (C3H8) and 70% butane (C4H10), has BM 42 - 58, boiling point> -44oF, relative gas density 1.45 - 2.00, ionization potential 10.95 Ev, vapor pressure> 1 atm [12].

Based on confirmation in the field, around the research location it was found that there were 2 gas stations, namely PT. Bhakti Mingasutama and PT. Indah Sri Rejeki, both located in Techno Park, Ciater, Serpong, South Tangerang. The distance of each gas station to the location of the nuclear reactor is 2.99 and 4.14 km, respectively. PT. Bhakti Mingasutama has 2 tanks with a capacity of 14,000 kg each. PT. Indah Sri Rejeki has 2 tanks (each has a capacity of 50,000 kg). Based on this data, we have evaluated the potential hazards of two gas station sources to determine the extent of their impact on nuclear reactor locations.

3.4 Fuel Station

Fuel stations (filling, storage and distribution depots) provide the potential for explosions, fires, release of combustible materials, explosives, asphyxia materials, corrosive materials and hazardous materials, and toxic materials [4,5]. Fuel stations have the potential to release hazardous, explosive, flammable, corrosive and toxic liquids, including liquefied gases which are usually stored in closed containers and which when released can cause harm to safety and human life. Refueling stations generally use premium, pertamax, pertamax plus, pertamina DEX, pertalite, diesel and biosolar. Fuels contain isooctane compounds which evaporate easily at normal temperatures, are colorless, transparent and smelly, have low flash points (-10o to - 15oC), low density (0.71 - 0.77 kg / l), produce heat in amounts large (9,500 - 10,500) kcal / kg). Refueling is carried out by fuel tank trucks that have a capacity of 8000, 16,000, 24,000, 32,000 and 42,000 liters [13].

Confirmation results in the field indicate that there are several fuel stations which are refueling, storage, and distribution sites around the nuclear reactor site between 1.94 - 12.66 km. The closest fuel station from the location of the nuclear reactor is the Kademangan gas station (No.34-15312) with 7 tanks, a total capacity of 165,000 liters, consisting of 60,000 liters of premium (2 tanks), 60,000 liters of diesel (2 tanks), 20,000 liters of pertalite (1 tank), 20,000 liters of pertamax (1 tank), and 5,000 liters of pertamina Dex[14]. While the Rawabuntu gas station (No. 34-15309) has a daily capacity of 24,000 liters, consisting of 16,000 liters of premium and 8,000 liters of pertamax. Fuel storage systems are given in different tank color codes, namely pertamax is blue, premium is yellow, diesel is gray, and pertalite is white, while pertamina Dex is a skid tank which is an underground storage tank[15]

3.5 Preliminary Screening For Hazard Results From Stationary Sources

In the initial screening analysis, if the nuclear reactor location is in SDV, it is considered a potential hazard for the plant. In this case, the chemical industry of PT. Indah Kiat Pulp & Paper is a chemical industry whose activities only use dyestuff chemicals to produce paper. The results of the initial screening analysis indicate that the nuclear plant is not in the chemical industry SDV (5 km) because the industrial distance to the nuclear reactor location is quite far, which is 12.46 km. Based on that, the chemical industry of PT. Indah Kiat Pulp & Paper has no potential hazards and does not interfere with the location of nuclear reactors so there is no evaluation of potential hazards.

Other industrial areas are Bizhub Serpong, a warehousing and industrial area that is 2.9 km from the location of a nuclear reactor, but the area is only for business development and progress and not a warehousing area that stores hazardous materials so that it does not have potential hazards to the nuclear plant locations.

3.6 Evaluation for Fire and Explosion Hazards from Fuel and Gas Stations

The evaluation results of the fire hazard from the fuel station source showed the distribution of flammable vapor clouds reaching 2.1 - 2.2 km and a large fire distance of 781 - 843 m from the fuel station source (Figure 1)[16]. While the evaluation results of the explosion hazard from the fuel station showed distribution up to 689 - 739 m can damage the building, 865 - 906 m causing the possibility of serious injury to people around, and 1.8 km can destroy the glass (Figure 2)[16]

