



## CONTROL OF RADIOISOTOPES AND RADIATION SOURCES IN INDONESIA

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**Abstract.** Radioisotopes and radiation sources are extensively used in Indonesia in medicine, industry, mining, agriculture and research. These materials are controlled by the regulatory authority, according to established legal procedures. The Nuclear Energy Control Board of Indonesia (BAPETEN), which was established in 1998 through the Nuclear Energy Act No. 10/1997, is entrusted with the control of any application of nuclear energy, including the application of radioisotopes and radiation sources, through regulation, licensing and inspection. The control is aimed to assure welfare, security and peace, the safety and health of workers and the public, and environmental protection. The number of licences issued to date is around 2400, consisting of 1600 licences for radioisotopes and radiation sources used in hospitals, 347 in radiography, 256 in industry, 53 in mining, and the rest in many other areas such as research and agriculture. A licence can cover one or more radioisotopes or radiation sources, depending on the location of the user institution. These radioisotopes and radiation sources are Co-60, Cs-137, Ir-192, Ra-226, Am-241, Sr-90, Kr-85, Pm-147, linear accelerator and X-ray, and short half-life radioisotopes such as I-125, I-131 and Tc-99m. There are 10 LINACs, 27 X-ray medicines, 61 radioisotope devices for Co-60 and Cs-137, and 10 mHDR Ir-192 for therapeutic purposes currently used in Indonesia and some Ra-226 in storage. Any activity related to the application of nuclear energy is required to be conducted in a manner which observes safety and security. According to the legal requirements, each user has to employ at least one radiation safety officer. To improve the control of the application of radiation sources and radioactive material in the country, BAPETEN introduced some new approaches to the users, including regular dialogues with radiation safety officers and the management of the users, requalification for radiation protection officers twice in five years, periodical newsletters and the establishment of a radiation safety officers' association, under BAPETEN supervision. The implementation of radiation safety control involving licensing, inspection, training and the regulatory framework are described in detail in this paper.

### INTRODUCTION

Indonesia has no nuclear power plant in operation yet, although it has had a nuclear energy programme since the late 1970's. At present, it is operating three research reactors, one nuclear fuel fabrication plant for research reactors, and one experimental fuel fabrication plant for nuclear power, one isotope production facility and some other research facilities. However, radioisotopes and radiation sources are being extensively used in medicine, industry, mining, agriculture and research. In anticipation of the expansion of the present nuclear activities, the Indonesian Government has, since April 10, 1997 enacted the new Law No. 10/1997 on Nuclear Energy. The law addresses several key requirements for the successful conduct of Indonesia's nuclear industry, including the establishment of both an executing body responsible for nuclear research and development, mining and processing of nuclear fuels and materials, production of radio-isotopes and management of radioactive waste and an independent Nuclear Energy Control Board, which will have the power to regulate, license and inspect all facets of any activity using nuclear energy. It also sets out the basic principles for regulating practices in the application of nuclear energy, the basic arrangements for managing and disposing of radioactive waste and the allocation of liability for nuclear damage. The law is being implemented through the application of further Government regulations. In brief, the Law on Nuclear Energy consists of 10 chapters with 48 articles. One chapter of eight articles is devoted to the basic principles of the regulation of nuclear energy, one chapter of six articles to the basic arrangement for radioactive waste management, and one chapter of 13 articles to nuclear damage liability. The penal stipulations are contained in one chapter of four articles.

## REGULATORY FRAMEWORK

The Nuclear Energy Law No. 10/1997 fully separates the promotional and regulatory functions in accordance with Article 3 and 4, and establishes the regulatory body for the control of the application of all nuclear energy through regulations, licensing and inspection. The regulatory body, Badan Pengawas Tenaga Nuklir (BAPETEN) and the Nuclear Energy Control Board (NECB), was then established by the Presidential Decree No. 76/1998 in May 1998 and is now in full operation.

Utilization of nuclear energy is defined in the law as “any activity related to nuclear energy utilization that includes research, development, mining, fabrication, manufacturing, production, transportation, storage, transfer, export, import, decommissioning and radioactive waste management to enhance people’s welfare”.

The authority and responsibilities of BAPETEN are described in Articles 14-21, 27, 38, and 39 of the law. Article 14, for example, stipulates that “the control of the application of all nuclear energy should be implemented through regulation, licensing, and inspection”, and aims to (Article 15):

- assure welfare, the security and peace of the people;
- assure the safety of the health of workers and public, and the environmental protection;
- maintain the legal order in implementing the use of nuclear energy;
- increase the legal awareness of nuclear energy user to develop a safety culture in nuclear field;
- prevent the diversion of the purpose the nuclear material utilization; and
- assure the maintenance and increase of worker discipline in the implementation of nuclear energy utilization.

