

Evaluation On The Status Of Indonesia Nuclear Infrastructure Development

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Abstract. The demand for electricity increases every year. The increase is commensurate with the rate of increase in economic development and in population growth, and with the rapid developments in the industrial sector. To meet this demand for electricity, it is becoming more and more difficult to rely on existing resources which are limited. It is therefore very important that steps should be taken to seek other sources of energy supply as alternatives. Based on the premise that a Nuclear Power Plant (NPP) is technically safe, reliable, clean and environmentally-friendly, relatively economical, and supported by our modest achievements in preparations in respect of human resources and infrastructure, including the results of the feasibility studies for NPP development and the comprehensive assessment of different energy sources for electricity generation in Indonesia, the option of nuclear power could well be the right solution. The aim of the evaluation approach is to : evaluate all relevant infrastructure issues in a consistent manner; bring the results together in order to identify a comprehensive action plan for moving into a subsequent phase of the establishment of a nuclear power infrastructure; provide a consistent international approach and enhance national competence through participation in a detailed and comprehensive evaluation. The 19 (nineteenth) of nuclear infrastructure are national position, nuclear safety, management, funding & financing, legislative framework, safeguards, regulatory framework, radiation protection, electrical grid, human resources, stakeholder involvement, site & supporting facilities, environmental protection, emergency planning, security, nuclear fuel cycle, radioactive waste, industrial involvement and procurement [1].

Key Word: Nuclear Power Infrastructure

1. INTRODUCTION

The national electricity demand is estimated to increase significantly in the near future as Indonesia is planning to boost its industrial sector. This condition makes Indonesia explore any possible energy sources available in the country to raise its energy supply and strengthen its energy security. Along with other energy sources, nuclear energy is considered one of the most potential options to meet the continuously increasing electricity demand. The introduction of NPP in Indonesia is not only to reach an optimum energy mix considering costs and environment, but also to relieve the pressure arising from increasing domestic demand for oil and gas (so that oil and gas resources can be used for export and feed stocks). Thus, the role of NPP is clearly to stabilize the supply of electricity, conserve strategic oil and gas resources and protect environment from harmful pollutants as the results of the use of fossil fuels. The national commitment to implementing a nuclear power plant program is confirmed by the issuance of Act No. 17 Year 2007, which states that the first NPP should be started to operate in the year of 2015-2019 with high consideration of safety factor.

A nuclear power programme is major undertaking requiring careful planning, preparation and investment in term of time and human resources. As with any major programme, the commitment of resources to a nuclear power programme needs to be phased and decision to move to subsequent phases, where the commitment of resources will increase significantly, need to be made with a full understanding of the requirements, risk and benefits [3]. The milestone to identified three distinct phases in the introduction of a nuclear power programme and identified separate conditions for each: phase 1 covers the preparatory work in order to make an informed decision about a potential nuclear programme; phase 2 covers the development of the infrastructure issues required to be ready to begin

and supervise construction of a nuclear plant; phase 3 covers the construction of the plant up to the approval to commission and operate [2].

In relation to the International Atomic Energy Agency (IAEA) doc No. NG-G-3.1 year 2007, Indonesia has included nuclear power option within its energy policy as indicated by Presidential Decree No. 5 year 2006. Indonesia is ready to make commitment to a nuclear power programme by the issue of Act No. 17 year 2007, which states that the first nuclear power plant should be started in the year of 2015-2019 with high consideration of safety factor. In order to find out the readiness of Indonesia in the deployment of the first NPP, the status of its nuclear infrastructure development should be identified.

Indonesia through National Nuclear Energy Agency (BATAN), a non-departmental research agency, has been experienced in operating a testing and research reactor for more than twenty years. However, deployment of a nuclear power plant is still considered a relatively complex and major project for Indonesia, since it involves many aspects of infrastructure that have to be taken into account thoroughly.

In line with Act No. 10 Year 1997 on nuclear energy, the decision to launch NPP project will be made by the Government after having consultation with the Parliament. While waiting for the decision, we have started some preparations related to nuclear infrastructure including nuclear regulatory framework in order to support the safe, reliable, and peaceful uses of nuclear energy system.

To support the nuclear energy program, i.e. deployment and development of an NPP, BATAN in cooperation with other relevant government institutions initiates to conduct a self-evaluation on the status of national nuclear infrastructure. This activity is planned to take place in two years, i.e. 2009 and 2010. The results are expected to indicate the readiness of Indonesia in launching such program. Identification of Indonesia infrastructure is carried out by referring to IAEA Nuclear Energy Series No. NG-T-3.2 on the Evaluation of the Status of National Nuclear Infrastructure Development. The objective of this infrastructure evaluation is to identify the status of Indonesia nuclear infrastructure development in order to support the construction of the first NPP.

