INDONESIA

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1. ECONOMIC, ENERGY AND ELECTRICITY INFORMATION

1.1. General Overview

The Republic of Indonesia is located in Southeast Asia between 6°08' north and 11°15' south latitude, and from 94°45' to 141°05' east longitude, and placed on an archipelago of about 18,000 islands astride the equator. Sumatra, the westernmost major island, lies south of Myanmar, while Irian Jaya or Papua on the island of New Guinea is the country's eastern extreme. Indonesia, formerly part of the Netherlands East Indies, proclaimed its independence on August 17, 1945, after more than 350 years under the Dutch control. The country is administratively divided into 32 provinces.

Indonesia is a maritime country with a total area of 9.8 million square kilometres in which the sea area, including Exclusive Economic Zone, is about 81% of the total or equals to 7.9 million square kilometres, and the land area is about 1.9 million square kilometres.

Figure 1 Map of Indonesia[1]

Most islands are hot and humid throughout the year. The temperature ranged from 27.6° to 36.8° C during the day and from 14.6° to 24.6° C during the night. The humidity ranged from 63% to 83%. Rain falls primarily from December to March, when the winter monsoon dominates. Only western Java and the Lesser Sunda Islands have a dry season, from June to September.

As in many rainy, tropical areas, the soils are predominantly infertile in Indonesia because of leaching. The most productive are those on Java and adjacent islands. Soil nutrients there are replenished by frequent volcanic eruptions, and the lava's alkalinity is conducive to plant growth.

Forests cover more than half of Indonesia's land area, and a significant portion is mountainous and volcanic. Java alone is home to 112 volcanoes, fifteen of which are still active. Volcanic activity through the ages has given the soil on Java and Bali a much higher degree of fertility than found in most other areas of Indonesia.

One of Indonesia's principal mineral resources is petroleum, which is extracted in eastern Sumatra and Kalimantan. Indonesia's oil reserves are not large (proven reserves about 5 billion

[1] CIA The World Factbook 2003: Indonesia 2003

barrels in 2002), being only about 1.2% of the world's oil reserves. Indonesia, a member of the OPEC since 1962, placed its oil industry under government control in 1965.

Indonesia is the world's largest producer of liquefied natural gas. In year 2002, the total gas reserves are respectively about 507 TSCF. Compared to the world reserves, Indonesia's natural gas reserves are small, only about 3.3%.

The total known coal resources of Indonesia in 2002 have reached 50 billion tonnes, about 3% of the world's coal reserves. But the amount of economically exploitable coal is still limited. The proven reserves is only 5 billion tonnes, the rest is still inferred or indicated and hypothetical reserves.

Other mineral resources are Tin, Bauxite, Copper, etc. Tin is abundant on some islands, and Indonesia ranks third in world tin production after Malaysia and Thailand. Bauxite is mined on Sumatra, nickel on Sulawesi, coal on Sumatra and Kalimantan, iron ore on Java, and copper on Irian Jaya.

Indonesia is the world's fourth most populous nation and continues to grow quite rapidly. According to the 2000 National Population Census, the population in the mid 2000 is about 203.5 million, with the growth rate of 1.35% during 1990-2000. A significant decline of growth rate has occurred in West Sumatra, Jakarta, Central Java, and Maluku with the growth less than 1%, respectively. The population in 2003 is estimated at about 215 million (July 2003). In 2002, about 43.1% of the population live in urban area. The population growth from 2002 to 2010 is predicted at about 9.4%, while for 2003 is estimated about 1.52%. Table 1 shows data of population from 1970 to 2002.

TABLE 1. POPULATION INFORMATION

							Growth rate (%/yr)
	1970	**1980**	**1990**	**2000**	**2001**	**2002**	**1990 To 2002**
Population (millions)	120.3	151.0	182.8	203.5	206.3	209.0	1.35
Population density (inhabitants/km²)	63.3	79.5	96.2	107.1	108.6	110.0	

Predicted population growth rate (%) 2002 to 2010	9.4
Area (1000 km²)	1904.6
Urban population in 2002 as percent of total	43.1

Source: National Statistic Bureau Database.

The results of the 2000 National Population Census also shows that Java Islands, which has area of 7% of the total area, resided by around 59% of the population, while Maluku and Papua which have area of 25% of the total area, inhabited by 2% of the total population. Population density of Java is around 945 persons per square kilometres, Bali 555 persons per square kilometres, and Papua 5 person per square kilometres. Jakarta is the most crowded city with population density nears to 13 thousand persons per square kilometres. The largest cities are Jakarta (the capital), Bandung, Surabaya, Semarang, Malang, Surakarta, and Yogyakarta, all of which are on Java, and Medan, on Sumatra.