BAPETEN is established as a governmental agency, under and directly responsible to the President of the Republic of Indonesia. BAPETEN’s status, tasks, function, structure and organization were established in the Presidential Decree No 76/1998. BAPETEN has, inter alia, the following functions:

- rulemaking for national policy in the control of nuclear energy utilization;
- planning the national programme for the control of nuclear energy utilization;
- guiding and rulemaking in the implementation of nuclear safety, radiation safety, and safeguards assessments;
- implementing licensing and inspection in the development and operation of nuclear reactors, nuclear installations, nuclear material facilities, and radiation sources, and developing nuclear preparedness;
- implementing co-operation in the control of nuclear energy utilization with the Government agencies or other organizations either internally or externally to the Government of Indonesia;
- implementing safeguards and the State’s system of accounting for and control of nuclear material (SSAC);
- implementing guidance and counselling related to the safety and health of workers and the people, and to environmental conservation;

At present BAPETEN has 173 staff, 120 of whom are professional staff. It has, excluding staff salaries, around US \$1 million annual operating costs. The organizational structure of BAPETEN can be seen on the Attachment. It is chaired by a chairperson, who is assisted by two Deputies, one Head of Administration and one Head of Safeguards Centre. One Deputy is responsible for the assessment of nuclear safety, who is in turn supported by three Directorates, each responsible for the assessment of reactor safety and of radiation safety and – for drafting nuclear and radiation safety rules. The other Deputy is responsible for licensing and inspection, and is supported by three Directorates, namely the Directorate for Licensing Radiation Sources and Radioactive Materials, the Directorate for Licensing Nuclear Installations and the Directorate of Inspection and Emergency Preparedness.

The law stipulates that any activity related to the application of nuclear energy is required to be conducted in a manner which observes safety, security and peace, and protects the health of workers, the public and the environment, which will further be implemented by Government Regulation (Article 16). Government Regulation No. 63/2000 on Radiation Safety was issued recently to administer these requirements. This Government Regulation is based on the International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources, IAEA Safety Series No. 115, and is issued to replace the old GR No 11/1975 which was based on old basic safety standards.

The law further stipulates that any use of nuclear energy, the construction and operation of nuclear reactors and other nuclear installations, and the decommissioning of nuclear reactors shall be subjected to licensing. A Control Board is authorized to license nuclear reactor operators and certain designated employees in other nuclear installations or those using ionizing radiation sources. Such employees will include radiography experts and operators, radiation safety officers, dosimetry officers and maintenance officers. The licensing process for this personnel shall include examinations. The requirements and procedures of the licensing process on utilization of radioisotopes and radiation sources is further detailed in Government Regulations No. 64/2000 on Licensing Process, and in some technical and standard requirement rules issued by BAPETEN. To date, BAPETEN has issued 23 various technical and standard requirements and guides. The requirements and procedures of the licensing process of the construction and operation of nuclear reactors is still under review.

The law provides the Control Board for the inspection of nuclear installations and any installation that applies ionizing radiation with the aim of controlling the fulfillment of the requirements in the licensing process and regulations in nuclear safety. An inspector appointed by the Control Board shall carry out such inspections and the results of such inspections shall be published in an open and transparent manner.

## **WASTE MANAGEMENT**

Law No.10/1997 on Nuclear Energy contains some provisions on radioactive waste management that need further elaboration and regulation. Article 1, for example, stipulates that radioactive waste is defined as any radioactive material and any material or equipment that has been contaminated by radioactive material or becomes radioactive due to the operation of a nuclear installation and cannot further be used.

In general, the basic principles underlying the law are:

- Radioactive waste management shall be conducted to mitigate radiation hazards to the workers, the public and the environment (Article 22 (1));

- Radioactive waste management shall be accomplished by the Executing Body, which may designate a state or private company or cooperative to conduct commercial waste management activities (Article 23);
- Users generating low and intermediate level of radioactive wastes shall be obliged to collect, segregate, or treat and temporarily store the waste before its transfer to the Executive Body (Article 24 (1));

Further,

- The transportation and storage of radioactive waste shall observe the safety of workers, the public and the environment (Article 27 (1)).
- The provisions on radioactive waste management, including waste transportation and disposal, shall be further implemented by Government regulation (Article 27 (2)).

The Government regulation to administer the waste management requirements as mentioned in Article 27 paragraph 2, is now under preparation. The law also contains some provisions on high-level waste management.

Elucidation of Article 25 prohibits the use of any part of Indonesian territory by any foreign or other country as a radioactive waste repository.

