2023

INDONESIA NATIONAL REPORT

Convention on Nuclear Safety

Report by The Government of Republic of Indonesia

for the 9th Review Meeting

Contents

A. INTRODUCTION

After signing the Convention in 1994, Indonesia then promulgated Act No. 10 Year 1997 on Nuclear Energy, which lays a strong foundation of national policy for nuclear safety in accordance with the Convention, including the creation of an independent regulatory body (BAPETEN). At the same time, the Act also adapts Vienna Convention on Nuclear Damage and provides penal provision. Indonesia consistently demonstrates its commitment to this Convention after ratifying the Convention in 2002.

The Act requires the Applicants and the Licensees of nuclear facility to demonstrate the safety throughout the lifetime of the source. More detail safety requirements were laid down in some Government Regulations (GRs) under the Act and followed by BAPETEN Chairman Regulations (BCRs) for technical matters. Furthermore, inspection and enforcement are an integrated part of the regulatory system in Indonesia, together with emergency preparedness arrangement, waste management, and management system requirements. Country reports submitted by Indonesia under the Convention highlight the national policy towards nuclear safety. Other national policies, such as stakeholder involvement, and transparency and openness in governmental decision making, are clearly support nuclear safety in Indonesia.

Concerning to construction and operation of NPP, Government established National Nuclear Energy Advisory Committee that has responsibility to provide consideration and recommendation related to nuclear energy utilization. The establishment of National Nuclear Energy Advisory Committee is stipulated in Presidential Regulation Number 83 of 2014.

The licensing process is technically carried out in accordance to GRs & BCRs, that adopting the IAEA Standards mostly, and international best practice in few cases. In order to ensure our preparation, Indonesia invited IAEA for the IRRS Mission in 2015. Since the 2015 Mission there had been a number of important improvements in the legislation. The Government of Indonesia has sent request to IAEA to conduct Follow Up Integrated Regulatory Review Service (IRRS) Mission on 22 May 2018 to review progress in implementing improvements resulting from the initial IRRS mission recommendations or suggestions. Responding this request, IAEA has decided to perform Follow Up Mission in 2019.

Regarding to the Lesson-Learned of Fukushima Daichi accident, Indonesia has highly committed to the Vienna Declaration on Nuclear Safety on February 9, 2015, in the implementation of the objective of the Convention on Nuclear Safety to prevent accidents and mitigate radiological consequences.

With the above explanation on national nuclear safety regime and national plan on nuclear energy development, Indonesia puts its highest commitment to the Convention, both for the current and future nuclear installation/facility—as defined by this Convention.

This national report is prepared in accordance to INFCIRC 572 Rev. 6 (2018). The current status of the safety of three research reactors operated in Indonesia was reported. New features, regulation and policies related to safety are also part of this report.

B. SUMMARY REPORT

This report is prepared not only to fulfil obligation of Indonesia as the party of this Convention and as the supporter of Vienna Declaration on Nuclear Safety (VDNS), but also a self-assessment result. The report demonstrates the commitment of Indonesia as an embarking country to nuclear safety. Through the submission and presentation of this report, Indonesia is open for any recommendation and suggestion that might arise during the review meeting.

For the existing three research reactors there is no significant safety issue found in the last three years. However, Indonesia is fully aware that the three facilities are more than 30 years old. Hence ageing management, the implementation of periodic safety review, development of a better decommissioning programme, and the enhanchement of safety culture are among the top priorities in Indonesia.

The current safety challenge in Indonesia is regarding the ageing management of research reactor, the implementation of periodic safety review and improvement of safety culture. To face this, both BATAN and the regulator (BAPETEN), utilized national researchers and engineers from national universities, research institutes, and government agencies as the service provider and technical support organization (TSO) during review and assessment of research reactor renewal operating license.

As an embarking country, Indonesia needs to learn more on the implementation of VDNS, as one of the topics identified and agreed upon at the Organizational Meeting. The method to evaluate the fulfilment of this Declaration is a challenge. Indonesia strongly supports the idea and spirit of VDNS as a proper world endeavour together to prevent such nuclear disaster from occuring in the future.

In improving safety culture, all nuclear facilities have been establishing and implementing Integrated Management System that consist of management system for health, safety, and environment (ISO 18001), management system for environmental (ISO 14001) and quality management system (ISO 9001) besides applying BCR No 4 of 2010 on facility management system and nuclear utilization activity. Some BAPETEN divisions also have been accredited ISO 9001.

Indonesia received a full scope of IAEA IRRS Mission in August 2015. Since the 2015 Mission there had been a number of important improvements in the legislation i.e. a new organizational structure had entered into force, the organization had grown considerably, and the authorization process had become more transparent. BAPETEN has made considerable effort in amending the Atomic Act No.10 of 1997 and establishing several Chairman Regulations to address International Safety Standards. BAPETEN continues to finalize the development of new regulations, guides, and procedures, in line with the new legislation. BAPETEN has implemented the new legislation, regulations, guides and procedures. BAPETEN has also developed and implemented its integrated management system and has made progress in the development of its documentation. This is part of commitment and strategy to implement recommendations and suggestions from the mission in effective and efficient ways. Indonesia will continuously evaluate the progress, and there will be a time expected in the near future to perform self-assessment before requesting another IAEA Mission.

BAPETEN invited IAEA Occupational Radiation Protection Appraisal Service (ORPAS) mission in order to develop an action plan for further improving the infrastructure for occupational radiation protection from 4 to 13 November 2018. In general, Indonesian legislation for radiation protection is consistent with the previous version of the International Basic Safety Standards (BSS No. 115, 1996) as recognised by IRRS mission in 2015. The ORPAS mission observed significant progress towards compliance with the current requirements of International Basic Safety Standards (GSR Part 3). Based on the evaluation results, there are some feedbacks, especially on the quality of regulations or policies that meet IAEA standards, including the implementation of radiation facilities and use.

In 2019, Indonesia received IAEA Expert Mission to review regulations regarding the licensing process for NPP. BAPETEN agreed with IAEA recommendation to address the aspect of ageing management more clearly as one of technical requirements of operating license, and provision of small size reactor to implement a graded approach in the licensing process. The results of this IAEA review will be used to revise GR Number 2 of 2014 and GR Number 54 of 2012 which are planned to be carried out by BAPETEN starting in year 2019 (commencing academic drafting activities) and continuing in the following years.

The 2015 Site and External Events Design Review Service (SEED) mission recommended that High Temperature Gas-cooled Reactor is categorized as medium hazard installation. Therefore, as one of graded approach implementation, peak ground acceleration for 10,000 years return period is applied for siting analysis and 1,000 years return period is used for design purposes with considering adequate safety margin.

In 2019 BAPETEN performed self-assessment on arrangement of emergency preparedness and response and reported in the National Report on Preparedness and Response for a Nuclear or Radiological Emergency of Indonesia. The report reflects the self-assessment made at national level against IAEA safety standards on emergency preparedness and response.

Indonesia has ratified international conventions related to nuclear safety. Among these are Convention on Nuclear Safety, ratified with Presidential Regulation (PR) No. 106 of 2001, Convention on Early Notification of a Nuclear Accident, ratified with PR No. 81 of 1993, Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency, ratified with PR No. 82 of 1993, and Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management, ratified with PR No. 84 of 2010.

During the Covid-19 pandemic, nuclear installation oversight has been adjusted to reduce physical interactions between regulator and operator staffs. License verification and inspections to nuclear facilities were still carried out, but discussion of results was performed through online meeting.

In the 7th review meeting, Indonesia received no recommendation and suggestion, and identified to have three good practices. Our target for this report is to maintain the fulfilment of the Convention and of the VDNS, and to demonstrate our commitment and measures in improving our safety performance and safety culture. To conclude, Indonesia welcomes any honest discussion to enhance our safety performance and safety culture.

C. ARTICLE BY ARTICLE REVIEW

Article 6 Existing Nuclear Installation

Each Contracting Party shall take the appropriate steps to ensure that the safety of nuclear installations existing at the time the Convention enters into force for that Contracting Party is reviewed as soon as possible. When necessary in the context of this Convention, the Contracting Party shall ensure that all reasonably practicable improvements are made as a matter of urgency to upgrade the safety of the nuclear installation. If such upgrading cannot be achieved, plans should be implemented to shut down the nuclear installation as soon as practically possible. The timing of the shut-down may take into account the whole energy context and possible alternatives as well as the social, environmental and economic impact.

Existing nuclear installations

Based on Act No 10 of 1997 on Nuclear Energy, Indonesia defines nuclear installation as a nuclear reactor; facilities used for purification, conversion, enrichment of nuclear material; nuclear fuel fabrication and/or reprocessing of used nuclear fuel and /or facilities to store nuclear fuel and spent fuel. However, research reactor is not nuclear installations defined by the convention. Currently Indonesia has not operated nuclear power plant yet but there are three research reactors and fuel fabrication facility, that being operated. The three nuclear reactors are situated in Java Island and shown in

Figure 1.

Figure 1. Research Reactors in Indonesia

(1) Multi-Purpose Reactor (MPR) GA Siwabessy

The MPR GA Siwabessy is located in the area for Development of Science and Technology (Puspiptek), Serpong, 40 km southwest of Jakarta. The reactor is a pool-type, cooled and moderated by light water with forced convection with nominal power 30 MWt. BATAN has been operating the reactor since 1987. The reactor is designed for material testing and analysis, radioisotope production, research, as well as education and training activities. In 2020 MPR GA Siwabessy was granted an operating license for the next 10 years until year 2030.

(2) TRIGA 2000 Reactor

The TRIGA 2000, located in Bandung, West Java, is a pool (TRIGA MARK II) type reactor using light water both as the moderator and coolant with licensed power at 1 MWt. The first criticality of the reactor was achieved in 1965, and currently is operated by BATAN for the purpose of material analysis, radioisotope production, research etc. In 2017 BAPETEN issued renewal the operating license for the operation period until 2027.

(3) Kartini Reactor.

Kartini Reactor, located in Yogyakarta, is a pool (TRIGA MARK II) type reactor with licensed power at 100 kWt. The first criticality of the reactor was achieved in 1979. This reactor is operated by BATAN for the purpose of material analysis, research, education, training, etc. In 2019 Kartini Reactor was granted an operating license for the next 10 years until 2029.

Safety related issues

The government has established the National Research and Innovation Agency (BRIN) through Presidential Regulation Number 78 of 2021. The establishment of BRIN is intended to integrate management, resources and research and innovation agendas in Indonesia. Several research and development institutions merged into BRIN, including National Nuclear Energy Agency (BATAN). Currently, all nuclear installations (research reactors and non-reactor nuclear installations) are managed by the Directorate of Nuclear Facility Management (DPFK).

(1) MPR GA Siwabessy

Based on licensee's operation report, the result of periodic safety review (PSR), and ageing management report, MPR GA Siwabessy revitalized some systems and components important to safety based on the priority. The systems and components include cooling tower, chiller, seismograph, and fire safety equipments. MPR GA Siwabessy is planning to replace instrumentation and control system from analogue to digital, as well as emergency diesel.

(2) TRIGA 2000 Reactor

On the renewal licensing process of TRIGA 2000 reactor, the licensee has performed periodic safety review and updating safety analysis report for operation. Some of recommendation and follow up to improve safety from PSR document are identified. BAPETEN continuously observe the progress of completion for recommendation and follow up until the next PSR period.

(3) Kartini Reactor

The safety issue of the Kartini reactor is aging management due to the reactor has been operating for more than 40 years. Operators pay special attention to the critical SSC's (structure systems and components), specifically the reactor tank. Reactor operators have been studying similar experiences from other research reactors with longer operating life.

Programmes and measures for the safety

Indonesia commits to further enhance safety culture applied both in the operator and regulator side. This would complete the existing programmes in maintaining and where possible improving nuclear safety in Indonesia. The operator continues developing their periodic safety review and ageing management, while at the same time also preparing their decommissioning programme as required by law. Regulator endures its task to ensure safety through regulation development, licensing review, and inspection. In order to assure sustainability in safety, both sides commit to further enhance knowledge management, and implement a better strategy on transparency and openness.

Statement of the operation of nuclear installation

Indonesia decides to continue the safe operation of the three research reactors until further decision taking into consideration the ageing management, fuel availability, and the utilization of the plants.

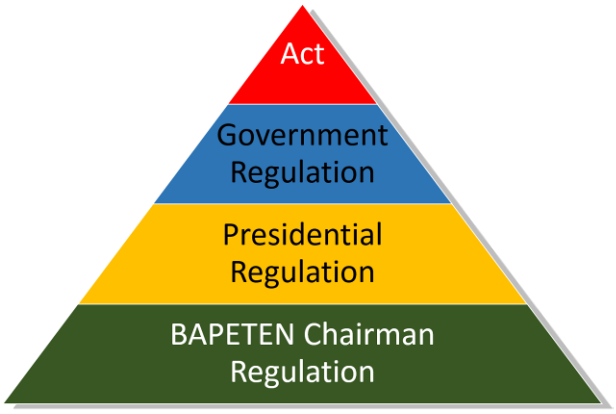
Article 7 Legislative and Regulatory Framework

1. *Each Contracting Party shall establish and maintain a legislative and regulatory framework to govern the safety of nuclear installations.* 2. *The legislative and regulatory framework shall provide for:* *i. the establishment of applicable national safety requirements and regulations* *ii. a system of licensing with regard to nuclear installations and the prohibition of the operation of a nuclear installation without a license;* *iii. a system of regulatory inspection and assessment of nuclear installations to ascertain compliance with applicable regulations and the terms of licenses;* *iv. the enforcement of applicable regulations and of the terms of licenses, including suspension, modification or revocation*

Article 7 (1) Establishing and maintaining a legislative and regulatory framework

Primary legislative framework

The hierarchy of national legislation system in Indonesia is described in The hierarchy of national legislation system in Indonesia is described in The hierarchy of national legislation system in Indonesia is described in Figure 2. The hierarchy of national legislation system in Indonesia



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On the framework for nuclear safety, Indonesia enacted Act No. 10 Year 1997 on Nuclear Energy, together with some ratification of safety related international conventions listed in the next paragraph. As the interface with national legislation, the establishment process of law and regulation is based on national regulation, i.e., Act No. 12 Year 2011 on the Establishment of Laws. In addition, the position, task, function, and authority of non-ministerial government institution, such as BAPETEN and BATAN, is regulated by GR No. 103 Year 2001. National legislation also addresses financial system of government institution, stakeholder involvement in governmental decision making, transparency and openness, industrial safety and health, environmental safety, and other administrative arrangements.

The implementing instruments of the above laws are listed in the Table 2. List of Regulation for Nuclear Installation. Enacted regulations after 2013 are:

- GR No 61 of 2013 on the Radioactive Waste Management
- GR No 2 of 2014 on the Licensing of Nuclear Installations and the Utilization of Nuclear Materials; and
- GR No. 58 of 2015 on the Radiation Safety and the Transport Security of Radioactive Materials.
- GR No 5 of 2021 on the Implementation of Risk-Based Business Licensing.

Since 2016, BAPETEN has been amending of Act No 10 of 1997 on nuclear energy. Amendment process commences from making of academic analysis, internal discussions, discussions between ministries and the preparation of draft amendments. The provisions added to the law are the strengthening of regulations and the principle of safety in the use of radiation sources and ionizing radiation. The fields of utilization of nuclear energy and radiation are also explained more clearly. Responding to the recommendations of the IRRS Mission regarding the implementation of the Fundamental Safety Principle (SF-1) that is clearer in the rules relating to safety also carried out by revising government regulations relating to the safety of the use of nuclear energy and radiation.

In the draft law the new framework for nuclear safety, Particularly, provisions for the fundamental safety principles, i.e. assigning the prime responsibility for the safety of the operating organization, or provisions for involvement of interested parties in the decision making process has already included.

The revision of Act No 10 of 1997 is still ongoing and the targets are to be completed by 2019. The difficulties faced are in coordination and harmonization with all parties involved and discussions with the parliament as the final stage to the regulatory approval process.

The government continues to strive all regulations and policies related to the safety of the use of nuclear energy and radiation are always in accordance with the international policies such as stated in IAEA GSR Part 3, Part 4, and Part 5, as shown in Table 1.

BAPETEN has initiated to revise government regulations adjusting to the provisions and standards that apply to GSR part 3, part 4 and part 5 such as GR No 33 of 2007 on safety of ionizing radiation and security of radioactive sources, GR No 29 of 2008 on Licensing for the Use of Ionizing Radiation Sources and Nuclear Materials, GR No 54 of 2012 on the safety and security of nuclear materials, GR No. 2 of 2014 on licensing of nuclear installations and utilization of nuclear materials. Changes to these regulations aim to improve the safety aspects of the use of nuclear power and radiation.

Table 1. List of Government Regulation being revised

IAEA Standards	Regulations
GSR Part 3	Revision of GR No. 33 of 2007 on Safety of Ionizing Radiation and Security of Radioactive Sources,
GSR Part 4	• Revision of GR No 29 of 2008 on Licensing for the Use of Ionizing Radiation Sources and Nuclear Materials • Revision of GR No. 33 of 2007 on Safety of Ionizing Radiation and Security of Radioactive Sources, • Revision of GR No. 2 of 2014 on Licensing of Nuclear Installations and Utilization of Nuclear Materials • GR No 54 of 2012 on the Safety and Security of Nuclear Materials
GSR Part 5	Revision of GR No. 61 of 2013 on the Management of Radioactive Waste

Indonesia has issued GR No 5 of 2021 on the Implementation of Risk-Based Business Licensing. This regulation is intended to provide ease of doing business for enterprises to invest in business activities that have safety risks including the use of nuclear energy.

Ratification of international conventions and legal instruments

Indonesia is a party to major international conventions related to nuclear safety. These include:

- Convention on Nuclear Safety, ratified with Presidential Regulation (PR) No. 106 of 2001
- Convention on Early Notification of a Nuclear Accident, ratified with PR No. 81 of 1993
- Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency, ratified with PR No. 82 of 1993
- Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management, ratified with PR No. 84 of 2010

Article 7 (2) (i) National safety requirements and regulations

Secondary legislation

BAPETEN is responsible to issue secondary legislation for nuclear safety including technical regulations and guides. BAPETEN Chairman Regulation (BCR) is issued to provide further detail technical requirements on safety in implementing a specific Government Regulation. BAPETEN has established BCRs for siting, design, operation, and decommissioning of nuclear installations adopting and/or adapting relevant IAEA standards. The list of BCR is attached in Table 6.

Regulations and guides issued

BAPETEN regulations are updated to the latest conditions and references. Since 2016, BAPETEN has been issuing several regulations include a new and amended previous Regulation. BAPETEN has initiated to revise BCR adjusting to the provisions and standards that apply to GSR part 7, IAEA SSR-3, IAEA SSR2/1 rev 1, IAEA NS-R-3 (Rev. 1), IAEA SSG 38, IAEA SSG 35, IAEA SSG 30, IAEA SSG-28, including:

- BCR No. 4 of 2019 on Dispersion of Radioactive Material in Air and Water and Consideration of Population Distribution in Site Evaluation for Nuclear Installation, amending BCR No. 3 of 2008 on Dispersion of Radioactive Material in Air and Water and Consideration of Population Distribution in Site Evaluation for Nuclear Power Plants.
- BCR No. 2 of 2019 on the safety of commissioning for Non-Power Reactor. This BCR adapts IAEA SSG 28: Commissioning for Nuclear Power Plants.
- BCR No. 4 of 2018 on Safety Provisions for Site Evaluation of Nuclear Installation, amending BCR No. 5 of 2007 on Safety Provisions for Site Evaluation of Nuclear Reactor. This BCR adaptation from IAEA NS-R-3 (Rev. 1) - Site Evaluation for Nuclear Installations.
- BCR No 6 of 2019 on Site Evaluation for Nuclear Installation on Human Induced Events. This BCR superseded BCR No. 6 of 2008 on External Human Induced Events in Site Evaluation for Nuclear Power Plants.
- BCR no 12 of 2020 on Classification of Structures, Systems and Components in Nuclear Installations. This BCR is an adaptation from IAEA SSG 30: Safety Classification of Structures, Systems and Components in Nuclear Power Plants.
- Amending BCR No. 2 of 2011 on Safety Operation of Research Reactor, which regulates extended shutdown. This BCR is an adaptation from IAEA SSR-3: Safety of Research Reactors. Status of this BCR still in the process of harmonization in legal bureau.

- Amending BCR No. 1 of 2010 on Nuclear Emergency and Preparedness. This BCR is an adaptation from IAEA GSR Part 7: Preparedness and Response for a Nuclear or Radiological Emergency. Status of this BCR still in the process of drafting.

- Drafting BCR on aspect of radiation protection for power reactor design. This BCR is an adaptation from IAEA SSR2/1 rev 1 – Safety of Nuclear Power Plants: Design.
- Drafting BCR on the safety of construction for power reactor.

