Legal analysis regarding nuclear power plant and its relation to the protection of environment and society

Yanti Fristikawati

Faculty of Law, Atma Jaya Catholic University of Indonesia, Jakarta, Indonesia

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ABSTRACT

The need for energy in Indonesia is increasing every year because Indonesia is a country with 742.308 square miles from east to west and the population in 2020 is estimated at 273.523.600 people. The Government of Indonesia has already planned to build Nuclear Power Plant (NPP) since the year 2000, but some people think that nuclear is very dangerous for man and the environment. So, the question is how are the regulations that already exist can protect humans and the environment in Indonesia from the operation of NPP. The goal of this research is to explore all regulations nationally and internationally regarding nuclear activity especially about NPP, and whether these regulations can protect humans and the environment in Indonesia. From the law perspective, Indonesia has Law Number 10 the Year 1997 on Nuclear Energy, Government Regulation (GR) Number 54 the Year 2012 on Safety and Security of Nuclear Installations, and GR Number 2 the Year 2014 on the Licensing of Nuclear Installations and Use of Nuclear Materials. Indonesia also ratified some international conventions such as the Convention on Nuclear Safety and the Convention on the Physical Protection of Nuclear Material. As a member of the International Atomic Energy Agency (IAEA), Indonesia has to follow IAEA rules and standards to protect humans and the environment from nuclear activity. The conclusion is that from a law perspective, it is safe to build NPP since these regulations are enough to protect the society and the environment of Indonesia.

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Introduction

Indonesia is a country which has a necessity of huge power to fulfil the needs of its approximately 270 million citizens, such population are spreading from Sabang to Marauke. Referring to the Ministry of Energy and Mineral Resources (ESDM), the needs of power will continuously increase into 1.208 kWh per capita by 2022, 1.336 kWh per capita by 2023, and eventually increase into 1.408 kWh per capita by 2024. Even though in 2019 the needs of power are still in the level of 1.084kWh. Looking to the fact that the needs of power is keep increasing, and in order to develop the economy and industry, it is necessary to find a solution for the procurement of power from the other new energy other than from the current sources of energy. Currently the national power plant can only generate 71 Giga Watt from the Steam Power Plant (PLTU), Hydro Power Plant (PLTA), Gas Power Plant (PLTG) and geothermal. Referring to the Ministry of ESDM, currently the government has also encouraged the potential use of new renewable energy (EBT) to be utilized as power plant. The new renewable energy power plant is no longer an alternative, instead it is now a requirement so that our country can be free of the fossil energy dependency (Maulidia et al., 2019; Tambunan et al., 2020; Hiron et al., 2021).

Indonesia has, since the year of 2000, planned to build Nuclear Power Plant or NPP (PLTN), however the country still facing an objection from the public for the reason of the hazard caused by the NPP, particularly by looking at the Chernobyl case. In reality, a

* Corresponding author.

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lot of countries have built the NPP, and no hazard or loss that have been suffered. The utilization of NPP is quite competitive compared to the petroleum, as a matter of comparison, 1 kg of uranium (nuclear fuel) will generate power of 50.000 kWh, while 1 kg of coal and petroleum will only generate power of 3 kWh and 4 kWh. In this regard, the government has determined to build PLTN, starting from the construction of Shelter in year of 2022. With regard to such plan, it is necessary to analyse the prevailing regulations in Indonesia as well as international regulations, in particular to respond the concern from the public on the hazard of NPP (Amir, 2009; Sugiawan & Managi, 2019).

As mentioned, the procurement of power is currently still depending on several power centre such as Hydro Power Plant, Steam Power Plant, and Gas power Plant. The government have also prepared the draft bill concerning New Renewable Energy which consists among others the plan to use nuclear energy and to build PLTN. The concern from the Indonesian people over the hazard of nuclear power must be anticipated by having the protection to the environment and the society. In actual, many people do not know that Indonesia has built research reactors, and has just utilized nuclear in several sectors such as for industry and health purposes that is by using the laser technic, etc (Subki, 2008; Afgan & Carvalho, 2002).

