The Government of the Republic of Indonesia

NATIONAL REPORT
ON COMPLIANCE TO
THE JOINT CONVENTION
ON THE SAFETY OF SPENT FUEL MANAGEMENT
AND ON THE SAFETY OF RADIOACTIVE WASTE
MANAGEMENT

October 2020


Sumatra
Kalimantan
Sulawesi
Papua
Java

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Section A - Introduction

Background

This report is the fourth National Report by the Republic of Indonesia. It presents the latest development in the management of radioactive waste and spent fuel in Indonesia, including a follow-up IRRS Mission recommendations and the implementation of clearance by The Center for Radioactive Waste Technology. As reported in the previous National Report and Review Meeting, Indonesia has ratified "the Joint Convention on the Safety of Spent Fuel Management and the Safety of Radioactive Waste Management," through the Presidential Regulation No. 84 Year 2010. The regulation demonstrates Indonesia's intention to fulfill its obligation on one of the aspects of nuclear energy's peaceful uses, namely the nuclear safety aspect.

BAPETEN has developed or initiated the development of regulations on spent fuel and radioactive waste management. As the result, Indonesia has the Act No. 10 Year 1997 on Nuclear Energy, Government Regulation (GR) No. 61 Year 2013 on Management of Radioactive Waste, BAPETEN Chairman Regulation No. 16 Year 2012 on Clearance Level, and BAPETEN Chairman Regulation (BCR) No. 8 Year 2016 on Radioactive Waste Treatment for Low Level and Intermediate Level waste. Though all regulations developed by BAPETEN have referred to the IAEA requirements and guides, BAPETEN continuously improves and develops its specific regulations and guidances to comply with the Convention obligation. BAPETEN also performs inspections to licensees to verify their compliance with nuclear regulations

As stipulated under the Act No. 10 Year 1997 on Nuclear Energy, National Nuclear Energy Agency (BATAN) as an executing body is responsible for conducting research, development, utilization of nuclear energy, and managementof radioactive waste, while Nuclear Energy Regulatory Agency (BAPETEN) is an independent nuclear regulatory body whose functions are developing regulations, issuing licenses, and conducting safety and security inspection.

The Center for Radioactive Waste Technology (CRWT) is operated by BATAN and responsible to manage spent fuel and radioactive waste in the country. CRWT has advanced interim storage facilities for spent fuel and radioactive waste, including treatment and conditioning facilities.

Act No. 10 Year 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 includes spent fuel.

Indonesia utilizes radioactive sources and radiation generators for a wide variety of peaceful purposes in industry, medicine, research, and education. To some extent, the uses of radioactive sources for those purposes may generate radioactive waste and Disused Radioactive Sealed Sources (DSRS). In addition, the industrial enhancement in the petroleum industry (oil and gas), mining and

processing of raw materials, and other industrial practices potentially create waste called Technologically Naturally Occurring Radioactive Materials (TENORM).

It is the Indonesian government policy to return radioactive waste and Disused Sealed Radioactive Sources (DSRS) to the origin countries if possible. If re-exporting is not possible, radioactive waste and DSRS will be transferred to and managed by CRWT.

Indonesia does not have nuclear power plants (NPPs), yet. However, in its national long-term strategic action plan, Indonesia has introduced nuclear energy to generate electricity. Several coordination meetings have been held recently between the government institutions and concluded that both large, as well as small and medium NPPs are required in Indonesia in the next ten years from now. Small and medium size of NPPs applies for the remote area with abundant natural resources such as for Borneo Island (Kalimantan) and eastern regions of Indonesia. With these NPPs, the needs of electricity residents and that of heat for industrial and mineral processing are expected to be achieved. Indonesia currently has three research reactors located in Serpong, Bandung, and Yogyakarta, with the power range between 100 kW and 30 MW. These reactors are operated by BATAN. By law, there are two options for managing spent fuel: re-exported 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 approved both by the Government and Parliament sides.

The Government of Indonesia has a strong commitment to continuous developing its regulatory system, i.e., regulation, licensing, and inspection system. The regulatory system is required to implement the obligations under the Convention. Furthermore, the improvement and development of disposal facilities and/or long term storage of spent fuel and radioactive waste shall comply with the Convention to maintain their sustainable performance.

Section B – Policies and Practices

Article 32 (Reporting), paragraph 1

Spent Fuel Management Policy

The management of spent fuel and radioactive waste is aimed to safely and securely manage Indonesia's past, current, and future spent fuel and radioactive waste through appropriate processing, containment, and eventual disposal. Doing so will reduce, to as low as practicable and justifiable, the associated health, safety, environmental, financial security, and safeguards risks to current and future generations.

Storage of spent fuel shall be performed according to radiation safety, physical protection, and safeguards regulations. BAPETEN controls the safety, security, and safeguards aspects of the storage facilities of spent fuels periodically.

The current policy, legislative, and regulatory frameworks for the safe management of spent fuel and radioactive waste include licensing activities. The spent fuel management methods must conform to the highest appropriate standards as determined by BAPETEN.

All the spent fuel management activities will be based on the available science and technology and conducted in an open and transparent manner to achieve these aims.

The Indonesian Government's approach toward long-term management of spent fuel and radioactive waste includes establishing a centralized radioactive waste management, namely CRWT, which belongs to BATAN. This facility will store all domestically produced spent fuel and radioactive waste (as mandated by regulation) for a period of time sufficient for the Indonesian Government to establish a permanent disposal facility, consistent with international obligations and best practices. Indonesian Government has also implemented policy, legislation, and regulations aimed at ensuring waste generators have:

1. adopted a measure for minimizing the generation of radioactive waste; and
2. safely managed the waste until it is transported to national storage or the origin country.

Spent Fuel Management Practices

Spent fuels from the 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.

BATAN manages 3 (three) research reactors in Serpong, Bandung, and Yogyakarta. Spent fuels from Serpong's research reactor are temporarily stored in the reactor's wet interim storage before sent to the Interim Storage for Spent Fuels (ISSF) as part of CRWT.

Spent fuels from Bandung's and Yogyakarta's research reactor will be temporarily stored in wet interim storage in the reactors before transported back to the country of origin, which is the United States (US). The spent fuels from Bandung's research reactor have been re-exported in 1999, 2004, and 2009.

Table 1. Research Reactor Data in Indonesia

Place/Site	Maker	Type	Recent Power	First Criticality	Status
Bandung	GA	Triga	2000 kW	1964	In operation
Yogyakarta	GA	Triga	100 kW	1979	In operation
Serpong	Interatom	MTR	30 MW	1987	In operation

Radioactive Waste Management Policy

The Act No. 10 Year 1997 on Nuclear Energy regulates nuclear energy is only for peaceful use to achieve public prosperity. The uses of nuclear energy shall consider the safety, security, peace, and health of workers and the public and protect the environment.

As required by Article 23 of the Act No. 10 Year 1997 on Nuclear Energy, the management of radioactive waste in Indonesia is solely performed by BATAN. However, BATAN may cooperate with or appoint other institutions, such as state-owned companies and/or private entities, in managing such radioactive waste.

Similar to spent fuel management policy, the policy of radioactive waste management is to re-export DSRS to the origin country whenever applicable, or stored them in CRWT.

CRWT, responsible for managing radioactive waste, shall take into account the safety and health of workers and the public and the protection of the environment from radiation hazards in handling, treating, and disposing of radioactive waste. Furthermore, research and development in radioactive waste management should be carried out to support present and future nuclear energy programs' safety aspects.

Radioactive waste management practices

The radiation facilities and nuclear installations are required to minimize the generation of radioactive waste, including discharged liquid and gas effluent to the environment.

BATAN, through CRWT, has implemented the radioactive waste management program with the following objectives:

1. to assure that no one receiving excessive radiation doses from radioactive wastes; and
2. to take the lead in practical and safe technologies for radioactive waste management.

Radioactive waste may be generated from the operation of nuclear installations and radiation facilities. There are eight nuclear installations in Indonesia, which consist of three research reactors and five non-reactor nuclear installations. All the research reactors and four out of five non-reactor nuclear installations are operated by BATAN. Whereas, radiation facilities cover medical, industrial, and research and development facilities.

The first nuclear installation built in Indonesia was TRIGA MARK II at Bandung Nuclear Research Center, firstly operated in 1965. It was initially upgraded from 250 kW to 1000 kW in 1971 the upgraded again to 2000 kW in 2000, from which it became known as TRIGA 2000. TRIGA 2000 is a pool-type reactor using light water (H_2O), both as the moderator and coolant. The fuel is U-ZrH with 19.75% enrichment, and the reflector is graphite. The reactor is operated with an operation mode of 3 days per week and 24 hours per operating day for material analysis, radioisotope production, and research purpose.

In 1979, reactor KARTINI at Yogyakarta Nuclear Research Center was commissioned. Kartini Reactor is also a pool (TRIGA MARK II) type reactor with 100 kW power, and the enrichment of U-

ZrH fuel is 19.75%. It utilizes graphite as a reflector and uses H_2O both as the moderator and coolant. The reactor is now operated five times a week for material analysis, research, and educational purpose.

The above two reactors 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, and reducing activity into insignificant concentration, then dispersing and discharging to the environment. The solid and organic liquid waste, collected in the containers, are kept and stored in storage facilities. To protect the environment, BAPETEN has established standards of quality for environmental radioactivity and the discharge limit for radioactive release to the environment as stipulated in BAPETEN Chairman Regulation No. 7 Year 2017 on Radioactivity Limit in the Environment.