2. METHODOLOGY

The infrastructure evaluation includes the 19 infrastructure issues as indicated in the IAEA Nuclear Energy Series No. NG-T-3.2. Status of each infrastructure issue is identified for Phase 1. Evidence of basis for evaluation will be collected in order to prove that each issue has been addressed adequately. For this infrastructure evaluation, the methodology are following : Evaluation preparation; Acquisition of data and information by questionnaire, interview and site visit; Observation of evidence; Analysis of data & information obtained; Verification of evidence; Identifying areas requiring further attention; preparing draft report.

Since this evaluation is focused at national level of infrastructure, coordination of inter-governmental institutions is necessary. The institutions which are required to participate are National Nuclear Energy Agency (BATAN), Nuclear Energy Regulatory Agency (BAPETEN), Ministry of Energy and Mineral Resources (MEMR), Ministry of Environment (KLH), and Ministry of Industry (DEPERIND).

Acquisition of data and information by questionnaire, interview and site visit. Evidence can include reports, meeting notes, correspondence, talks and presentations, conferences attended with meeting reports, discussions, curriculum vitae, organization descriptions, and job descriptions.

3. EVALUATION

3.1. National Position

Utilization of NPPs as a part of national energy mix was noted in the Presidential Regulation No. 5 in 2006 on the National Energy Policy, as well as in the Act No.17 in 2007 on the National Long-term Development Plan for 2005-2025. This last Act of 2007 mentions that the introduction of nuclear power should be utilized with high consideration of safety factor. According to these two legal documents, NPPs utilization may be initiated within the period mentioned.

Nuclear Energy Program Implementing Organization (NEPIO) was not established yet, but some of its functions have been carried out by other related agencies (BATAN, MEMR, Ministry of Foreign Affairs, etc). The draft of the Presidential Decree about establishment National Team of NPP (like NEPIO) has been prepared. The structure of National Team of NPP are followings:

- **Steering Committee:** The leader is Ministry of Energy and Mineral Resources. The members are: Ministry of Finance, Ministry of Industry, Ministry of Science and Technology, National Nuclear Energy Agency (BATAN), Nuclear Energy Regulatory Agency (BAPETEN).
- **Implementer Team:** Ministry of Energy and Mineral Resources, National Nuclear Energy Agency (BATAN).
- **Information dissemination of nuclear energy utilization for NPP Working Group:** The leader is Ministry of Energy and Mineral Resources. The members are: National Nuclear Energy Agency (BATAN), National Planning and Development Agency, Ministry of Communication And Information, Ministry of Foreign Affairs, Ministry of Environment, Province of Central Java.
- **Formulation for Organization, Owner and Regulation Working Group:** The leader is Ministry of Energy and Mineral Resources. The members are: National Nuclear Energy Agency (BATAN), Nuclear Energy Regulatory Agency (BAPETEN), National Planning and Development Agency, Electricity State Own Company, Ministry of Finance, State Own Enterprises.
- **Formulation for Preparation Document of NPP Working Group:** The leader is National Nuclear Energy Agency (BATAN). The members are : Ministry of Energy and Mineral Resources, Nuclear Energy Regulatory Agency (BAPETEN), National Planning and Development Agency, Ministry of Environment, Electricity State Own Company, The Agency for Assessment and Application of Technology.
- **Formulation for Transfers of Technology Working Group:** The leader is National Nuclear Energy Agency (BATAN). The members are: Ministry of Energy and Mineral Resources, Ministry of Science and Technology, Ministry of Foreign Affairs, Ministry of Industry, The Agency for Assessment and Application of Technology, Secretary of Governmental Cabinet , Electricity State Own Company (PLN), PT. BATEK (Batan Technology Company).

The gaps and issues of the national position is the National Team on NPP Development Planning not yet established.

3.2. Nuclear Safety

BATAN has the understanding and commitment to the safety objectives and principles. International safety standards and nuclear safety good practices have been understood by BATAN personnel. Act No. 17 Year 2007 on National Long Term Development Program explains that Nuclear Power Plant should be operated in safe condition.

Act No. 10 Year 1997 on Nuclear Energy, Article 4 explains that the Government establishes a Regulatory Body, under and directly responsible to the President. The Regulatory Body shall have the

task to control any activity using nuclear energy. To accomplish the task mentioned above, the Regulatory Body establishes regulations, conduct licensing processes and inspections.

Article 15, Act No. 10 Year 1997 explain that the control is aimed to: assure the welfare, the security and the peace of people; assure the safety and the health of workers and public, and the environmental protection; maintain the legal order in implementing the use of nuclear energy; increase the legal awareness of nuclear energy user to develop a safety culture in nuclear field; prevent the diversion of the purpose of the nuclear material utilization; and assure for maintaining and increasing the worker discipline on the implementation of nuclear energy utilization.

The gaps and issues of the nuclear safety are needed to build an appropriate safety culture in Regulatory Body (RB), Technical Support Organization (TSO) and Operator (OP).

3.3. Management

At present time, all nuclear installations are owned and operated by the government, that is, the National Nuclear Energy Agency (BATAN) which based on the Act No.10 of 1997 is a supreme executive and to promote the application and the research activities in the field of nuclear energy in Indonesia.