The regulation concerning nuclear is indeed required, as one of the efforts to protect the society and the environment from the utilization of nuclear is by having a regulation. Currently Indonesia has enacted Law Number 10 Year 1997 on "Nuclear Power" and few implementing regulations has also been issued to regulate the utilization of nuclear for health, industry as well as for the utilization of nuclear for power plant. The supervisory and regulating body has also been formed, that is Badan Pengawas Tenaga Nuklir (Nuclear Power Supervisory Board - Bapeten), while National Nuclear Energy Agency (Badan Tenaga Nuklir-BATAN) is the body appointed to do the research and to implement the utilization of nuclear. Since September 2021, with the Presidential Regulation Number 78 Year 2021, BATAN is under the National Research and Innovation Agency, and they also change the name into Organisation Research on Nuclear Power (ORTN) (Bond, 2003; Kostadinov, 2011; Zulfikar et al., 2021).

On international level, few conventions have also been issued, among others, Convention on Nuclear Safety on 1994, and Vienna Convention on Civil Liability for Nuclear Damage. International body or international organization having the role to supervise and regulate the utilization of nuclear shall be IAEA (International Atomic Energy Agency) (Abdel-Wahab et al., 2013; Hardi et al., 2021).

In this regard, the issues to be discussed are how nuclear is to be regulated in Indonesia as well as internationally, specifically related to the construction of NPP, and does the prevailing regulation concerning nuclear is legally be able to protect to protect the society and the environment from the hazard of nuclear radiation.

The US Energy Information Administration (EIA) said that radioactive wastes are subject to special regulations to protect human health and the environment, concern to that, the U.S. Nuclear Regulatory Commission (NRC) regulates the operation of nuclear power plants. From the observation finds that the risk of uncontrolled nuclear reaction at nuclear power plants in the United States is small because of such matters: a. the diverse and redundant barriers and safety systems in place at nuclear power plants, b. the training and skills of the reactor operators, c. testing and maintenance activities, and d. the regulatory requirements. From the perspective of EIA US, nuclear power plant is safe if we followed the regulations and the operators are skilled and has been trained (Wisnubroto et al., 2021; Cho et al., 2021; Syaeful et al., 2021). Indonesia's readiness to apply nuclear energy as energy for sustainable development is carried out by ratifying international conventions, and issuing laws/regulations from the Nuclear Energy Regulatory Agency. Nuclear is one of an energy which concluded as sustainable development, but this article not analyse about the conventions and the regulations protecting the environment from the NPP, its focused on the preparation of the operator and human resources for NPP (Tanoto and Wijaya, 2012; Budi et al., 2021).

The method for this research is normative research and qualitative analyses which need secondary data such as article from journals, books, any research concerning nuclear installations and international convention and standard, as well as national regulations. All these data needed to analyse about the plan to construct NPP in Indonesia whether it is safe to the environment and the society. Data will be analyzed using qualitative methode, Qualitative research investigates the things to explore and describe, to find the problem, and how the regulationscan solve the problem

The purpose of this research is to identify the regulation concerning nuclear and whether such regulation is sufficed and be able to protect the society and environment from the hazard of radiation. This research is essential to be conducted so that the result can be socialised to the society to decide if, the suspension or even prevention of NPP construction is required or instead to support the construction of NPP.

Convention on Nuclear Safety

This convention made in 1994, and focused to regulate the construction of nuclear installation as well as the required conduct in relation to the installation located at its country. Under Article 1 letter b it is stipulated that one of the purposes of this convention is to protect individual and society as well as environment from the radiation impact on nuclear installation. This article mentioned that the main purposes is to protect the environment from harmful effects, and protect human from radiation. From those purposes, states have to establish and maintain nuclear installations with effective defences.

Nuclear installation referred to in this convention includes the reactor for NPP, as such this regulation can be used in order to protect the society and the environment from the impact of the operation of NPP. It also can be identified under Article 2 which mentions the definition of nuclear installation which includes handling and treatment facilities for radioactive materials as are on the same site and are directly related to the operation of the nuclear power plant. Take from Article 2, the treatment is not only for the NPP itself, but also to the facilities at the same site related to the installation.