The Serpong Nuclear Research Facilities consist of Center for Multipurpose Reactor (CMPR) Center for Nuclear Fuel Technology (CNFT), which has two installations, namely Experimental Fuel Element Installation (EFEI) and Radiometalurgy Installation (RMI), and Center for Radioisotopes and Radiopharmaceutical Technology (CRRT). Still in Serpong site, besides the above facilities operated by BATAN, there is a state-owned company namely PT INUKI which has one non-reactor nuclear installation (FEPI, Fuel Element Production Facility) and one radiation facilities (RII, Radioisotope Installation). All the facilities above have generated a large quantity of low and intermediate-level waste.

Besides nuclear installations, BATAN has also research facilities in Pasar Jumat area. The Pasar Jumat Nuclear Research Facilities consist of Center for Isotope and Radiation Application (CIRA), Center for Radiation Safety Technology and Metrology (CRSTM), Center for Nuclear Minerals Technology (CNMT), Center for Education and Training (CET), and Center for Dissemination and Partnerships (CDP). The facilities as part of these center, such as Co-60 Gamma Irradiator, electron accelerator, uranium processing laboratory, the radiation measuring instruments, chemical, biology, hydrology laboratory, and training facility generate small quantities of radioactive wastes. They are collected in the containers, kept, and stored in their storage facilities before sent to CRWT.

Radioactive wastes generated by radiation facilities from medical applications, industries, and research institutes are as follow: DSRS, liquid waste, and solid waste. The radioactive wastes from medical applications consist of DSRS, i.e., Cs-137, Ra-226, and Co-60. For industrial applications, radioactive wastes include DSRS for radiography, logging, gauging, lightning rods, and solid waste from gas-mantle lamp manufacturers.

To manage low and intermediate-level waste produced by those facilities, BATAN has established the centralized Radioactive Waste Management Installation (RWMI) as a part of CRWT.

Criteria to define categories of radioactive waste

Radioactive wastes are classified as low-level radioactive wastes, intermediate-level radioactive wastes, and high-level radioactive wastes. The low-level radioactive wastes are

subclassified into (1) very short half-life, (2) very low-level, and (3) relatively low-level. The intermediate-level radioactive waste consists of DSRS with (1) a half-life less than 15 years, (2) a half-life between 15 and 30 years, (3) a half-life for more than 30 years, and (4) other than DSRS. The high-level radioactive wastes include nuclear spent fuel.

For reactor facilities, liquid wastes are grouped into low active waste with the activity of 37 kBq/m^3 to 0.37 GBq/m^3, and intermediate active waste with the activity of 0.37 GBq/m^3 to 3,700 GBq/m^3. The low level of liquid waste is originated from the systems and components of pool drainage, shower and rinsed water, and ventilation systems. The intermediate level of radioactive liquid waste is originated from resin flashing, power ramp test, and isotope box decontamination. The spent resin resulting from the water purification system with the maximum activity of 3.7 GBq/m^3 is treated as semi-liquid waste. Solid wastes such as used reactor components, filters, papers, contaminated linens, etc., are categorized as compactable solid wastes with the maximum exposure rate of 25 mR/h (250 μSv/h) and burnable solid wastes with the maximum activity of 0.0037 GBq/m^3 for alpha emitter and 0.037 GBq/m^3 for beta-gamma emitter.

For radioisotope facilities, low-level liquid radioactive waste is originated from the shower and rinsed water, decontamination activities, or others with the maximum activity of 0.37 GBq/m^3. High-level waste results from the processing of the irradiation target in the hot cell. The solid waste is grouped into two categories: exposure rate less than 1,000 mR/h (1 mSv/h) at the surface, and the other is more than 1,000 mR/h (1 mSv/h) at the surface.

Radioactive liquid wastes from fuel element fabrication, such as in FEPI, are mostly contaminated with chemical waste containing very low amount of uranium.

The solid wastes from Serpong site, such as contaminated linens, papers, filters, shoe-cover, and gloves with the maximum exposure rate of 25 mR/h (250μSv/h) are collected in plastic bags and put into 100-L drums before transported to RWMI.

Section C –Scope of Application

Article 3 (Scope of application), paragraph 2

Indonesia has the policy to prioritize re-exporting the spent fuels to the origin countries or storing them within the authorized facility. With regards to the processing of nuclear spent fuel activities, Indonesia does not possess a nuclear weapon program. Indonesia has been critical of those non-universal nonproliferation mechanisms that potentially limit the access of non-nuclear-weapon states (NNWS) to technologies for the peaceful uses of nuclear energy. In 1970, Indonesia signed the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) as a NNWS and ratified it in 1978 through Act No. 8 Year 1978. Indonesia is a prominent member of the Association of Southeast Asian Nations (ASEAN), supporting the formation of Southeast Asian Nuclear-Weapons-Free-Zone (SEANWFZ), and

became the party of the Bangkok Treaty, which entered into force in 1997. Indonesia has signed as well the Comprehensive Nuclear Test Ban Treaty (CTBT) in 1996 and ratified it in February 2012. In addition, Indonesia has agreed to a Comprehensive Safeguards Agreement for its nuclear facilities, marking the beginning of Indonesia's role as a proponent of the peaceful uses of nuclear technology. Indonesia acceded to the Additional Protocol in 1999, becoming the first state in Southeast Asia to be bound by this more rigorous verification mechanism. Indonesia began the implementation of the IAEA Integrated Safeguards, including the Additional Protocol, in 2003. Indonesia continues to advocate strongly for protecting the rights of NNWS to peaceful uses of nuclear technology.

Radioactive waste resulting from NORM is also reported in this National Report to be in line with Article 3 of the Convention. Concerning the non-peaceful uses, Indonesia does not produce any spent fuel or radioactive waste from military applications.

Section D– Inventories and Lists

Article 32 (Reporting), paragraph 2

List of Spent Fuel Management Facilities

Indonesia has only one interim storage facility for spent fuel at the Serpong site to serve the Serpong's research reactor, namely ISSF, which is part of CRWT. However, there is a pool/pond as the interim storage for spent fuel in the Serpong's, Bandung's, and Yogyakarta's reactor sites.

Inventory of Spent Fuel

There are 401 items of spent fuels in Indonesia, consisting of 287 items in ISSF and 114 items in the storage pool of the Serpong's research reactor.

List of Radioactive Waste Management Facilities

RWMI, as a part of CRWT, is the only installation authorized to manage radioactive waste in the form of liquid, spent resin, combustible waste, high active waste, and sealed sources. RWMI is equipped with an evaporator, compactor, incinerator, chemical treatment, conditioning facilities for DSRS, and interim storage.

Inventory of Radioactive Waste

Each radionuclide's total activity in the waste stored in CRWT is shown in Section L- Annexes (Table 2). The inventory of NORM is also presented in Section L – Annexes.

List of Nuclear Facilities in the Process of Being Decommissioned and the Status of Decommissioning Activities

At present, there is no facility in the process of being decommissioned.

Section E – Legislative and Regulatory System

Article 18 (Implementing Measures)

Indonesia has ratified and implemented the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management by Presidential Regulation No. 84 Year 2010, enacted on 28 December 2010.

The Act No. 10 Year 1997 on Nuclear Energy contains provisions for licensing nuclear installations, that include facilities for managing spent fuel and radioactive waste. The Government also has enacted several regulations derived from the Act. Furthermore, BAPETEN, as an independent regulatory body under the President's direct supervision, has performed regulatory processes to ensure compliance with the Convention.

Article 19 (Legislative and Regulatory Framework)

The primary legislation governing spent fuel and radioactive waste is the Act No. 10 Year 1997 on Nuclear Energy. In 2002, GR No. 27 Year 2002 on Radioactive Waste Management was enacted, then substituted in 2013 with GR No. 61 Year 2013 on the same title. Apart from this, GR No. 101 Year 2014 on Hazardous Waste Management also include provisions which consider TENORM as part of hazardous waste.

BAPETEN has issued two BAPETEN Chairman Regulations (BCR) regarding the radioactive waste management : (1) BCR No. 16 Year 2012 on Clearance Level, and (2) BCR No. 8 Year 2016 on Radioactive Waste Management for Low-Level and Intermediate-Level waste.

Chapter VI (Article 22 – 27) of the Act regulates radioactive waste provisions and requirements. As stated in Article 22 clause (1), radioactive waste management's main objective is to protect workers, the public, and the environment from radiation hazards. BATAN implements radioactive waste management as an executing body, and BATAN may cooperate with or assigned state-owned companies and/or private entities (Article 23).

A licensee producing low and intermediate-level wastes shall collect, classify, or process, and temporarily store them before sending them to BATAN (Article 24 (1)). A Licensee producing high-level radioactive wastes shall store them temporarily in a reactor storage pool for at least in a period of the lifetime of the reactor (Article 24 (2)). Article 2 of BCR No. 8 Year 2016 states that low level and intermediate-level waste cover radioactive sealed sources, radioactive unsealed sources, contaminated materials, and equipment. Furthermore, the BCR regulates the different type of process for radioactive sealed sources waste (delay and decay, and conditioning) and for radioactive unsealed sources (delay and decay, reduction, decomposition, and conditioning).

According to BCR No. 16 Year 2012, licensees are allowed to release their radioactive waste after obtaining a clearance approval from BAPETEN. The clearance can be applied for contaminated materials, radioactive waste, and unsealed sources. The licensees are allowed to propose a higher clearance level than that determined by the BCR under the condition that the effective dose received by public members is less than 100 μSv/y.

In relation to the disposal of high-level wastes, BATAN is required to provide sites for disposal. The Government determines the selected sites for disposal with the Parliament approval (Article 25). Storage of radioactive wastes in radioactive waste management facility in BATAN (RWMI) is subject to a fee (Article 26). The waste management fee shall be established in government regulation. Transportation and storage activities shall consider the safety of workers, the public, and the environment (Article 27 (1)).