According to the UNDP Human Development Report 2003, the life expectancy at birth for all population of Indonesia is 66.2 years (2001). The number of life expectancy slightly increase to be about 68.94 years (2003, est., CIA Factbook); adult literacy rate for 2001 is about 87.3%, and it is estimated about 88.5% for 2003 (CIA Factbook). Indonesia has a Human Development Index (HDI) ranking of 112 among 175 nations, and is thereby placed among the medium HDI countries.

1.1.1. Economic Overview

The Republic of Indonesia achieved remarkable economic development success over the past three decades and was considered to be among the best performing East Asian economies until the regional financial crisis of 1997. Indonesia had an average growth rate of 7.1 percent between 1985 and 1995, a real gross domestic product (GDP) growth of 7.8 percent in 1996, a poverty reduction from 60 percent of the population to 11 percent, and a significant overall improvement in general standard of living. With these statistics, Indonesia was seen as a "model of development", and relatively well placed to weather the troubling signs of the Asian crisis. However, during the first two years of the crisis, Indonesia was subjected to unprecedented economic pressures

The Indonesia's economy was plunged into a deep recession in 1998 accompanied by rising inflation, falling exchange rate, increasing interest rates and sinking asset value. The crisis severely set the clock on the achievement of a decade of sustained high growth. During recession, GDP growth was contracted by less than minus 13.5%.

By the end of 1999, national economic grew 0.79%. The economic growth was 4.92 % in 2000, 3.44% in 2001 and 3.66% in 2002.

TABLE 2. GROSS DOMESTIC PRODUCT (GDP)

						Growth rate (%/yr)
	1980	**1990**	**2000**	**2001**	**2002**	**1990 To 2002**
GDP (millions of current US$)	78,013	114,427	153,256	151,583	151,451	2.4
GDP (millions of constant 1990 US$)	64,222	114,426	172,844	171,629	168,106	3
GDP per capita (current US$/capita)	517	626	724	707	698	0.9

Source: IAEA Energy and Economic Database.

1.1.2. Energy Situation

The energy sector is of particular importance in the development of the Indonesian economy. Indonesia has considerable reserves of primary energy resources, even though not abundant. Indonesian current per capita energy consumption is relatively low compared to that of other ASEAN countries. The increase of population, especially in the rural areas which does not yet have adequate access to electric power, is an indication of an expected high-growth rate of electricity demand. Most energy resources are located outside the Island of Java; yet Java, with its large population and industry, constitutes the major area of energy demand.

1.2. Energy Policy

In order to successfully support the national development program in Indonesia and in consideration to the changes of global strategic environment, Government of Indonesia is now planning an integrated and solid energy policy called National Energy Policy. The policy will be issued officially in the early of year 2004.

Actually, there are five main energy policy measures:

- Diversification: to maximize and economize the supply of energy, to curb the rate of excessive use of hydrocarbon resources, to reduce the dependence on a single type fuel (i.e. petroleum) and later to replace it with other available fuels. In 1995 oil shares was around 60%, and in 2020 is projected to be around 40%;
- Intensification: to increase and expand the exploration of the available energy sources aiming to secure sufficient supply of energy;
- Conservation: to economize energy production and utilization;
- Energy Price: to formulate energy prices based on economic values and by taking into

consideration its environmental cost;

- Clean Energy Technologies: to support the environmental program and towards a sustainable development.

TABLE 3. ESTIMATED ENERGY RESERVES

	Estimated energy reserves in (Exajoule)					
	Solid	**Liquid**	**Gas**	**Uranium (1)**	**Hydro (2)**	**Total**
Total amount in place	119.93	29.69	83.28	3.44	206.97	443.32

(1) This total represents essentially recoverable reserves.

(2) For comparison purposes a rough attempt is made to convert hydro capacity to energy by multiplying the gross theoretical annual capability (World Energy Council - 2002) by a factor of 10.

Source: IAEA Energy and Economic Database.

The focuses of the policy are as follows:

- Supporting national stability and fueling macro economic recovery by ensuring the availability of energy in enough number and realistic price, which is efficient, safe, reliable and environment-friendly.
- Conducting energy sector restructuring through regulation and legislation.
- Improving the efficiency of the State-owned companies.
- Supporting the implementation of Regional Autonomy based on legislation and its rule of implementation.