The management of the Indonesian NPP is determined by the financing conditions for the NPP development. It could be a state company, a private company or another corporate. Example, for the conventional financing scheme, the NPP Owner will be a government-owned company. Therefore, the GOI will designate the organization that will own and operate the NPP. There is still a possibility that the National Electric Company (PT. PLN) will act as the utility.

Based on Act No 17, 2007 on National Long Term Development Planning and President Regulation No 5, 2006 on National Energy Policy Nuclear energy will be utilized as part of optimum energy mix with high consideration of safety factor. It was projected that in 2025, 5% of National Energy Demand will supplied by renewable Energy resources, 2% of it comes from Nuclear Energy

In order to develop nuclear power program, Indonesia has been provided with Technical Cooperation project by IAEA, Korea, and Japan. For example, BATAN had provided teamwork from multi discipline to prepare BIS with assistance from International Atomic Energy Agency. The involvement of external expertise and experience has developed technology and management knowledge of BATAN personnel.

Technical guidance of BAPETEN' Chairman No. DT-0601, 2006 on Safety Culture Implementation has shown government commitment to develop a leadership and strong safety culture in all nuclear management system in Indonesia, including management system of future NPP's organization.

In this Management issue, Indonesia has started second phase of preparation by drafting BIS of NPP however it need to be updated. The gaps and issues of the management is lack of management system for project implementation, technological and organization distance between pre-project and project implementation. The IAEA document GS-R-3 about The Management System for Facilities and Activities will be addressed to the NPP program in Indonesia.

3.4. Funding and Financing

Funding scheme for the project is still under consideration. Regarding to the financial scheme, a study done by BATAN, PLN and Korea Hydro Nuclear Power (KHNP) proposes financing scheme and ownership structure for the first NPP in Indonesia. The funding for the construction of NPP may be a combination of long term loans and equity. The loan would be used mostly to finance procurement of foreign contents, most likely obtained from ECA (Export Credit Agency) and commercial bank through loan agreement with the NPP company that could be owned by the government. Most of the

equity portion would be used to finance local capital expenditure, such as land acquisition, professional fee, mobilization, certification, etc. The equity is sourced partly from the public utility, might be PLN or other state owned enterprises, and some other parts from private investors as partners. Funding for spent fuel handling and final disposal, waste management and decommissioning is under the owner responsibilities. Analysis of conventional, BOO/BOT and counter trade scheme has been done. The best scheme is conventional scheme. BOO scheme is not feasible, as it is too expensive, and there is no warranty from government.

NPP financing risk analysis has been performed. The risks may include delays and cost overrun during development and construction. To minimize the risk, a turnkey contract is expected and a performance bond from a bank is required. Implication of financing scheme involving international fund institutions has been understood. One of international financing resources that can be used is export credit agency. The gaps and issues of the funding and financing are needed to develop an evaluation of financing and economic viability of Government and operator. Lack of understanding of financial implications of national and international legal frame work and analysis of financial.

3.5. Legislative Framework

The draft of Government Regulation on National System of Emergency Preparedness and Response is under process of establishment. Another draft of Government Regulation which is under process of establishment is the draft of Government Regulation on the Safety and Security of Nuclear Installations and Material. Joint Convention on The Safety of Spent Fuel Management and on The Safety of Radioactive Waste Management is under process of ratification.

Amendment of Convention on The Physical Protection of Nuclear Material (CPPNM) is under process of ratification. BAPETEN Chairman Regulation No. 1 of 2009 on Provisions of Physical Protection of Nuclear Material and Nuclear Installations. Indonesia has not ratified the Vienna Convention on Civil Liability for Nuclear Damage since no nuclear power plant has been built yet. However some articles of the Protocol to Amend the Vienna Convention on Civil Liability for Nuclear Damage and the Convention on Supplementary Compensation for Nuclear Damage have been adopted by the Act No.10 of 1997 on Nuclear Energy and Presidential Decree No.46 of 2009 on Civil Liability for Nuclear Damage.

Additional protocol has been implemented in Indonesia through examination and verification. Coordination between BAPETEN and related institutions is being conducted to establish an export control system. Additional protocol has been implemented in Indonesia through examination and verification. Coordination between BAPETEN and related institutions is being conducted to establish an export control system.

Most of international, multilateral and bilateral agreements have been signed and ratified by government. They include:

- Convention on Early Notification of a Nuclear Accident (Presidential Decree No. 81, 1993)
- Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency (Presidential Decree No. 82, 1993)
- Convention on Nuclear Safety (Presidential Decree No. 106, 2001)
- Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste management (under process of Ratification)
- Convention of Physical Protection of Nuclear Materials and its Amendment (Presidential Decree No. 49, 1986)

- Comprehensive Safeguards Agreement between the State and the IAEA (Act. No. 8, 1978, INFIRC 283 and Add 1 on Safeguards Agreement between Government of Indonesia and IAEA)
- Revised Supplementary Agreement concerning the provision of Technical Assistance by the IAEA

Indonesia has not ratified the Vienna Convention on Civil Liability for Nuclear Damage, the Protocol to Amend the Vienna Convention on Civil Liability for Nuclear Damage since no nuclear power plant has been built yet. However some articles of the Protocol to amend them have been adopted by Act No. 10, 1997 on Nuclear Energy and Presidential Decree No. 46, 2009 on Civil Liability for Nuclear Damage.