GR No. 61/2013 provides 2 (two) options regarding the radioactive waste management, which are to re-export the waste or to transfer it to BATAN. However, the Government established a policy that every person or legal entity with the intention to utilize nuclear energy should declare to the regulatory body (BAPETEN) the will to re-export their wastes to the origin country. GR No. 61/2013 requires that the evidence of re-exporting shall be submitted to BAPETEN no later than 14 days after the date of re-exporting.

Radioactive wastes from other countries are prohibited from entering into the jurisdiction of the Republic of Indonesia (Article 46 (1) GR No. 61 Year 2013) unless they are generated from radioactive sources produced in Indonesia (Article 46 (2)). For spent fuels, the generator shall temporarily store the spent fuel on the site during the reactor's operational period (Article 32) and re-export to the origin country or send it to BATAN for the final repository afterwards (Article 33).

Based on GR No. 61/2013, there is a possibility of reusing DSRS after BATAN has performed the safety assessment.

Several BCRs also have been enacted as implementing norms of the related government regulations. Another regulation also relevant in this case is Article 77 of GR No. 101 Year 2014 on Hazardous Waste Management. It prohibits the user from utilizing toxic and hazardous wastes that have a radioactive contamination equivalent to or greater than 1 Bq/cm^2 and/or an activity concentration equivalent to 1 Bq/gram for each radionuclide of the uranium and thorium decay chain, or an activity concentration equivalent to 10 Bq/gram for potassium.

BAPETEN collaborates with the Ministry of Environmental and Forestry to control TENORM in Indonesia. BAPETEN is responsible for TENORM with the activity concentration of radionuclide equivalent to or greater than 1 Bq/gram, while the Ministry of Environmental and Forestry is responsible for TENORM with the concentration of radionuclide less than 1 Bq/gram.

The legislation and regulations related to radioactive waste and spent fuel management are listed in Table 6.

As stated in the government regulations, law enforcement to any violation of the regulatory requirements is performed through administrative sanctions, such as written notices, license suspension, and license revocation. While Act No. 10 Year 1997 stipulates that unauthorized utilization is subject to penal sanctions.

Article 20 (Regulatory Body)

The Nuclear Energy Regulatory Agency or BAPETEN is the only regulatory body responsible for controlling or regulating nuclear energy utilization. BAPETEN is directly responsible to the President of the Republic of Indonesia. The regulatory processes performed by BAPETEN include developing regulations, issuing license, and conducting inspections, including unannounced inspection.

To support the activity of its main function, BAPETEN has its internal technical support units, i.e, the regulatory assessment unit, the emergency and preparedness unit, and the cooperation unit that strengthen the effectivity of BAPETEN's regulatory function.

BAPETEN is responsible for ensuring the safety of workers, the public, and the environment from any harmful radiation effect. As such, BAPETEN needs a sufficient number of human resources that are competent to perform regulatory duties. In the human resources development framework, BAPETEN has developed bilateral cooperation programs with partner countries, such as Japan, South Korea, Australia, Canada, Russia, Slovak, Germany, and the USA. BAPETEN has established an Education and Training Center to develop staff competency through education and training organized by BAPETEN, IAEA, or other international organizations.

In 2019, BAPETEN hosted ORPHAS mission and a follow-up IRRS mission. BAPETEN is also initiating the drafting of the new Act on nuclear energy, as is usually done by BAPETEN in the process of drafting regulations. BAPETEN involves public participation by holding public consultation events. To fulfill transparency and openness, BAPETEN uploads draft regulations on its official website (bapeten.go.id) to gain feedback on the draft.

The financial resources of BAPETEN are from the state's budget under the annual budget plans approved by the National Planning Agency, Ministry of Finance, and the Parliament. In the licensing processes, licensing fees are imposed on the licensee, where the fees are assigned to the Government's account as a non-taxes state's income.

Section F – Other General Safety Provision

Article 21 (Responsibility of the license holder)

BATAN as the executing body shall administer radioactive waste management based on the safety concern and technical capability it possesses and also for the ease in implementation of control.

The management is administered in a noncommercial manner. For commercial activities of radioactive waste management, BATAN may designate a state-owned company, cooperatives, or any private entities in accordance with the existing regulations.

The generator of low and medium-level radioactive wastes should manage radioactive waste within the nuclear installation location to not pose hazards to workers, the public, and the environment and enable further management by CRWT as part of BATAN. The management of radioactive waste from the generator includes temporary disposal. The purpose of temporary disposal is to reduce the radiation level of short live radioactive materials before transferring them to CRWT. The generator of high-level radioactive wastes shall temporarily store those wastes (spent fuels) during the period not less than the nuclear reactors' lifetime.

The determination of a final repository site for high-level radioactive wastes shall be discussed with the Parliament of the Republic of Indonesia to obtain approval. Radioactive wastes from other countries shall not be allowed to be disposed of in Indonesia's territory.

As stipulated by GR No. 33 Year 2007, BAPETEN will take security measures against orphan sources and conduct a search for information. In case the owner of the source is not found, BAPETEN will declare the orphan as radioactive waste. Meanwhile, in relation to the radioactive waste generated by the licensees, the provision in radioactive waste management shall refer to the GR No. 61 Year 2013. Hence, based on the ownership, radioactive waste can be categorized into (1) radioactive waste generated by the licensees; and (2) radioactive waste generated from an orphan source.

As stipulated by the GR No. 61 Year 2013, BATAN is responsible for:

a. carrying out the management of radioactive waste (Article 5),
b. providing technical assistance to waste generator and educational assistance to the public (Article 43),
c. providing storage and disposal facilities (Article 16, Article 27, Article 38, Article 40); and
d. developing procedures and technical guidance on radioactive waste management (Article 12).

Whereas, the waste generator according to the regulation shall:

a. minimize the volume and activity of radioactive waste as low as possible;
b. collect, segregate, and store the waste temporarily prior to being transferred to BATAN (Article 7);
c. develop and maintain an inventory of radioactive waste (Article 19 clause(1)); and
d. submit inventory of radioactive waste to BAPETEN at least once in six months (Article 19 clause (2)).

Regarding the spent fuel, the licensees shall develop and maintain an inventory of spent fuel, accountability and control system of nuclear material, and physical protection system. The inventory shall be reported to BAPETEN at least once in six months.

Standard operating procedures (SOPs) in licensing the radioactive waste have been developed by BAPETEN. The SOPs provide guidelines for the licensees to declare a commitment to returning the radioactive source to the country of origin once it becomes radioactive waste. The returning can be conducted through the importer or independently by the licensee.

As mentioned in Section A above, it is a policy established by BAPETEN as the regulatory body that in the licensing process of importation of the radioactive source, the importers shall submit a commitment letter, which is the commitment made by the importers to return radioactive materials no longer used by the licensees to the country of origin.

Article 22 (Human and Financial Resources)

Article 16 of GR No. 33 Year 2007 requires the licensees to have qualified and competent personnel on relevant practices. Information regarding personnel's education and training records shall be submitted in a license application. Furthermore, the sufficiency of the required personnels is verified through inspections. The licensing unit's verification process in BAPETEN is stipulated on the Management System of BAPETEN (BAPETEN Chairman Regulation No. 14 Year 2014). A more detailed evaluation of licensing process is regulated in GR No. 29 Year 2008. Re-evaluation is conducted during the license renewal and/or when BAPETEN requests (Periodic Safety Review).

The Indonesian Government guarantees adequate financial resources for necessary infrastructures and equipment of CRWT facilities, as well as for its decommissioning. Waste generators shall provide sufficient funding for paying their wastes before transferred to and managed by CRWT, as required by GR No. 29 Year 2011 on Tariff for BATAN Services.

Article 23 (Quality Assurance)

GR No.58 Year 2015 on Safety and Security of Transport of Radioactive Materials, GR No. 61 Year 2013 on Radioactive Waste Management, GR No. 33 Year 2007 on Safety of Ionizing Radiation and Security of Radioactive Sources, and GR No. 29 Year 2008 on Licensing of Ionizing Radiation Source and Nuclear Material Utilization clearly state that management system in nuclear and radiation facilities and activities, which encompasses quality control, is one of the technical requirements in the licensing process. Furthermore, based on BAPETEN Chairman Regulation No. 4 Year 2010, management system shall comprise of: Safety culture, graded approaches, document control, management responsibilities, resource management, process implementation and measurement, assessment and improvement. This concept was adopted from the IAEA GS-R-3. The management system of facilities and activities is also subject to inspection by BAPETEN.

The testing laboratory for radioactive materials package operated by BATAN has applied ISO 9001: quality management system and has been accredited by ISO 17025 standards, as required by GR No. 33 Year 2007. BAPETEN certifies or re-certifies a package based on the result of this testing laboratory. BAPETEN may validate a package certificate from the country of origin. The certification and validation scheme of the package also apply for waste and spent fuel packages. Radioactive waste

management is implemented in accordance to an approved management system and quality control such as: for single batches of treated and conditioned waste, samples are taken for compressive strength tests and leaching tests. These tests are carried out in compliance with BCR No. 7 Year 2020 on Safe Transport and Administrative Requirement of the Transport of Radioactive Sources.

Article 24 (Operational Radiation Protection)

Radiation protection requirements have been specified in GR No. 33 Year 2007 which in line with BSS-115. The licensee shall comply with the dose limit and implement the optimization of radiation protection as stipulated in BCR No. 04 Year 2013 on Radiation Protection and Safety in Nuclear Energy Utilization. Numerical values for the dose limit are in line with the IAEA GSR Part 3. However, it still implements similar process-based (intervention and practice) instead of recommended exposure situation-based, as stated in the IAEA GSR Part 3. BAPETEN, as the regulatory body, encourages the operators of spent fuel and radioactive waste management facilities to undertake deliberate efforts in fulfilling the requirement of the dose limit.