The goals of the policy are outlined as the following:

- Supporting to increase private companies' role in energy business that leads to establishing free market mechanism.
- Reaching electrification ratio of 90% in the year 2020
- Increasing the share of renewable energy to be at least 5% in the year 2020. The renewable energy which consist of fulfill geothermal, biomass and micro/mini-hydro
- Increasing strategic partnership between domestic and international companies to explore and/or exploit energy source in-country and abroad as well.
- Supporting domestic energy companies to "go international" to compete in global market
- Decreasing energy intensity to 1% per year so that the energy intensity becomes 3 SBM/ thousand US, and its elasticity becomes 1 dollar in the year 2020.
- Increasing the domestic manpower share/role in energy industry so that the dependence foreign companies and or manpower can be minimized.

The Implementation of the energy policy covers several aspects such as the issuance of regulations, standards, energy-pricing incentives and disincentives, and the application of appropriate technology. The technologies that would be considered are identified as follows:

- Technologies to produce substitutes for oil, as oil are non-renewable and are a very limited resource.
- Technologies to support a more sustainable energy supply.
- Technologies for clean and efficient energy to support environmental programs and towards sustainable development.

TABLE 4. ENERGY STATISTICS(*)

	1970	1980	1990	2000	2001	2002	Average annual growth rate (%) 1970 To 1990	Average annual growth rate (%) 1990 To 2002
Energy consumption								
- Total (1)	1.35	2.29	5.01	6.60	6.63	6.70	6.79	2.45
- Solids (2)	0.88	1.14	1.46	2.14	2.13	2.13	2.57	3.19
- Liquids	0.41	0.97	2.19	3.47	3.49	3.50	8.75	3.99
- Gases	0.05	0.16	1.26	0.84	0.85	0.89	17.89	-2.87
- Primary electricity (3)	0.01	0.03	0.11	0.16	0.17	0.19	10.89	4.56
Energy production								
- Total	2.72	5.03	7.93	9.77	9.80	9.91	5.49	1.87
- Solids	0.88	1.14	1.59	3.81	4.06	4.23	3.00	8.51
- Liquids	1.78	3.25	3.89	3.69	3.55	3.37	3.97	-1.19
- Gases	0.05	0.61	2.35	2.11	2.03	2.12	21.62	-0.84
- Primary electricity (3)	0.01	0.03	0.11	0.16	0.17	0.19	10.89	4.56
Net import (Import - Export)								
- Total	-1.27	-2.57	-2.68	-3.91	-4.14	-4.42	3.80	4.24
- Solids	0.00	0.00	-0.13	-1.67	-1.94	-2.18	30.10	26.54
- Liquids	-1.27	-2.05	-1.47	-0.68	-0.51	-0.38	0.71	-10.68
- Gases		-0.51	-1.09	-1.56	-1.69	-1.86		4.57

(1) Energy consumption = Primary energy consumption + Net import (Import - Export) of secondary energy.

(2) Solid fuels include coal, lignite and commercial wood.

(3) Primary electricity = Hydro + Geothermal + Nuclear + Wind.

(*) Energy values are in Exajoule except where indicated.

Source: IAEA Energy and Economic Database.

The nuclear energy option is unquestionably capable of meeting the objectives of reducing the dependence on oil and gas, so that oil and gas could be used for export and feed-stocks to support the take-off era. Nuclear energy provides a secured long-term energy supply as well as supporting the reduction of potential of air pollution. According to the results of the study on the *Comprehensive Assessment of Different Energy Sources for Electricity Demand (2001-2002),* it is reasonable to operate nuclear power plant in about 2016.

1.3. Electricity System

1.3.1. Structure of the Electricity Sector

The State Electricity Company (PLN) supplied most electricity used in Indonesia, while the rest produced by private companies. Since PLN could not serve the entire regions of Indonesia, Non-PLN companies emerged to produce electricity on their own capacity, for example those managed by cooperatives, local government, and other private companies.

On August 1998, the government of Republic Indonesia has taken out certain policy regarding restructuring of electric power sector, which called as a white paper. In the white paper, the main target is to power generation industry, which is formerly monopoly in nature become competition, where the price of electric power determined by market price in competition.

It is hoped that competition will exist in electric power generation site and to retail site, while transmission and distribution are monopoly in nature. For creating competition at generation site, Government (PLN) has established two generation companies such as PT. Indonesia Power and Java-Bali Electric Company (PJB) and affiliated firm of State Electricity Enterprise PLN. All generators in Java and Bali are separated as two parts, there is a part for PT. Indonesia Power and the rest is for Java-Bali Electric Company. Private company gives a chance for making Generation Company (GenCo), which the Company can sell power to the Transmission Company (Transco) as sold agent. Then sold agent (Transco) sell the electric power to the Distribution Company (Disco) and

Distribution Company sell to the retail, which connected directly to the electric's consumer. This concept is known as Multi-Buyer Multi-Seller (MBMS) and the plan is supposed to be started in the year of 2003.