Relevant national legislations that have been enacted include:

- Establishing an effectively independent regulatory body (BAPETEN), Article 4 of Act No. 10, 1997 on Nuclear Energy
- Establishing authorization system, responsibility of the operator, inspection and enforcement, Article 4 of Act No. 10, 1997 on Nuclear Energy. Government Regulation (GR) No. 43, 2006 on Licensing of Nuclear Reactors and GR No. 29, 2008 on Licensing of Ionizing Radiation Sources and Nuclear Material, have already included authorization system, responsibility of the operator, inspection and enforcement
- Formulating principles and requirements for each subject area (e.g. radiation protection, radiation sources, nuclear installations, radioactive waste management and spent fuel, decommissioning, mining and milling, emergency preparedness, transport of radioactive material): GR No. 33 of 2007 on Safety of Ionizing Radiation Sources and Security of Radioactive Sources; GR No.26 of 2002 on Safe Transport of Radioactive Material (plant to be revised in 2010); GR No. 27 of 2002 on Radioactive Waste Management ((plant to be revised in 2010) at the moment, the draft of Government Regulation on National System of Emergency Preparedness and Response is under process of establishment. Another draft of Government Regulation which is under process of establishment is the draft of Government Regulation on the Safety and Security of Nuclear Installations and Material. Nuclear-related mining and milling has not been considered yet. Therefore, no relevant regulation is necessary
- Establishing compensation mechanisms for nuclear damage
- GR No. 46 of 2009 on the Limit of Nuclear Liability for Nuclear Damage, the draft of Presidential Regulation on Nuclear Liability Mechanisms is under process of establishment
- Implementing IAEA safeguards
- Act No. 8 of 1978 on Ratification Non Proliferation Treaty INFCIRC 283 and Add. 1 on Safeguards Agreement between the Government of Indonesia and IAEA, etc
- Implementing import and export controls of nuclear material and items

Bapeten Chairman Regulation (BCR) No. 9 of 2006 on Additional Protocol. Additional protocol has been implemented in Indonesia through examination and verification. Coordination between BAPETEN and related institutions is being conducted to establish an export control system.

Formulating security principles, including physical protection of nuclear material and nuclear facilities.

BCR No. 1 of 2009 on physical protection of nuclear material and nuclear facilities. The draft of Government Regulation on the Safety and Security of Nuclear Installations and Material is under process of establishment. The gap and issues of the legislative framework is needed to complete national legislation before issue the bid.

3.6. Safeguards

The implementation of System of Accounting for and Control of Nuclear Materials has been carried out periodically. Additional protocol has been implemented in Indonesia through examination and verification. Coordination between BAPETEN and related institutions is being conducted to establish an export control system.

Indonesia signed the treaty on March 2, 1970 and ratified the Act. No. 8 Year 1978. Indonesia signed “Protocol Additional to the Agreement between the Republic of Indonesia and the IAEA for the Application of Safeguards in connection with the Treaty on the non Proliferation of Nuclear Weapons” on Sept. 29, 1999. The gap and issues of the safeguards is implementation for NPP

3.7. Regulatory Framework

Act No. 10 of 1997 on Nuclear Energy Article 14: The control on the use of any nuclear energy shall be carried out by the Regulatory Body. The control should be implemented through regulations, licensing, and inspections.

- Licensing units both for radiation facilities and radioactive materials, and nuclear installations and nuclear materials
- Regulation development units both for radiation facilities and radioactive materials, and nuclear installations and nuclear materials
- Safety review and assessment groups both for radiation facilities and radioactive materials, and nuclear installations and nuclear materials
- Inspection units both for radiation facilities and radioactive materials, and nuclear installations and nuclear materials

BAPETEN’s roles in oversight and regulation are essential and significant. BAPETEN was established by Act No. 10/1997 on nuclear energy. Its tasks and functions are nationally strategic in supervising the use of nuclear energy in Indonesia. The basic policies of nuclear energy supervision in Indonesia consist of six main components: licensing, regulation, inspection, assessment, engineering, and nuclear emergency preparedness. Each policy covers management of complete and comprehensive regulation establishment in accordance with the latest development and international standards in nuclear energy uses. (Roles of BAPETEN in NPP Construction Plan in Indonesia” written by Helen Rafli). Technical support unit and safety regulatory assessment center. Technical support organization (TSO) is still being considered. Regulatory framework had been developed through National Regulation, Law, and Bapeten’s Chairman Rule as shown in the following Table 1.