In regard to the regulation of nuclear in national level, Article 7 mentioned the duties of each country. Furthermore, Article 7 said that the contracting party shall establish regulations with regulatory framework which govern safety of nuclear installations (Mujiyanto & Tiess, 2013). The regulatory framework shall provide:

- i. national safety requirements and regulations
- ii. system of licensing regarding nuclear installations, and every nuclear installation are prohibited without a licence

As consequence of this regulation, each country is required to have a regulation concerning safety of nuclear installation including regulation on the licencing. Under this convention, it is also stipulated that each country shall have special institution or body having the role to supervise and regulate the issuance of licence for nuclear installation, whereas this body shall be separated from the body conducting nuclear research or body which operate nuclear installation. In Indonesia, such body already separated being Bapeten as supervisory and regulatory body, while BATAN as the nuclear installation executor and user.

For the safety during the operation of the installations, Article 10 mentioned again the importance to regulate the safety in the operation of nuclear installation. Every State shall take all appropriate steps to make sure that all body or organizations which directly engaged in activities to nuclear installations establishes policies to give priority for nuclear safety. Then the institution or body related to nuclear installation has to make a policy with safety as a priority.

In the operation of nuclear installation, including the operation of nuclear reactor or NPP, it shall implement the principle of ALARA (As Low as Reasonably Achievable). Every State shall take appropriate steps to make sure that no radiation exposure to workers and public in their nuclear installation which also has to keep as low as reasonably achievable, so no individual can be exposed to radiation doses which exceed prescribed national dose limits.

When constructing the NPP, several actions shall be performed before the reactor or generator is constructed. The aforementioned actions are:

- i. Assessment or test/analysis has been done to identify the impact of such NPP before the construction of NPP. It is mentioned in Article 14 (i) which said that comprehensive and systematic safety assessments are carried out before the construction of nuclear installation including NPP.
- ii. Ensure and evaluate that the area or site where the NPP will be constructed shall not cause radiation which has detrimental effect to the society, worker and environment. Mentioned in Article 17 (ii) that safety impact of a proposed nuclear installation on individuals, society and environment has to be evaluated during the construction.
- iii. Ensure the selected design and type of reactor is in accordance with and shall not cause harmful radiation. Article 18 (i) said that the country can choose the design of nuclear installation which provides for several reliable level and methods of protection especially for the release of radioactive materials. In this matter, also include that the selected design has been tested and proven as not cause any hazard by looking to the past experience.
- iv. Availability of mitigation plan and clear steps, in the occurrence of event which could cause any danger. States shall have any steps to make sure that there are on-site and off-site emergency plans that are routinely tested for nuclear installations, as well as steps or plan to cover the activities to be carried out in the event of an emergency.

Regulation by IAEA (International Atomic Energy Agency) Safety Standard

IAEA as international body or organization which takes care nuclear issue has issued several regulations which shall be complied by the member country of IAEA. Such regulation is known as Safety Standards Series, in which stipulates in details the standard safety or Specific Safety Requirement, SSR in short, which among other things are in relation to Nuclear Power Plant such regulation is IAEA SSR -2/1-year 2012 concerning Safety of Nuclear Power Plants: Design.

Under this regulation it regulates the safety and protection of radiation which mentioned that doses from exposure to radiation within the installation or exposure due to any planned radioactive release from the installation are kept below the dose limits and kept as low as reasonably achievable. This is to satisfy the safety principles, which required to ensure for all operational states of a nuclear power plant and for any associated activities. It is once again emphasized that the limitation of dose that can be well accepted by human or environment must be applied as minimum.

This regulation also mentioned about the importance of selection of design and type of reactor that will be used. Therefore, the selected reactor which will be put on priority is the one that has been tested as safe for human and environment.