In the electric sector restructuring, Government has submit the legislation plan of electric power to Indonesian Legislative Assembly to be legalized, as substitute for electric power constitution, which is much relevant to the concept of restructuring. But until this time, the Indonesian Legislative Assembly cannot issue the electrical power legislation plan because there are many things to be discussed to make it perfect. In fact it is impossible to do the MBMS in 2003, and then the Government has changed the target of MBMS realization into 2007.

1.3.2. Decision Making Process

According to the Act No.10 of 1997, Article 13(d) which performs to the mention above is described that the decision over the construction nuclear power plant is established by the Government after Consultation with the People's House of Representatives of the Republic of Indonesia. The consultations are conducted for each site where one or more nuclear power plants are to be built in this consultation. The Government shall give its utmost considerations to the comments and recommendations from the People's House of Representatives of the Republic of Indonesia, and the results of the consultations shall be respected and shall become the guidance by the Government and People's House of Representatives of the Republic of Indonesia.

1.3.3. Main Indicators

Installed capacity of PLN electricity tended to increase during the last five years, with 10.62 % increase per year. The PLN total installed capacity up to 2001 was 21,058.83 MW with more than 29 million consumers or increase 1.43% compared to 20,761 MW in 2000. In Java the installed capacity in year 2001 was 15,494 MW or 74% of the total installed capacity. The peak load for Indonesia was 16,314 MW in 2001, or increase 6,5% from that of 2000.

TABLE 5. ELECTRICITY PRODUCTION AND INSTALLED CAPACITY

							Average annual growth rate (%)	
	1970	1980	1990	2000	2001	2002	1970 To 1990	1990 To 2002
Electricity production (TW.h)								
- Total (1)	4.67	14.23	48.90	99.51	105.73	111.97	12.46	7.15
- Thermal	3.23	11.23	37.53	83.14	88.24	92.56	13.05	7.81
- Hydro	1.44	3.01	10.24	13.72	14.71	16.54	10.31	4.08
- Nuclear								
- Geothermal			1.13	2.65	2.77	2.87		8.11
Capacity of electrical plants (GWe)								
- Total	1.61	4.88	12.92	25.41	27.17	28.90	10.99	6.94
- Thermal	1.29	3.90	9.63	20.65	22.09	23.48	10.56	7.71
- Hydro	0.31	0.98	3.15	4.39	4.71	5.04	12.25	4.00
- Nuclear								
- Geothermal			0.14	0.36	0.38	0.39		8.83
- Wind								

(1) Electricity losses are not deducted.

Source: IAEA Energy and Economic Database.

PLN sold electricity of 84,520.3 GWh. The number increased 5,355.5 GWh or 6.3% over that of 2000. The sales to industrial sector were 35,593.2 GWh, household 33,339.7 GWh, commercial/business sector 11,395.3 GWh, for public service 4,192 GWh.

The number of PLN's consumers in 2001 had been increased to be 29.8 million consisting of household of 27.88 million or 93.4%, industrial consumer of 46.0 thousand or 1.5%, commercial 1.17 million or 3.9% and public of 728.8 thousands or 2.4%.

Electricity consumption per capita has also been increased from 130 kWh at the first year of long-term development plan (1969/1970) to be 405 kWh per annum at the end of 2001. In addition, consumption per consumer had been increased from 1,638 kWh to be 2834 kWh.

TABLE 6. ENERGY RELATED RATIOS

	1970	1980	1990	2000	2001	2002
Energy consumption per capita (GJ/capita)	11	15	27	31	31	31
Electricity per capita (kW.h/capita)	37	90	263	465	488	511
Electricity production/Energy production (%)	2	3	6	10	10	11
Nuclear/Total electricity (%)						
Ratio of external dependency (%) (1)	-94	-112	-54	-59	-62	-66
Load factor of electricity plants						
- Total (%)	33	33	43	45	44	44
- Thermal	29	33	44	46	46	45
- Hydro	53	35	37	36	36	37
- Nuclear						

(1) Net import / Total energy consumption.
Source: IAEA Energy and Economic Database.

2. NUCLEAR POWER SITUATION

2.1. Historical Development and Current Nuclear Power Organizational Structure

2.1.1. Overview

We all have come to realize that the increasing demand and supply of energy is a reality and a necessity to support social-economic development. Developing countries, like Indonesia and other South East Asian countries, have low a standards of living and low consumption of energy. In their endeavours to reach a high quality of life, they need a lot of energy and electricity to fuel their social-economic development. The electricity demand in Indonesia is very high due to the National Economic Development based on industrialization and supported by a strong agriculture base. It can be noted that in the last five years, the annual electricity growth rate has been assumed at around 15% per annum. However, due to the economic crisis the electricity demand has experienced a reduction. Nevertheless, it is forecast that eventually in the early 2000s the economic growth in Indonesia will gradually increase. As a consequence, the electricity growth rate will also increase in the next coming decades.