Table 1. National Regulation Bapeten’s Chairman Rule

Activities	Decree
Establishment of authorization process;	BAPETEN Chairman Decree No. 1 rev. 02 of 2004 on Organization and Working Order, Licensing units both for radiation facilities and radioactive materials, and nuclear installations and nuclear materials.
Development of regulations and guides;	BAPETEN Chairman Decree No. 1 rev. 02 of 2004 on Organization and Working Order, Regulation development units both for radiation facilities and radioactive materials, and

	nuclear installations and nuclear materials.
Safety review and assessments;	BAPETEN Chairman Decree No. 1 rev. 02 of 2004 on Organization and Working Order, Safety review and assessment groups both for radiation facilities and radioactive materials, and nuclear installations and nuclear materials.
Inspection;	BAPETEN Chairman Decree No. 1 rev. 02 of 2004 on Organization and Working Order, Inspection units both for radiation facilities and radioactive materials, and nuclear installations and nuclear materials
Enforcement;	BAPETEN Chairman Decree No. 1 rev. 02 of 2004 on Organization and Working Order, Legal affairs and organization bureau
Coordination with other national and international bodies;	BAPETEN Chairman Decree No. 1 rev. 02 of 2004 on Organization and Working Order, National and international cooperation section
Public information;	BAPETEN Chairman Decree No. 1 rev. 02 of 2004 on Organization and Working Order, Public relations section
Provision of adequate supporting technical resources.	BAPETEN Chairman Decree No. 1 rev. 02 of 2004 on Organization and Working Order, Technical support unit and safety regulatory assessment center. Technical support organization (TSO) is still being considered.

The gap and issues of the regulatory frameworks is need assistance to perform necessary actions as those described in IAEA Safety Standard publication.

3.8. Radiation Protection

Assessment has been conducted on the applicability of the IAEA safety standards, including: Power reactor operation; nuclear safety requirement (NSR-2): Operation; Radiation protection aspects on the Design of NPP; Fuel Transport; Waste management and storage; Decommissioning.

As NPP has not been constructed in Indonesia, risk analysis still refers to that for research reactor and nuclear facilities in Indonesia, and international standards. Government Regulation No.27 of 2002 on Radioactive Waste Management will be revised based on revision of IAEA standards. BCR No. 1 of 1999 on Safety of Occupational Radiation will be revised. Study on this area is mainly focused on the release of radionuclide during normal and abnormal condition and some preliminary study of waste management.

Jointly works between BATAN and BAPETEN was developed toward the enhancement National Regulation and Infrastructure. There are various joint researches and consultative meeting in topic of Radiation Protection were held. Mostly BAPETEN take actions for the joint work.

The gap and issues of the radiation protection is need assistance to perform appropriate hazards analysis based on IAEA safety Standard.

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3.9. Electrical Grid

A complete analysis of the inclusion of a nuclear power plant into the existing and future electrical grid has been done. Report of transient stability study for Java-Madura-Bali system in 2005-2018, carried out by BATAN – PLN in 2005. Report of study on optimization of electric power development in Java-Madura-Bali Grid, by Newjtec Inc. The Kansai Electric Power Co., Inc. August 2008. This study covers analysis of flow of power, transient stability, and grid system if NPP is introduced to Java-Madura-Bali system. The results show that grid system can accommodate electricity from NPP in

2016. The NPP site is assumed to be at Muria, Jepara. Analysis of power flow has been carried out. The gap and issues of the electrical grade is still need to complete a study on electric expansion planning with nuclear option.

3.10. Human Resources

The human resources development program and activities have been conducted not only for BATAN personnel, but also for personnel from various potential institutions and companies, such as the Agency for the Assessment and Application of Technology (BPPT), PT. PLN and national engineering companies, such as PT. Boma Bisma Indra and PT. Rekayasa Industry. The human resources development is also expected to be a part of the contract bids so that the vendors would include the human resources development program to produce qualified personnel.

The demand for the qualified professionals, technicians and craftsmen is the decisive factor in the Nuclear Power Plant Program Planning and implementation. It is possible and may be necessary to obtain some highly specialized experts and training from domestic and abroad, in particular during the early stages of a nuclear power program. But this can only be applied in a very limited way and it certainly does not constitute a long-term solution.

An article entitled “Role of University on preparing Human Resources for Nuclear Power Plant” by Air Darmawan Pasek, Center of Industrial Engineering of Institute Technology of Bandung (ITB) has identified competences and human resources needed by future organization of NPP based on TRS 200 IAEA. However, more detail competences and human resources needed for future organization and blue print of Human Resources Development (HRD) programmed and concept of Nuclear Training Center (NTC) facilities are still under preparation.

In order to develop and maintain human resources BATAN have sent many personnel abroad to obtain Master and Doctoral degree and is sending personnel abroad to notable NPP Company such as General electric, Westinghouse Companies, Atomic Energy of Canada Limited, Mitsubishi, Korea Nuclear and Hydro Power (KHNP), Korea Atomic Energy Research Institute (KAERI) and Korea Power Engineering Company (KOPEC).