Other than IAEA SSR-2/1, regulation concerning the operation of Nuclear Power Plant is also regulated, the regulation also stipulated under IAEA Safety Series Standards No NS-R-2-year 1996 which consist of regulation on Safety Nuclear Power Plants: Operation

In the General section it is stipulated that This Safety Requirement publication establishes the requirements to be met to ensure the safe operation of nuclear power plants. This standard was later renewed on 2011 to become “IAEA Safety Series Standards No SSR-2/2: Commissioning and Operation. If in 1996, it regulates the operation of Power Plant, in 2016 such regulation was renewed and supplemented with commissioning or discontinuation of nuclear reactor. Under this safety series, it is stipulated a few principles which must be implemented in the operation of NPP are:

- i. Responsibility for safety principle. Main responsibility is lays on the institution/company and person who committed and operated the NPP which cause the radiation.
- ii. Leadership and management of safety principle. Safety management must be continuously conducted and the appointed Institution shall also show its leadership.
- iii. Optimization of protection principle. Protection must be optimally conducted to achieve optimum protection.
- iv. Principle to implement so that in the occurrence of radiation, it shall the in the lowest level for human (Limitation of Risks to Individuals). Risk to radiation shall be monitored, such that it will not exceed the determined dose or limit.
- v. Principle of protection of present and future generation, which in this case is also to maintain and protect the environment (Protection of Present and Future Generations). People and environment are the main priority which must be protected from radiation.
- vi. Prevention of accidents principle. All efforts must be conducted to prevent the occurrence of nuclear accident.

Type of Power Plant Reactor

Power plant reactor was started to be developed with Generation I which was used in America and Britain, later in mid-1960, Generation II was developed which was a commercial reactor. In 1990 the advanced Light Water Reactor was developed, and it was known as Generation III. This Generation III reactor is used by many countries including Indonesia as research reactor. This Generation III is later developed into types European Pressurized Water Reactor (EPR) and the Westinghouse Advanced Plant 1000 (AP1000) Pressured Water Reactor. Generation IV is currently under development as Next Generation Nuclear plants. According to Stefano Monti, section head of Nuclear Power of IAEA, Small Modular Reactor (SMRs) is one type of small nuclear reactor, however it has power which may reach to 300 MW, and it is also easily movable or located anywhere whether from the aspect of transportation as well as the storage. Fuel for power plant is usually uranium that is UO_2 , however for the latest type of reactor it can also use neutron. In a new reactor with new fuel a neutron source is needed to get the reaction going. Usually this is beryllium mixed with polonium, radium or another alpha-emitter. Types of nuclear reactor which currently are available are:

- i. Pressurised Water Reactor (PWR)
- ii. Boiling Water Reactor (BWR)
- iii. Pressurised Heavy Water Reactor (PHWR)
- iv. Advanced Gas Cool Reactor (AGCR)
- v. Light Water Graphite—Moderated Reactor (LWGR)
- vi. Fast Neutron Reactor (FBR)

From the above types of reactors, the utilization can be seen in Table 1.

Table 1: Nuclear power plants in commercial operation or operable

Reactor type	Main countries	Number	GWe	Fuel	Coolant	Moderator
Pressurized water reactor (PWR)	USA, France, Japan, Russia, China, South Korea	302	287.0	Enriched UO_2	Water	Water
Boiling water reactor (BWR)	USA, Japan, Sweden	63	64.1	Enriched UO_2	Water	Water
Pressurised heavy water reactor (PHWR)	Canada, India	49	24.5	Natural UO_2	Heavy Water	Heavy water
Advanced gas-cooled reactor (AGR)	UK	14	7.7	Natural U (metal), Enriched UO_2	CO_2	Graphite
Light water graphite reactor (LWGR)	Russia	12	8.4	Enriched UO_2	Water	Graphite
Fast neutron reactor (FBR)	Russia	2	1.4	PuO_2 and UO_2	Liquid Sodium	None
TOTAL		442	393			

Source: World Nuclear Association, February 2021

Analysis for Nuclear Power Plant in Indonesia

Indonesia has to follow all conventions regarding nuclear installation especially for the conventions already ratified by the government of Indonesia. Beside the international regulations, to protect the society and the environment from the construction and operation of NPP, Indonesia has some regulations.

Law Number 10 Year 1997 on Nuclear Energy

This regulation stipulates that the construction, operation and decommissioning of commercial nuclear reactor is performed by state owned enterprise, cooperative, and/or private entity. Further, the construction of commercial nuclear reactor in the form of nuclear power plant determined by the Government after consultation with the Parliament (Article 13 paragraph 3 and 4). Further, it is stipulated that for the construction and operation of nuclear reactor and other nuclear installation must have a licence (Article 17 paragraph (2)).