Process of establishing and revising regulatory requirements

BAPETEN has issued a law-making procedure for establishing and revising BCR, adopting Act No. 13 of 2022 on Second Amandement of Act No 12 of 2011 on the Establishment of Laws. The procedure includes a process for obtaining comments from interested parties, including receiving public comment through the website. The BCRs are required to be published in the Official Gazette as the final process of the enactment. Then BAPETEN disseminates the new issued BCRs to the stakeholders.

Implementation of this process is in accordance with BCR No. 8 of 2018. The process of establishing and revising regulatory requirements is carried out through stages planning, drafting, discussing, establishing, and enacting. Prior the draft legislation is established, BAPETEN can engage the public to provide input.

Article 7 (2) (ii) System of licensing

Licensing system and processes

Indonesian Government has reformed the risk-based electronic business licensing system as an effort to improve the ease of doing business in Indonesia, the implementation of risk-based business licensing through the Online Single Submission System (OSS) is regulated by Act No. 11 of 2020 on Job Creation, GR No 5 of 2021 on the Implementation of Risk-Based Business Licensing. The application of this risk-based business license determines the type of business license and the frequency of surveillance. In Article 6 of GR No. 5 of 2021, nuclear energy is classified as high-risk business activities. This new Government Regulation revises the period of licensing process and procedures, as well as administrative requirements of GR No. 2 of 2014 on Licensing of Nuclear Installations and the Utilization of Nuclear Materials. However, licensing requirement documents still refers to the old Government Regulation.

Nuclear installations Licensing process is multi-step, starting from siting, construction, commissioning, operation, to decommissioning. Licensing requirements in each step are categorized into administrative, technical, and financial requirements. Administrative requirements are, inter alia, related to legal ownership of operating company and other license that has to be obtained from other related licensing institution(s). Technical requirements are required by BAPETEN to ensure the safety of nuclear installations, and the detailed provision regarding technical document is stipulated on BCRs. Financial requirements are financial assurance for construction, commissioning, operation, and decommissioning, as well as the liability for nuclear damage during commissioning and operation. The financial requirements are only applied to commercial nuclear installations.

BAPETEN performs review and assessment of the submitted licensing application documents to ensure that all requirements are fulfilled. During this review and assessment process, BAPETEN performs inspection to verify the conformity of safety requirements and conducts public hearing.

Involvement of the public and interested parties

The Involvement of public and interested parties in the licensing process is stipulated in Act No. 30 of 2014 on Government Administration. This Act requires the government institution to provide an opportunity for the public to be heard in the decision-making process. Public involvement includes in

license or approval issuance/revocation/suspension/modification process. BAPETEN, through Directorate of Licensing of Nuclear Installation and Materials (DPIBN) revised a procedure to include the mechanism of consultation with interested parties/public hearing process before issuance license or approval. The procedure refers to administration requirement on GR No.2 of 2014 and Act No. 30 of 2014 and it is part of Procedure for Licensing for Nuclear Reactor and Procedure for Licensing for Non-Reactor Nuclear Installation. Questions, recommendation, and answers that arise during public hearing event are collected by BAPETEN as attachment in Safety Evaluation Report and as base for issuing nuclear reactor license renewal. Figure 2 shows public hearing event on MPR GA Siwabessy license renewal organized by BAPETEN.

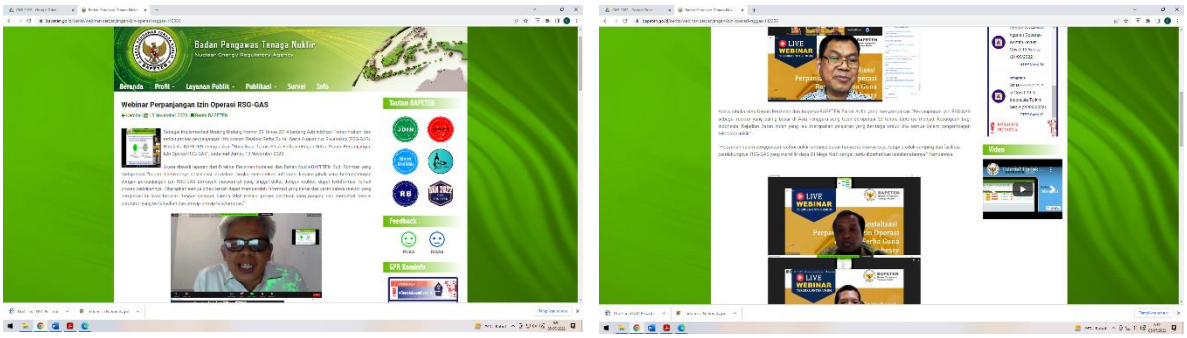


Figure 2. Public hearing on reactor license renewal

In accordance with Act No. 30 of 2014 on Government Administration, BAPETEN issued BCR No. 3 of 2018 on public communications strategy of regulatory body. The strategy was arranged as part of the institution's efforts to provide information to the public on the importance of the aspect of nuclear energy oversight. The public communication strategy is prepared based on the transparency, accountability, and responsibility principles.

BAPETEN determines communication targets to the affected people. First, the groups of people affected directly, namely the permit holder. Second, indirectly affected community groups include community organizations, local governments, other relevant government agencies, academics, NGOs, mass media and the public.

Preventing the operation of a nuclear installation without a valid license

To prevent the operation of a nuclear installation and radiation workers without a valid license, Act No. 10 of 1997 on Nuclear Energy provides penal provision with fine or imprisonment. Furthermore, for the existing facilities, BAPETEN may send notification to remind the licensees on their licensing status that would be expired soon. For new built installation, such prevention could also be conducted through coordination with related government institutions dealing with import-export control.

Article 7 (2) (iii) System of regulatory inspection and assessment

Regulatory strategies

Act No. 10 of 1997 on Nuclear Energy states that BAPETEN shall perform inspection to nuclear installations to ensure the compliance to nuclear safety regulations and licensing conditions. The strategies to implement the inspection policy are:

1. BAPETEN develops inspection program to carry out regular and unannounced inspection activities as mandated by the Act.
2. To carry out the tasks, inspectors are provided with sufficient authorities as stipulated in GR No. 2 of 2014 on the Licensing of Nuclear Installations and the Utilization of Nuclear Materials. In order to ensure their competences to perform inspection, BAPETEN develops inspector

training and qualification program. To maintain the inspector competence, BAPETEN conducts refreshment training course, and organize inspection experience sharing forum which is held twice a year.

3. BAPETEN coordinates with related institutions for law enforcement to follow up inspection findings if necessary.
4. BAPETEN provides sufficient infrastructure to support safety inspection program, such as:
   - a real time and online monitoring system for the reactor operating parameters and environmental radiation level
   - an online radioactive waste inventory reporting system
   - a worker doses evaluation reporting system
   - environmental laboratory
   - inspection procedures and work instructions; and
   - Inspection tools and equipment

IF necessary, BAPETEN may request assistance from external independent laboratories and/or experts.

BAPETEN has not carried out safety culture inspection to licensee yet. BAPETEN Inspection directorate plans to develop an inspection system that includes the inspection of the implementation of safety culture in the nuclear installations in 2020-2024.

BAPETEN has developed online inspection management system namely BAPETEN Licensing and Inspection System- Inspection Management and Electronic Report System (B@lis SMILE). The system aims to manage inspection activities, operational reporting of nuclear installation and review of safety and security performance.

Regulatory inspection and assessment proces

Regulatory inspection is managed in accordance with the Management System of BAPETEN (SMB). Planning of inspection is conducted each year by determining the number of inspections, inspection personnel, objects and scopes, and schedules. The scopes of nuclear safety inspection are operation, radiation protection, maintenance and ageing management, emergency preparedness, and management system. BAPETEN inspects licensee through verification, confirmatory measurements, auditing, and data review. During preparation, the inspection team conducts an internal meeting to detail the inspection scope, and discuss the previous inspection report, time allocations, distribution of inspection tasks, and the need of inspection tools.

Basic features of inspection programmes

Inspection program is developed based on risk assessment of the facilities, as illustrated in Table 2. The higher risk facility, the more frequent BAPETEN performs inspection. The risk-based nuclear installation inspection is carried out in accordance with BCR No. 1 of 2017 on performing inspection in nuclear energy oversight.

Table 2. Frequency of inspection based on facility risk

Risk	Facilities and Activity	Frequency of inspection
High	2 MWt < Nuclear reactor < 100 MWt	Three times per year
Moderate	• Nuclear reactor ≤ 2 MWt • Fuel cycle facilities (not including fuel storage facilities)	Twice per year

	• Radioactive waste management facilities • Production of radioisotopes facilities	
Low	Spent fuel storage facilities (pool type) with small inventory	Once per year

BAPETEN provides written guidance including inspection procedures, working instruction and checklists. These documents are periodically reviewed and updated. During the inspection, inspectors are required to be accompanied by the technical staffs of the facility to confirm any potential findings. The inspection findings are presented to the facility top management in the exit meeting. The facilities are required to develop and implement action plan related to the findings, and this plan is a subject to BAPETEN approval. Figure 3 shows BAPETEN inspection activities.

Figure 3. BAPETEN routine inspection activity

In addition, since 2016 BAPETEN has set up and measured safety and security indicators, which are obtained from a summary of inspection results at each facility. Safety indicators contain assessments of safety performance including aspects of operation, ageing management, radiation protection, and environmental management and monitoring, nuclear preparedness, and management systems.

During the Covid-19 pandemic, nuclear installation oversight has been adjusted to reduce physical interactions between regulator and operator staffs. License verification and inspections to nuclear facilities were still carried out, but discussion of results was performed through online meeting.

Article 7 (2) (iv) Enforcement of applicable regulations and terms of licenses

Power for legal actions

The legal basis for enforcement is stipulated in the Act 10 of 1997, GR No. 54 of 2012, GR No. 61 of 2013 and GR No. 2 of 2014. These law and regulations provide power to BAPETEN to take or to initiate necessary legal enforcement actions.

Enforcement measures

Enforcement actions shall be applied in accordance with safety condition of the facility. These actions could be in the form of written warning, license suspension, ultimately revocation of license, or penal provision. In the case of penal prosecution, BAPETEN has to follow national civil law.

Experience with legal actions and enforcement measures.

The most common enforcement measure taken by BAPETEN was written warning. Facilities have to follow up this written warning and submit the progress report to BAPETEN. Inspector then performs inspection to verify the follow up action.

Implementation of enforcement shall be carried out professionally, effectively, and responsibly. It requires a measurable and definite provision as a guideline for nuclear safety inspectors. BAPETEN views that non-compliance of utilization of nuclear energy by licensees with licensing requirements and nuclear regulations can be enforced by law as a last effort (*ultimum remedium*) measure that shall be regulated in the BAPETEN Regulation.

For this reason, BAPETEN has issued BCR No. 1 of 2017 on conducting inspections in the nuclear energy oversight. It regulates enforcement which is generally applied both to the field of installation and nuclear materials as well as to radiation and radioactive materials.

Enforcement in the BCR No. 1 of 2017 is the process of imposing administrative and criminal sanctions to licensees who violate regulations.

Article 8 An Independent Regulatory Body

1. *Each Contracting Party shall establish or designate a regulatory body entrusted with the implementation of the legislative and regulatory framework referred to in Article 7, and provided with adequate authority, competence and financial and human resources to fulfil its assigned responsibilities.*
2. *Each Contracting Party shall take the appropriate steps to ensure an effective separation between the functions of the regulatory body and those of any other body or organization concerned with the promotion or utilization of nuclear energy.*

Article 8 (1) Establishment of the regulatory body

Legal foundations and statute of the regulatory body

The Act No. 10 of 1997 on Nuclear Energy separates regulatory and executive function. In implementing this policy, Presidential Decree No. 76 of 1998 on Nuclear Energy Regulatory Authority establishes BAPETEN as an independent governmental organization for the regulatory control in the use of nuclear energy. Its responsibilities are clearly set out in the Act and its implementing regulations. It is important to underline that according to the Act, the Chairman of BAPETEN is responsible and report directly to the President of the Republic of Indonesia.

Mandate, Mission, and Tasks

The mandate of BAPETEN to regulate the utilization of nuclear energy in Indonesia is also fostered by the Presidential Decree No. 103 of 2001 on the Status, Main Task, Function, Authority, Organizational Structure and Working Orders of Non-Department Government Institutions, as latest amended by Presidential Regulation No. 145 of 2015.

The mission of BAPETEN, in accordance with Act No. 10 of 1997 on Nuclear Energy, are to:

1. assure the welfare, the security, and the peace of people
2. assure the safety and the health of workers and public, and the protection to the environment
3. maintain legal order in implementing the use of nuclear energy
4. enhance legal awareness of operator to foster nuclear safety culture
5. prevent the diversion of the peaceful uses of nuclear material
6. assure the maintenance and improvement of the worker discipline in carrying out nuclear energy utilization

The Act No. 10 of 1997 on Nuclear Energy provides BAPETEN with the main tasks to develop regulation, conduct licensing process, and perform inspection. In order to implement its tasks, Presidential Decree No. 103 of 2001 grants BAPETEN with the function to:

1. perform assessment and develop national policy in the field of nuclear regulation
2. coordinate functional activities in implementing the tasks
3. facilitate and provide guidance for government activities in the field of nuclear regulation
4. organize supervision and service on public administration in the field of general planning, management, organization and management system, staffing, finance, archive, legal affairs, encryption, accommodation, and housekeeping.

Authorities and responsibilities

To carry out its functions, Presidential Decree No. 103 of 2001 provides BAPETEN with the authorities and responsibilities to:

1. develop national plan in nuclear regulation
2. formulate national policy in nuclear regulation to support national development
3. establish accreditation and certification in nuclear regulation
4. other relevant authorities and responsibilities:
   a) develop and implement regulatory policy
   b) establish regulatory management system
   c) assure welfare, security, and people in nuclear energy utilization
   d) assure the safety and the health of workers and public, and the protection to the environment from the harmful effects of radiation
   e) prevent the diversion of the peaceful uses of nuclear material

Organizational structure of the regulatory body

The organizational structure of BAPETEN is outlined in Figure 4. BAPETEN is led by a chairman, who is appointed by and report directly to the President of the Republic of Indonesia. The operational 'core' activities are carried out under the leaderships of the Deputy Chairman for Nuclear Safety Assessment and the Deputy Chairman for Licensing and Inspection. The two Deputy Chairmen as well as the Executive Secretary are appointed by the President.

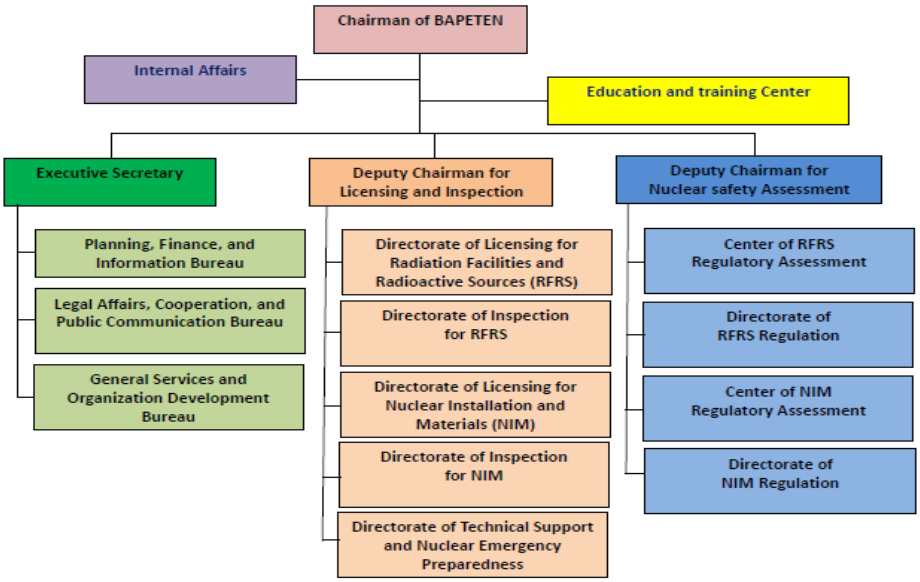


Figure 4. The organizational structure of BAPETEN

BAPETEN has re-structured its organization in order to strengthen its function. A new section of human resource division as a part of General Services and Organization Development Bureau was formed with the main task for mapping employee needs and planning employee competencies development in the long-term periods.

Development and maintenance of human resources over the past three years

In National level, human resource is developed based on Act No.5 of 2014 on the State Civil Apparatus (ASN). In this Act the government officer has the right to obtain competency development. State Civil Apparatus career development is based on qualifications, competencies, performance appraisal, and needs of Government Agencies (article 69). These competencies include:

a. technical competencies measured by the level and specialization of education, functional technical training, and experience working technically
b. managerial competencies measured from the level of education, structural or management training, and leadership experience
c. Cultural social competence measured by work experience is related to plural societies in terms of religion, ethnicity, and culture so that they have national insight.

In Article 70 of this Act, it is also stipulated that every State Civil Apparatus has the right and opportunity to develop competence. Competency development includes education and training, seminars, courses, and upgrading.

BAPETEN performed Training Need Assessment (TNA) for technical staffs. TNA refers to IAEA TecDoc 1254: Training the staff of the regulatory body for nuclear facilities: A competency framework Safety Report Series No. 79 "Manageing the Competence of a Regulatory Body". In collaboration with the IAEA, BAPETEN organized a workshop on Systematic Assessment of Regulatory Competence Needs for Regulatory Bodies of Nuclear Facilities (SARCON); while with the USNRC, BAPETEN arranged a workshop on evaluating the competency requirements and the adequacy of reviewer for site licensing application. Based on the SARCON's conclusion, BAPETEN developed human resource development plan and its training programme.

BAPETEN Training Center developed training programs for its employees based BAPETEN Chairman Decree on plans and development for BAPETEN Human Resources for period 2015-2019.

Statement of adequacy of resources

Regarding the adequacy of resources of BAPETEN, Act No. 5 of 2014 on the State Civil Apparatus states the Government financially guarantee BAPETEN to perform its tasks and functions with sufficient number of management and employees. Additionally, Presidential Decree No. 76 of 1998 on Nuclear Energy Regulatory Agency, stipulates that the entire budget needed is billed to the Government budget. The financial resources of BAPETEN are based on the national annual budget plan which is approved by Ministry of National Development Planning, the Ministry of Finance, and the Parliament. Aside from the government funding, financial resources of BAPETEN come from licensing fees as stipulated in the Act No. 10 of 1997 on Nuclear Energy. The amount of these licensing fees is stipulated by the Government Regulation 56 of 2014 on Non-Tax Revenues Applicable for BAPETEN.

In implementing the HRD plan, BAPETEN develops training programme for their employee, including advance degree and various types of training activities. The number of needed employees is also evaluated, and projection has been made, especially in anticipating the introduction of NPP technology to the Country. Currently, the number of BAPETEN employees is sufficient to perform their tasks but further training activities is still needed. However, additional staff is significantly needed in coming years. Dealing with this, BAPETEN has coordinated with national institution to provide human resource recruitments.

BAPETEN will allocate adequate human and budgetary resources to support the implementation of regulation function carry out by BAPETEN.

To support the implementation of regulation function on the utilization of nuclear energy and radiation, BAPETEN requires competent human resources to carry out all regulation functions in a long period of time. BAPETEN does not have a long-term human resource management plan especially in terms competencies and personnel regeneration. Government has online employee planning system named e-formation.

BAPETEN recruits new employees in accordance with government regulations to ensure that all employees understood their task and function more clearly. To improve employee competency, BAPETEN has assigned employees to pursue higher education level both master and doctoral degrees in accordance with the needs and challenges of the organization.

Age distribution of BAPETEN employees is shown in Figure 5Figure 5. Most of BAPETEN employees are between 41 and 45 years old (35%). There are 14% of the employees that have working experience less than 5 years, who get priority in the competence development. Meanwhile 16% of the employees are above 50 years old, nearing retirement.