BATAN has established Pusat Pendidikan dan Latihan (PUSDIKLAT-BATAN) or the Education and Training Center (ETC) which is responsible for implementing education and training programmed, especially in the nuclear science and technology related to BATAN’s competency. The development programmed is oriented to provide well educated and well trained personnel in the fields of research, development and application of nuclear technology, as well as to promote nuclear science and technology to the public, especially industrial society, through education and training programmed.

BATAN has established higher institute of STTN (Nuclear Technology High School) based on Presidential Decree No. 71, of 2001. STTN is an official education institute carrying out nuclear science and technology manpower development program through carefully crafted four year education. STTN has two majors study programmes as follows:

- Nuclear Techno-chemistry. The purpose of this major is to educate students in the field of chemical processes using nuclear technology (nuclear techno-chemistry)
- Nuclear Techno-physics. The purpose of this major is to educate students in the field of monitoring, measuring, and controlling physical processes related to nuclear reaction and radiation

Besides, for human resources development BATAN has also established cooperation with University of Gajah Mada, University of Indonesia, and ITB in various field of study. The gap and issues of the human resources is programme especially for phase 2 and 3 of NPP infrastructure development and design of appropriate NTC facilities and programme.

3.11. Stakeholder Involvement

Strong public information and education program has been initiated. The dissemination of nuclear energy has been done in Muria Peninsula by BATAN in coordination with the local Government. Interaction and cooperation plan among stakeholders should be formalized

Public Information and education programmed have been conducted through Center for Nuclear Technology and Science Dissemination. The vision of the program is to develop public understanding on the use of nuclear technology for peaceful purpose including nuclear power plant technology. The program includes public education, public information, visiting, and publishing. The activities include providing stadium general to postgraduate students, workshop and training, visiting Junior and Senior High school and University, local government; sending information through leaflet, competition, Technology –expo, and etc.

For open and timely interaction and communication regarding NPP, some training program and interaction with stakeholder were provided such as meeting with local government, group of public who support nuclear power program. The gap and issues of the stakeholder involvement is public information and education programme and tools still need to be improved and limited number and lack of capability of spokespersons.

3.12. Site and Supporting Facilities

General survey of potential sites has been conducted. BAPETEN Chairman Decree No. 01 Year 1999 on Guidance of Determining the NPP site. The requirement and screening criteria are explained in this document. Report on Feasibility Study by NEWJEC, Phase 1, 2, and 3. Based on Feasibility Study, three (3) candidate sites i.e. Ujung Lemahabang (ULA), Ujung Watu and Ujung Grenggengan have been selected. These sites which lie on the north Coast of Java Sea of Muria Peninsula, Central Java are similar in nature. Finally, BATAN has selected site of Ujung Lemahabang (ULA) as location of the first NPP. The report need s to be updated based on IAEA recommendations.

NEWJEC Inc. was established in 1963 as a subsidiary of The Kansai Electric Power Co., Inc. one of the largest investor-owned electric utilities in the world. Accordingly, NEWJEC has a competitive advantage in the electric utility market as it specializes in engineering and consultancy services for a broad range of power projects, such as hydroelectric, fossil thermal, nuclear (including site investigation), cogeneration and waste-to-energy plants, and transmission, distribution and communication systems. A preferred candidate site, the Ujung Lemahabang site, has been selected through step-1 and step-2 studies conducted as part of the site and environmental study of the first nuclear power plants at Muria peninsula region, central java.

The following site characteristics were considered and evaluated for each particular site. Based on NEWJEC's technical judgement and taking into consideration the provisions of the IAEA safety series no.50-SG-S9 for comparison and ranking of candidate sites: With regard to safety aspect: (a) Surface faulting, (b) Seismicity, (c) Foundations characteristics, (d) Ground characteristics, (e) Volcanic characteristic, (f) Coastal flooding, (g) River flooding, (h) Groundwater movement, (i) man-induced events, (j) population distribution and resettlement of residents With regard to economic aspects, (k) cooling water system, (l) harbor facility, (m) foundation preparation for the main buildings, (n) access roads, (o) site land arrangement With regard to environmental aspects, (p) land and water use, (q) endangered species and historical monuments ecology. The gap and issues of the site and supporting facilities is preparation of Site Evaluation Report (SER) for Preferred Site.

3.13. Environmental Protection

Procedures for the elaboration and reporting of the environmental impact assessments for nuclear and other related facilities, including assessment of their overall and radiological impacts; BAPETEN Chairman Decree No. 03-P/Ka-BAPETEN /VI-99 on Environmental Impact Analyses for

Construction and Operation of Nuclear Reactor. This document clearly covers the procedures for the elaboration and reporting of the environmental impact assessment.

Identification of the organization charged with the elaboration of the environmental impact assessment report for the selected site and nuclear facility, including the pre-operational environmental monitoring program; BAPETEN Chairman Decree No. 4/P/Ka. BAPETEN/VI-99 on Technical Guidance for Preparing Environment Impact Analysis of Nuclear Facility Technical Guidance for Preparing Environment Impact Analysis of Nuclear Power Plant is not available yet.