## **LICENSING AND VERIFICATION PROCESS**

Issuance of a licence is subject to the fulfilment of the requirements set out in BAPETEN's rules and procedure such as providing the document of procurement or importation, technical specifications of the radioisotopes and/or radiation sources, design of facility, necessary monitoring equipment, standard operating procedure including emergency handling, waste management and availability of trained and certified personnel or radiation safety officer at the user institution. The fulfilment of radiation safety requirements is ensured through safety assessments, surveillance of the installations and review of the standard operating procedure. If it is considered necessary, verification on site will be carried out. During the useful life of radioisotopes and/or radiation sources, prior approval of BAPETEN is required for transfer, transport, resale, re-export or storage. If later on the radioisotopes will not be used any more, it is advised to arrange for temporary safe storage before final re-export to the original supplier.

As stated earlier, the National Nuclear Energy Agency is the competent authority to manage radioactive waste in the country. Any radioactive waste can be temporarily stored on site only with a special licence from BAPETEN. It is advised that waste should be stored finally in the facility belong to the National Nuclear Energy Agency.

## **RADIOISOTOPES AND RADIATION SOURCES IN INDONESIA**

The radioisotopes in Indonesia are used mainly in hospitals, industry, mining and research activities. Two types of sources are used, unsealed and sealed. Unsealed sources are generally used up during their "useful life". In hospitals, they are used for diagnosis and for treatment of patients. Except for those used for therapeutic purposes in medicine, and for gauging in industry, these isotopes are of short half-life.

The following are various radioisotopes commonly used in hospitals, industries and mining:

- Co-60, from a few mCi to a hundred thousand Ci, is used for gauging, radiography, therapy, and radiation sterilization;
- Cs-137, from a few mCi to a few thousand Ci, is used for gauging, radiography, logging and therapy;
- Am-241, only a few mCi, is used for gauging and logging;
- Cd-109, Cf-252, Cm-244, Fe-55, Kr-85, Pm-247, and Sr-90 are used for gauging;
- Gd-153, Hg-203, Ra-226, Sc-46, Sb-124, Th-228 and Th-232 are used in companies provide logging services;
- Ir-192 is used in radiography;

The following are various radioisotopes used in education, research and development and in nuclear medicine:

Ag-110m, Am-241, Au-198, Ba-133, Bi-207, Bi-210, Br-82, Br-85, C-14, Ca-45, Cd-109, Cm-244, Co-57, Co-60, Cr-51, Cs-137, Eu-152, Fe-59, Ga-167, Ge-68/Ga-68, H-3, Hg-197, Hg-203, Hg-204, Hg-207, I-125, I-131, In-111, In-115m, Ir-192, Kr-85, La-140, Mn-54, Mo-99, Na-22, Na-24, P-32, Pb-210, Po-209, Pu-242, Ra-226, S-35, S-36, Sc-46, Se-75, Sm-153, Sn-113, Sn-113/In-113, Sn-119, Sr-80, Sr-85, Tc-99m, Te-132/I-132, Th-229, Th-232, Ti-204, Tl-201, Tl-204, U-236, U-238, Xe-133, Y-80, Y-87/Sr-87, Y-88, Yb-169, Zn-65, Zr-95.

For radioisotopes not in use or unlikely to be used for further application, the licensee is advised to get a licence from BAPETEN to temporarily store the waste on site, before it is finally transferred to a waste management facility of the National Nuclear Energy Agency, the institution authorized by law to dispose of radioactive waste. Radioactive waste is now accumulating from industries with gauging equipment and from hospitals with disused Cs-137 and Ra-226 from therapy practices. Many users are reluctant to send their disused radioisotopes to the waste management facility, due to the high fee this facility charges. The users prefer to keep them on site by extending their storage licence as this practice is much cheaper. Although this radioactive waste is properly controlled, BAPETEN is now starting to worry in view of the increasing number of accidents connected with unused radioisotopes. BAPETEN is now trying to offer a solution in co-operation with other Government institutions to tackle this waste problem.

## **LAW ENFORCEMENT AND COMMUNICATION**

Law No. 10/1997 states that the control of the utilization of nuclear energy aims to maintain legal order and increase the legal awareness of the nuclear energy users. The law authorizes BAPETEN to inspect nuclear installations and any installation that applies ionizing radiation with the aim of controlling the fulfilment of the requirements in the licensing process and regulations in nuclear safety. BAPETEN is the only institution in the country authorized by the law to appoint inspectors.

To achieve this goal, BAPETEN organizes periodic and unprogrammed inspection. During the past two years, no major misconduct has been found in industrial application of radiation and radioisotopes. All user institutions respect legal administrative requirements and operate according to the safety standards and operating procedures approved by BAPETEN. Some minor administrative failures have been found but they are usually rectified immediately.

In hospitals, particularly in public hospitals, however, there were some infringements. Not only were legal administrative requirements not always fulfilled but, in some cases, safety procedures were not carried out. For example, many licences had expired, the radiation logbook was missing, medical checkups for radiation workers were not performed. In addition, the recalibration of teletherapy equipment was not carried out; in some hospitals calibration had not been performed at all. One fatal accident occurred in 1998, a few days before BAPETEN came into being; a patient with breast cancer received unpredicted doses and died four months after irradiation. The accident was not reported to BAPETEN until a few months later.