The licensees shall implement a radiation protection program to maintain the dose received by workers and the public as low as reasonably achievable (ALARA). They also shall establish a dose constraint to ensure the objective of radiation protection is achieved. Currently, BAPETEN has established guidelines regarding the implementation of optimization requirements, including the guidance to establish the dose constraint, since the licensees have difficulty in understanding and applying the optimization principle at the operational stage.

Article 25 (Emergency Preparedness)

On-site and off-site emergency plans

Provisions on nuclear emergency preparedness and response are outlined in GR No.33 Year 2007 on Safety of Ionizing Radiation and Security of Radioactive Sources and GR No.54 Year 2012 on Safety and Security on Nuclear Installation. Particularly on the latter, nuclear emergency preparedness and response are classified into three levels: the installation level, the provincial level, and the national level.

For the installation level, the nuclear emergency preparedness program is established and implemented by each licensee, who also has the responsibility to declare a nuclear emergency status, should this be necessary. The licensee is requested to submit a daily report of the implementation of nuclear emergency response actions to BAPETEN until the nuclear emergency status is ended. The technical requirement is governed on BCR No. 1 Year 2010 on the Emergency Preparedness and Response.

GR No. 33 Year 2007 governs that licensees shall perform the intervention in the case of emergency exposure in their facility. The intervention activity involves protective and remedial actions under their emergency preparedness program, which is subject to BAPETEN approval. An emergency

situation with off-site radioactive release shall be reported immediately to BAPETEN. The emergency preparedness program shall include functional aspects (identification, reporting, and activation; mitigation action; urgent protective actions; protective actions for radiation workers and the public; and/or information and instruction to the public) and infrastructure aspects (organization; coordination; facility and equipment; response procedures; and/or training program). The intervention shall be done until the concentration activity of radionuclides is below the intervention level. The intervention concept adopts from BSS-115, and the response arrangement refers to the updated IAEA Tecdoc-953.

BCR No.1 Year 2010 regulates that the licensees such as waste generators, treatment operators, and the waste management operators shall undertake precautionary measures on the occurrence of a nuclear accident or radiological emergency. In a nuclear accident or radiological emergency, waste generators, treatment operators, and the waste management operators shall take appropriate mitigation and remedial actions. Licensees shall report to the BAPETEN Chairman in case of a nuclear emergency at the latest of 1 hour after the incident/accident by phone, facsimile, or email, and submit the written report within 2 days after the incident/accident. Currently, BAPETEN Chairman's Regulation No. 1 Year 2010 on the Emergency Preparedness and Response is under revision to commensurate its arrangement with GSR Part 7.

GR No. 58 Year 2015 on Safety and Security of Transport of Radioactive Materials governs that the shipperis are required to have an emergency preparedness and countermeasures system for Radioactive Source Transportation. Emergency preparedness and response systems include preparing and establishing emergency response procedures, emergency training and drill, and emergency response.

Since 2005, BAPETEN has widely promoted the "National Nuclear Emergency Preparedness System" (SKNN), including the arrangement of the National Response Organization for Nuclear Accident (OTDNN). This measure is an inter-ministerial mechanism in preparedness and response to radiological and nuclear safety events. OTDNN is led by National Agency for Disaster Management and supported by NUBIKA (CBRN-Army), POLRI (The National Police, including FEMT and Bomb Squad), Fire Brigades, Emergency Ambulance, BATAN, Ministry of Health, and Ministry of Transportation.

In 2010, the SKNN concept was integrated into a draft GR on nuclear installation's safety and security. The draft of SKNN is mainly based on the IAEA GS-R-2. In 2012, GR No. 54 on Safety and Security of Nuclear Installation was issued. The draft of OTDNN adapted from the updated IAEA Tecdoc 953, but until now, the draft of OTDNN has not yet been established.

Preparation and coordination of emergency plan

BAPETEN organizes a series of national exercises, meetings, and workshops to establish robust emergency management and operations, including for spent fuel and radioactive waste management. Furthermore, in implementing BCR No. 1 Year 2010 on the Nuclear Emergency

Preparedness and Response, all nuclear installations, including ISSF and RWMI, conduct emergency exercise annually based on their emergency preparedness program approved by BAPETEN.

BAPETEN is also mandated to perform a response in the case of an orphan source. BAPETEN secured 3 unidentified orphan sources found in scrap metal yards in Gresik, East Java (2000); Palembang, South Sumatra (2007); and North Jakarta (2007).

For the provincial and national level, as regulated by GR No. 54 Year 2012 on Safety and Security on Nuclear Installation, the nuclear emergency preparedness program is established by the Chairman of the Local Disaster Management Agency (LDMA) for provincial level and National Disaster Management Agency (NDMA) for the national level. This program involves coordination with relevant institutions and licensees within their territories.

BAPETEN with other related ministries and agencies have initiated a national program to build and improve the Nuclear Preparedness System's capability and National Nuclear Security through the Indonesia Center of Excellent on Nuclear Security and Emergency Preparedness (I-CoNSEP). The I-CoNSEP consists of four pillars: coordination, technical support, capacity building, and infrastructure. BAPETEN conducts several activities through the I-CoNSEP. Firstly, BAPETEN has a focus on increasing and strengthening the cooperation with related ministries and agencies. Next, BAPETEN improves infrastructure capabilities, equipment for the surveillance system, and human resources' quality on nuclear security and emergency preparedness program. Lastly, BAPETEN develops the installation and operation of integrated online early warning systems (Radiation Portal Monitor and Radiation Data Monitoring System) at strategic locations/areas or national vital objects. All of the activities are held to build and enhance a reliable, world class national nuclear preparedness system and capability.

Under the Joint Convention on Early Notification and Assistance, the Deputy Chairman of BAPETEN for Licensing and Inspection takes the responsibility as National Coordinating Authority Abroad (NCA-A). At the same time, the Director of Technical Support and Nuclear Emergency Preparedness is assigned as National Coordinating Authority Domestic (NCA-D) and Coordinator for Nuclear Emergency Preparedness served as National Warning Point (NWP).

In the case of a transport accident, Chapter VI of the GR No.58 Year 2015 on Safety and Security of Transport of Radioactive Materials governs that transporters shall report to the relevant regulatory authorities, the shipper, and the consignee. All parties shall take prompt actions. In a nuclear accident or radiological emergency, waste generators, treatment operators, and the waste management operators shall take appropriate mitigation and remedial actions. Licensees shall report to the Chairman of BAPETEN in case of a nuclear emergency at the latest of 1 hour after the accident by phone, facsimile, or email, and shall submit the written report within 2 days after the accident.

BAPETEN is also mandated by Regulation No. 33 Year 2007 to perform a response in the case of an orphan source. In Indonesia, scrap metal is one of the raw material for metal factories. Since

2009, BAPETEN has been performing the orphan source search. And BAPETEN hold-annual "search campaign" to some provinces dealing with scrap metal import and export businesses.

BAPETEN has issued BCR No. 1 Year 2015 on Emergency Preparedness Team to improve the quality of nuclear emergency responses.

Article 26 (Decommissioning)

Decommissioning requirements for ISSF have been regulated in GR No. 2 Year 2014 on Licensing of Nuclear Material and Nuclear Installation, while decommissioning requirements for RWMI are regulated in GR No. 29 Year 2008 on Licensing of Ionizing Radiation Source and Nuclear Material Utilization. In both GRs, the licensees are required to develop a decommissioning program which is further elaborated in BCR No. 4 Year 2009 on Decommissioning of Nuclear Reactors and BCR No.6 Year 2011 on Decommissioning of Non-Reactor Nuclear Installation. The decommissioning program contains information regarding radioactive waste handling, radiation protection, safety analysis, and financial estimation. The decommissioning program of ISSF shall be proposed to BAPETEN to apply for a construction permit and operating license of nuclear installation.

Section G – Safety of Spent Fuel Management

Article 4 (General Safety Requirement)

Safety requirements for the facility are stipulated in GR No. 33 Year 2007 on Safety of Ionizing Radiation and Security of Radioactive Sources and GR No. 54 Year 2012 on Safety and Security of Nuclear Installation.

Any spent fuel management facility shall comply with GR No. 33 Year 2007 and GR No. 54 Year 2012 that specify the safety and security requirements, i.e., management system, safety and security culture, emergency preparedness, design, construction, commissioning, operation, and decommissioning requirements, and safety and security analysis or verification. The facility shall also meet technical requirements based on the defence in depth principle and good engineering practices. Based on GR No. 2 Year 2014 on Licensing of Nuclear Material and Nuclear Installations, the spent fuel facility shall submit applications to BAPETEN to obtain site, construction, commissioning, operation, and decommissioning permit/license. BAPETEN then verify and evaluate the licensing application submitted by the applicant.

Article 5-8 (Existing Facilities, Siting of proposed facilities, Design and construction of facilities, Assessment of the safety of facilities)

The only existing facility authorized by BAPETEN for spent fuel management is ISSF, which is part of CRWT and owned by BATAN. It was built and put into cold commissioning in 1998. ISSF was once operated by Research Reactor Center, but since 2006, the facility has been operated by CRWT.

ISSF has renewed its license from 2018 to 2028, while for the RWMI, the renewal is from 2017 to 2022. BAPETEN approved the license renewal after ensuring that the ageing management program's implementation report and periodic safety review met the requirements.

Government regulations and BAPETEN Chairman Regulations require the licensee to take the appropriate measures to review any existing spent fuel management facility's safety and ensure that all reasonable practical improvements are made. As part of its regulatory activities, BAPETEN routinely inspects the ISSF.

Article 9 (Operation of Facilities)

ISSF's capacity is designed to store 1,448 fuel elements, sufficient to store spent fuel for 25 years of reactor's operation (CMPR) 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. The current status of ISSF is presented in Table 3 of Section L.