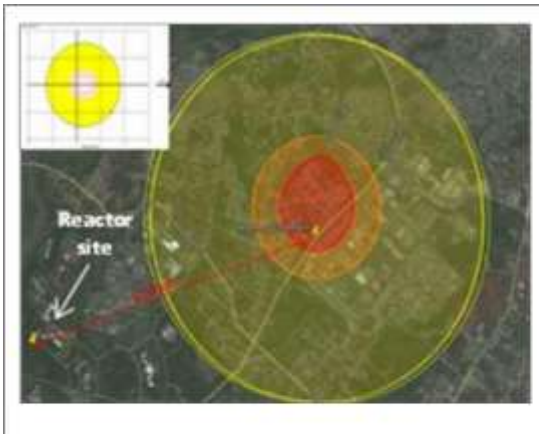

Figure 1. Fire area around Fuel Station[16]

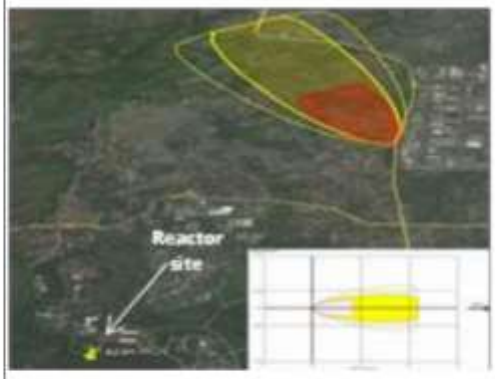

Figure 2. Explosion area around Fuel Station[16]

Evaluation result of the fire hazard from gas stations indicates the distribution of the flammable vapor cloud reaches 1.1 – 2 km from a gas stations source and a large fire distance of 300 – 676 m from the source (Fig.3). While the evaluation results of explosion hazards from gas station show the distribution up to 284 – 577 m its can destruction of building, up to 0.77 – 1.5 km can shatters glass, 362 – 717 m causing serious injury likely of people around (Fig.4).

Figure 3. Fire area around Gas station

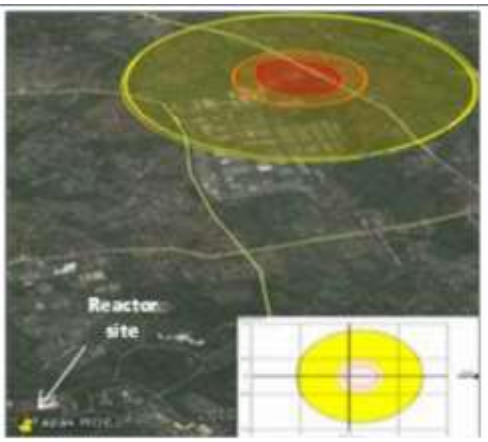

Figure 4. Explosion area around Gas Station

In general the results of fire and explosion evaluation generated by fuel and gas stations are still local and far enough away from nuclear reactor site. Based on this it can be said that the nuclear reactor site is still in the safe category.

IV. CONCLUSION

Based on the results of the research note that around the nuclear reactor site there is no activity related to oil refinery and chemical industry, but found the activity of pulp and paper industry PT Indah Kiat. PT Indah Kiat Pulp & Paper is not a chemical industry but an industry that uses chemicals (dye) to produce paper, and is quite far from nuclear reactor site (outside SDV) so it is not considered potential hazards.

At a radius of less than 5 km from the prospective nuclear reactor site, several fuel stations and LPG gas stations were found, and the reactor sites were within the SDV radius of the two sources. However, the results of the explosion simulation and the fire distribution from both stations (LPG fuel and gas) did not reach the location of the nuclear reactor site so that the location of the nuclear reactor site was categorized as safe. Based on the results of the study it can be said that the prospective nuclear reactor site is safe from the potential hazards of stationary sources such as the chemical industry, fuel and LPG gas station. This data can be used as a reference in location selection and basic design in the evaluation of nuclear power plants in Puspiptek Serpong, South Tangerang.

The results showed that activities classified as stationary sources and potentially disrupting the safety of nuclear reactors because they could trigger danger by releasing radioactive elements into the environment were fuel and gas stations. This is because of the location of the nuclear reactor site inside the SDV from the fuel and gas station (5 km). However, the results of a detailed evaluation by simulating using ALOHA software showed that the fire and explosion of the fuel and LPG gas stations did not reach the location of the nuclear reactor. Based on this, it can be said that nuclear reactors are categorized as safe from hazards caused by gas stations and fuel.

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