The gap and issues of the environmental protection is procedure for elaboration and reporting of the environmental impact assessments including assessment of radiological impact need to be developed, others key environmental issues not yet recognized, and document on specific safety requirement need to be prepared.

3.14. Emergency Planning

Clear definition of roles and responsibilities of all organizations to be involved as part of a national emergency preparedness and response plan. National Nuclear Emergency Preparedness plan has been discussed by BAPETEN.

BATAN has prepared General Guidance for Nuclear Emergency Preparedness for Serpong Nuclear Area. Interdepartmental meeting discussing draft of National Nuclear Emergency Preparedness should be continued.

BATAN nuclear facilities have identified nuclear emergency related equipment. Guidance on nuclear emergency preparedness plan has been prepared for Serpong nuclear facilities. During the exercises, it showed that some equipment such as communication devices, radiation protection equipment, environmental monitoring, and incident emergency crises equipment need repair and improvement. Plan to revise document of guidance on nuclear emergency preparedness with reference to the latest IAEA publication.

Workshop on Emergency Preparedness for NPP was held in January 2008. The implementation of document of general guidance on nuclear emergency preparedness will support preparing detail emergency plan and identifying the need of personnel, equipment, and procedures.

Draft of National Nuclear Emergency Responses describes tasks, duties and authorities of local government. Local nuclear emergency responses were proposed to be established. Interdepartmental meetings have discussed the involvement of all local government offices that are expected to involve in nuclear emergency preparedness plan.

General guidance on nuclear emergency preparedness describes needs and requirements that should be prepared by nuclear facility management. Equipment such as environmental monitoring, meteorology (wind speed and direction), and radiation detection equipment should be appropriately provided by management responsible for the safety and security of Serpong nuclear area.

Nuclear emergency preparedness system for Serpong nuclear area is regularly reviewed by BAPETEN through the evaluation of exercises conducted by both BATAN and BAPETEN as shown in Inspection Results Report by BAPETEN. Team of Emergency Preparedness Program Review (EPREV) from IAEA has reviewed nuclear emergency system of BATAN in 1999 and 2004. These reviews results in recommendation to improve capability of personnel, equipment, and document needed. The gap and issues of the emergency planning is emergency planning need to be prepared

3.15. Security

At national level, National Detection Strategic committee involving all off-site responses to deal with thief and sabotage of radioactive material and sources, and prevention of sabotages of nuclear facilities

has not been established. At operator level (BATAN), coordination with police and military stationed around Serpong nuclear area has been initiated. National detection strategic committee related to nuclear security has to be established. Its member may include BATAN, BAPETEN, Police, Military, Custom, etc. At operator level, cooperation with off-site response forces should be carried out.

At national level, only few related agencies understand about nuclear security and physical protection. At operator level, philosophy of nuclear security and physical protection has been understood. At national level, understanding about the philosophy of nuclear security and physical protection should be improved through workshop/seminar and training.

At national level, the organization in charge of physical protection arrangement and NPP plan is not available yet. BATAN as an operator has established nuclear security organization for each nuclear area. IAEA has conducted a special evaluation on BAPETEN related to Indonesia's legal arrangements relevant to nuclear security. National nuclear security organization should be established.

The results of evaluation concluded that nuclear security organization at Serpong site (nuclear island) has to be handled by one command. IAEA has reviewed all regulation and legislation related to nuclear security. The gap and issues of the security is security and physical protection need to be prepared.

3.16. Nuclear Fuel Cycle

Act No. 10 of 1997 on Nuclear Energy Article 2 explain that Nuclear materials consist of: nuclear material ore; nuclear fuel, and and spent fuel. Nuclear materials are authorized by the State and their utilization are regulated and controlled by the Government.

General surveys, explorations and exploitations of nuclear material ore shall only be performed by the Executing Body and The Executing Body may cooperate with State Company, cooperative, private company, and/or other bodies as mentioned in the article 9.

Article 10 mention that the production and/or procurement of raw materials for manufacturing nuclear fuel shall only be performed by the Executing Body and The Executing Body may cooperate with State Company, cooperative, and/or private company.

Article 11 mentions that the non-commercial production of nuclear fuel is performed by the Executing Body and the commercial production of nuclear fuel is performed by State Company, co-operative, and/or private company.

Temporarily spent fuel is already available at BATAN facilities and is provided for research reactor spent fuel whose specification is different from that of NPP spent fuel. Dry storage for spent fuel has not been constructed so far. Some studies on dry storage have been carried out. BAPETEN Chairman Decree (BCR) No. 2/2006 on Licensing for Non-reactor Nuclear Installation

BATAN has constructed a Connection Channel of Spent Fuel Temporary Storage Installation, which is meant for temporary storage of spent fuel from three research reactors of BATAN. This installation is able to store spent fuels for 25 years. The supporting document of this installation is complete and this channel has been licensed to operate by BAPETEN Decree No. 460/IO/DPI/11-XII/2008 for 10 years from December 11, 2008 to December 10, 2018. Technically, the storage for NPP spent fuel is similar with that for research reactor spent fuel. It differs only in size, because of different size and type of these fuels. Many studies on NPP spent fuels have been done.