The operators and supervisors of the facility have been granted work permits by BAPETEN, as mandated by GR No. 2 Year 2014 on Licensing of Nuclear Installation and Nuclear Material Utilization, that the operator shall obtain authorization from BAPETEN prior to the facility's operation.

In conducting its operation, ISSF follow BAPETEN Chairman Regulation No. 3 Year 2006 on Licensing of Non-Reactor Nuclear Facility that requires operational limits and conditions must be established. The operational limits and conditions are derived from the tests and operational experience and assessments, followed by safety analysis conducted by the facility.

Article 10 (Disposal of Spent Fuel)

The final repository facility provision has been accommodated in Act No. 10 Year 1997 on Nuclear Energy and GR No. 2 Year 2014. The implementation of this provision is essential when the nuclear power program is established. Currently, there is no final repository facility for spent fuels.

Section H – Safety of Radioactive Waste Management

Article 11 (General safety requirements)

Criticality and removal of residual heat are the requirements that have to be fullfilled by licensee in the licensing process as well as during the periodic inspection by BAPETEN to:

1. minimize the generation of radioactive waste,
2. take into account interdependencies among the different steps in radioactive waste management,
3. provide for effective protection of individual, society and the environment,

4. take into account the biological, chemical, and other hazards.

Indonesia's policy is to manage radioactive waste in order to protect future generations and minimize the burden. Although the disposal issue is not yet solved, adequate research and development for disposal has been established.

Article 12 (Existing Facilities and Past Practices)

BATAN has established the centralized Radioactive Waste Management Installation (RWMI) as a part of CRWT. By law, RWMI is the only facility in Indonesia authorized to manage radioactive waste in the form of liquid, spent resin, combustible waste, high active waste, and sealed source. It was built in 1989 in Serpong. RWMI has two interim storage buildings, namely Interim Storage 1 (IS-1) and Interim Storage 2 (IS-2), and equipped by processing units, such as Evaporation System, Ion Exchange Unit, Compaction System, Incineration System, Cementation System, Interim Storage for Embedded Waste (ISEW), and Interim Storage for High-Level Waste (ISHLW).

The Evaporation System processes liquid wastes with the maximum activity of 0.74 GBq/m^3 into radioactive concentrates (with maximum activity of 37 GBq/m^3) and normal water distillates. The evaporator unit is a thermosiphon circulating thermal evaporator with the operating capacity of 0.75 m^3/h and is designed to reduce the waste volume in the maximum ratio of 50: 1, depending upon initial salinity.

The Ion Exchange Unit performs liquid waste treatment by feeding the liquid waste from the waste storage tank using a pump to the ion exchange column. In the ion exchange column, there is an exchange of radionuclides of Cs-137, Co-60, and other radionuclides in the form of cations with H^+ ions found in cation resins. The ion exchanger's basic design consists of a resin feed system, a prefilter system, and an ion-exchange column system. The resin feed has a capacity of 100 litres equipped with a centrifugal pump with a capacity of 4 m^3/hour. The prefilter system has a column design with a diameter of 12 inches and a height of 100 cm. The prefilter system used is a cartridge with a pore size of 10 µm. The ion exchange column has a diameter of 14 inches and a height of 120 cm, made of stainless steel, and is equipped with safety and security systems, such as fuse, overload, mainswitch, and interlock systems.

The Compaction System is used to treat compactable low-level solid wastes. It compresses solid wastes contained in 0.100 m^3 mild steel drums. In the compacting step, 0.100 m^3 drums are compacted in a 0.200 m^3 steel drum using a 600 kN hydraulic press. This drum is then solidified with cement slurry, closed, and sealed.

The Incineration System processes burnable solid wastes having activity of 0.0037 GBq/m^3 for the alpha emitter and of 0.37 GBq/m^3 for the beta, gamma emitter, waste oils, and liquid organic solvents, and animal's carcasses into radioactive ashes and off-gases. The radioactive ashes are then solidified by cementation in a 0.100 m^3 steel drum.

The Cementation System solidifies evaporator concentrates and spent-resins (with the maximum activity of 3.7 GBq/m^3) using 0.950 m^3 concrete shells. The 0.350 m^3 shells and 0.200 m^3 shells are used for the immobilization of non-compatible solid waste. The Compaction System is used to treat low compactable level solid wastes; it compresses solid wastes into a 100-L mild steel drums. In the compacting step, 100-L drums are compacted in a 0.200 m^3 steel drum utilizing a 600 kN hydraulic press. This drum is then solidified with cement slurry, closed, and sealed.

The interim storage is used as an engineered storage of the solidified wastes contained in 0.100-m^3 and 0.200-m^3 steel drum, 0.200-m^3, 0.350-m^3, and 0.950-m^3 concrete shells. The Interim Storage for High-Level Waste (ISHLW) started its commissioning in 1997. The facility has 20 dry wells (each well has the capacity of 6 drums of 0.060 m^3) and 3 dry ponds (each pond measures: 2 m x 6 m x 6 m). The high-level waste from radioisotope production and nuclear fuel examination is filled into the standard drums of 0.060 m^3 and then stored in the ISHLW's dry wells. When their radioactivity has decayed, they are processed in the treatment facility as a low and intermediate-level waste. ISHLW is not a facility to store high-level waste, i.e., spent fuels; it is only used to store radioactive waste categorized as high-level radioactivity waste by RWMI.

CRWT has developed a management information system (MIS) to maintain database in managing wastes stored in CRWT. The system is used to identify accurately and immediately radioactive waste being transported or in storage. The MIS's other objective is to maintain records of waste histories (inventories, transports, treatment/conditioning, and storage).

Article 13 (Siting of Proposed facilities)

CRWT is planning to build new interim storage building (IS-3) for radioactive waste by 2022. The IS-3 will be built on the site between IS-1 and IS-2. The purpose of building the third interim storage is to anticipate the need of radioactive waste which has been estimated to be full in the near future. CRWT has started with the initial design and financial analysis, as well as having consultation with BAPETEN with regards to the technical requirements in the licensing process. In 2021, CRWT will start to make a detailed design of the building.

According to GR No. 29 Year 2008 on Licensing of Ionizing Radiation Source and Nuclear Material Utilization, the siting is subject to a permit by BAPETEN. Therefore, CRWT will apply for a site permit for IS-3 to BAPETEN in 2021. Prior to applying the permit, CRWT will be required to gather the data regarding the effect of the external situation on the site (which covers the seismology, flood, volcanology, plane crash path estimation, hydrology, meteorology, geology, and tsunami), site and environment characteristic affecting the radioactive waste management facility; demography and any other characteristic affecting the risk evaluation on the public community and the feasibility of the implementation of emergency response.

In addition, the siting of IS-3 is required to have an environmental impact assessment. The assessment process shall take into account public participation as stipulated in GR No. 27 Year 2012 on Environmental Licensing.

Article 14 – 16 (Design and construction of facilities, Assessment of Safety Facilities, Operation of facilities)

As for the radioactive waste management facilities, based on GR No. 29/2008, the technical requirements for construction include:

a. environmental documents from the environmental ministry; and
b. construction program.

And for commissioning license, the requirements include:

a. construction implementation report;
b. commissioning program; and
c. management system document.

The requirements of an operation license include:

a. commissioning implementation report;
b. environmental management and monitoring implementation report;
c. management system document;
d. radioactive waste package criteria;
e. initial closure plan;
f. cooperation program; and
g. financial assurance documents for closing.

Research and Development (R & D) in various radioactive waste management fields are carried out to meet future needs. CRWT has been operating since 1989. Several research activities to support the routine operation of waste management have been performed. Among the facilities' activities are the utilization of silicone oil anti-foaming on the evaporation process, the de-scaling process of the evaporator circuits, utilization of evaporation data to determine fouling factor, utilization of some additives for cementation process, the study of chemical treatment, design-construction and commissioning of the chemical treatment plant.

R & D activities to meet future needs have been performed, while R & D on predisposal waste management cover these following topics :

a. liquid radioactive waste treatment using ion-exchange resin;
b. liquid radioactive waste treatment using local minerals such as zeolite and bentonite;
c. high-level waste immobilization using borosilicate glass and synrock;
d. treatment of radioactive waste from radioisotope production;
e. dry storage cask for spent fuel; and
f. corrosion of radioactive waste containers.

R & D on disposal waste management covers these topics:

a. disposal site criteria, preparation of disposal plans and concepts, the initial survey on disposal site selection in Java;
b. R & D and preparation of near-surface disposal (NSD) prototype for demonstration plants in the Serpong Nuclear Area (site characterization, design preparation, safety assessment, licensing, construction plan);

c. engineering geology and hydrogeological investigations of the Serpong Nuclear Area site for NSD demonstrations disposal;
d. developing a concept and planning for disposal of radioactive waste from nuclear power plants and an initial survey on the selection of disposal sites in the Bangka Belitung islands; and
e. research and development for geosciences and disposal safety related to the planning of disposal demonstration facilities for NSD and BHD types at the Serpong Nuclear Area.

Operational Experiences:

CRWT started as a Radioactive Waste Installation (RWI) project in 1986 and commissioned in 1989. CRWT has a mission to promote research, development, and implementation of radioactive waste technology in sustainable, safe, and secure ways to protect human health, and the present and future environment without burdening future generations. CRWT has a unit responsible for examining packaging and reporting any damage, leakage, or other irregularities with packaging. It is also responsible for examining radioactive waste carrier documents and protecting and securing packaging. Another unit is the research unit, responsible for developing and increasing CRWT's services.

The average annual amount of wastes collected are:

1. Liquid waste from research reactor : 141854 L
2. Resin : 1357 L
3. Solid Waste : 207 x 100 L-drums
4. Spent Radiation Sources : 160 pieces

Radiation exposure to staff

Figure 1 below shows in graphical form the average annual dose to the staff. No single person involved in handling and incinerating radioactive waste has ever had a radiation dose in excess.