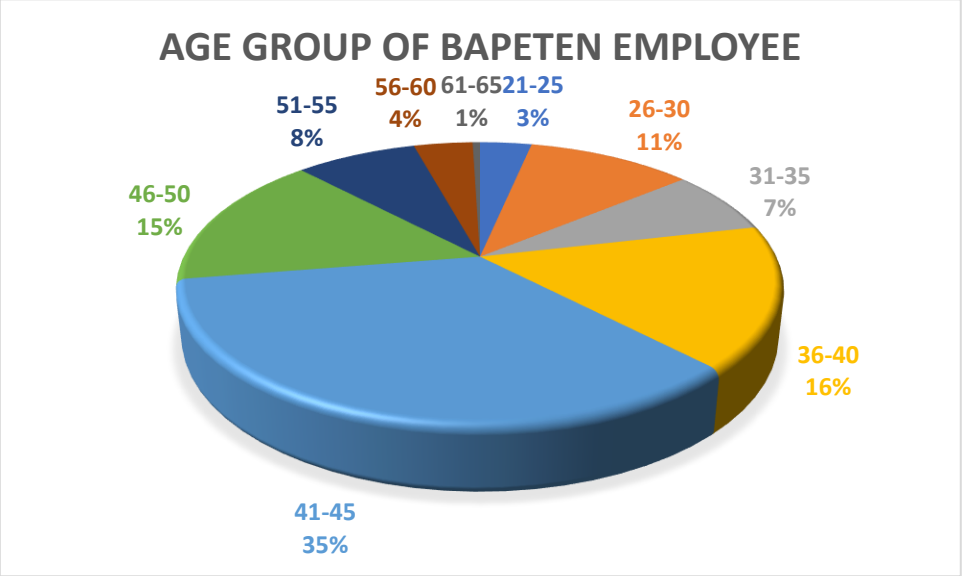


Figure 5. Range of BAPETEN Employees Age in 2022

Management system of the regulatory body

The existing BCR No. 14 of 2014 on BAPETEN Management System was developed based on IAEA GSR 3, ISO 9001:2008, and ISO 9004:2009. In 2018, BAPETEN start to revise this BCR based on GSR Part 2, ISO 9001:2015, and ISO 9004:2018. In the drafting process of the BAPETEN Management System, the issues of leadership, safety culture, risk management, and communication issues both internal and external, as well as organization changes management will be included. The issues about the values, policies, and procedures for decision making are also included in the draft of BAPETEN management system. This BAPETEN Chairman Regulation will be issued soon and after the BCR issued, it will be disseminated to all BAPETEN staff members.

In 2018, a review of the BAPETEN management system was conducted by inviting two experts from the IAEA under the TC Project. BAPETEN received input and suggestions for improvements to the BAPETEN management system from experts brought in by Risk Audit - the European Union which began in 2017 and continued until 2019.

Place of the regulatory body in the governmental structure

BAPETEN is an independent statutory agency. This is outlined in Presidential Decree No. 103 of 2001 on the Status, Main Task, Function, Authority, Organizational Structure and Working Orders of Non Department Government Institutions, as latest amended by Presidential Regulation No. 145 of 2015. The Chairman of BAPETEN is responsible and report directly to the President of the Republic of Indonesia.

Reporting obligations

As a non-ministry agency, BAPETEN has responsibility to the President directly. The concept of a central nuclear regulatory body positioned under the President minimizes the possibility of conflicting responsibilities and should provide this authority with effective independence.

Means for the effective separation

Based on Act No. 10 of 1997, there are separation between the functions of the regulatory body and promoting body of nuclear energy. The Act states that the Government establishes a promoting body, under and directly responsible and report to the President of the Republic of Indonesia. The promoting body has the task to utilize nuclear energy. The regulatory body's task is to regulate any nuclear energy utilization.

Article 9 Responsibility of License Holder

Each Contracting Party shall ensure that prime responsibility for the safety of a nuclear installation rests with the holder of the relevant licence and shall take the appropriate steps to ensure that each such licence holder meets its responsibility

Prime responsibility for safety

In accordance with GR No. 54 of 2012 on the Safety and Security of Nuclear Installation, the prime responsibility of safety in the nuclear energy utilization lies on the license holder, and this responsibility cannot be delegated.

Discharging the prime responsibility for safety

GR No. 54 of 2012 on the Safety and Security of Nuclear Installation requires the licensee to be responsible in implementing nuclear safety. These responsibilities are:

a) achieving the safety objective.
b) establishing and performing policy according to the safety objective.
c) determining the safety criteria.
d) assuring the safety in utilizing the nuclear material.
e) establishing, performing, and developing internal procedures and provision to ensure safety.
f) creating an organization with task, authorization, responsibility, and clear communication path.
g) establishing and ensuring that the personnel have the appropriate competency and skills with their task field; and
h) Performing evaluation, monitoring, and periodically auditing all items related to safety.

Mechanisms for the license holder to maintain transparency and openness

The license holders convey the activity of transparency and openness of operating reactor on their website. Figure 6 shows the implementation of BATAN to give information of nuclear energy promotion to public by that website. The activity of transparency and openness is including a schedule of reactor inspection, operation, and maintenance.

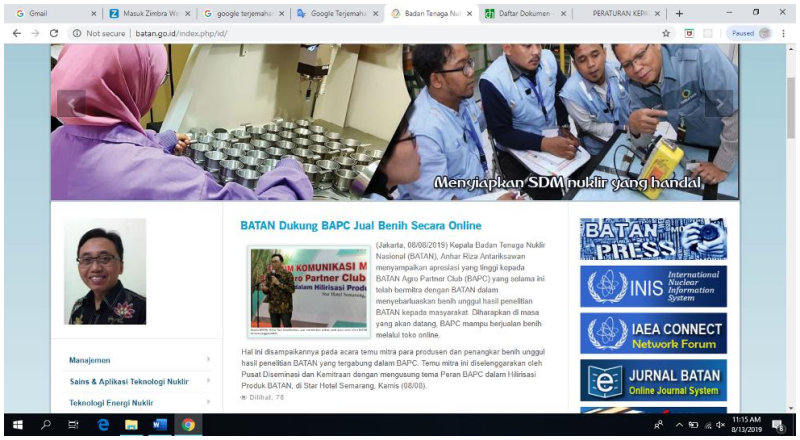


Figure 6. Website of BATAN

BATAN conducts public communication to public and stakeholder regarding the development of nuclear utilization in nearby area of facility. Figure 7 shows public consultation performed by BATAN.

Figure 7 . Public consultation performed by BATAN in 2018

PSTNT BATAN, the center which operates TRIGA 2000 reactor, has carried out meeting with customer for product service dissemination. The participants came from educational institutions, private companies, state owned companies, and government agencies.

Ensuring that the license holder has appropriate resources

To ensure that the licensee of the nuclear facility has appropriate resources (technical, human, financial), it has been stipulated in BCR 4 of 2010 that a licensee must allocate adequate resources to implement, conduct, assess, and improve management system continuously. In addition, the licensee of nuclear facility has approriate resources

Article 10 Priority to Safety

Each Contracting Party shall take the appropriate steps to ensure that all organizations engaged in activities directly related to nuclear installations shall establish policies that give due priority to nuclear safety

Regulatory requirements

Regulatory requirements regarding policies and programmes to be used by the licensee to prioritize safety in activities for design, construction and operation of nuclear installations are stipulated in:

- GR No 54 of 2012 on the Safety and Security of Nuclear Installation.
- GR No. 2 of 2014 on the Licensing of Nuclear Installations and the Utilization of Nuclear Materials.
- BCR No. 4 of 2010 on the Management System for Nuclear Facilities and Activities; and
- BCR No 2 of 2011 on the Provision of the Operational Safety of Non-Power Reactor.

Safety policy

GR No 54 of 2012 on The Safety and Security of Nuclear Installation put the bases to the licensees to establish their safety policies. The GR requires the licensees to put high priority to safety in all of their activities and facilities. The prime responsibility of lies on the license holder, and management at all levels including staff shall demonstrate its commitment to safety.

BATAN as a licensee of three reactors has also established it safety policies and safety culture programme in BATAN Chairman Regulation No. 200 of 2012 which was later updated into BATAN Chairman Regulation No. 4 of 2019 on the guidelines for Implementing a safety culture in BATAN's Organization. BATAN has stated in its safety policy that high priority is given to safety in all of its activities to achieve zero accident to protect workers, facilities, public and environment from any potential hazard. All staffs are obligated to seek the safety goal achievement appropriate to their roles and responsibilities. This safety policy is then implemented in all three reactors.

Safety culture programme and development

Implementation of safety culture in BATAN has been performed intensively since 2014. The BATAN Safety Culture Team was formed through the BATAN Chairman Decree (since 2015 and renewed annually). The team is tasked with promoting and fostering a Safety Culture in BATAN. The team's mission in 2015-2019 is to improve the guidelines and standards for implementing safety culture at BATAN and to raise a good perception on safety culture for all staffs in BATAN.

Activities related to safety culture that have been carried out, consist of convey safety policy anually by BATAN managements, visits to all work units for diseminating and fostering safety culture, annual safety culture workshops, safety culture self-assessment, dissemination of safety culture self-assessment results, annual occupational health and safety seminars, safety culture informal meetings involving staff and management of BATAN and other activities carried out independently by work units at BATAN to foster and strengthen a safety culture.

Arrangements for safety management

Meanwhile, pursuant to BATAN Chairman Regulation No. 4 of 2019, the management of organization in all levels establish of safety culture, include:

1. The Chairman of BATAN determines safety policy.
2. Each of center / division in BATAN organization develops and implements safety culture programme. The safety culture program is a series of activities aimed at improving the

commitment to implementation the 5 (five) safety culture characteristics. The safety culture program is developed based on the results of safety culture self-assessment.
3. Each of center / division in BATAN organization annualy performs safety culture self-assessment.
4. One unit in BATAN (PSMN) performs audit and monitor safety culture implementation as a part of organization management system audit.
5. One unit in BATAN (PTKRN) develops and fosters safety culture.

The practise of safety culture covered by several method that is to:
1. Build commitment to all members of the organization.
2. Build a common understanding of safety culture and establish the level of safety culture to be achieved.
3. Conduct a self-assessment of the safety culture within the organization based on characteristics and attributes of safety culture and communicating the results of self-assessment to any individu in the organization.
4. Identify gap between levels of safety culture to be achieved, perform root causes analysis, and develop corrective actions required.
5. Develop and define improvement programs and change processes, and communicate to individuals at all levels of the organization; and
6. Maintain continuous improvement towards desired level of safety culture.

The Five Safety Culture characteristics and example practical implementation are:
1. Safety is a clearly recognized value, with the practices:
   a) communicating safety values through socialization, workshops and training,
   b) sharing the the practices of safety culture between work units,
   c) morning briefing, coffee morning, daily meeting, safety posters and banners.
2. Leadership for safety is clear, with the practices:
   a) active management involvement in safety activities.
   b) monitoring activities that impact on safety.
   c) increasing the frequency of visits by the manager to the workplace.
   d) facilitating of safety training and upgrading individual competences.
   e) Implementating two-ways open communication.
3. Accountability for safety is clear, with the practices:
   a) assigning and documentating of duties and responsibilities each individual.
   b) evaluation of safety performance indicators regularly.
   c) obedience to standard operating procedures
   d) routine reporting of operation activities according to safety requirements.
   e) open reporting of safety issues
4. Safety is integrated into all activities, with the practices:
   a) implementation of risk assessment on each important activity.
   b) internalization of the STAR (Stop-Think-Act-Review) concept in work.
   c) strengthening competency through training.
   d) developing safety-based behavior,
   e) performing safety induction or briefing before work.
   f) good document management,
   g) implementation of 5S principle (Simple, Tidy, Clean, Maintain and Diligent) in the workplace.
   h) strengthening teamwork,
5. Safety is learning driven, with the practices:
   a) joint inspections by individuals and management on Health, Safety and Environment (HSE).
   b) implementation of safety culture self-assessment.
   c) open reporting of safety issues.
   d) sharing information and experiences related to implementation of safety culture between work units.

e) training, requalification of individuals, provision of facilities and adequate learning infrastructure.
f) performing root cause analysis in every incident related to safety.

Arrangements for safety monitoring and self-assessment
BATAN performs self-assessment for both technical aspect and safety culture aspect. There are 37 indicators that should be achieved on safety culture aspect. In performing the self-assessment, BATAN has established online system tools to review safety culture. Each centre in BATAN has implemented safety culture self-assessment.

Independent safety assessments
BCR No 4 of 2010 states that license holder is responsible to the implementation of independent safety assessment. The independent assessment has to be performed regularly by independent external organization on behalf of the license holder is aimed to:

- evaluate the effectiveness of processes in meeting and fulfilling goals, strategies, plans and objectives.
- determine the adequacy of work performance and leadership.
- evaluate the organization's safety culture.
- monitor product quality; and
- identify opportunities for improvement.

Moreover, GR No. 54 of 2014 requires the licensee to establish safety committee that has responsibility to conduct safety assessment and suggest recommendation to the license's holder related to the design, construction, operation safety.

Discussion on measures to improve safety culture
The licensees have to continually improve safety culture as required in the BCR No. 4 Year 2010. Measures to improve safety culture shall be identified based on the self-assessment and independent assessment. Actions to improve the processes shall be selected, planned and recorded. Focused group discussion in all levels is also use to communicate safety culture performance, assessment, and improvement. Benchmarking through regional meetings, such as the IAEA Asia Nuclear Safety Network, is also encourageing this improvement measures.

A process oriented (quality) management system
A provision process oriented (quality) management system is stipulated in BCR No 4 of 2010, that requires the licensee to implement process oriented (quality) management system. It should be noted here that BCR No 4 of 2010 is fully adopting the IAEA GS-R-3. Hence, this regulation requires that the processes of the management system that are needed to achieve the goals, provide the means to meet all requirements and deliver the products of the organization shall be identified, and their development shall be planned, implemented, assessed, and continually improved. The sequence and interactions of the processes shall be determined. Furthermore, the methods necessary to ensure the effectiveness of both the implementation and the control of the processes shall be determined and implemented.

Licensees Good Practices and safety culture achievements
BATAN as the license holder of three reactors has established its guidance on safety culture implementation by BATAN Chairman Regulation No. 4 of 2019. BATAN safety culture implementation consists of safety policies establishment, safety culture programme development and implementation, capacity building, and safety culture assessment. All working units in BATAN have established and implemented the safety culture programme. Based on definition of IAEA–TECDOC-1329- Safety culture in nuclear installations, BATAN safety culture level has achieved safety culture

level 2 and is on the way to achieve level 3. Level 2 and 3 are defined safety as an organizational goal and safety can always be improved respectivley. This is very encouraging development.

Regulatory processes for monitoring and oversight

BAPETEN performs monitoring and oversight of arrangements used by the licensee to prioritize safety through licensing and inspection process. In the licensing process, BAPETEN reviews the safety policies of the licensee through management system of the licensee and conduct inspection to verify the implementation of the management system. Particularly, BAPETEN also performs survey and interview to all level of the licensee's organization related to the implementation of safety culture programme.

Means used by the regulatory body to prioritize safety in its own activities

The provision for the BAPETEN priority to safety in its own activities is established in its internal regulation No. 14 year 2014 on Management System of Nuclear Energy Regulatory Agency. Practically, BAPETEN priority to safety is implemented in its main task through risk-based inspection. The more risk of the facility or activity, the more comprehensive and frequent inspection conducted by BAPETEN.

Article 11 Financial and Human Resources

1. *Each Contracting Party shall take the appropriate steps to ensure that adequate financial resources are available to support the safety of each nuclear installation throughout its life.*
2. *Each Contracting Party shall take the appropriate steps to ensure that sufficient numbers of qualified staff with appropriate education, training and retraining are available for all safety-related activities in or for each nuclear installation, throughout its life.*

Article 11 (1) Financial resources

Provision of financial resources

Based on GR No. 2 of 2014 on the Licensing of Nuclear Installations and the Utilization of Nuclear Materials, financial requirement is one of the licensing requirements for the construction, commissioning, and operation of commercial power reactor or commercial non power reactor.
Financial requirements are design to guarantee safe operation of nuclear installation and performance of decommissioning at the end of the cycle, and to provide the liability for nuclear damage. Act No. 10 of 1997 on Nuclear Energy describes liability of nuclear damage, The maximum limit of liability may be reconsidered through the Government Regulation.

For obtaining a construction and operation license, the financial requirements include terms deposit in Government Banks, guarantee letter from Government or private national Bank, or saving account. Meanwhile, the financial requirements to obtain a commissioning and operation license, include liability for nuclear damage insurance or other financial guarantee, and financial guarantee to implement decommissioning.

Statement of adequacy

The adequacy of financial requirements is subject to evaluation by the Ministry of Finance, the National Agency for Development Plan, and other main stakeholders such as BATAN during the development of GR No. 2 Year 2014. Furthermore, the President Regulation detailing the limit of liability of nuclear damage is also a subject to periodic review initiated by the regulatory body, depending on the special drawing rate.

Financial requirement assessment

Assessment to financial requirements is performed by the regulatory body to ensure the safe operation of nuclear installation and the performance of decommissioning at the end of the cycle, and to provide the liability for nuclear damage.

Financial resources availability in the event of a radiological emergency

Act No. 10 of 1997 stated that the fund for liability of nuclear damage shall be available within seven days following the declaration of nuclear accident by the Chairman of BAPETEN. In this case, the Chairman shall make the declaration within 3 (three) days after a nuclear accident. The insurance company liable for nuclear damage due to a nuclear incident shall pay the compensation within 7 (seven) days after the date of issuance of nuclear incident statement by the Regulatory Body.

Article 11 (2) Human resources

Regulatory requirements

Act No. 10 of 1997 required that all employees operating a nuclear reactor shall be subjected for obtaining a working permit from the regulatory body. These requirements lead to the establishment of BCR No. 7 of 2019 on the Working Permits for Personnel of Nuclear Installation and Materials, which arrange staffing, qualification, training, and retraining mechanism. This safety related personnel include Reactor Operator, Reactor Supervisor, Radiation Protection Officer (RPO), Maintenance Officer, and Nuclear Material Officer.

Competence analysis method

In developing general and specific requirements for obtaining working permit, regulation requires knowledge, skill and attitude needed to perform these safety personnel. Based on these requirements, the operator (applicant) performs gap analysis for their personnel and training needs assessment. If the candidate for obtaining working permit fulfill all these requirements, then the operator submit an application to the regulatory body. To fulfill the requirements, candidates are required to attend and pass training or retraining (refreshment), apply certification to BAPETEN. BAPETEN examines the applicants and issues the working permit.

Training and retraining

According to BCR No. 7 of 2019 on the Working Permits for Personnel of Nuclear Installation and Materials, the operator has an obligation to perform initial training and retraining to all the staff. In this case, the existing operator (BATAN) performed training needs assessment before organizing any training and re-training needs by the staff. BAPETEN assigns designated training institution to conduct training and retraining. BATAN has training center facilities for training and retraining of nuclear installation officers. For commercial power plant, this BCR requires the use of simulator training and examination of various scenarios, such as normal operation, transients, design bases accidents, beyond design bases accidents, and operation management.

BATAN has routinely implemented training and retraining its personnel (Figure 8). Referring to the BCR No. 7 of 2019, all operators and supervisors shall attend retraining to maintain their competencies and proposed for a new license permit to BAPETEN every 3 years. The Center for Education and Training (BATAN) held the event for 2 weeks, with consist of 1 week retraining for license renewal and additional 1 week for the new applicant/candidate for operator or supervisor. The similar scheme is also applied for maintenance technician (retraining periodicity every 4 years) and safeguards officer (retraining periodicity every 4 years). The trainer is recruited from the local resources of BATAN or BAPETEN who is independently from outside of the Reactor division e.g. researcher from the related subject of the training course (neutronics expert, thermal hydraulics expert, etc.). The curriculum and syllabus have been validated by the BAPETEN.

Other practice of training is also applied such as by local coaching from the senior staff who are nearly in retirement to preserve and pass along the critical knowledge to junior staff. This practice has very significant advantage to deliver best practice to the new or junior staff.

Figure 8. Routine training in TRIGA 2000 Reactor

Plant simulator (Internet Reactor Laboratory/IRL)

Currently, there is no full-scale plant simulator available for power reactors in Indonesia. In early 2014, the managament of Kartini Reactor has studied and developed online facilities and offer both online and offline services for employees and student training, namely Internet Reactor Laboratory (IRL).

IRL was presented at the Nuclear Youth Summit in Jakarta in the end 2014, and it is based on distance learning. Reactor operators in Yogyakarta explained how to start, operate, and shutdown the reactor, while participants in Jakarta directly observed the operation of the reactor through the video conference platform and websites.

The Kartini reactor continues to develop and evaluate different types of training in the reactor. A training for reactor power callibration and temperature coefficient of the fuel were vailable in 2019. Then, by 2021, seven types of training were provided in the Kartini reactor, namely Kartini reactor operation, reactor power callibration, temperature coefficient of the fuel, control rod reactivity measurement, reactor criticallity, neutron flux measurement, and fuel burn up measurement. The addition of a variety of training will continue with installation and database software that is more stable in acquiring data.

The Covid-19 pandemic in early 2020 became a turning point for the development of the Internet Reactor Laboratory. Currently, online learning is a popular method in the academic community (Figure 9). Distance learning is becoming the new normal in higher education. This is leading to an increase in the use of IRL in many universities from 19 institutions in 2020 to 28 institutions by the end of 2021, with more than 2400 students, and 15% of these are international students from three universities in Asia.

Figure 9. Internet reactor laboratory in Kartini Reactor

Kartini Reactor focuses on promoting national and international cooperation as key performance indicators under the National Research and Innovation Agency (BRIN). Indonesia has officially requested to IAEA to establish Kartini Reactor IRL as an official partner of IAEA so that Indonesia can contribute to the international community in human resource development. Offers of cooperation in research and education are also being made through various other international forums and direct contact with universities that potentially need nuclear research reactors to support learning.