BCR on Provisions of Fuel Handling and Storage for NPP is under process of establishment. The Government Regulation on Licensing of Non-Reactor Installations is under process of drafting, which starts in 2010. The gap and issues of the nuclear fuel cycle is Planning for long term storage of spent fuel.

3.17. Radioactive Waste

Referring to Act No. 10/1997 and Government Regulation No. 27/2002, BATAN has sufficient capabilities of managing low and intermediate level radioactive wastes and has received an operation license to manage and to store them. Document of Safety Analysis Report for Radioactive Waste Management is available.

At present, low and intermediate level radioactive wastes have not been disposed, but are still stored in a temporary storage facility. Selection of site for near surface disposal has been carried out. Reports of studies on disposal criteria are available.

Based on Government Regulation No. 27/2002, there are two options for high level waste management. If this waste is not sent back to the country of origin, it must be stored in a final disposal permanently. The criteria of the final disposal site are mentioned in the Government Regulation and BAPETEN Chairman Regulation. Government approval is required to carry out this type of disposal. Nowadays, countries operating NPP have not performed final disposal for high level radioactive waste. Most of them still wait and see concerning the management of high level waste. Studies on selection of final disposal site and its criteria have been carried out. Options for high level waste disposal have been understood. The documents of studies on this issue are available. The gap and issues of the radioactive waste is Planning for long term storage of spent fuel.

3.18. Industrial Involvement

Specific policy for industrial companies to support NPP construction has not regulated yet, even though Ministry of Industry has released Decree No. 04/M-IND/PER/1/2009 on Local Content for Fossil Fuel Power Plants, Water and Geothermal Generated Power Plant. Meeting with suppliers has been initiated. However, standard and qualification topics have not been discussed. Indonesia National Standard has not elaborated nuclear components and equipments. Even though there are some industrial companies potential and capable of constructing NPP, no financing scheme has been addressed.

Policies related to nuclear equipment and services have not been decided. Investment policy can be assumed to be similar with that of fossil fuel power plant. Further confirmation to PLN (State Electricity Company) and BKPM (Capital Investment Coordination Agency) is needed. The gap and issues of the industrial involvement is a policy for national industrial involvement need to be decided properly.

3.19. Procurement

There is recognition of the issues. However, Special Procurement Team has not been established. Presidential Decree No. 80/2003 has been amended and is planned to make it an act in order to cover procurement of supplies of items and services by private companies. It is possible that the procurement of supplies will be done by private companies. Recruitment team has not been established yet. A synergy between BIS and Presidential Decree No. 80/2003 is needed. Participation of national industries in nuclear energy program is not available, even though some national policies for industrial development provide good support to construction and services of conventional power plants. The gap and issues of the procurement is Planning of procurement programme.

4. RESULT

The result of the evaluation on the status of Indonesia nuclear power infrastructure development explain in Table 2.

Table 2. The Status of the Indonesia Nuclear Power Infrastructure Development

No.	INFRASTRUCTURE ISSUES	PHASE 1, STATUS
1.	National position	Minor Actions Needed
2.	Nuclear safety	Minor Actions Needed
3.	Management	Minor Actions Needed
4.	Funding and Financing	Minor Actions Needed
5.	Legislative Framework	Minor Actions Needed
6.	Safeguards	Minor Actions Needed
7.	Regulatory Framework	Minor Actions Needed
8.	Radiation protection	Minor Actions Needed
9.	Electrical Grid	No Actions Needed
10.	Human resources	Minor Actions Needed
11.	Stakeholder involvement	Minor Actions Needed
12.	Site and supporting facilities	Minor Actions Needed
13.	Environmental protection	Minor Actions Needed
14.	Emergency planning	Minor Actions Needed
15.	Security	Minor Actions Needed
16.	Nuclear fuel cycle	Minor Actions Needed
17.	Radioactive waste	Minor Actions Needed
18.	Industrial Involvement	Minor Actions Needed
19.	Procurement	Significant Actions Needed

5. FUTURE PLAN ACTION

Based on the result of the evaluation and the gaps found in the each phase. The action plan for future activities is to solve the gaps found in the each phase through technical assistance from IAEA INIR mission.

6. CONCLUSION

Indonesia has completed issues of phase 1 of electrical grid with no action needed. Issues of National position, Nuclear safety, Management, Funding and Financing, legislative frame work, Radiation protection, Human resources, Stakeholder involvement, Site and supporting facilities, Environmental

protection, Emergency planning, Security, Nuclear fuel cycle, Radioactive waste and Industrial Involvement are need minor action. Significant action must be taken on Procurement.

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