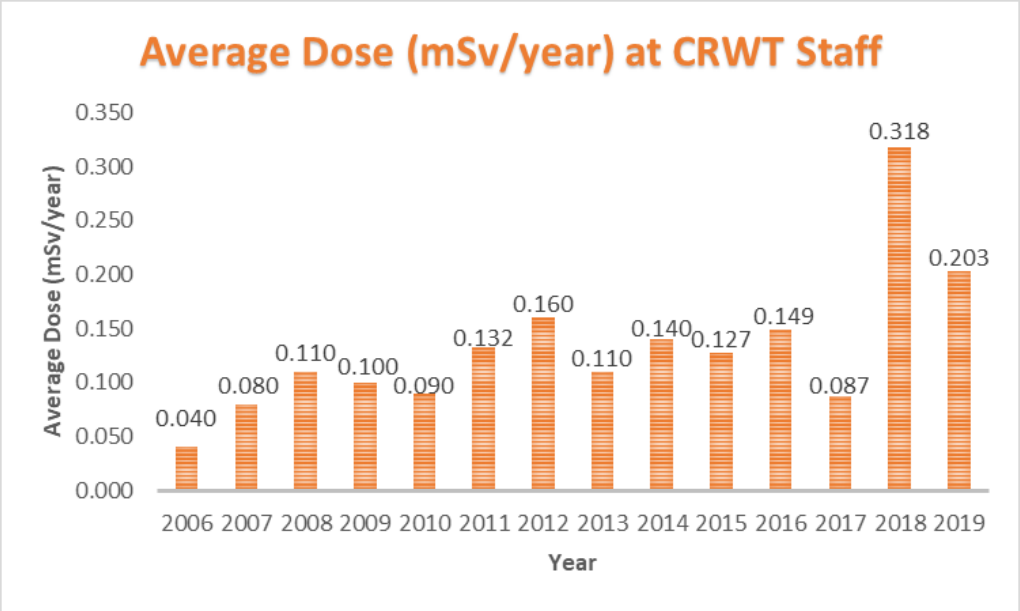

Figure 1. Average Dose to Staff of CRWT (2006-2019)

Based on the experience with the management of waste at CRWT, it is shown that the radiation exposure to staff/public from the stack and effluent is still below the dose limit.

Article 17 (Institutional measures after closure)

There is no plan in the near future to close BATAN disposal facilities. As for the radioactive waste management facilities, based on GR No. 29 Year 2008 on Licensing of Ionizing Radiation Source and Nuclear Material Utilization, the technical requirements for closure include the final closure plan.

Section I – Transboundary Movement

Article 27 (Transboundary movement)

The transboundary movement of radioactive waste shall comply with GR No. 58 Year 2015 on Safety and Security of Transport of Radioactive Materials. Several IAEA standards and requirements have been referred in the development of the regulation, for instance the IAEA 2012 edition of SSR-6 on Safe Transport of Radioactive Material and NSS-9 on Security in Radioactive Material Transport. Based on GR No. 58 Year 2015, BAPETEN makes the radioactive material transport arrangement to minimize the risks. The arrangement consists of radioactive material transport approval, radioactive material transport certificate notification, validation on the package design certificate, and validation of the tansport approval issued by the regulatory body's country of origin. To prevent and detect illicit sources and unauthorized package transported, the regulatory body has installed the radiation portal monitors in several ports.

Furthermore, radioactive wastes from other countries are prohibited from entering into the jurisdiction of the Republic of Indonesia (Article 46 (1) of GR No. 61 Year 2013) unless they are generated from radioactive sources produced in Indonesia (Article 46 (2)). For spent fuels, the generator shall store them temporarily on-site during the reactor's operational period (Article 32). The generator then will re-export the spent fuels to the origin country or send them to BATAN for the final repository (Article 33).

Section J –DSRS

DSRS shall be re-exported to the origin country. If re-export is not possible, they shall be transferred to and managed by CRWT (Article 7 of GR No. 61 Year 2013). CRWT is authorized to reuse and/or recycle after assessing the DSRS.

Sealed radioactive sources are widely used for medical, industrial, agriculture, and research applications. The IAEA defines a sealed source as "a radioactive material that is permanently sealed in a capsule, or closely bonded, and in a solid form".

Indonesia's current regulatory control over DSRS is through requirements to the sources' owner to have a confirmed arrangement with the supplier for the sources' return at the end of their lifetime. However, there are many DSRS, including Indonesia's legacy and orphan sources, due to some reasons, are not possible to be returned to the origin country, which should be stored in CRWT BATAN. Indonesian regulation allows DSRS to be reused or recycled when they meet the specified requirements.

Moreover, to reduce the amount of radioactive waste stored in BATAN facilities, reuse of DSRS is also carried out. The legal basis for this activity is GR No. 61/2013 on Radioactive Waste Management and BAPETEN Chairman Regulation No. 8/2016 on Radioactive Waste Management for Low and Intermediaate-Level Radioactive Waste. Meanwhile, the implementation instructions are based on BATAN Chairman Regulation No. 7/2017 on Reuse and Recycle of Disused Sealed Radioactive Sources.

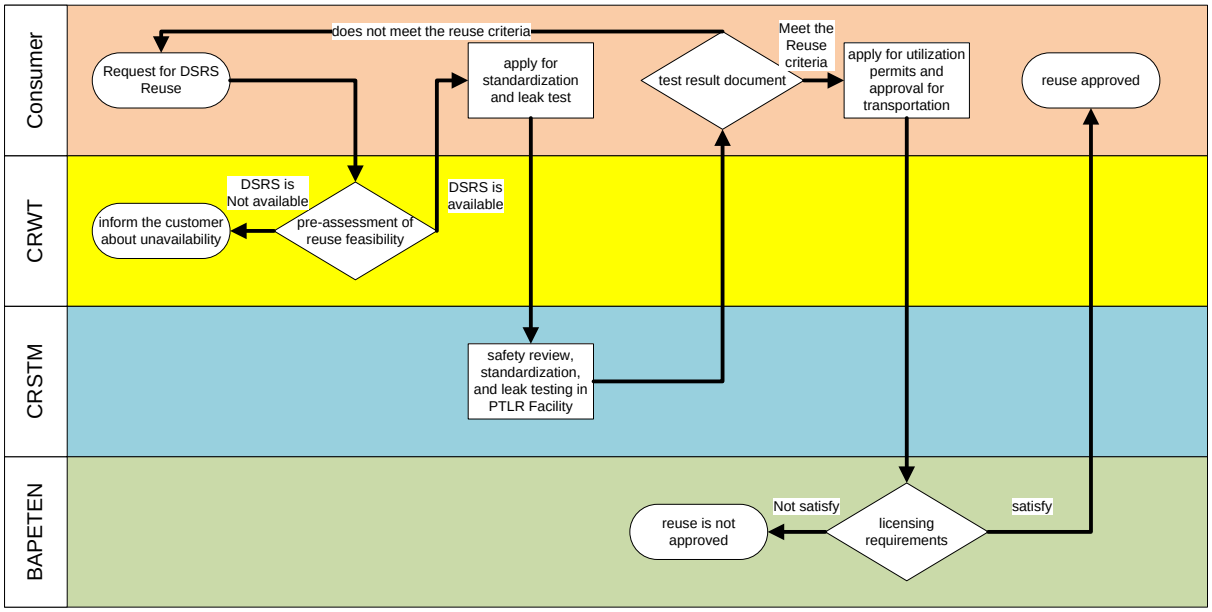

Figure 2. The Stages for DSRS Reuse (BATAN Chairman Regulation Nr. 7/2017)

From 2017 to 2019, the reuse processes has been carried out for 6 units of DSRS, with details: 4 units of DSRS for educational institutions (Cs-137 or Co-60), 1 unit of DSRS for calibration facilities (Co-60), and 1 unit of DSRS for industrial (Am241-Be). Meanwhile, the practice of DSRS recycle has never been done.

Section K – General Efforts to Improve Safety

The efforts that have been accomplished and that are in progress to improve the safety of nuclear spent fuel management and the safety of radioactive waste management are presented in this report as follows:

- BAPETEN hosted the IAEA Follow Up IRRS Mission in November 2019. The IRRS Mission Team has highlighted the best practices. However, there are several points requiring attention for improvement. The Mission Team believe the improvement would reinforce the legal and regulatory framework for safety in Indonesia. Accordingly, Indonesia needs to take further actions to:
    - complete the update of its legislative framework and align it with the IAEA safety standards; and
    - strengthen the legal and regulatory framework regarding waste management, decommissioning, and remediation, including funding arrangements, and develop a policy and strategy in this area, taking into account a future nuclear programme;

- GR No. 29 Year 2008 on Licensing of Ionizing Radiation Sources and Nuclear Material, including the license for radioactive waste management installation, is under revision and at the final stage;
- GR No. 33 Year 2007 and BAPETEN Chairman Regulation No. 4 Year 2013, both are under revision, and have incorporated and in line with GSR part 3; and
- CRWT is planning to construct Interim Storage 3 in 2022 and will start to apply for site permit to BAPETEN in 2021.

The clearance concept is implemented according to BAPETEN Chairman Regulation No. 16 Year 2012 on Clearance Level, to reduce the amount of radioactive waste stored at BATAN's facilities. The concept is depicted in Figure 2 below.