Training of maintenance and technical support staff

As stated previously, training and qualification for maintenance officer and technical support staff (such as RPO) are required by the above BCR. The training and qualification program includes preparation of safety related systems and components needed for operation; preparation of personal protective equipment, materials, tools and measurement apparatus; implementation procedures; isolation systems; and warning notes and signs.

Improvements to training programmes

In order to response generation gap problem in the operator side, BATAN improves their training program with the use of coaching methods and computer-based training. Coaching is found to be a useful process in developing competency for operator and supervisor reactor, especially to face the fact that most of senior operator and supervisor is due to retirement soon. Computer based training is also important part of nuclear knowledge management.

Staff sufficiency assessment

The operator as required by national law regarding staffing has to fulfill J1 & J2 form or Staff Position Analysis. In this case, J1 is analysis of number of staff needed with specific duties and competency requirements, and J2 is the number of staff available fulfilling all competency requirements in this position. Hence, this is a form of gap analysis, both quantitative and qualitative ways.

Contracted personnel and assessing their qualification and training

In principle, BATAN only contract external support personnel for their specific competency that is not available in BATAN but is related to nuclear safety, for example in performing site evaluation in a certain aspect, and in making conceptual and detail design for a specific type of power research reactor. For seismic and meteorological aspects are supported by experts from the Meteorology,

Climatology and Geophysics Agency (BMKG), and the Centre for Geological Studies (PSG). Volcano aspects are supported by experts from Volcanology and Geological Disaster Mitigation (PVMBG). BATAN requirements for these contracted personnel usually related to educational background, publication and working experiences, and certification. Assessment by BATAN on the fulfilment of these requirements is a national obligation before the contract can be made.

National experts in nuclear science and technology

National experts, who technically support BATAN and BAPETEN function, are mostly supplied by universities and research institute. In this instance, Gadjah Mada University (UGM) has a nuclear engineering department; Bandung Institute of Technology has a nuclear science program under Department of Physics; and, University of Indonesia has a Health Physics Department, which is related to radiation protection.

Competence analysis for severe accident management staff

Building competence in severe accident management is regarded as an important subject. At the facility level, Article 64 of the GR No.54 of 2012 requires the licensee to conduct human competencies analysis. Furthermore, in the draft revision of BCR No. 1 of 2010 on Nuclear Emergency Preparedness and Response (Article 10) mentioned that the licensee should identify knowledge, skills and attitude required for emergency response staff and should establish qualifications and competencies for emergency response staff. Thus, the licensee should develop and establish tools of analysis to ensure that the emergency response staff comply with the established qualifications and competencies.

At the national level, the I-CoNSEP (Indonesia Center of Excellence on Nuclear Security and Emergency Preparedness) launched in 2014, as one of the initiatives to improve national capabilities in nuclear security and emergency preparedness. The I-CoNSEP is continuously being developed through a better coordination among stakeholders, training and exercise, technical support, and infrastructure development. Competence analysis, especially for anticipating severe accident, is one of the top priorities in the I-CoNSEP forum. Knowledge, skill, and attitude requirements, gap analysis; training needs assessment; and four quadrant model are very important tools of analysis in this challenge.

Regulatory review and control activities

BAPETEN established BCR No. 7 of 2019, a regulation regarding training, retraining, qualification, and certification of operator staff related to safety. Then, BAPETEN perform surveilance and review of training programme organized by the training institution before personnel obtains working permit. BAPETEN performs review and assessment of human resource adequacy as part of Periodic Safety Review (PSR) document submitted by the operator to renew the operating license.

Article 12 Human Factors

Each Contracting Party shall take the appropriate steps to ensure that the capabilities and limitations of human performance are taken into account throughout the life of a nuclear installation

Overview of the Contracting Party's arrangements and regulatory requirements to take human factors and organizational issues into account for the safety of nuclear installations

In accordance to GR No. 54 Year 2012, licensees shall conduct human reliability analysis and develop training and education program to ensure consideration of human factors in nuclear installations. Human reliability analysis shall consider personnel qualification, health factor, task analysis, ergonomic factor, and man machine interface factor. In implementing training and education program, licensees shall establish personnel qualification, competency, and level of expertise in conducting site monitoring until decommissioning stage.

Consideration of human factors in the design of nuclear installations and subsequent modifications

Based on GR No. 54 Year 2012, BCR No. 1 Year 2011 on Design Safety Provision of Non Power Reactor, and BCR No. 3 Year 2011 on Design Safety Provision of Power Reactor, human factors and man machine interface shall be considered in the design of nuclear installations and its subsequent modifications.

Methods and programmes of the license holder for analyzing, preventing, detecting and correcting human errors in the operation and maintenance of nuclear installations;

Nuclear installations in Indonesia have stated method and program for analysing, preventing, detecting and correcting human errors during operation and maintenance on their respective management system documents as required in BCR No. 4 Year 2010 on Management System for Facilities and Activities. Licencees are responsible for corrective action of nonconformity found. Corrective actions shall first identify nonconformity that could potentially reduce performance of the organization. Licensees define and implement prevention action to eliminate possible cause of nonconformity. Status and effectiveness of all corrective actions and preventions are monitored and reported.

Self-assessment of managerial and organizational issues by the operator

BATAN has been developing an Enhancing Computer Based Predictive (CRP) Model Analytical Tool for Trustworthiness Programmes since 2019. The overall activity within this CRP program is being designed to comply the existing Human Reliability Program (HRP) in place and particularly is expected to contribute for other Member States trustworthiness assessment policies.

The first prototype of questionnaires has been deployed to 60 responders. The reliability and validity of the questionnaire were calculated using a statistical analysis from the results of the sample questions first provided to abovementioned responders, as well as for the new questions that were developed to be specific to the program in Indonesia. Cultural norms in Indonesia have been factored into the questions being administered.

This first prototype of the questionnaires have to be re-modified to correct any answers which are potentially biased from the last activity and advanced statistical analysis will be used to reanalyze the results as well.

BATAN is developing a computer program as a tool to analyze the results of the questionnaire. This program will correlate the respondent's answers to the dimensions of trustworthiness (which were previously defined with the consultation of experts). Bayesian theory will be utilized to transform

qualitative answers into quantitative probabilities that will identify the likelihood an employee will act as an insider. The developing of this computer model is expected to be completed in 2023.

Arrangements for the feedback of experience in relation to human factors and organizational issues
Arrangements for feedback of experience has been conducted in the facility as a mean of knowledge preservation and written as knowledge management program. Licensees consider lesson learned from experiences of other organizations and also past operation and maintenance experience of the facility.

Regulatory review and control activities.
BAPETEN has conducted review and assessment of human factors as part of review and assessment of existing facility design and its modification, as well periodic safety review.

Article 13 Quality Assurance

Each Contracting Party shall take the appropriate steps to ensure that quality assurance programmes are established and implemented with a view to providing confidence that specified requirements for all activities important to nuclear safety are satisfied throughout the life of a nuclear installation.

Overview of the Contracting Party's arrangements and regulatory requirements for quality assurance programmes, quality management systems, or management systems of the license holder

The existing BAPETEN Chairman Regulation (BCR) No. 14 of 2014 on BAPETEN Management System was developed based on GSR 3, ISO 9001:2008, and ISO 9004:2009. In 2018, BAPETEN started to revise this BAPETEN Chairman Regulation based on IAEA GSR Part 2, ISO 9001:2015, and ISO 9004:2018. In the drafting process of the BAPETEN Management System, the issues of leadership, safety culture, risk management, and communication issues will be included as well as the values, policies, and procedures for decision making. This BAPETEN Chairman Regulation will be issued in 2023.

For nuclear reactor licensing process, GR No. 2 of 2014 states that integrated management system (IMS) is one of the licensing requirements of the licensing of nuclear facilities in each stage, from siting to decommissioning. The implementing instrument of IMS is detailed in BCR No. 4 of 2010 on the Management System for Nuclear Facilities and Activities, which is fully adopting the IAEA GS-R-3.

Status of implementation of integrated management systems at nuclear installations

All nuclear facilities have been establishing and implementing IMS since 2012 which was later stipulated in the BATAN Chairman regulation on management standard in 2018. Besides applying BCR No. 4 Year 2010, all nuclear facilities are required to implement ISO 9001, OHSAS 18001, and ISO14000. Furthermore, they should be accredited by Researcher and Developer Accreditation Committee (KNAPPP). For the example, TRIGA 2000 Reactor and Kartini Reactor are made mandatory for implementing management system for quality, environment, health and safety, management system for nuclear facilities and activities, and KNAPPP guidance.

BATAN Chairman Regulation on management standard in 2018 integrated BCR No. 4 Year 2010, ISO 9001, OHSAS 18001, ISO 14000, Requirements for Researcher and Developer Accreditation based on the KNAPPP Guidance no. 2 year 2017 into BATAN quality manual/ management system (SMB). The implementation of SMB is one of the efforts to support every employee to always be oriented towards safety in carrying out their duties.

Audits of vendors and suppliers by the license holders

The management of organization in all levels establish a mechanism for implementing a second party audit (against suppliers) if the procurement document requires that the supplier has implemented a quality management system. Based on BCR No. 1 of 2017, BAPETEN nuclear inspectors have an authority to inspect and verify quality of product to supplier or vendor during licensee process.

Regulatory review and control activities

Regulatory review and control activities performed by BAPETEN includes conducts of IMS/QA audit/inspection for nuclear facility and supplier having the activities and supplying the safety related system, structures and components.

Article 14 Assessment and Verification of Safety

Each Contracting Party shall take the appropriate steps to ensure that:

i. Comprehensive and systematic safety assessments are carried out before the construction and commissioning of a nuclear installation and throughout its life. Such assessments shall be well documented, subsequently updated in the light of operating experience and significant new safety information, and reviewed under the authority of the regulatory body;

ii. Verification by analysis, surveillance, testing and inspection is carried out to ensure that the physical state and the operation of a nuclear installation continue to be in accordance with its design, applicable national safety requirements, and operational limits and conditions.

Article 14 (1) Assessment of safety

Regulatory requirements

Regulatory requirements to perform comprehensive and systematic safety assessments are stipulated in:

1. GR No. 2 of 2014 on Licensing of Nuclear Installation and Utilization of Nuclear Material
2. GR No. 54 of 2012 on The Safety and Security of Nuclear Installation
3. BCR No 2 of 2015 on Safety Verification and Assessment of Non-Power Reactor

The provisions for the licensee to perform comprehensive and systemic safety assessments are established in GR No. 2 of 2014 and GR No. 54 o 2012. GR No.2 Year 2014 requires the licensee to submit a set of documents with the application that depends on the reactor life-cycle phase. Those documents include the information of safety aspect of siting, construction, commissioning, operation and decommissioning activities of nuclear installations. The types of documents include administrative, technical, and financial.

Technical documents to be submitted to BAPETEN to obtain a license in each phase are mainly to demonstrate the safety of the installation. In the siting phase, licensee has to submit Site Evaluation Report to demonstrate all factors at a site that could affect safety at the nuclear installation and the safety of its activities has been considered. This includes site characterization and consideration of factors that could affect the safety features of the nuclear installation or its activities and result in a release of radioactive material and could affect the dispersion of such material in the environment.

BAPETEN has issued several BCRs related to assessment of safety. In 2017, BAPETEN issued BCR No. 7 year 2017 on the amendment of BCR 7 of 2013 on the Environmental Radioactivity Limit. This BCR regulates the value of radioactivity limits in the environment for nuclear installations. Regarding safety verification, the licensees must carry out monitoring of nuclear installation at the operational stage to reassess whether the releases limit from nuclear installation is below the value stated on this BCR.

BAPETEN issued BCR No. 4 Year 2018 on Safety Provisions for Site Evaluation of Nuclear Installation, amending BCR No. 5 Year 2007 on Safety Provisions for Site Evaluation of Nuclear Reactor. This BCR provides a guidance to perform assessment of safety for siting aspect.

BAPETEN issued BCR No. 4 Year 2019 on Dispersion of Radioactive Material in Air and Water and Consideration of Population Distribution in Site Evaluation for Nuclear Installation, amending BCR No. 3 Year 2008 on Dispersion of Radioactive Material in Air and Water and Consideration of Population Distribution in Site Evaluation for Nuclear Power Plants. This BCR applies to all nuclear installations not limited to nuclear reactors. In addition, BAPETEN issues BCR No. 2 Year 2019 on the safety of commissioning for Non-Power Reactors.

Safety assessments within the licensing process

In the construction including design, and operation phases, safety analysis report has to be submitted to BAPETEN. More detailed provisions for the Safety Analysis Report (SAR) is defined in BCR No 1 Year 2011 and BCR No 8 of 2012. The SAR must contain the information related to characterization, postulated initiating events, analysis of the sequence of events and evaluation of the consequences of postulated initiating events, comparison of the results of the analysis with the acceptance criteria and design limits, proof that the action of the automatic safety system combined with specific actions the operator is able to cope with the consequences, limiting conditions for operation, conduct of operation, analysis of safety systems and technical safety features, and analysis of confinement. The SAR is required to be updated for license renewal and when modifications are approved by BAPETEN.

The general safety principles and criteria for each stage of nuclear installation life-cycle are defined in GR No. 54 of 2012, which consist of site monitoring, design and construction, commissioning, operation, modification, decommissioning; and safety verification and assessment.

Re-evaluation of hazards assumptions is conducted during the periodic safety review, which has to be carried out by the licensee during construction, commissioning, and operation of installation, as stipulated in the GR No. 54 of 2012. The periodical safety review includes:

a. nuclear installation design
b. current condition of structure, system, and component.
c. equipment qualification.
d. ageing; performance and operation experience feedback.
e. safety management and nuclear emergency preparedness program; and
f. environmental radiological impact.

The provision for a periodic safety review is outlined more detailed in BCR No 2 of 2015 which requires the licensee to submit a report to BAPETEN every ten years. The contents of the periodic safety review report include organization and administration, procedures, current plant safety documents, operating experience feedback and lessons learned from incidents or occurrences, the condition of structures, systems and/or components, qualification of equipment, safety performance, nuclear emergency preparedness program, ageing management program, radiation protection program, management system, data and information related to supervisor reactor, reactor operators, maintenance supervisors, and maintenance technicians, covering training, refreshment training and mutations, releases of radioactive effluents into the environment and the handling of radioactive waste.

Regulatory review and control activities

BATAN reactors conduct the periodical safety review. There is an agreement between licensee and BAPETEN on which safety factors will be reviewed and its extent.

(1) MPR GA Siwabessy

From 2016 to 2019, the licensee conducted several safety assessments which include:

1. Implementation of PSR.
2. Ageing management for critical SSC's: as heat exchanger, reactor tank, and cable panel.
3. Repair S-5 beam tube.
4. Revitalization of cooling tower, fire safety system, and seismograph system.
5. Structure and building.
6. Reevaluation for siting.
7. Updating all data and information on Safety Analysis Report.

(2) TRIGA 2000 reactor

From 2016 to 2019 the licensee conducted several safety assessments which include:

1. Implementation of PSR.
2. Ageing management for critical SSC's.
3. Updating all data and information on Safety Analysis Report.

(3) Kartini reactor

From 2016 to 2019 the licensee conducted several safety assessments which include:

1. Implementation of PSR.
2. Ageing management for critical SSC's.
3. Structure and building.
4. Updating all data and information on Safety Analysis Report.

Article 14 (2) Verification of safety

Regulatory requirements

Regulatory requirements for the verification of safety include:

1. GR No. 54 Year 2012 on The Safety and Security of Nuclear Installation,
2. BCR No. 2 Year 2015 on Safety Verification and Assessment of Non-Power Reactor
3. BCR No.8 Year 2008 on Safety Provision of Non-Power Reactor Ageing Management

GR No. 54 Year 2012 and BCR No.2 Year 2015 stipulate requirements for safety verification and assessments for all stages in the lifetime of nuclear installations. Safety verification has to be performed through analysis and surveillance which include:

a. implementation of management system in each stage of activities
b. design confirmation by independent team
c. review of site related factors
d. continuous surveillance during commissioning and operation nuclear installations including environmental monitoring, and
e. Assessment of modification and its control.

Main elements of programmes for continued verification of safety

Licensee of all reactors implement verification of safety (in-service inspection, surveillance, functional testing of systems, etc.) based on the licensing document that have been reviewed and approved by BAPETEN, such as Operating Limit and Condition and Ageing Management Program. BAPETEN perform routine inspection to ensure the implementation of the verification of safety and particularly for MPR G.A. Siwabessy reactor, BAPETEN also perform online and real time monitoring of safety operational parameters.

Elements of ageing management programme(s)

More detail provision on ageing management programme is stipulated in the BCR No.8 of 2008 on Safety Provision of Non-Power Reactor Ageing Management. Based on this BCR, the licensee shall establish ageing management program which consist of several steps, i.e.: screening of SSC's, program surveillance, data collection and evaluation of ageing. Ageing analysis report has to be submitted to BAPETEN as a requirement for license renewal.

Arrangements for internal review by the license holder of safety cases to be submitted to the regulatory body

An arrangement for internal review of safety cases by the licensee that has to be submitted to the regulatory body is stipulated in GR 54 Year 2012. The internal review for safety cases carried out by safety committee which is independent from the licensee organization.

During the construction, commissioning, and operational phase of reactor, the licensees are allowed to conduct modification. For safety related SSC modification, the licensee has to submit approval application to BAPETEN prior to the modification. More detail provision on modification is stipulated in BCR No. 5 Year 2012 on Safety in Non Power Reactor Utilization and Modification.

Regulatory review and control activities

BAPETEN review to the licensee's Assessment and Verification of Safety is performed through review and assessment of the license renewal application document, particularly in the Report of Periodic Safety Review. BAPETEN also conducts inspections to ensure that licensees always maintain compliance to the programmes for continued verification of safety (in-service inspection, surveillance, functional testing of systems, etc.) as stipulated in the administrative requirements of Operational Limit and Condition.

PRSG-BATAN, the center which operates MPR GA Siwabessy, has submitted a Report of Periodic Safety Review for the assessment of all systems, structures, and components that are important for safety. The crucial issue for this safety review is seismic aspect, which considers Peak Ground Acceleration (PGA) site specific value for 10,000-year return periods. In the implementation of periodic safety review, BATAN collaborates with the Agency for the Application of Technology (BPPT) to analyze the strength of buildings and structures by considering the seismic load with that PGA value. The activity is still in process, recommendations and follow-up including engineering solutions will be carried out after the results are obtained. BAPETEN continues to monitor these activities.

PRSG-BATAN also conducts an ageing assessment of electrical cable and panels related to safety. From the results of the implementation of this assessment, it was concluded that several cable in the reactor must be replaced. Lesson learned from cable ageing assessment, PRSG-BATAN prepares maintenance procedures for electrical cables and panels for next operation reactor.

In the assessment of the Ageing Report document, the implementation of ageing management is on the Critical of SSC's. Since 2005 PRSG-BATAN has been monitoring and collecting all of SSC. The results of monitoring are then identified and screened by operator; hence a number of critical SSC's are obtained as a priority in ageing management. These critical SSCs include primary cooling systems, reactor systems including internal components of the reactor core, and buildings and structures.

During 2017 to 2019, BAPETEN performed assessment of neutronic parameter including power peaking factor of TRIGA 2000 reactor, assessment of thermal-hydrolic and safety of utilization for Kartini reactor, assessment of neutronic and thermal-hydrolic of MPR GA Siwabessy, and assessment of critical structure, system and component during the licensing process of non-power reactor.

Kartini reactor has implemented ageing activity in the renewal operating license application since 2017. Some structure, system and components which have been replaced related ageing management activity are heat exchanger (shell and tube), secondary coolant pipe and cooling tower

During the period 2016-2019, Kartini Reactor continues to assess its reactor tank annually. The results are summarized in ageing assessment report and submitted to BAPETEN in 2019. The assessment of Kartini's reactor tank continues until now. Indonesia has been working with the IAEA under the TC INS 1030 activity. Twelve expert missions are planned for 2022-2023. The topic that will be discussed is ageing management of three Indonesian nuclear research reactors.

Article 15 Radiation Protection

Each Contracting Party shall take the appropriate steps to ensure that in all operational states the radiation exposure to the workers and the public caused by a nuclear installation shall be kept as low as reasonably achievable and that no individual shall be exposed to radiation doses which exceed prescribed national dose limits.

Regulatory requirements

The GR No. 33 of 2007 has adopted some important principles from IAEA BSS-115, i.e justification of practices, dose limitation and optimization of protection and safety. Dose limits have been set for radiation workers, apprentices and the public. To implement the optimization principle, BAPETEN includes the provision of dose constraint into the GR. The licensee shall make a radiation protection programme and implement the ALARA principle through the monitoring and maintaining the dose of workers to be agreed with the dose constraint and below the dose limit and monitoring the release of radioactive materials into the environment.