The criminal sanction is also regulated under this Law, whereby the criminal sanction can be imposed for the party which have no licence or if such party violate the licence to operate nuclear installation:

- i. Each person who constructs, operate, or perform decommissioning of nuclear reactor without licence as mentioned under Article 17 paragraph (2) shall be subjected to criminal sanction of imprisonment in the period of at maximum 15 (fifteen) years and monetary penalty of at maximum Rp 1.000.000.000,00 (one billion rupiah).
- ii. Each person who commits the action as mentioned in paragraph (1) which cause nuclear loss shall be subjected to criminal sanction of lifetime imprisonment or imprisonment in the period of at maximum 20 (twenty) years and monetary penalty of at maximum Rp 1.000.000.000,00 (one billion rupiah).

Government Regulation Number 52 Year 2012 concerning Safety and Security of Nuclear Installation

In general, the definition of nuclear safety is any activity which must be conducted to protect human as well as environment from nuclear hazard. While nuclear security is all effort to maintain that nuclear is only utilized for the purpose of peace that is to utilize nuclear for common interest such as for the purpose of medical or health, as well as for the development of food technology and industry. Nuclear security must be maintained so that nuclear is not mis-utilized for non-peace purpose such as the creation of nuclear weapon.

Under Article 3 of this Government Regulation, it is stipulated that the safety dan security of nuclear installation shall covered: a. technical safety of nuclear installation; b. technical security of nuclear installation; c. security and safety management of nuclear installation; and d. awareness and mitigation of nuclear emergency.

This regulation is regulating the requirements to be fulfilled to construct nuclear installation including NPP, starting from the determination of location or site, selection of design or type of nuclear reactor, and equipment or mechanism in the event of emergency situation.

Government Regulation Number 2 Year 2014 concerning Licensing for Nuclear Installation and Utilization of Nuclear Material

This Government Regulation (PP) does not specifically regulate the licencing to construct NPP, however may be implemented for the licencing of NPP construction. It can be identified in the Article 1 paragraph (2) of this PP which elaborate that nuclear reactor means reactor operated by nuclear fuel which may cause controlled chain nuclear reaction and used to generate power, or research, and/or radioisotope production. Therefore, the NPP is included as power generator reactor as referred to in this PP. For the construction of NPP, Article 4 stipulates that in the construction of nuclear reactor shall require licence, consisting of site licence and construction licence, while for the operation of nuclear reactor shall require commissioning licence and operation licence. Such licences shall be submitted to BAPETEN, and the nuclear reactor construction licence, following issuance shall be valid for 8 years, as regulated under Article 45, if within 8 years the construction is incomplete, such licence may be extended.

In relation to the supervisory of nuclear utilization, if there is violation of licence, the control body (BAPETEN), in this matter as issued by the Chief of the Body (BAPETEN), may impose administrative sanction in the form of:

- i. written warning;
- ii. administrative monetary penalty;
- iii. suspension of licence; and/or
- iv. revocation of licence.

In particular for the nuclear activity of Nuclear Agency (BATAN), in 2019 the Chief of BATAN issued regulation concerning "The Implementation of Safety Culture in BATAN". Under such regulation, it is among others mentioned that the safety culture is the combination of characteristic and attitude towards the organisation and individual which put safety as major priority.

This reactor is located in the region of Uni Soviet which currently becomes Ukraine, and few observers state that this accident happened among others as a result of competition or cold war between United States and Uni Soviet, whereby both parties intended to develop nuclear technology which part of it was performed in secrecy or without broadcasting. The occurrence of nuclear accident in Chernobyl, Rusia (formerly part of Uni Soviet) on April 1986, was the only biggest accident occurs to the nuclear reactor. The impact to the environment occurs on the day of the explotion and some years after the accident. The environment had been impacted after the Chornobyl accident in 1986, the largest changes occurred with vegetation on agricultural lands. The explode reactor at that time was RBMK 1000 which has just been developed on 1983. According to the expert, few things causing such accident are:

- i. Reactor design has yet appropriately tested.
- ii. Few of the personnel or human resources operating such reactor are not sufficiently trained.
- iii. No safety culture, or no implementation of required measures.