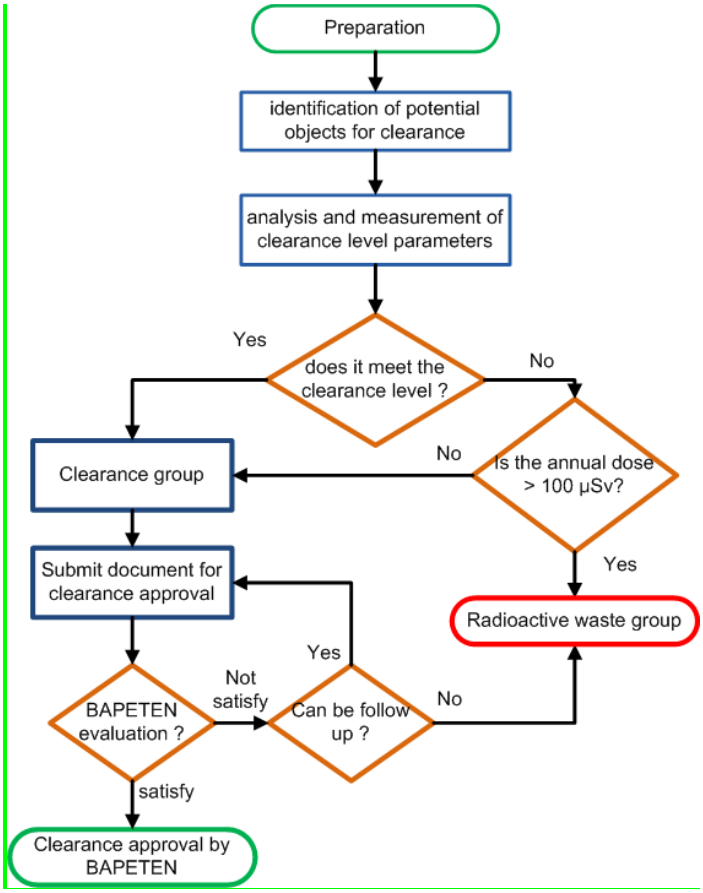

Figure 3. Clearance Concept based on BAPETEN Chairman Regulation No.16/2012

In 2019, BATAN applied for clearance approval of contaminated metal scrap from a phosphate purification plant's decommissioning, which had made decontamination efforts several years ago using the chemical treatment method. Out of the 70 pieces of metal scrap re-measured, there were 65 pieces of metal scrap, weighing 1226 kg, which had met the clearance level. After evaluating the application, at the end of 2019, BAPETEN issued a clearance approval for the 65 pieces of metal scraps.

GR No. 61 year 2013 requires the waste generator to conduct an inventory of radioactive waste at each stage of its waste management. The inventory and their management activities shall be reported to BAPETEN at least once in six months.

To support the inspection program, BAPETEN has established SALT (Integrated Waste Accounting System). This system will be developed continuously based on the experience and the available technology. SALT is an Integrated Accountable System for Radioactive Waste that contains all information about radioactive wastes in Indonesia.

BATAN has already developed radiation monitoring system by integrating radiation equipment with a computer system, in order to control and monitor the radiation area of Radioactive Waste.

Section L – Annexes

Annex A – Inventory of radioactive wastes

Inventory of radioactive waste held in the Center for Radioactive Waste Technology (CRWT).

Table 2. Inventory of Radioactive Wastes

	Total Activity per 30 September 2020 (GBq)
Cd-109	0,807
Fe-55	2,6865
Cf-252	0,3546
Sr-90	297,4337
Pm-147	108,8287
Kr-85	21470,520
Ir-192	521,1803
Cs-137	176485
Co-60	886648,9
Cm-244	45,4573
Se-75	3,2616
Ge-68	0,000066
Ra-226	214,2479
Am-241	5743,1151
Am-Be	5345,7122
C-14	0,3688
Ni-63	4,295
Pu-238	0,5517
Ba-133	0,1136
Th-232	0,062
Th-228	8,7796
Co-57	0,0009

* 30 September. 2020

Table 3. Research Reactor Spent (Used) Fuels Inventories

Facility Name	Owner	License	Critical Date/ Commissioning	Facility Type	Fuel Type	Storage Type	Storage Location	Storage Update	Design Capacity (elements)	Inventory (elements)
CMPR	BATAN	BAPETEN	1987	MPR 30	MTR	Pool pond	At ReactorSerpong	2020	300	114
ISSF	BATAN	BAPETEN	1999	Interim Storage for Spent Fuel	MTR/TRIGA	Pool/pond	Serpong site	2020	1458	287
TRIGA-2000	BATAN	BAPETEN	1965	Triga Mark II	TRIGA	Pool/pond	At Reactor Building	2020	330	0
Kartini	BATAN	BAPETEN	1979	Triga Mark II	TRIGA	Pool/pond	At Reactor Building	2020	90	0

Table 4. Radioactive Waste Management Facilities and Inventories as of September 30, 2020

Site Name	Facility Name	Location	License Holder	Facility Type	Waste Class Name*	Waste Type	Capacity	Volume
CRWT	Interim Storage 1	Serpong.Banten	BATAN	Interim Storage	LLW	Storage	1500 x.200 L drums 500 x 950/350 L shells	22 x 950 L-concrete shells contain immobilized concentrate waste. 130 x 950 L-concrete shells contain immobilizedsemi-liquid waste / spent resin 4 x 950 L-concrete shells contained immobilized Uncompacted solid waste
					ILW			12 x 350 L- concrete shell contain 860 piecesDSRS DSRS= 216 pieces
	Interim Storage 2	Serpong.Banten	BATAN	Interim Storage	LLW	Storage	1500 x.200 L drums 500 x 950/350 L shells	653 x 200 L-drums contain immobilized uncompacted solid waste 674 x 200 L-drums contain immobilized compacted solid waste
					ILW			14 x 200 L-shell drums contain 531 pieces of Radium 11 capsules contain 319 pieces DSRS: 1264 pieces
	ISHLW	Serpong.Banten	BATAN	Interim Storage	ILW	Storage	20 wells = 70 m^3 drums 3 pools = 129,6 m^3	7 capsules contain 272 pieces DSRS : 13 pieces Reflector: 1 piece
CNFT	EFEI	Serpong.Banten	BATAN	Interim Storage	ILW/LLW	Storage		36510 L liquid waste 6 drums 100 L solid waste
	RMI	Serpong.Banten	BATAN	Interim Storage	ILW/LLW	Storage	-	160 L liquid waste 3drums 100 L solid waste
CMPR	CMPR	Serpong. Banten	BATAN	Interim Storage	ILW	Storage	-	2500L liquid waste 4 drums @ 100 L solid waste 5 boxes solid waste (HEPA filter)
CRRT	CRRT	Serpong. Banten	BATAN	Interim Storage	LLW/ILW	Storage	-	25 L liquid waste (Sm-153, I-131) 8 drums 100 L solid waste 483 capsules Al
PT. INUKI	FEPI	Serpong. Banten	BATAN	Interim Storage	LLW/ILW	Storage	-	71 bags HEPA filter compactable solid waste 66 bags compactable and flameable solid waste 1 bag uncompactable solid waste 4 drums 100 L compactable solid waste

Site Name	Facility Name	Location	License Holder	Facility Type	Waste Class Name*	Waste Type	Capacity	Volume
								4 drums 100 L compactable and flameable solid waste 37 drums 100 L flameable solid waste 6 bags flameable solid waste
	RII	Serpong. Banten	BATAN	Interim Storage	LLW/ILW	Storage	-	40670 L liquid waste 2 drums 100 Lcompactable solid waste 29 drums 100 L flameable solid waste 6 drums 200 L charcoal 32 jerrycans20 L charcoal 129bags HEPA filter 1600 pieces capsule FPM SS 2724 capsule Al 130 drums of other radioactive solid waste
Bandung research reactor	CANST	Tamansari. Bandung	BATAN	Storage	LLW/ILW	Storage	Solid waste = 4000 Kg Liquid waste = 202 m^3	1300 Kg solid waste 190 m^3 Liquid waste
Yogyakarta research reactor	CAST	Babarsari. Yogyakarta	BATAN	Storage	LLW/ILW	Storage	-	1739 Kg solid waste 1,149 m^3 liquid waste surface dose rate (0,002 – 1,07µSv/h)
	CRSTM	PasarJumat. Jakarta	BATAN	Storage	LLW/ILW	Storage	-	32 jerrycans 15 L liquid waste 15 L liquid waste 13,5 Kg plastic bags solid waste 4 plastic bags 5 Kg solid waste
PasarJumat research facility	CIRA	PasarJumat. Jakarta	BATAN	Storage	LLW/ILW	Storage	-	6 containers liquid waste, spent source (Sr-90, Co-60, Cs-137, Zn-65) total 0,1 L in volume. Dose rate 10 – 12 µSv/hr on surface 11 bags liquid waste, spent source (Co-57, C-14, P-32) total 0,5 L in volume. Dose rate 1 – 8,9 µSv/hr on surfac. 4 containers solid waste, spent source Co-60 total 20 gr in weight. Dose rate 100 – 150 µSv/hr on surface. 1 container liquid waste spent source Th-232, Pu-239 + Pu-240 total 5 L in volume 7 bags solid contamination waste total 63 Kg in weight (contamination of P-32, I-125, Sc-46, Co-60). Dose rate 1,5 – 100 µSv/hr on surface. 3 jerrycans liquid contamination waste, total 53,5 L in volume (contamination of P-32, Zn-65, Pb-210).