The GR governs that the licensee shall continuously, periodically and/or incidentally monitor the environmental radioactivity. The level of environmental radioactivity shall not exceed the environmental radioactivity limit established in the BCR No. 7 Year 2013. Besides that, GR No. 2 Year 2014 requires the licensee to submit the plan and report of environmental management and monitoring.

Based on follow up of IRRS Mission in 2015, since 2017 BAPETEN initiated to amend several government regulations. For instance, Government Regulation No. 33 of 2007 on Safety of Ionizing Radiation Sources and Security Radioactive Sources is being revised with coverage the provision on reviews including an investigation and critical review on justification and optimisation, periods for retention of records of patient dosimetry and independent audits. It is expected that the amendment of GR No 33 of 2007 will be enacted at the end of 2019.

BAPETEN also issued BCR No. 7 year 2017 to amend BCR 7 year 2013 on the Environmental Radioactivity Limit. This BCR regulates the value of radioactivity limits in the environment for nuclear installations. Regarding safety verification, the applicant must carry out monitoring of nuclear installation at the operational stage to reassess whether the releases limit from nuclear installation is below the value stated on this BCR.

BAPETEN also is currently making BAPETEN regulation that regulates radiation protection of the workers, the public and the environment, taking into account the potential future of the nuclear power plant program. This regulation adapts the IAEA Safety Guide No. NS-G-1.13, Radiation Protection Aspects of Design for Nuclear Power Plants. When this National report was made, the draft regulation is in the harmonization stage of the legal bureau - BAPETEN. It is expected that this regulation can be issued in the end of 2019.

Regulatory expectations for the license holder's processes to optimize radiation doses and to implement the 'as low as reasonably achievable' (ALARA) principle

In order to improve assurance on safety for harmful impact to the environment, BAPETEN has amended several implementing regulations such as BCR No. 1 Year 1999 on Provision of Working Safety against Radiation into BCR No.4 Year 2013 on Radiation Protection and Safety in Nuclear Utilizations.

Document of radiation protection programme is one of technical requirements to obtain a license/approval from BAPETEN. The Licensee is required to implement radiation protection programme, and to measure that occupational dose is ALARA. The BCR 4 of 2013 requires licensee to implement optimization radiation doses through establishment of dose constraint for worker and public. Dose constraint is implemented in the construction phase and operation and decommissioning or closure of nuclear installation, which is established as part of radiation protection programme.

According to the follow up of ORPAS Mission 2018, BCR No.4 of 2013 on Radiation Protection and Safety of Nuclear Energy Utilization is being revised to cover equivalent dose limit for the lens of the eye for apprentices.

Implementation of radiation protection programmes by the licence holders

In general, BATAN as a licensee established BATAN standard No. 16 year 2014 on radiation safety and protection, to implement radiation protection measures and environmental management and monitoring in order to meet the requirements set out in the regulations. Licensees have established dose constraint and discharge limit for each nuclear area.

Table 3. Radiation doses received by worker (2018)

Installation	Number of radiation workers	Maximum doses (mSv)	Average doses (mSv)
MPR 30	135	3.46	0.1
TRIGA 2000	84	5.8	1.1
Kartini	120	2.15	1.14

Table 4. Radiation doses received by worker (2019)

Installation	Number of radiation workers	Maximum doses (mSv)	Average doses (mSv)
MPR 30	150	0.74	0.04
TRIGA 2000	95	2.69	0.35
Kartini	106	0.63	0.28

To conclude from Table 3 and Table 4, there is not workers receive doses (in a year) beyond dose limit as required in BCR 4 Year 2013 (20 mSv/year). BATAN have implemented well a radiation protection measures and monitor in order to meet the requirements set out in the regulations

Regulatory review and control activities

BAPETEN review to the licensee's protection and radiation safety is performed through review and assessment of the license application document and renewal application document, particularly in the protection and radiation safety document, safety analysis report (chapter radiation protection), also in the report of Periodic Safety Review. BAPETEN also conducts inspections of radiation protection scope to ensure that licensees always maintain compliance to their documents.

BAPETEN also developed a worker doses evaluation reporting system. This system evaluates and monitors dose all of personnel who work in nuclear installation, as shown in Figure 10.

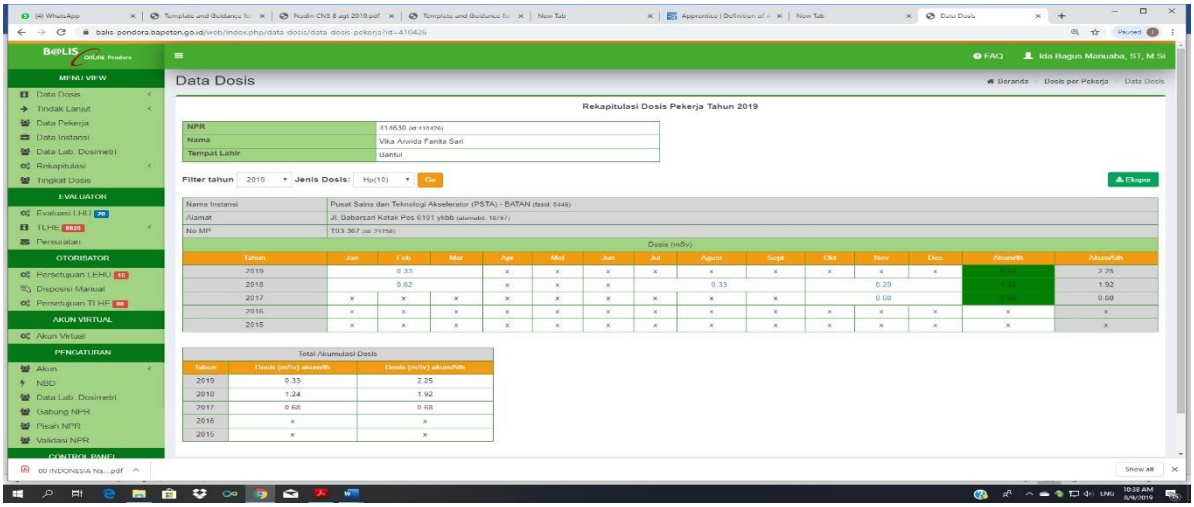


Figure 10 . Main menu of doses evaluation reporting system

BAPETEN invited IAEA Occupational Radiation Protection Appraisal Service (ORPAS) mission in order to develop an action plan for further improving the infrastructure for occupational radiation protection from 4 to 13 November 2018.

ORPAS mission has been running well and produced a number of inputs for Indonesia. Based on the evaluation results, there are some feedbacks, especially on the quality of regulations or policies that meet IAEA standards, including the implementation of radiation facilities and use.

In order to follow up on the recommendations of the IRRS Mission, in 2019 BATAN has coordinated the implementation of the IAEA Education and Training Appraisal Service (EduTA) mission. In implementing this mission BAPETEN has been involved to fill out module questionnaire related to the National Legal and Regulatory Framework for radiation protection education and training. It is expected that with the implementation of IAEA EduTA Indonesia will be able to know the status of its national regulatory infrastructure, specifically related to education and training in radiation protection and safety. Also with this mission the status of national policy and strategy is expected can be evaluated and adequacy of the training infrastructure can be assessed in terms of current and future national needs.

Article 16 Emergency Preparedness

Each Contracting Party shall take the appropriate steps to ensure that there are on-site and off-site emergency plans that are routinely tested for nuclear installations and cover the activities to be carried out in the event of an emergency

For any new nuclear installation, such plans shall be prepared and tested before it commences operation above a low power level agreed by the regulatory body

i. *Each Contracting Party shall take the appropriate steps to ensure that, insofar as they are likely to be affected by a radiological emergency, its own population and the competent authorities of the States in the vicinity of the nuclear installation arc provided with appropriate information for emergency planning and response.*

ii. *Contracting Parties which do not have a nuclear installation on their territory, insofar as they are likely to be affected in the event of a radiological emergency at a nuclear installation in the vicinity, shall take the appropriate steps for the preparation and testing of emergency plans for their territory that cover the activities to be carried out in the event of such an emergency.*

Article 16 (1) Emergency plans and programmes

Overview of the Contracting Party's arrangements and regulatory requirements for an emergency preparedness

Nuclear installations in Indonesia are categorized into facilities in Emergency Preparedness Category (EPC) II and III, according to IAEA Safety Standard Series No. GSR Part 7. The existing regulations, GR No. 54 of 2012 and BCR No. 1 of 2010, require the licensee to develop Emergency Preparedness and Response (EPR) programme based on facilities/acitivities hazard assessment, and submit it to BAPETEN as one of the licensing requirements.

The EPR programme should consist of infrastructure elements and response functions. In the draft revision of BCR No. 1 of 2010, the infrastructure elements consist of at least: organization and authority, coordination, facility and equipment, response procedure, and nuclear emergency training and exercise. Meanwhile, the response functions consist of at least: emergency response management operation; identification, report, and activation; mitigation measures; protective actions; providing warning, instructions and information to the public; protective measures for emergency workers, medical response, public communication, radioactive waste management, mitigation non-radiological consequence, nuclear emergency termination, analysis of the emergency and emergency response. The amendment of BCR No.1 of 2010 aims to be in line with the IAEA General Safety Requirement Part 7 - Preparedness and Response for a Nuclear or Radiological Emergency.

BAPETEN launched an initiative called I-CoNSEP (Indonesia Center of Excellence on Nuclear Security and Emergency Preparedness) in 2014. The initiative ultimately aims to improve the national capabilities in nuclear security and emergency preparedness, through a better coordination among stakeholders, training and exercise, technical support, and infrastructure development.

Indonesia has been developing and operating the national environmental radiation monitoring system and its early warning system since 2018. The system is urgently needed due to:

- An increase of nuclear technologies application and radioactive source spreading over global and national region.

- Potential hazard from radioactive or contamination release generated from emergency nuclear in Indonesia or across national border.
- Indonesia may face any potential threats due to its geography conditions.
- As an effort to develop environmental radiation baseline map/data; and
- As an effort to develop and established a national system for environmental radiation monitoring, nuclear emergency and early warning system.

One aspect in infrastructure development in Indonesia is the development of an emergency response monitoring and detection system by installing environmental radioation monitoring equipment that can monitor real-time radiation level in several locations. The equipments provide radiation level data as baseline of national surveillance data. The system is namely Indonesian Radiation Data Monitoring System (I-RDMS) (Figure 11).

Stationary detectors of I-RDMS have been installed in strategic locations, nuclear areas in Serpong, Yogyakarta and Bandung, CTBTO stations, and some meteorological stations located in area where potentially be affected by trans-boundary release of nuclear fallout. Meanwhile, the detectors also will be installed in airport, train station and industrial area.

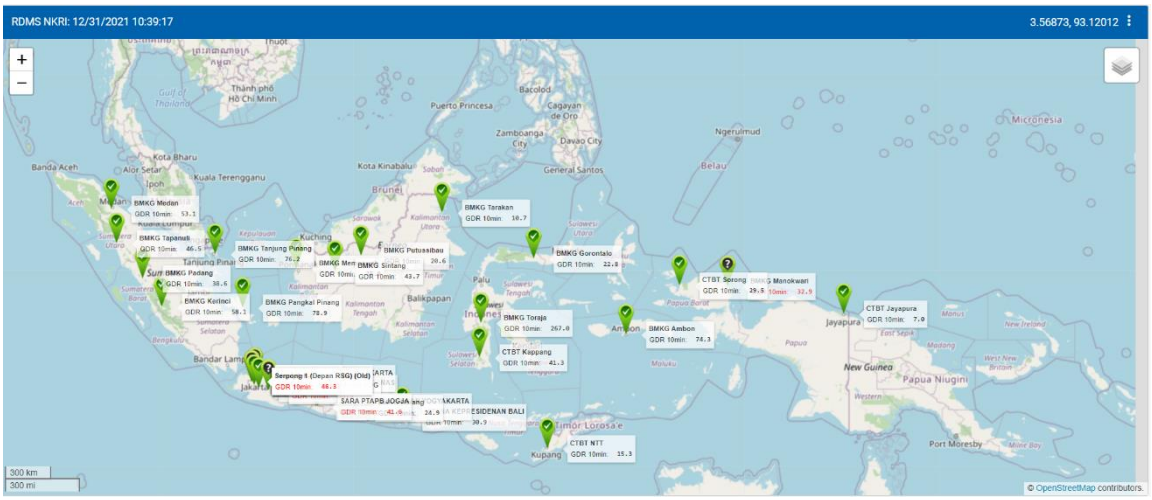


Figure 11. I-RDMS Installed in Indonesia

As one of Indonesia contribution to the international communities, Indonesia has signed an agreement with the IAEA on voluntary exchange of radiation monitoring data in December 2016. An example of the observed environmental radiation monitoring data by I-RDMS connected to IRMIS (International Radiation Monitoring Information System) network is shown in Figure 12.

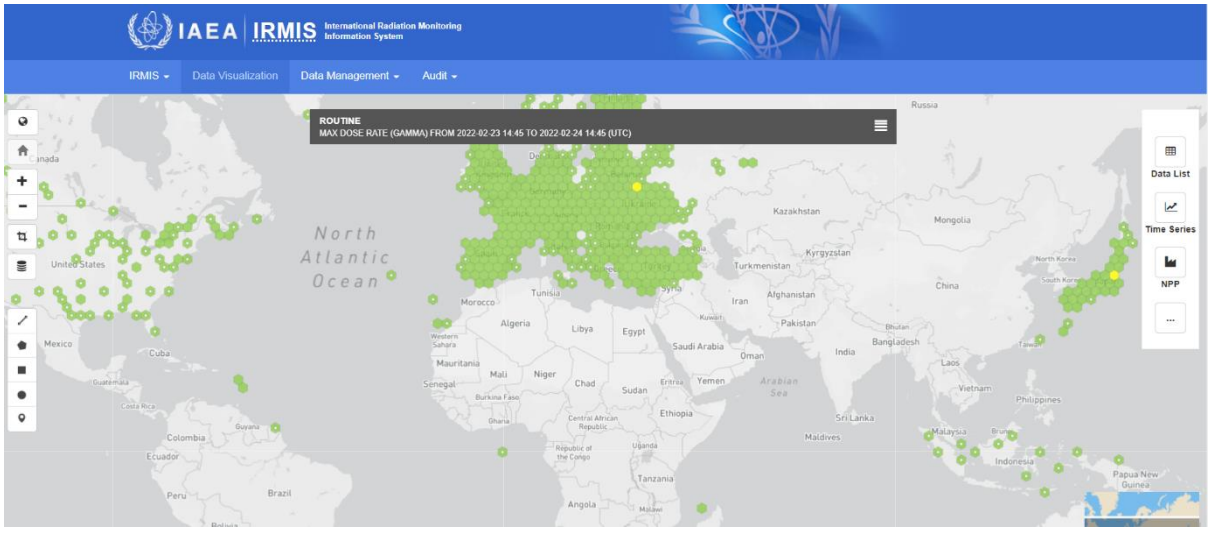


Figure 12. I-RDMS connected to IRMIS

Overview and implementation of main elements of national plan

The main elements of EPR programme at facility, local, and national levels are stated in key regulations that defines EPR, they are:

- Government Regulation No. 54 of 2012 on the Safety and Security of Nuclear Installation;
- Presidential Instruction No. 4 of 2019 on Capacity Enhancement in Preventing, Detecting, and Responding to Disease Outbreaks, Global Pandemics, and Chemical, Biological, and Nuclear Emergencies; and
- BAPETEN Chairman Regulation No 1 of 2010 on Nuclear Emergency Preparedness and Response.

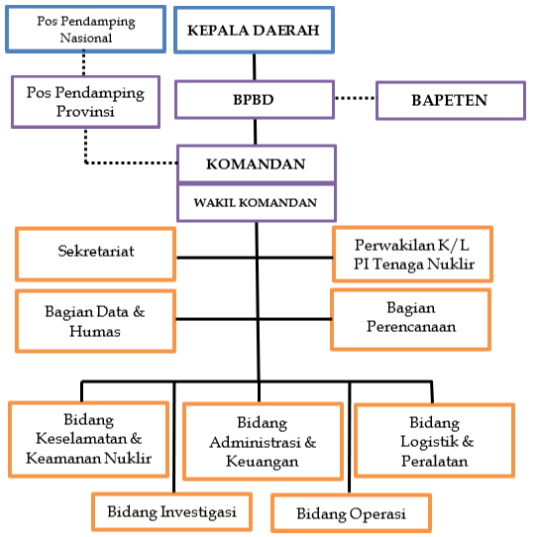
The Disaster Management Act No. 24 of 2008 mandates the National Disaster Management Agency (BNPB) as the coordinator for disaster management activities covering natural and non-natural disaster. Furthermore, the Presidential Instruction No. 4 of 2019 mandates BNPB to carry out coordinating and implementing functions prior and after disasters, and to carry out command functions during non-natural disaster/emergency involving disease outbreaks, global pandemics, and chemical, biological, and nuclear emergencies with domestic and global impacts. For nuclear EPR, BNPB collaborates with BAPETEN as the nuclear regulator. BAPETEN provides expert recommendation on protective actions and other response actions to Local Disaster Management Agency (BPBD)/BNPB in case the nuclear emergency provide impact to the public.

For public information**,** BAPETEN provides information on regulation of utilization of nuclear energy through press release and information provided in the BAPETEN website. BRIN (BATAN) provides information on nuclear energy utilization through press release and information provided in the BRIN (BATAN) website. In case of emergency/disaster, the information to the public will follow regulations and procedures applicable at BPBD/BNPB as the coordinator of emergency countermeasures. The licensee, BAPETEN, and other relevant agencies provide inputs to the designated Public Information Officer (PIO) in an emergency.

Licensee is responsible for mitigating the consequences and carrying out urgent protective measures within the facility and responsible for reporting BAPETEN of any nuclear incident/accident/emergency. Should the urgent protective actions and other response actions be needed to be taken outside the facility, the licensee should immediately inform and collaborate with the BPBD.

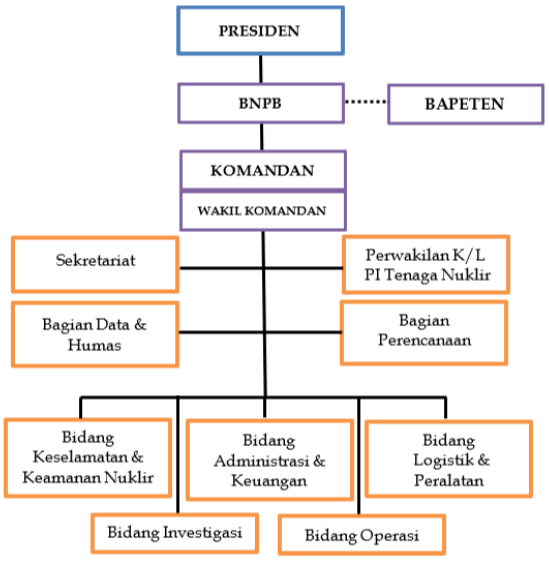
Regarding alarming, the licensee should inform the public in the vicinity and immediately report to BAPETEN regarding any incident/accident/emergency. BNPB handles national contact point (24/7) for all type's emergencies. BAPETEN handles national contact point (24/7) for nuclear/radiological emergency. BAPETEN has installed environmental radiation monitoring stations (I-RDMS) in Serpong, Bandung, and Yogyakarta nuclear areas. In collaboration with Meteorology, Climatology and Geophysics Agency (BMKG), BAPETEN has also installed I-RDMS outside nuclear areas. Currently, there are 34 monitoring stations have been installed. The monitoring stations are connected online to BAPETEN Crisis Centre and to the IRMIS-IAEA.

Regarding Organizational structure, BAPETEN and other relevant ministries and agencies has developed the conception of National Nuclear Emergency Response Organization (NNERO) in 2006. In 2021 this concept has been revitalized in order to be in line with the concept of disaster emergency response command structure (Figure 13). The revitalization as one of the efforts to integrate nuclear emergency management system into national multi-hazards emergency management system under coordination of BNPB.