The Chernobyl accident in 1986 was the result of a flawed reactor design that was operated with inadequately trained personnel. Such accident surely caused loss and radiation impact that is harmful to human as well as environment. The resulting steam explosion and fires released at least 5% of the radioactive reactor core into the environment. Study and evaluation of the result from Chernobyl accident is still running, because some effect of the radiation maybe still happen.

Lessons learned that we can see from the accident were:

- i. The role of IAEA to control and give assistance to the countries about the safety design reactors, and the state have to prepare the emergency plan. "Much of this work focused on identifying the weaknesses in and improving the design safety of VVR and RBMK reactors.....detailed research can also be a guideline for other countries with NPP to prepare with an updated and comprehensive emergency plan.
- ii. In the Chernobyl accident, not only the design of the reactor, but human error also played the role in this accident, so the staff (workers), and the operator of NPP, have to be well trained.
- iii. All countries have to apply the "safety culture". Most crucially, it focused global attention on safety and the importance of human and organizational factors in achieving it. As a result, the term "safety culture" was coined. On the safety culture we have to link between human (workers), technology (reactor design), organisation (government and company), and implementation of safety standards (regulations).

From this Chernobyl accident, all states have to follow the rules and standards to use nuclear as an alternative energy. Although nuclear accidents may reach to the catastrophic level if it goes beyond human control, it is still recorded as low number of accidents in the industry.

Preparation to Construct NPP

According to IAEA, infrastructure required to support the implementation of NPP consists of wide coverage, whether from the aspect of soft infrastructures and the aspect of hard infrastructure. In the construction of NPP in Indonesia, there are few licences which shall be obtained by the entrepreneur which plan to do such construction, whereby such licence is divided into two parts that is nuclear reactor construction licence which consists of site licence and construction licence, and licence to operate nuclear reactor which consists of commissioning licence and operation licence.

The application of the abovementioned licences shall be submitted to the Chief of BAPETEN who subsequently will analyse and investigate whether such licence application has fulfilled the requirements, that is the administrative requirement, technical requirement and financial requirement. Relating to the construction of NPP, IAEA has issued guideline and standard which can be used, among others safety standards for construction that is Construction for Nuclear Installation No SSG-38, 2015.

The Table 2 is the requirements which shall be fulfilled before the construction of nuclear installation in order to maintain safety for the people and the environment.

Table 2: Safety Fundamentals Fundamental Safety Principles

No	General Safety Requirement	No	Specific Safety Requirement
1	Governmental, Legal and Regulatory Framework for Safety	1	Site Evaluation for Nuclear Installation
2	Leadership and Management for Safety	2	Safety of Nuclear Power Plant 2/1 design, 2/2 Commissioning & operation
3	Radiation Protection and Safety of Radiation Sources	3	Safety of Research Reactor
4	Safety Assessment for Sources Facilities and Activities	4	Safety of Nuclear Fuel Cycle Facilities
5	Predisposal Management of Radioactive Waste	5	Safety of Radioactive Waste
6	Decommissioning and Termination of Activities	6	Safe Transport of Radioactive Material
7	Emergency Preparedness and Response		

Other than that, there are few things which must also be conducted by the country in the construction of installation, that is the needs to form nuclear energy program implementation organization or NEPIO, the members of such organisation are from the relevant ministries such as ESDM, BPPT, BATAN and BAPETEN. The formation of such organisation shall be by Presidential Decree and its tasks are as the executor of NPP construction program.

Conclusions

Nuclear is one of the new energies especially in Indonesia to overcome the need of energy in Indonesia. From that point of view the conclusions are (i)Indonesia has to build Nuclear Power Plant (NPP) to cover the need of energy, the regulation regarding the construction of NPP and its operation already set up internationally, and also in national level in Indonesia. Indonesia has BAPETEN (Nuclear Regulatory Body) which regulate and control the use of nuclear and also for the NPP; (ii) the country which want to build the NPP has to follow some international regulations such as Convention on Nuclear Safety, as well as the regulations and standards made by the International Atomic Energy Agency (IAEA) as the international organisation which control the use of nuclear energy including the NPP, (iii) on the Nuclear Safety Convention and the IAEA standards mentioned that states have to protect human and the environment from the use of nuclear energy by following the safety standards and applied all the safety principles.

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