Site Name	Facility Name	Location	License Holder	Facility Type	Waste Class Name*	Waste Type	Capacity	Volume
								Dose rate 0,25 – 1,5 μSv/hr on surface.
	CET	PasarJumat. Jakarta	BATAN	Storage	LLW/ILW	Storage	-	7 sealed sources, Cs-137, Ir-192, C-14 13 bags 500 gram solid waste (P-32)

* Based on Indonesian classification of radioactive waste

Table 5. Inventory of controlled NORM wastes not originating from the nuclear fuel cycle

Site	Estimated Quantity	Type of Waste
Senipah	52 m^3	NORM from sandblasting of oil and gas industry
Duri	920 items of NORM contaminated pipe	NORM from the oil and gas industry
PT. CitrabaraBinaMandiri (Batam)	± 30 jumbo bags @ 100 kg	NORM from sandblasting

Annex B – List of National Laws. Regulations and Guides

Table 6. List of Legislations and Regulations Concerning Radioactive Waste and Spent Fuel Management

No.	Name of Regulation
1.	Act of the Republic of Indonesia No. 10 Year 1997 on Nuclear Energy
2.	Act of the Republic of Indonesia No. 32 Year 2009 on Environmental Protection and Management
3.	Government Regulation No. 58 Year 2015 on Safety and Security of Transport of Radioactive Materials
	The Government Regulation No.58 Year 2015 on Safety and Security of Transport of Radioactive Materials
4.	Government Regulation No. 2 Year 2014 on Licensing of Nuclear Installation and Nuclear Material Utilization
5.	Government Regulation No. 101 Year 2014 on Hazardous Waste Management
6.	Government Regulation No. 61 Year 2013 on the Radioactive Waste Management
7.	Government Regulation No. 27 Year 2012 on Environmental Licensing
8.	Government Regulation No. 29 Year 2008 on Licensing of Ionizing Radiation Source and Nuclear Material Utilization
9.	Government Regulation No. 33 Year 2007 on Safety of Ionizing Radiation and Security of Radioactive Sources
10.	President Regulation No 84 Year 2010 on Ratification for Joint Convention On The Safety Of Spent Fuel Management And The Safety Of Radioactive Waste Management
11.	BAPETEN Chairman Regulation No. 7 Year 2020 on Safe Transport and Administrative Requirement of Radioactive Sources
12.	BAPETEN Chairman Regulation No. 7 Year 2017 on Radioactivity Limit in the Environment
13.	BAPETEN Chairman Regulation No. 8 Year 2016 on Radioactive Waste Treatment for Low Level and Intermediate Level Waste
14.	BAPETEN Chairman Regulation No. 4 Year 2013 on Radiation Protection and Safety of Nuclear Energy Utilization
15.	BAPETEN Chairman Regulation No. 16 Year 2012 on Clearance Level
16.	BAPETEN Chairman Regulation No. 2 Year 2014 on Core Management and Fuel Handling and Storage for Research Reactor
17.	BAPETEN Chairman Regulation No. 2 Year 2011 on Safety Requirements on the Operational of Non-power Reactors
18.	BAPETEN Chairman Regulation No. 6 Year 2011 on Decommissioning of Non -Reactor Nuclear Facility
19.	BAPETEN Chairman Regulation No. 4 Year 2010 on Management Systems for Facility and Activity in the Utilizations of Nuclear Energy
20.	BAPETEN Chairman Regulation No. 4 Year 2009 on Decommissioning of Nuclear Reactors
21.	BAPETEN Chairman Regulation No. 11 Year 2007 on Safety of Non-Reactor Nuclear Facility
22.	BAPETEN Chairman Regulation No. 3 Year 2006 on Licensing of Non-Reactor Nuclear Facility

Annex C – Figures

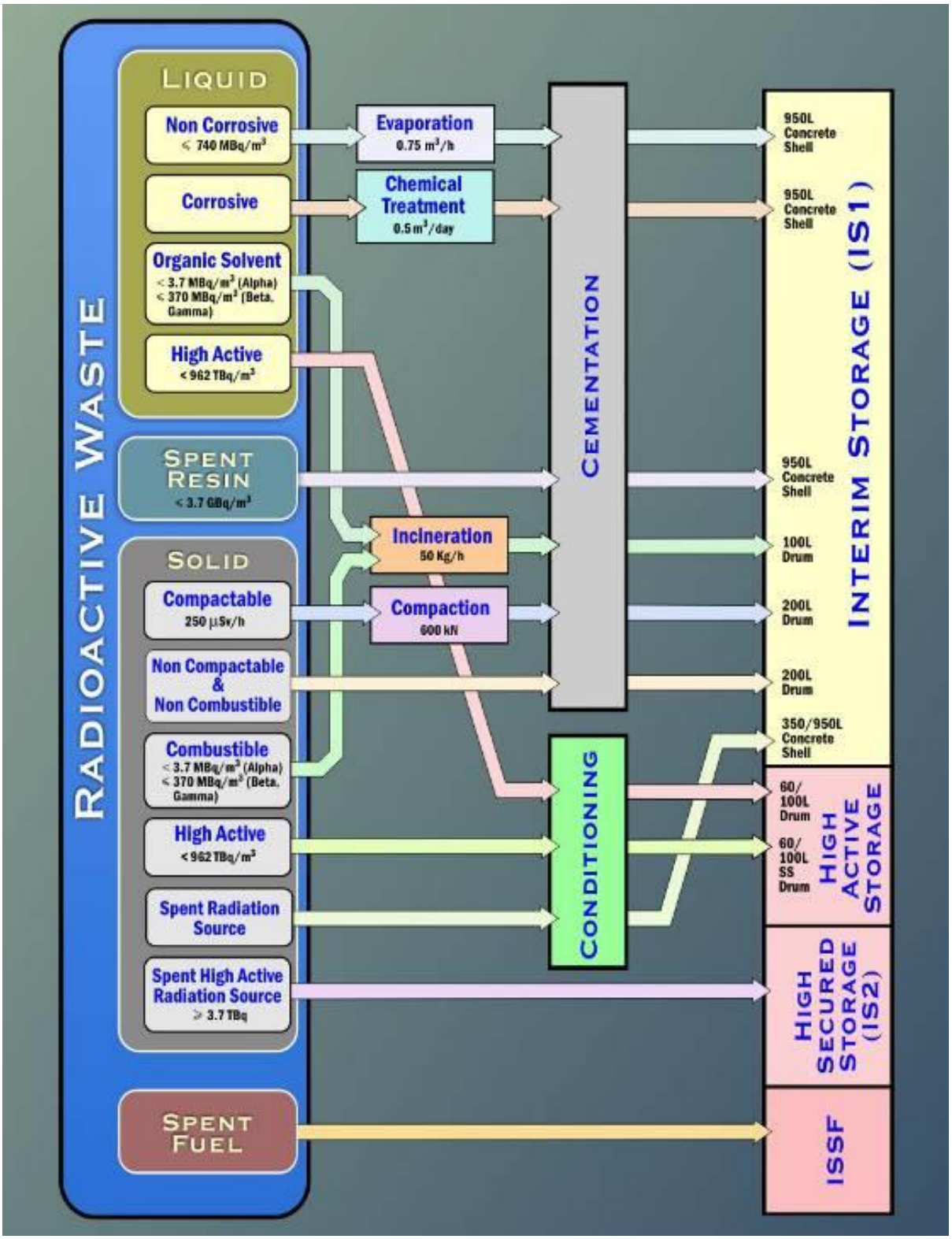

Figure 4. Principles of Management of Low and Intermediate Level Wastes

Figure 5. Interim Storage Building No. 1

Figure 6. Interim Storage Building No. 1

Figure 7. Interim Storage Building No. 2

Figure 8. Interim Storage Building No. 2

Figure 9.High Level Radiation Waste Building

Figure 10. Interim Storage for Spent Fuel Facility

Figure 11. Multipurpose Research Reactor Facility

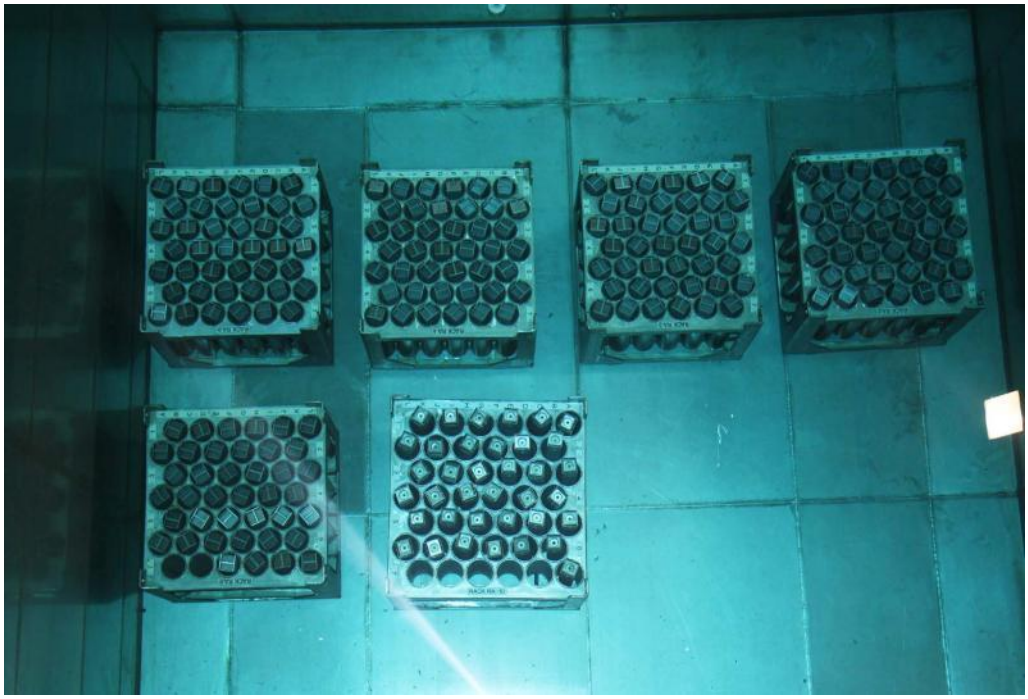

Figure 12. Spent Fuel Storage Pool