Local Nuclear Emergency Response Command Post Structure

Bagian/Bidang	Identifikasi K/L/OPD
Data dan Humas	BPBD, BAPETEN, Diskominfo
Perencanaan	BPBD, BAPETEN, BRIN, BMKG, BAPPEDA
Keselamatan dan Keamanan Nuklir	TNI (PusZiAD-Nubika), Polri (KBR, Polwil), BAPETEN, BRIN (Pengkaji Radiologi), BMKG, BNPT
Operasi	Disdamkar, Dinkes, Dishub, Dinas Lingkungan Hidup, Dinas Pertanian, Kepolisian Wilayah, Basarnas, Kemenkes, BMKG
Investigasi	Polri
Logistik dan Peralatan	BPBD, Dinsos, Dinas PUPR
Administrasi dan Keuangan	BPBD, Kemendagri, Kemenkeu



National Nuclear Emergency Response Command Post Structure

Bagian/Bidang	Identifikasi K/L/OPD
Data dan Humas	BNPB, BAPETEN, Kemenkominfo
Perencanaan	BNPB, BAPETEN, BRIN, BMKG, BAPPENAS
Keselamatan dan Keamanan Nuklir	TNI (PusZiAD-Nubika), Polri (KBR, Polwil), BAPETEN, BRIN (Pengkaji Radiologi), BMKG, BNPT
Operasi	OPD (Disdamkar, Dinkes, Dishub, Dinas Lingkungan Hidup), TNI, Polri, Basarnas, Kemenkes, Kemenhub, KLHK, Kementan, Kemen PUPR, BPOM, KKP
Investigasi	Polri
Logistik dan Peralatan	BNPB, Kemensos, Kemendagri, Kemen PUPR
Administrasi dan Keuangan	BNPB, Kemendagri, Kemenkeu

Figure 13. The Organizational Structure of National Nuclear Respond Organization NNERO local (above) and National level (below)

BAPETEN maintains and enhances coordination with relevant ministries and agencies, one of them is through I-CoNSEP as discussed above. One of the important results of coordination with the Ministry of Health was the designation of national nuclear disaster referral hospitals in 2018 (Minister of Health's decision No. HK.01.07 Year 2018). At the regional level, BAPETEN coordinates with ASEANTOM and contributes to the ASEAN EPR project funded by the IAEA and EU. In 2020 and 2021, BAPETEN participated in Tabletop Exercise on Decision Support System for ASEAN countries organized

by EU. BAPETEN also participated in International Emergency Response Exercise Convex-3 organized by the IAEA in 2021.

Implementation of emergency preparedness measures by the license holders

GR No. 54 of 2012 requires licensee to have a nuclear EPR program at facility level. o ensure that the facility-level nuclear EPR program can be implemented, the GR also requires licensee to conduct nuclear emergency training and exercise at facility level at least 1 (one) time in 1 (one) year. The training and exercise should also involve off-site emergency services identified in the facility EPR program.

Due to covid-19 pandemic in 2020 and 2021, the facility emergency exercise was conducted virtually or hybrid (in person and virtually) as shown in Figure 14.

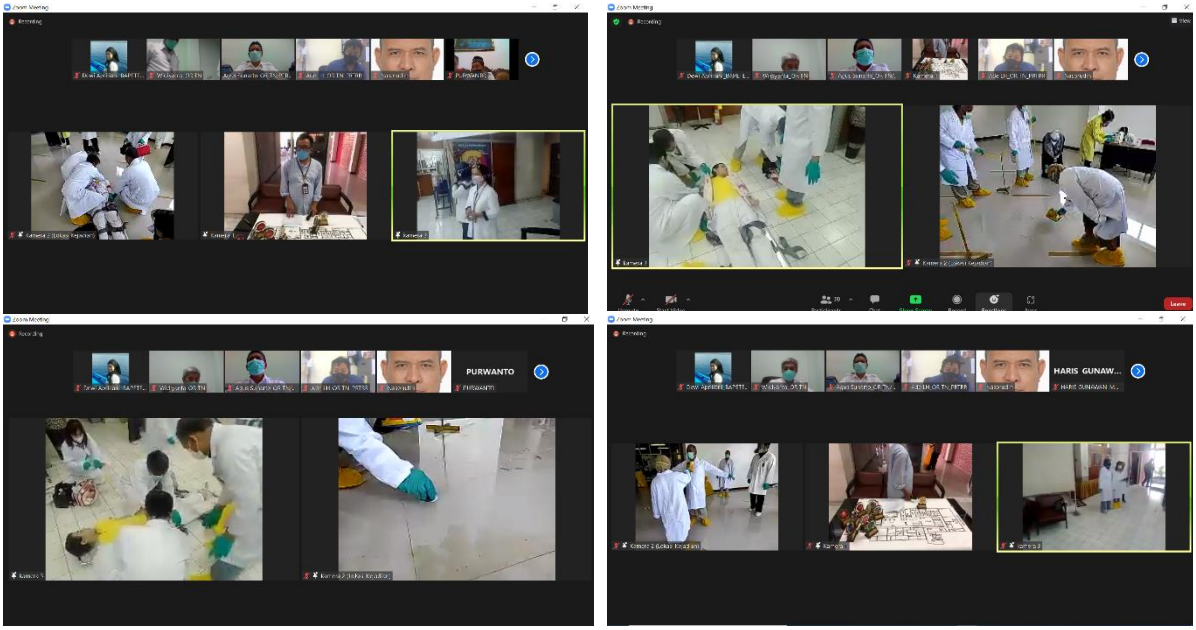


Figure 14. Hybrid Emergency Exercise Conducted by a Nuclear Facility in 2021

The BAPETEN Regulation concerning Nuclear Emergency Preparedness and Response describes the roles and responsibilities of nuclear license holders in more detail. The EPR program should be established, maintained and tested for its applicability. In a nuclear emergency, the licensee is responsible at least for:

- Carrying out emergency response and mitigating of the emergency
- Protecting facility workers and emergency workers
- Reporting the emergency to BAPETEN
- Notifying the emergency and its development to the local government (BPBD)
- Providing recommendations on public protective actions to the local government, if needed;
- Providing warnings to the public in the vicinity; and
- Conducting environmental radiation monitoring.

Training and exercises

Several exercises were conducted in 2017-2019:

1. Field exercise in nuclear area in Serpong with transportation accident scenario.
2. Annual exercise on nuclear accident in TRIGA 2000 reactor in 2018 involving operator, BAPETEN and Provincial Disaster Management Agency,

3. Radiological emergency exercise for first responder in Bandung in 2019.

Figure 15. Emergency exercise in Bandung, 2019.

Lesson learned from the above exercises are coordination among stakeholders during an emergency response should be improved, and the capabilities of the most responders still need to be upgraded.

Regulatory review and control activities
Regulatory review and control activities performed by BAPETEN includes conducts of emergency preparedness program audit/inspection for nuclear facility. As the result, all nuclear facilities have the program in place, and perform an exercise regularly as stated in the regulation. BAPETEN also involved in several licensee exercise as observer, to make sure that the exercises have meet their objection as planned.

BAPETEN has registered its contact points in the Incident Emergency Center (IEC) reporting system. All contact points are made available 24 hour/7 days should any information need to be shared. BAPETEN also participated regularly on ConvEx exercise held by the IEC, to maintain an effective communication.

Article 16 (2) Information of the public and neighboring States

Overview of the Contracting Party's arrangements for informing the public in the vicinity of the nuclear installations about emergency planning and emergency situations
BCR No. 1 of 2010 obliged the licensee to report to the chairman of BAPETEN in the event of a nuclear emergency and the report should be submitted not later than one (1) hour by telephone, facsimile or electronic mail, and in writing no later than 2 (two) days after an accident occurrences. It also required the licensees of category I and II facilities to inform and giving instruction to the public during an emergency, and this requirement consistent with IAEA standards.

Arrangements to inform competent authorities in neighboring States
In GR No. 54 of 2012, the chairman of BAPETEN as NCA-A (National Competent Authority – Abroad) informs the IAEA and the neighboring state governments, if any nuclear emergency occurs that might give impact to the neighboring states.

Article 17 Siting

Each Contracting Party shall take the appropriate steps to ensure that appropriate procedures are established and implemented

i. for evaluating all relevant site-related factors likely to affect the safety of a nuclear installation for its projected lifetime;

ii. for evaluating the likely safety impact of a proposed nuclear installation on individuals, society and the environment;

iii. for re-evaluating as necessary all relevant factors referred to in sub-paragraphs (i) and (ii) so as to ensure the continued safety acceptability of the nuclear installation;

iv. for consulting Contracting Parties in the vicinity of a proposed nuclear installation, insofar as they are likely to be affected by that installation and, upon request providing the necessary information to such Contracting Parties, in order to enable them to evaluate and make their own assessment of the likely safety impact on their own territory of the nuclear installation.

Article 17 (1) Evaluation of site related factors

Regulatory requirements

The Government of Indonesia takes necessary efforts to ensure that the future NPP site will comply with established requirements for site safety. In accordance with GR No. 2 Year 2014 on Licensing of Nuclear Installations and Nuclear Materials Utilization, site evaluation approval application shall be submitted together with its administrative and technical requirement documents. Site evaluation activity is one of the pre-requisite for issuing site license. Site evaluation approval application shall be submitted together with its administrative and technical requirement documents. In accordance with GR No. 54 Year 2012 on Safety and Security of Nuclear Installations, site monitoring of the nuclear installation shall be conducted in the construction, commissioning, operation, and decommissioning stage.

For implementing the above GR, BAPETEN has issued BCR No. 4 Year 2018 on Safety Provisions for Site Evaluation of Nuclear Installation, amending BCR No. 5 Year 2007 on Safety Provisions for Site Evaluation of Nuclear Reactor. This BCR adapts IAEA NS-R-3 (Rev. 1) - Site Evaluation for Nuclear Installations for a more detail provisions related to siting. In addition to the BCR No. 4 Year 2018, BAPETEN has also issued several BCR as guidance to conduct specific site evaluation in every aspect of site evaluation, namely:

a) BCR No. 8 of 2013 on the Nuclear Installation Site Evaluation in the Aspect of Seismology.
b) BCR No. 4 of 2008 on the Nuclear Installation Site Evaluation in the Aspect of geotechnical.
c) BCR No. 5 of 2015 on the Nuclear Installation Site Evaluation in the Aspect of Volcanology.
d) BCR No. 6 of 2014 on the Nuclear Installation Site Evaluation in the Aspects of Meteorology and Hydrology.
e) BCR No. 4 Year 2019 on Dispersion of Radioactive Material in Air and Water and Consideration of Population Distribution in Site Evaluation for Nuclear Installation, amending BCR No. 3 Year 2008 on Dispersion of Radioactive Material in Air and Water and Consideration of Population Distribution in Site Evaluation for Nuclear Power Plants; and
f) Amending BCR No. 6 Year 2008 on External Human Induced Events in Site Evaluation for Nuclear Power Plants: Status of this BCR still in the process of harmonization in legal bureau.

From all aspects in site evaluation, there are two aspects that include site rejection criteria, which are seismic and volcano.

BAPETEN also developed Standard Review Plan for reviewing licensing documents during siting stage for all siting aspects (seismic, geotechnical, volcanology, meteorology, hydrology, dispersion, and human induced event).

BAPETEN already consider developing detailed guidance on inspections during site stages of nuclear reactor. The Working Instruction (WI) is expected to support inspector when ensuring between the conditions of the site with site evaluation report document. WI consists of:

- WI for site inspection activities for earthquake aspects.
- WI for site inspection activities for aspects of human induced external events.
- WI for site inspection activities for aspects of flood hazards.
- WI for site inspection activities for geotechnical aspects
- WI for site inspection activities for aspects of quality assurance
- WI for site inspection activities for the aspects of the utility.
- WI for site inspection activities for dispersion aspects

Regulatory review and control activities

BAPETEN conducts review of site evaluation approval application that will be submitted together with its administrative and technical requirement documents (site evaluation programme and management system for siting aspect). Site evaluation activity is one of the pre-requisite for issuing site license. To ensure that site evaluation is performed in accordance with site evaluation programme and site evaluation management system, BAPETEN perform inspection and verification of the site evaluation activities and has also involved third party as external TSO for review and assessment of the site license requirement documents.

Article 17 (2) Impact of the installation on individuals, society, and environment

BAPETEN has conducted a review on site characteristics in the framework operating license renewal through Safety Analysis Reports and Periodic Safety Review, submitted by BATAN for MPR GA Siwabessy Reactor in Serpong Area. The scope of site characteristics is seismic, volcano, geotechnic, meteorology, hydrology, human induced events, and dispersion of radioactive materials.

In the calculation results in Chapter 3 SAR of RSG-GAS rev. 11 for the MPR GA Siwabessy site between the maximum concentration of radioactive substances in wells and in river water, the results showed that the concentration of radionuclide activity in wells was 0 Bq/m^3 and in the river ranged from 0 Bq/m^3 to 10^{-10} Bq/m^3. These results indicate that the concentration of radionuclides in ground water and surface water around the site comply with the quality standard.

Article 17 (3) Re-evaluation of site related factors

Ministry of Public Work has updated Indonesia earthquake map and it was found that earthquake potential increases all over Indonesia.

MPR GA Siwabessy has submitted a Report of Periodic Safety Review for the assessment of all, structures, systems and components that are important for safety. The crucial issue for this safety review is seismic aspect, which considers Peak Ground Acceleration (PGA) site specific value for 10,000 year return periods. In the implementation of periodic safety review, BATAN collaborates with the Agency for the Application of Technology (BPPT) to analyze the strength of buildings and structures by considering the seismic load with that PGA value. The activity is still in process, recommendations and follow-up including engineering solutions will be carried out after the results are obtained. BAPETEN continues to monitor these activities.

Site analysis on seismic aspects for the MPR GA Siwabessy site refers to the site characteristics document for the experimental power reactor (RDE) installation as a reference, consider the location of the MPR GA Siwabessy and RDE reactors as one region, namely in the Puspiptek area. BCR No. 8 of

2013 on Nuclear Installation Site Evaluation for Seismic Aspects contains site acceptance criteria. The site acceptance criteria include site safety related to the presence of a fault which states that a nuclear installation site must not have a fault fracture within a 5 km radius of the site.
RDE site evaluation results which include analysis and interpretation of geological and geophysical data within a 25 km radius as well as earthquake data, deformation data, and paleo seismology or test trenches show that, Serpong RDE site does not have a capable fracture and a surface fracture within a 5 km radius. Based on the location of the MPR GA Siwabessy site that is still within a radius of less than 5 km from the RDE site, it is concluded that the MPR GA Siwabessy site also has no fault fractures and surface faults (within a 5 km radius).
Linkage to large earthquakes (> 6 Richter scale) on the RDE site has never happened, according to monitoring of BATAN's earthquake instruments which focus on a 5 km radius and also based on the USGS and BMKG catalogs. Peak ground acceleration in bedrock 10,000 year return period is 0.57 g and 1,000 year return period is 0.29 g, this shows that the PGA value still meets the provisions of BCR No. 8 of 2013. The MPR GA Siwabessy system is designed to withstand the intensity of earthquakes that is expected to occur during the operation of the facility. It is sufficient to determine the intensity of VIII¼ (Mercalli scale) with an incidence rate of 10^{-4}/year.

While the analysis of building resilience and supporting structures of MPR GA Siwabessy from Interatom is 0.25 g. The strength of the 0.25 g scale has been confirmed to the relevant institutions as well as the structure and components are still safe against the earthquake. This is also reinforced through Results The 2010 Earthquake Map Revision Team Study in Indonesia stated that site characteristics for the seismic design of the Serpong area and the integrity of the terrace is still able to be maintained in conditions of an earthquake with a magnitude of 0.25 g. Nevertheless, the results of site evaluation conducted for RDE in the region Serpong concluded that the site characteristics for seismic design Serpong area is 0.57 g (for a 1000 year return period).

Related to the difference in the value of the earthquake strength, the MPR GA Siwabessy needs to identify matters related to the design buildings and structures by forming a seismic study team that will conduct analysis of the design of the MPR GA Siwabessy reactor core on the aspects of the seismic. Based on the study/analysis that will be obtained separate reports and work programs as supporting data for PSR documents.

In accordance with GR No. 2 of 2014 on Licensing of Nuclear Installations and Nuclear Materials Utilization, periodic site evaluation reviews are carried out through the RSG-GAS Periodic Safety Report. The MPR GA Siwabessy will assess the structure of the RSG GAS building by considering the results of the evaluation of the seismic aspect of the site characteristics in the Serpong Nuclear Area, including engineering solutions.

MPR GA Siwabessy provides siting aspects information (seismic, geotechnical, volcanology, meteorology, hydrology, dispersion, and human induced event) from SAR of RDE and Document of Updating Environmental Baseline Data in the Serpong Nuclear Area in 2020.

Regulatory review and control activities
According to GR No. 54 of 2012, the licensee shall perform safety verification and assessment during construction, commissioning, and operation stage of nuclear installation. In the operation stage, safety verification shall be performed through analysis and surveillance that consist of: review of the site-related factors, surveillance that is performed continuously during the commissioning and operation of a nuclear installation shall include monitoring of nuclear installation, and assessment to the modification of condition and its control.

Article 17 (4) Consultation with other Contracting Parties likely to be affected by the installation
BAPETEN and BATAN are performed public consultation/socialization to public periodically. In addition, BAPETEN and BATAN must have stakeholder meeting with other government institution and local government including Forestry and Environment Ministry, Energy and Mineral Resource Ministry, Environment Ministry, and Industrial Ministry.

International arrangements
Information on the site study activities for nuclear installation is always shared in IAEA forum. All IAEA members' countries will have access to this information. There is also regional network under IAEA such as ANSN where neighbouring countries that could be potentially affected by nuclear installation that will be built can have direct shared information.

Article 18 Design and Construction

Each Contracting Party shall take the appropriate steps to ensure that:

i. *the design and construction of a nuclear installation provides for several reliable levels and methods of protection (defense in depth) against the release of radioactive materials, with a view to preventing the occurrence of accidents and to mitigating their radiological consequences should they occur;*

ii. *the technologies incorporated in the design and construction of a nuclear installation are proven by experience or qualified by testing or analysis;*

iii. *the design of a nuclear installation allows for reliable, stable and easily manageable operation, with specific consideration of human factors and the man-machine interface.*

Article 18 (1) Implementation of defence in depth

In accordance with GR No. 54 Year 2012, construction activities shall be performed based on safety design principles. The basic safety principles include the inherent safety, multiple barriers, safety margin, redundancy, diversity, independence, fail-safe and safety qualification. The requirements of safety design shall be implemented from construction to decommissioning stage. Licensee, in order to accomplish design requirements, shall establish a classification for structure, system, and component of nuclear installation, based on safety class, quality class, and seismic class.

To comply with the design requirements, the licensee shall establish a classification of structures, systems and components of nuclear installations, based on the safety class, quality class and/or seismic class.

Based on GR No. 2 Year 2014, Licensee shall obtain a design approval from BAPETEN before applying for Construction permit by submitting the documents of Nuclear Reactor Detailed Design and Safety Analysis Report.

Based on GR No. 54 Year 2012, licensees are responsible to implement the principle of defence in depth effectively to achieve safety objectives.
BAPETEN is developing work instructions (WI) for inspection as guide to conduct inspection on the construction stage. Inspection is conducted to ensure that all SSCs under construction will satisfy the principle of defence in depth and be able to carry out their safety functions, as follows:

- WI for valve installation inspection.
- WI for inspection of installation of components and instrumentation systems.
- WI for inspection of installation of mechanical components.
- WI for HVAC system installation inspections.
- WI for inspection of installation of piping systems.
- WI for inspection of installation of fire protection systems.
- WI for welding inspection.
- WI for foundation inspection.
- WI for inspection of systems and radiation monitoring components.
- WI for inspection of concrete structures.
- WI for vendor inspection.

Article 18 (2) Incorporation of proven technologies

In accordance GR No. 2 Year 2014, construction of commercial power reactor shall fulfil the criteria as following: (a) all structures, systems and components important to safety in nuclear reactor has been tested in a relevant environment or in accordance with operating conditions, and applied in the

prototype; and (b) has been granted commercial operation license by the regulatory body from the state which has built a commercial nuclear power plant.
Inspectors will participate in evaluating the proposed reactor designs, including the evaluation of the technology applied to the design.

Article 18 (3) Design for reliable, stable and manageable operation

Overview of the Contracting Party's arrangements and regulatory requirements for reliable, stable and easily manageable operation
According to GR No. 54 of 2012, licensee shall design reliable of SSC and easily manageable operation of nuclear installation.
Currently BAPETEN is drafting BCR on safety, quality and seismic classification for SSCs important to safety.

Implementation measures taken by the license holder
In order to implement the GR No. 2 of 2014, several BCRs on the Safety Provisions of NPPs design and construction have been revised referring to the current IAEA documents, i.e. BCR No. 3 of 2011 on Safety Requirements for the Design of Nuclear Power Reactors.

BAPETEN is revising BCR No.3 of 2011 on the Safety Requirements for the Design of Power Reactors. The new BCR used IAEA SSR 2/1 rev.1 as reference. The provisions which stipulated in the new BCR have considered the lesson learned from Fukushima Daichi accident. For example, the need to provide mobile diesel generator and mobile water pumps to deal with station black outs. The equipment must be able to provide electricity for at least 7 days. The new BCR will provide an attachment with a format guide and the contents of the detailed design of reactor. This guidance assists applicants to obtain design approval.