Since its inception, BAPETEN has given the problems associated with teletherapy practices high priority. No sanctions have been imposed so far; rather visits to hospitals to meet the hospital managers and radiologists is seen as the most appropriate way to improve the situation. To improve communication with institutional users, BAPETEN organizes periodic dialogues in many big cities. Radiation safety officers working for these users are also invited. These modalities are part of the major policy of BAPETEN to pursue the establishment of a safety culture, and to create an atmosphere of mutual understanding, trust and respect. The results have been encouraging. At present, almost all teletherapy equipment in Indonesia has been re-calibrated, and their licences extended. Unused radiation sources have been reported, managed, stored and licensed properly.

The Ministry of Health supports the policy and programme of BAPETEN for restoring medical practices using radioisotopes and radiation sources in hospital to the expected normal and safe condition. A MOU between the two institutions was signed recently, under which a joint committee was created to plan joint action. It is anticipated that in the year 2001, legal action will be taken against those hospitals and clinics that do not respect legal administrative requirements or honour safety procedures.

## **TRAINING AND COUNSELLING**

An important component of the nuclear regulatory practices in Indonesia is the organization of comprehensive training for new radiation safety officers, and requalification training for radiation safety officers holding working licences from BAPETEN. A new radiation safety officer has to pass an examination to obtain a working license from BAPETEN. Requalification training is carried out twice in five years. It is a new modality and mandatory for radiation safety officers to obtain automatic extension of their working licence. During the requalification process, an interview was organized to get information from the field. From these dialogues, BAPETEN has concluded that the existence of a professional association for radiation safety officers is important to support their work. It is expected that through this association, the role and responsibilities of a radiation safety officer will become more visible and recognized. The establishment of such an association under BAPETEN supervision is under way. Better communication and exchange of views among radiation safety officers and between them and BAPETEN is also a feature in establishing safety culture. A periodical newsletter is now published by BAPETEN to accommodate this need.

Training programmes are also organized for customs, airport and seaport officials, to bring about a general awareness regarding the general policy, the legal requirements, the nature and dimensions of the problem of radiation safety and security, and the role of these officials in supporting the work of BAPETEN to ensure safety of radioisotopes by checking all necessary importation documents and checking the possibility of any illicit trafficking of radioisotopes.

With regard to counselling, Article 21 of the Nuclear Energy Law No. 10/1997 states that “the Control Board provides guidance and counselling on the implementation of efforts related to the health and safety of workers, the public, and environmental protection”. To carry out this mandate, BAPETEN organizes several counselling activities in many big cities, where the managers of user institutions, their radiation safety officers, local government officials, local authorities of the Ministry of Health and the Ministry of Industry, and university staff are invited. They are given up-to-date information about radiation safety, procedures and legal requirements in performing activities utilizing radioisotopes and radiation sources, and the regulatory authority and its mandate.

## **EMERGENCY PREPAREDNESS**

From the time of the establishment of BAPETEN, an emergency preparedness unit has been considered important to be created to respond to any radiological emergencies. This Unit was established under the Directorate of Inspection and Emergency Preparedness. Some incidents connected with the loss of the radioisotopes for logging equipment in wells have been reported. An incident connected with melting, due to fire, of two casks each containing radioisotope 15 mCi and 50 mCi Cs-137 in gauging equipment belonging to a refinery company was reported. The unit responded immediately by sending its staff to the site to give advice and take action. In all cases reported to BAPETEN, there were no injuries or fatalities. So far, no other incident or accident has been reported.

## **REFERENCES**

- [1] Act No. 10/1997 on Nuclear Energy, BAPETEN PPN 0100.0599.
- [2] Presidential Decree No. 76/1998 on BAPETEN, BAPETEN 0200.0599.
- [3] Government Regulation No. 63/2000 on Radiation Safety.
- [4] Government Regulation No. 64/2000 on Licensing Process.
- [5] Chairman BAPETEN Decree No. 01/Ka-BAPETEN/V-99 on Radiation Safety.
- [6] Chairman BAPETEN Decree No. 03/Ka-BAPETEN/V-99 on Waste Management.
- [7] Chairman BAPETEN Decree No. 04/Ka-BAPETEN/V-99 on Transport of Radioactive Materials.
- [8] Chairman BAPETEN Decree No. 15/Ka-BAPETEN/VIII-99 on Inspector.
- [9] Chairman BAPETEN Decree No. 17/Ka-BAPETEN/IX-99 on Licensing Procedure.
- [10] Chairman BAPETEN Decree No. 20/Ka-BAPETEN/II-00 on Licensing Exception.