Regulatory review and control activities
BAPETEN conducts review of the design and construction of nuclear reactors through review on the license requirement documents, especially Reactor Main Data, Detail Design, Safety Analysis Report (SAR) and the Periodic Safety Review (PSR). BAPETEN also conducts inspections to ensure that licensees always maintain compliance to the design requirements**.**

Article 19 Operation

i.	*Each Contracting Party shall take the appropriate steps to ensure that: the initial authorization to operate a nuclear installation is based upon an appropriate safety analysis and a commissioning programme demonstrating that the installation, as constructed, is consistent with design and safety requirements;*
ii.	*operational limits and conditions derived from the safety analysis, tests and operational experience are defined and revised as necessary for identifying safe boundaries for operation;*
iii.	*operation, maintenance, inspection and testing of a nuclear installation are conducted in accordance with approved procedures;*
iv.	*procedures are established for responding to anticipated operational occurrences and to accidents;*
v.	*necessary engineering and technical support in all safety-related fields is available throughout the lifetime of a nuclear installation;*
vi.	*incidents significant to safety are reported in a timely manner by the holder of the relevant licence to the regulatory body;*
vii.	*programmes to collect and analyse operating experience are established, the results obtained and the conclusions drawn are acted upon and that existing mechanisms are used to share important experience with international bodies and with other operating organizations and regulatory bodies;*
viii.	*the generation of radioactive waste resulting from the operation of a nuclear installation is kept to the minimum practicable for the process concerned, both in activity and in volume, and any necessary treatment and storage of spent fuel and waste directly related to the operation and on the same site as that of the nuclear installation take into consideration conditioning and disposal.*

Article 19 (1) Initial authorization

Regulatory requirements

Under GR No. 2 of 2014 on Licensing of Nuclear Installations and the Utilization of Nuclear Materials, many technical requirements shall be submitted to the Regulatory Authority by the applicant to obtain a commissioning license. These requirements include: Safety analysis report, operational limits and conditions (OLC), commissioning programme; radiation protection and safety programme, safeguards system and physical protection documents, management system document or quality assurance programme for siting, ageing management programme, decommissioning programme, emergency preparedness and response programme, report of the environmental license implementation, report of construction activity results, and as-built drawing of the reactor.

Furthermore, on the content of commissioning programme, GR No. 54 Year 2012 on the Safety and Security of Nuclear Installation states that the applicant shall establish and implement a commissioning programme to ensure that all structure, system and component (SSC) of the nuclear installation that has been built could function properly as its intended design.

BAPETEN has drafted the amendment of BCR No. 2 year 2011 on Safety Operation of Research Reactor. Extended shutdown will be included in the new BCR. This draft of BCR is still in the process of harmonization in legal bureau.

Conduct of appropriate safety analyses

As it is mentioned previously, the applicant shall submit a safety analysis report (SAR) as one of the requirements in obtaining a commissioning license under GR No. 2 of 2014. This report has to describe

both qualitative and quantitative analysis, applying both deterministic and probabilistic methods (where applicable), for all areas of safety issues. BAPETEN has an experience in enacting BCR No. 8 Year 2012 on the SAR of Non-Power Reactor, adopting the IAEA standards. With this experience, then BAPETEN sufficiently is confident to develop a BCR on the SAR of Power Reactor in the near future.

The current licensing procedure in BAPETEN obliges its evaluator to perform review and assessment of an SAR submitted by the applicant. The evaluation shall be done in accordance with the appropriate BCR or international best practice for each topic. In doing so, the evaluator may request assistance from both Center of Assessment (internal department) and external TSO, depending on the complexity of the problem and availability on internal resources (See discussion on the use of TSO in Article 8). Based on the review and assessment results, BAPETEN therefore publishes a Safety Evaluation Report (SER), describing how the applicant copes with all safety requirements. In the last five years, BAPETEN always established this SER to support decision making process for nuclear facility license. Except for its part related to proprietary and confidential information, the SER is available for public on request.

Commissioning programme

GR No. 54 Year 2012 on the Safety and Security of Nuclear Installation stated that commissioning programme submitted by the applicant shall describe an integrated testing procedure of the design for all systems operated with nuclear materials, means for both cold and hot test. In this procedure, the applicant shall perform verification to establish OLC in accordance with the general and the specific design requirements. On the OLC itself, BAPETEN has established BCR No. 3 Year 2009 on the OLC and Operational Procedure of Power Reactor.

BAPETEN issued BCR No 2 of 2019 on safety provision of the commissioning for non-power reactor. This BCR requires that before the implementation of commissioning activity, the construction license holders must determine that the commissioning program shall contain at least: schedule of activities; organizational structure; testing procedure; type of testing; acceptance criteria; and documentation and reporting.

Verification programme

It has been described earlier that both GR No. 2 Year 2014 and GR No. 54 Year 2012 stated that the applicant shall establish and implement a commissioning programme. This programme, inter alia, describes the requirement to perform verification in ensuring that the nuclear installation as constructed is consistent with design and safety requirements. In addition, all SSC of the nuclear installation that has been built could be functioned as its intended design.

Regulatory review and control activities

According to GR No. 2 Year 2014, BAPETEN performs review and assessment to licensing document for the commissioning phase. However, currently there is no commissioning license applied to BAPETEN.

In 2019, BAPETEN issued BCR No. 2 year 2019 on safety provision of the commissioning for non-power reactor. This BCR regulates the safety provisions of the commissioning which includes the safety requirements for all stages (testing for nuclear fuel loading and initial criticality; low power testing; and rising of power and full power) in commissioning activities

Article 19 (2) Operational limits and conditions (OLC)

Regulatory requirements

OLC is one of the licensing requirements under GR No. 2 Year 2014 on Licensing of Nuclear Installations and the Utilization of Nuclear Materials. BAPETEN also established BCR No. 3 Year 2009 on the OLC and Operational Procedure of Power Reactor and BCR No. 9 of 2013 on the OLC of Non-Power Reactor. In these BCRs, the OLC shall describe operational provision for start-up, high power operation, shutdown, maintenance, testing and refuelling; limit and condition that assuring the safety system, including engineering safety features, will be well functioned in all condition of operation, including in

accident condition; and, limit and condition that oblige the reactor operator and the supervisor, radiation protection officer, maintenance technician and the supervisor to take necessary actions. The licensee shall operate the nuclear installation in accordance with the OLC.

It should be mentioned also here that OLC is comprised of safety limit, safety system setting, limiting condition for operation, surveillance requirements, and administrative requirements. The last requirements are regarding organizational structure, personnel training and qualification, audit and review, procedure, records, reports, radiation safety, and modification; including actions have to be taken if there is a deviance from the limiting condition for operation and safety limit.

Implementation of OLC

All requirements for OLC as described in BCR No. 3 of 2009 on the OLC and Operational Procedure of Power Reactor and in BCR No. 9 Year 2013 on the OLC of Non-Power Reactor shall be used as a mandatory guideline document in operating the installation and is a subject for verification and review by the regulatory body from time to time. The operator has to use it also as guide in developing their training and qualification programme for their staff. The BCRs also arranges that the OLC shall be available in the main control room and other place that easily accessed by safety related staff such as the reactor operator and the supervisor, radiation protection officer, maintenance technician and the supervisor.

OLC in MPR GA Siwabessy that described in chapter 17 SAR of MPR GA Siwabessy rev. 11 was developed according to the licensing requirements under GR No. 2 of 2014 on Licensing of Nuclear Installations and the Utilization of Nuclear Materials and BCR No. 9 of 2013 on the OLC of Non-Power Reactor. OLC describes operational provision for start-up, power operation, shutdown, maintenance, testing and refuelling. The limit and condition that assuring the safety system, including engineering safety features, must be well functioned in all condition of operation, including in accident condition. Limit and condition oblige the reactor operator & supervisor, operation safety officer, radiation protection officer, maintenance technician & supervisor, and nuclear material inventory officer & supervisor to take necessary actions.

OLC is comprised of safety limit, safety system setting, limiting condition for operation, surveillance requirements, and administrative requirements. The last requirements are regarding organizational structure, personnel training and qualification, audit and review, procedure, records, reports, radiation protection, modification, and utilization. This requirement also applied for Anticipated Operational Occurence (AOO) condition.

OLC parameters are displayed in the main control room and other place (in field) in order to easily accessed by reactor operator and supervisor, radiation protection officer, as well as maintenance technician and supervisor. OLC parameters are available in SAR, Piping & Instrumentation Diagram (P&ID) for confirmation during deviation condition.

Review and revision of OLC

In the operation of nuclear installation, it is possible for the operator to revise the OLC. This might be caused by modification activities, utilization changes, or uprating of the power. BCR No. 3 Year 2009 and BCR No. 9 Year 2013 stated that the operator cannot revise the OLC unless has an approval from BAPETEN. The revision of OLC shall be based on safety analysis and be assessed by the safety committee of the operator. Furthermore, GR No. 2 Year 2014 on Licensing of Nuclear Installations and the Utilization of Nuclear Materials regulates that should there is a revision of the OLC in the operation phase, and then the operator shall apply a new license.

Regulatory review and control activities

GR No. 2 of 2014, GR No. 54 of 2012, BCR No. 3 of 2009 and BCR No. 9 of 2013 state that the Licensee shall establish OLC that has been assessed by their safety committee before submitted it to BAPETEN for obtaining commissioning and operation license. The OLC shall be specific for each unit of nuclear

installation. BAPETEN performs review and assessment to licensing document for the commissioning phase, including LCO document. However, up to now there is no commissioning license applied to BAPETEN.
To build BAPETEN staff's competency on the regulation of nuclear installation in commissioning phase and to prepare the introduction of NPP in Indonesia, BAPETEN already develop a plan for both international (with IAEA through TC Project) and bilateral cooperation (with advanced country in nuclear energy and with potential countries of origin).

Article 19 (3) Procedures for operation, maintenance, inspection, and testing
Regulatory requirements
Kartini Reactor and MPR GAS sent the revised SAR to BAPETEN in 2019 and 2020 respectively. The document covers OLC and other safety requirements. In addition, the Programme Guide for the Operation, Maintenance, Utilization and Modification of Reactor is used in the implementation of the reactor operation. SOPs for operation and maintenance have been prepared and form the basis for the implementation of reactor operation with several procedures for operation, maintenance, and utilization. Records of the reactor operation and maintenance activities have been recorded in the operation and maintenance logbook. The summary of these activities is reported to BAPETEN on a quarterly basis. The Regulatory body routinely inspects the operation and maintenance of the Kartini reactor. As part of Kartini's commitment to prioritise safety, the assessment and improvement of non-conformities was followed up immediately.
Environmental radiation dose rate on both reactors is continuously monitored internally by the internal safety unit through a radiation protection programme. The programme ensures radiation protection in relation to all activities in the Yogyakarta Nuclear Area (KNY) and Serpong Nuclear Area (KNS). The monitoring of this protection programme also includes environmental monitoring. All these activities are carried out independently from the operator of the Kartini and MPR GAS reactors.

Operational procedures, their implementation, periodic review, modification, approval, and documentation
According to GR No. 54 of 2012 and BCR No. 3 of 2009, the licensee shall establish operational procedures covering normal operation, anticipated transients, design bases accidents, and beyond design bases accident. For the implementation in normal operation, the procedures include for functional and performance test; loading, unloading and fuel movement inside the core; maintenance of SSC important to safety; inspection, calibration and surveillance of SSC important to safety; radiation protection activities; review and approval for operation and maintenance; operator response to anticipated transients, design bases accidents, and beyond design bases accident; emergency preparedness and response; physical protection; radioactive waste management and monitoring and control of radioactive release; modification and access control. All these documents have to be reviewed periodically and updated based on the management system established by the licensee.

For safety review, based on BCR No. 3 of 2009, the licensee shall implement it periodically covering on the design of nuclear installation, current condition of SSC, equipment qualification, ageing, safety performance and operational experiences feedback, and radiological impacts to the environment.

BCR No. 4 of 2010 on Management System for Facilities and Activities requires the licensee to develop procedure for modification, approval, and documentation.

Implementation in Kartini Reactor
The Kartini reactor has received an extension of its operating licence in 2019. This operating licence is valid for 10 years until the end of 2029. Compliance with this operating license is supported by periodic safety assessment documents. This document is the written evidence of various studies and assessments of all structures, system, and components (SSCs) of the Kartini reactor. The SSC's of the

Kartini reactor must be assessed for their capability and reliability in fulfilling the operational safety function during the period for which the operating licence is applied for.

Implementation in MPR GA Siwabessy Reactor

Normal safe operation of MPR GA Siwabessy is guided by procedures such as procedure for functional and performance test, loading-unloading fuel, fuel movement inside the core, maintenance of SSC important to safety, inspection, calibration and surveillance of SSC important to safety, radiation protection activities, review and approval for operation and maintenance, operator response to anticipated transients, design bases accidents, and beyond design bases accident, emergency preparedness and response, physical protection, radioactive waste management and monitoring and control of radioactive release, modification and access control. These Procedures have been described in SAR of MPR-GAS rev. 11 (Chapter 12, 13, 14, 15, 16, 17, 18, dan 20) and have been reviewed periodically by operation safety officer and updated based on the management system.

Design and current condition of SSC of MPR GA Siwabessy, equipment qualification, ageing managemenet, safety performance and operational experiences feedback, and radiological impacts to the environment are reviewed periodically.

Availability of the procedures to the relevant nuclear installation staff

BAPETEN regulates that all procedures on nuclear installation shall be available for relevant staff and can be reached easily and inspected regularly. For example, written procedures for reactor operation have to be available in the control room.

The SOP for the operation and maintenance of the the reactor has been prepared to support operators and technicians's tasks on site. The availability of the documents is based on the applicable management guidelines. The SOP for the operation of the reactor is always available in a location that is easily accessible from the relevant SSC. This convenience also applies to the recording of operational results and abnormal events during SSC operation.

Involvement of relevant nuclear installation staff in the development of procedures

A process of developing procedures on safety nuclear installation is guided in the BCR No. 3 of 2009. The process describes validation and verification steps before the establishment of the procedure, role of manager, supervisor, and operator in developing a procedure.

SOPs are reviewed every 5 years or when there is a change in the characteristics of the SSCs. SOP are reviewed by competent personnel and having work permits according to their scope of work. Reviewing proces of SOP involves technicians/operators, supervisors, managers, and the quality assurance unit. The results of the review are used as a reference for the latest revision of SOPs and implementation of O&M activities.

Incorporation of operational procedures into the management system of the nuclear installation

The licensee is required to develop procedure for document control and records, technical documents such as procedure for operation, and other documents incorporated into the integrated management system.

Kartini Reactor as well as other research reactors have introduced the Operation and Maintenance Manual as the main Level 1 document. This manual has been further developed into technical and administrative SOPs for all aspects of activities at the facility. The Level 1 documents are reviewed regularly every 5 years. Minor revisions may be made each time the provisions of the programme change. This programme is developed by relevant and competence staff, then reviewed by Safety Committee and the Quality Assurance Unit. Finally, the Level 1 programme is approved by the Director of the facility.

Regulatory review and control activities
All safety related documents established by the licensee, including records, are subject for review and/or audit by BAPETEN during the licensing and inspection process. Priorities are given to review and observe the implementation of procedure for operation, maintenance, inspection and testing, and other safety related procedures. Inspector may perform witnessing of the implementation of procedure; cross-checking the actual situation with the records, measurement, and testing results; and interview relevant staff of the operator and their contractor/supplier.

Article 19 (4) Procedures for responding to operational occurrences and accidents
Regulatory requirements
BAPETEN requires the licensee to establish operational procedures covering normal operation, anticipated transients, design bases accidents, and beyond design bases accident. For non-power reactor, a more detail requirements for this response can be found in BCR No. 2 of 2012 on the Safety Provision for Non-Power Reactor.

BCR No. 1 of 2010 on the Nuclear Emergency Preparedness and Response, and Nuclear Emergency Preparedness and Response guidance PUK/DK2N.3/PT.16 of 2021 which was developed by adopting the IAEA standards, provides a systematic and step-by- step approach on preparedness and response procedures in the case of emergency situation.

Kartini reactor's operating procedure has covered all modes of operation. The SAR of the Kartini reactor has defined and reviewed the worst-case scenarios for the operation of the reactor and the precautionary measures to be taken. Meanwhile, MPR GA Siwabessy has established operational procedures covering normal operation, anticipated transients, Design Bases Accidents (DBA), and Beyond Design Bases Accident (BDBA).

The reactor operation SOP describes in detail the measures to be taken for the various situations in the reactor. The SOPs for emergencies also serve as a guide for all staff involved in mitigating and saving all available resources. The Kartini reactor is relatively small in terms of worst-case emergency response. The exclusion zone of the Kartini reactor is in the radius maximum of 100 metres from the reactor core. This distance is still within the Yogyakarta Nuclear Area.

Event based and/or symptom-based emergency operating procedures
Procedures for anticipated transients, DBA and BDBA is regulated with BCR No. 3 of 2009. Depending on the accident scenarios developed in the SAR, then the operator may develop these emergency operating procedures using event based and/or symptom-based approach.
All Three reseach reactors have reactor emergency safety programme. The programme is reviewed independently by the Safety Committee before being implemented. The implementation of this programme is decribed in the emergency SOPs. This SOPs always been disseminated, trained and drill exercise at least once a year. The lessons learned from those activity have been as a good point for continuous improvements for safety issues to all stakeholders.

Procedures and guidance to prevent severe accidents or mitigate their consequences
In preventing severe accidents, GR No. 54 of 2012 describes that the use of defence in depth strategy aims to fulfil fundamental safety function of nuclear installation in controlling reactivity, removing heat from the core, and containing radioactive materials and shielding the radiation. This strategy shall be implemented by the licensee through their procedure and work instruction.
To mitigate the consequences of severe accident, BCR No. 1 Year 2010 provides a systematic and step-by-step approach on nuclear emergency preparedness and response procedures. These mitigation procedures have to be completed with relevant analysing tools and computer codes, and with description of protective actions and evacuation schemes.

Regulatory review and control activities

All safety related documents established by the licensee are subject for review and/or audit by BAPETEN during the licensing and inspection process. Nuclear emergency preparedness and response, and management system, are some of the topics of regulatory inspection.

Experience the reactor operation with response to the Covid-19 pandemic

1. MPR GA Siwabessy

During Covid 19 pandemic, MPR GA Siwabessy operated nuclear reactor according to the schedule. MPR GA Siwabessy implemented health protocols to prevent the spread of Covid-19 through regulating the number of workers performing reactor operation, safety and health induction every morning. The arrangement of the employee work system is carried out using systems of work in the office (WIO) and work from homes (WFH). It was recorded that one employee of the RSG-GAS died and several employees were infected by Covid-19 virus in 2020 and all of them have been declared cured. Cleaning and desinfecting workspace and inside the reactor building were periodically performed. All workers were required to use personal protective equipment in accordance health protocols. MPR GA Siwabessy limits user interaction with operators by utilizing online communication.

In terms of irradiation services, to support the of MPR GA Siwabessy operations during the Covid-19 pandemic, the use of online applications is carried out optimally so that MPR GA Siwabessy's customer do not interact directly with radiation workers. Furthermore, to carry out the scheduled maintenance program, maintenance activities for SSC important to safety are still carried out by maintenance officers based on schedule with the oversight of maintenance supervisor. BAPETEN inspections used to be face-to-face method during normal inspections, however during Covid-19 pandemic, both parties agreed to use BAPETEN cloud storage platform for audited documents and teleconference for inspection.

2. Kartini Reactor

During the pandemic COVID -19 Kartini Reactor imposed restrictions on the number of workers and implemented strict health protocols. This restriction still meets the minimum regulatory aspects required for the maintenance and operation of the reactor. Kartini reactor's irradiation services to the public is still in-service.

Article 19 (5) Engineering and technical support

General availability of necessary engineering and technical support in all safety related fields for all nuclear installations, under construction, in operation, under accident conditions or under decommissioning

Service providers might be utilized by the operator in all safety related fields for all nuclear installations, under construction, in operation, under accident conditions or under decommissioning. In other side, BAPETEN as the regulator might use their independent TSO for the same purposes. As an example of the uses of service provider, BCR No 2 of 2011 stated that modification of the installation might be carried out by other party or contractor, yet the responsibility cannot be delegated. In this case, BCR No. 4 of 2010 on Management System for Facilities and Activities requires the licensee to perform audit to safety related contractor/supplier. In Indonesia, service provider and TSO can be from universities, national research institutes, state own and private companies. For the current situation in the utilization and regulation of nuclear energy, national service providers and TSOs are considered as available.

General availability of necessary technical support on the site and also at the license holder or utility headquarters, and procedures for making central resources available for nuclear installations
All research reactors and the site for experimental power reactor are located in one island, i.e. Java Island. This situation makes it easier for the operator and BAPETEN to receive prompt support from their service providers or TSO.

General situation with regard to dependence on consultants and contractors for technical support to nuclear installations
For the existing research reactors both BATAN and BAPETEN have a sufficient competency to discuss all technical problems with their consultants and contractors. Competency building planned by BATAN and BAPETEN might be expected that both sides could be a smart customer of their service providers or TSOs in the future needs of specific expertise both in deterministic and probabilistic safety assessment. For example, BAPETEN involves the External Technical Support Organization from Universities to give scientific expertise on reviewing and assessing of technical documents. In 2017 and 2018, Gadjah Mada University, Bandung Institute of Technology (ITB), and Institute of Sepuluh November (ITS) are requested by BAPETEN in reviewing design of RDE reactor (experimental power reactor) that proposed by BATAN. In 2019, ITB support BAPETEN in reviewing Periodic Safety Assessment and Ageing Analysis Report of MPR GA Siwabessy.

Regulatory review and control activities
Under BCR No. 4 Year 2010 on Management System for Facilities and Activities, BAPETEN performs review and assessment of resources management performed by the licensee. Furthermore, review and assessment of applicant licensing document based on GR No. 2 Year 2014 might reflect the sufficiency of the applicant resources, including the availability of their technical support.

Article 19 (6) Reporting of incidents significant to safety
Regulatory requirements
GR No. 54 Year 2012 on the Safety and Security of Nuclear Installation requires the licensee to report to the Chairman of BAPETEN should there is an anticipated transient, DBA, BDBA or nuclear emergency. The report shall be communicated in oral no later than one hour and in written no later than 2x24 hours after the event is identified. The content of the report and detail procedure of reporting protocol can be found in BCR No. 1 of 2010 on the Emergency Preparedness and Response. In Chapter 20 SAR of RSG-GAS rev. 11 states for the MPR GA Siwabessy to report to the Chairman of BAPETEN should there is an anticipated transient, DBA, BDBA or nuclear emergency. The report shall be communicated in oral no later than one hour and in written no later than 2x24 hours after the event is identified.

Reporting criteria and reporting procedures
As general criteria, MPR GA Siwabessy has to report anticipated transient, DBA, BDBA or nuclear emergency, through an oral and written procedures.

Statistics of reported incidents significant to safety for the past three years
For the research reactor, there were no significant to safety incidents in the past three years. Complete report of incident has been sent to the IAEA Incident Reporting System for Research Reactors (IRSRR) programme. In 2020, MPR GA Siwabessy reported incident through IAEA Incident Reporting System for Research Reactors (IRSRR) programme. The report contains mishandling of fuel element number RI-227 on the oxide core and fuel element number RI-312 on the silicide core. This leads to imbalance of reactivity in reactor core and economic losses.

Documentation and publication of reported events and incidents by both the license holders and the regulatory body

Documentation of reported events and incidents by both the license holders and the regulatory body shall be subject for implementation under the management system of both sides, including lesson learned from the events. Publication of these reported events in the research reactors is carried out through the IAEA IRSRR programme. In Indonesia, this involves national coordinator and local coordinators of each reactor. IRSRR can be used as a medium for sharing experiences of the incident which occurred in each local research reactors or also of similar research reactors worldwide. Both BATAN and BAPETEN are actively participated in the IAEA-IRSRR forum. For publication purposes, all national institution has to follow Act No. 14 Year 2008 on the Transparency of Public Information. This Act states that government institution has to provide opportunity for public to obtain information related to function, task and activities of the institution.

Policy for use of the INES scale

The Director of Technical Support and Emergency Preparedness issued a guideline on the use of INES (international Nuclear Event Scale) as a communication tool to facilitate communication and understanding among the nuclear/radiation expert community (both from industry and the regulatory body), the media and the public regarding the safety aspects of an event. The establishing of this guideline involves all of related stakeholders, namely: BATAN, the agency of management regional disaster, local government, hospital management, fire fighting management, and police.

Regulatory review and control activities

BAPETEN performs review and inspection in the scope of emergency preparedness and response to all of the licensees. The inspection includes witnessing of facility-scale emergency drill and exercise. BAPETEN also organizes national scale emergency exercise every four years and engages in international exercise through the IAEA ConvEx programme.

Article 19 (7) Operational experience feedback

Regulatory requirements

BCR No. 2 Year 2015 on the Verification and Safety Assessment of Non-Power Reactor requires the licensee to submit the review of feedback experiences, which are: identification of operational experiences and important to safety information from other nuclear installation experiences including the result of research. The feedback is an integrated part of periodic safety review document. Managing operational experience feedback is also a function of Management System that must be implemented by the licensee and regulator.

Overview of programmes of license holders for the operating experience feedback

It's been reported that operation experience feedback, especially from participation to the IAEA IRSRR programme, is positive and very important for the licensee in order to perform a better maintenance and ageing management, improving procedures and staff competency. The licensee programme for this issue is also in accordance to BCR No. 4 Year 2010 on Management System for Facilities and Activities.

Procedures to analyse domestic and international events

Safety committee analyse domestic events during normal operation. However, if there is event occured. Head of BATAN assigned competent personel or management to analyse and clarify safety related domestic and international events.

Procedures to draw conclusions and to implement any necessary actions
Conclusion and the proposed action plan, including modification to the installation and to personnel training programmes and simulators (where applicable), is a subject of review by senior operator and safety committee before it can be established by the licensee. In this case, the licensee has to consider and implement recommendation or suggestion made by the regulatory body.

Mechanisms to share important experience with other operating organizations
Sharing important experience with other operating organizations can be done through the IAEA IRSRR mechanism or through bilateral cooperation where applicable.

Use of international information databases on operating experience
The use of international information databases on operating experience is also carried out through the IAEA IRSRR mechanism.

Regulatory review and control activities for license holder programmes and procedures
BAPETEN performs review and audit in the scope of emergency preparedness and response to all of the licensees, including how they manage operational experience feedback from all resources, both domestic and international. This is also part of licensing issues.

Regulatory body programmes for feedback of operational experience and the use of existing mechanisms to share important experience with international organizations and with other regulatory bodies.
Under the BMS, BAPETEN organize activities related to feedback of operational experience and the use of existing mechanisms to share important experience with international organizations and with other regulatory bodies. BAPETEN also actively participated in the IAEA Asia Nuclear safety Network (ANSN), IRSRR, and other related international missions through TC and other Projects.

Article 19 (8) Management of spent fuel and radioactive waste on the site

Regulatory requirements
Indonesia ratified the Joint Convention on the Safety of Spent Fuel Management and the Safety of Radioactive Waste Management through the Presidential Regulation No. 84 of 2010. BAPETEN has developed or initiated the development of regulations on spent fuel and radioactive waste management. As the result, this regulation are:

- Government Regulation (GR) No. 54 of 2012 on Safety and Security of Nuclear Installations;
- GR No. 2 of 2014 on Licensing of Nuclear Installations and Nuclear Material utilizations;
- GR No. 61 of 2013 on Management of Radioactive Waste;
- BAPETEN Chairman Regulation (BCR) No. 3 Year 2010 on System Design for Handling and Storage of Nuclear Power Plant Fuel;
- BCR No. 16 of 2012 on Clearance Level,
- BCR No. 2 of 2014 on the Core Management and Handling & Storage of Nuclear Fuel of Non-Power Reactor, and
- BCR No. 8 of 2016 on Radioactive Waste Treatment for Low Level and Intermediate Level waste.

Act No. 10 of 1997 classifies radioactive waste as low, intermediate, and high level of radioactive waste. Furthermore, GR No. 61 Year 2013 states that high-level radioactive waste is spent fuel. The government has included long-term waste management regulations, spent fuel management and decommissioning in a draft amendment to Act No.10 of 1997 on Nuclear Power. Currently the government has Government Regulation No. 61 of 2013 on the Management of Radioactive Waste that regulates the management of waste from general decommissioning activities.

BATAN has produced the draft of National Policy and Strategy for Spent Fuel and Radioactive Waste Management for the Republic of Indonesia with support from European Union. Five important elements in this National Policy document:

- Policy objectives such as safety, security, safeguard compliance and waste minimization,
- Roles and responsibilities including the responsibilities of waste producers, regulators and policy makers,
- Institutional arrangements from planning new waste producing activities to implementing, decommissioning and disposal activities,
- Strategic planning which identifies the main sources of spent fuel and waste in Indonesia, including the decommissioning of facilities, and assist in the establishment of national inventory, and
- Sustainable long-term funding arrangement including full life cycle waste management costs being factored into consideration of new waste producing activities.

The draft will be proposed to be determined by BRIN as a National Policy and Strategy Document for Spent Fuel and Radioactive Waste Management for the Republic of Indonesia.

On-site storage of spent fuel

There are two options for managing spent fuel, re-export /repatriated or stored in the interim storage during the reactors' lifetime. After the end of the reactors' operation, all spent fuels are delivered to the final repository. The decision on the location of the final repository shall be determined by Government after approved by the Parliament sides.

If spent fuel from research reactors are stored in the facilities before re-exported to the country of origin, shipments of spent fuel are conducted under the transport and safeguards regulations that comply with international practices and standards.

Spent fuels from MPR GA Siwabessy reactor are temporarily stored in the reactor's wet interim storage before this spent fuel is sent to the Interim Storage for Spent Fuels (ISSF). Spent fuels from TRIGA 2000 and Kartini Reactor will be temporarily stored in wet interim storage their reactor facility. PTLR (Centre for Radioactive Waste Technology) is operated by BATAN/BRIN and responsible to manage spent fuel and radioactive waste in Indonesia. PTLR has advanced interim storage facilities for spent fuel and radioactive waste, including treatment and conditioning facilities (Figure 16). Indonesia collaborated with the USA to re-export LEU spent fuel through the FRR-GTRI Program in 1996 -2019.

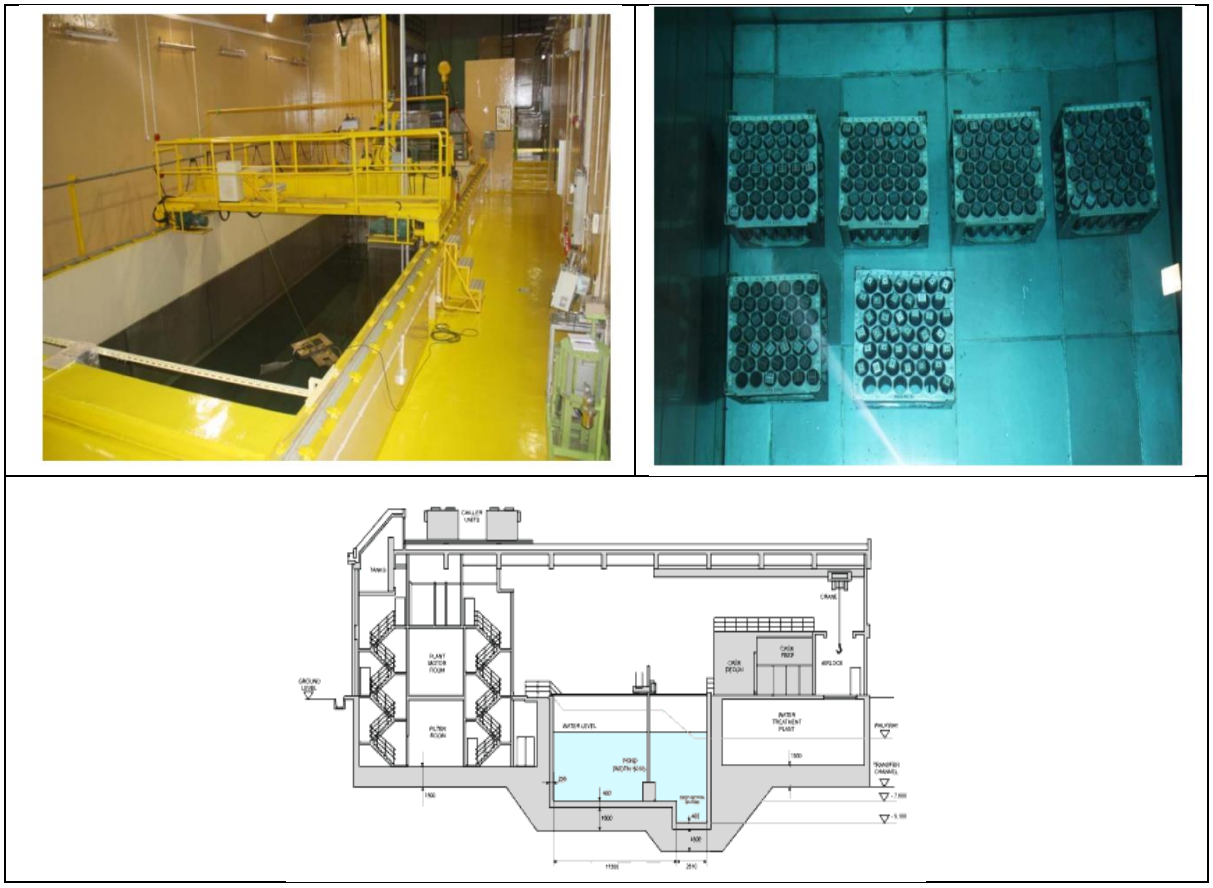


Figure 16. Interim Spent Fuel Storage Facility

ISSF's capacity is designed to store 1,448 fuel elements, sufficient to store spent fuel for 25 years of MPR GA Siwabessy operation (30 MWt) if there are eight fuels to be discharged per cycle and seven cycles per year. The annual discharge, based on recent experience, is about twenty fuels. Hence, the facility could cover for about fifty years of the reactor's operation.

Implementation of on-site treatment, conditioning and storage of radioactive waste

The TRIGA 2000 Reactor and Kartini Reactor generate short-life radionuclide and low-level liquid radioactive waste. The treatment of liquid radioactive waste in those facilities includes collecting in the hold-up tank for delays and decays to let activity reduce into below threshold limits then dispersing and discharging to the environment. The solid and organic liquid waste is collected in the containers, kept and stored in storage facilities.

Meanwhile, MPR GA Siwabessy generates solid, liquid, and gas waste with different activity that described in Table 5.

Table 5. Radioactive waste from MPR GA Siwabessy

Category	Activity		
	Low	**Intermediate**	**High**
Solid	contaminated linens, papers, filters, shoe-cover, and gloves	Spent resin from resin flashing, power ramp test, and isotope box decontamination.	Spent fuel. reactor components, filters, papers, contaminated linens, etc., are categorized as compactable solid wastes
Liquid	Stored and streamed to low activity waste water disposal system. originated from the systems and components of pool drainage, shower and rinsed water, and ventilation systems	Stored and streamed to intermediate activity waste water disposal system. Originated from resin flashing, power ramp test, water purification system.	-
Gas	One of the sources of radioactive gas waste is from the in pile loop system.		

Handling of radioactive waste in MPR GA Siwabessy is carried out by classifying the types of radioactive waste that occur during normal operation, namely;

a. Handling of solid waste which includes, among others:

1) Type and classification of waste, origin and quantity of solid waste, including physical form, volume and isotopic composition, and measured or estimated activity; and
2) Methods of collection, processing, packaging, storage, and transportation.

b. Handling of liquid waste which includes:

1) Type, classification and volume of liquid waste; origin, location, form, and estimated activity of liquid waste.
2) Flow rates, process equipment, storage tanks and release points to the environment.
3) Design of liquid waste management equipped with flow diagrams and instrumentation.
4) Purpose of effluent release; and
5) Capacity, redundancy and flexibility of the system.
6) The system capabilities needed to simplify maintenance, reduce leakage and prevent uncontrolled releases to the environment.
7) Criteria and concentration for recycling or releasing liquid waste into the environment; and
8) Estimated total annual release to the environment.

c. Handling of gas waste which includes:

1) Type and volume of gas waste: origin, location, form and amount of radionuclide.
2) Flow rate, process equipment and point of release to the environment.
3) Design of gas waste management equipped with flow diagrams and instrumentation.
4) Purpose of effluent release.
5) System capacity, redundancy and flexibility.
6) The system capabilities needed to simplify maintenance, reduce leakage and prevent uncontrolled releases to the environment.
7) Design requirements for handling potentially explosive gases; and
8) Estimated total annual release to the environment

Established procedures for clearance of radioactive waste

BAPETEN has issued regulations related to clearance restrictions such as BCR No. 16 of 2012 on the Clearance Level, GR No. 2 of 2014, GR No. 61 of 2013, and GR No. 33 of 2007. BAPETEN monitors on-site handling of spent fuel and radioactive waste through inspection and review/evaluation of the operation of reports submitted periodically.

Clearance procedure at PTLR, first conducting waste characterization to determine concentration/activity below the clearance requirements. Second if waste activity is below the clearance level, an application for exemption can be submitted to BAPETEN.

Regulatory review and control activities

BAPETEN has developed SALT (Integrated Waste Accounting System), an online application system of waste accounting for all waste producers to report online. BAPETEN conducts inspections on the management of spent fuel and spent fuel storage installations.

Annexes

Table 6. List of Regulation for Nuclear Installation

No.	Title
1	Nuclear Energy Act No. 10 Year 1997 on Nuclear Energy.
2	GR No. 33 Year 2007 on the Ionizing Radiation Safety and Security of Radioactive Sources.
3	GR No. 29 Year 2008 on the Licensing of Ionizing Radiation Sources and Nuclear Material.
4	GR No. 46 Year 2009 on the Limit of Nuclear Damage Liability.
5	GR No. 54 Year 2012 on the Safety and Security of Nuclear Installation.
6	GR No. 2 Year 2014 on the Licensing of Nuclear Reactor and Utilization of nuclear materials.
7	GR No. 61 Year 2013 on the Radioactive Waste Management.
8	GR No. 58 Year 2015 on the Safety of Radioactive Material Transportation.
9	Presidential Decree No. 82 Year 1993 on the Ratification of Convention on Assistance in the Case of a Nuclear Accident or Radiology Emergency.
10	Presidential Decree No. 81 Year 1993 on the Ratification of Convention on Early Notification of a Nuclear Accident.
11	Presidential Decree No. 106 Year 2001 on the Ratification of Convention on Nuclear Safety.
12	Presidential Regulation No. 46 Year 2006 on the Ratification of Amendment to the Convention on the Physical Protection of Nuclear Material.
13	Presidential Regulation No. 74 Year 2012 on the Nuclear Liability.
14	BAPETEN Chairman Regulation (BCR) No. 1 Year 2011 on Safety Design of Non Power Reactor.
15	BCR No. 3 Year 2011 on Safety Design of Nuclear Power Reactor.
16	BCR No. 7 Year 2011 on Safety Design of Emergency Power Supply for Nuclear Power Reactor.
17	BCR No. 1 Year 2012 on the Design of Protection against Fire and Explosive Hazards for Nuclear Power Reactor.
18	BCR No. 2 Year 2012 on the Design of Protection against Internal Hazards other than Fire and Explosive Hazards for Nuclear Power Reactor.

No.	Title
19	BCR No. 6 Year 2012 on the Design of Computer Based Important to Safety System for Nuclear Power Reactor.
20	BCR No. 8 Year 2012 on the Format and Content of Developing Safety Analysis Report of Research Reactor.
21	BCR No. 4 Year 2013 on Protection and Radiation Safety for Utilizing Nuclear Energy.
22	BCR No. 6 Year 2013 on Working Permit for Personnel in Installation and Nuclear Material.
23	BCR No. 8 Year 2013 on the Site Evaluation in the Seismic Aspect of Nuclear Installation.
24	BCR No. 9 Year 2013 on Operational Limit and Condition for Non Power Reactor.
25	BCR No. 2 Year 2014 on Core Management and Fuel Handling and Storage for Nuclear Power Reactor.
26	BCR No. 3 Year 2014 on the Format and Content of Environmental Impact Analysis of Nuclear Energy Utilization.
27	BCR No. 6 Year 2014 on the Site Evaluation in the Meteorology and Hydrology Aspect of Nuclear Installation.
28	BCR No. 2 Year 2015 on the Assessment and Verification of Safety for Non Power Reactor.
29	BCR No. 5 Year 2015 on the Site Evaluation in the Volcanology Aspect of Nuclear Installation.
30	BCR No. 8 Year 2016 on Management radioactive waste for intermediate and low level.
31	BCR No. 1 Year 2017 on conducting inspections in the nuclear energy oversight.
32	BCR No. 7 Year 2017 on the amendment of BCR No. 7 Year 2013 on the Environmental Radioactivity Limit.
33	BCR No. 3 Year 2018 on public communications strategy of regulatory body.
34	BCR No. 4 Year 2018 on Safety Provisions for Site Evaluation of Nuclear Installation, amending BCR No. 5 Year 2007 on Safety Provisions for Site Evaluation of Nuclear Reactor.
35	BCR No. 8 Year 2018 on the establishing of legislation in nuclear energy regulatory agency (BAPETEN).
36	BCR No. 2 Year 2019 on the safety of commissioning for Non Power Reactor.
37	BCR No. 4 Year 2019 on Dispersion of Radioactive Material in Air and Water and Consideration of Population Distribution in Site Evaluation for Nuclear Installation,

No.	Title
	amending BCR No. 3 Year 2008 on Dispersion of Radioactive Material in Air and Water and Consideration of Population Distribution in Site Evaluation for Nuclear Power Plants.