Increased concern on the long-term effect of greenhouse gas emissions calls for greater priority in utilizing electricity generation, which is produce less greenhouse gases. So, it is very important to reduce the greenhouse gas emissions that are forecast to lead to atmospheric warming with global and regional climate changes, which is mainly due to fossil fuel combustion. With awareness to the environmental benefits of nuclear power, which produces remarkably little environmental pollution without any greenhouse gas emissions and with its potential as a sustainable long-term energy supply into the distant future, nuclear energy is an option that must be developed in Indonesia.

Indonesia became a Member State of the IAEA in 1957 and has been an active participant in its Technical Co-operation (TC) Program since then. BATAN, the National Nuclear Energy Agency of Indonesia was established in 1965. The multidisciplinary research complex at Serpong is focal point of nuclear R&D in the country. Major facilities at this centre include a 30 MW, high flux multipurpose research reactor, a nuclear fuel element centre, a low energy cyclotron based

radioisotope production centre, and a radioactive waste management technology centre. Two other research reactors have been set up at the nuclear institutes at Bandung and Yogyakarta. Although the country has not established any nuclear power plant so far, the decision to launch a nuclear power program was taken by the Government in the late 80's. Subsequently, considerable Agency assistance was provided to facilitate the implementation of Indonesia's first nuclear power reactor project. An independent nuclear regulatory authority, BAPETEN, for licensing and inspection of nuclear facilities and radiation sources was established in May, 1998. Agency has been associated with the evolution and growth of Indonesia's nuclear program, which has covered the entire spectrum of its activities, other than the power reactors.

During the last 4 years, Indonesia received total assistance amounting to US$3.541m for its broad-based program. Over 90% of these funds were disbursed in seven areas, namely: agriculture (22.75%), industry and hydrology (17.39%), general atomic energy development (15.21%), nuclear engineering and technology (11.07%), application of isotopes and radiation in medicine (10.06%), nuclear safety (8.15%), and nuclear chemistry (7.07%). While the years up to 1990 were capacity building in Indonesia's partnership with the Agency, a clear shift to end-user orientation is discernible in the program during the last ten years.

In addition to making excellent use of the country TC program, Indonesia has been an excellent partner in the Regional Cooperation Agreement (RCA) program. It was one of the six founding members who launched the RCA program in 1972. According to a recent review of the Technology Transfer through RCA program, Indonesia participated in 28 areas of RCA activities and has attained a sustainable (highest) level of technology transfer in six of these areas and a self-reliant level in another 18. This was achieved through the devotion, dedication and hard work of scientists, engineers and technicians, sustained support from the Government, and a judicious combination of IAEA country projects with the RCA program. This is a good achievement and reflects the growing maturity of Indonesia's nuclear program.

2.1.2. National Nuclear Organization

In recognition of the need to develop a viable nuclear regulatory infrastructure in order to proceed with the development of nuclear power, the government of Indonesia has issued the new basic nuclear energy act on April 1997 (Act No. 10 of 1997) to replace the Act No. 31 of 1964 which have become inappropriate. In this new Act, the authority in executing and regulating nuclear energy is separated into two different institutions to guarantee the control of nuclear energy to be more credible in order to suffice the nuclear safety.

According to this new Act, Chapter II Article 3, the responsibility to promote the application of nuclear energy is vested to the “Promotional Body” (National Nuclear Energy Agency [NNEA] or BATAN) and, as stated in the Chapter II Article 4, the responsibility to regulate and control is vested to the “Regulatory Body” (Nuclear Energy Control Board or BAPETEN).

The institution which has responsibility to promote the applications of nuclear energy is vested in the promotional body, and the new President Decree No.197 of 1998 was also issued to established the National Nuclear Energy Agency (NNEA, also known as BATAN) which has responsibility to execute, and to promote the research and the use of nuclear energy in Indonesia.

In the year 2000, the Government of the Republic of Indonesia issued Presidential Decree No. 178/2000 concerning the new structural organization of Non Ministerial Government Agency where BATAN is one of its components. For the implementation of the Presidential Decree, the Chairman of BATAN issued Decree No. 166/Ka/IV/2001 concerning structural organization of BATAN. In this recent organization BATAN is headed by a Chairman with four Deputies and one Executive Secretariat.

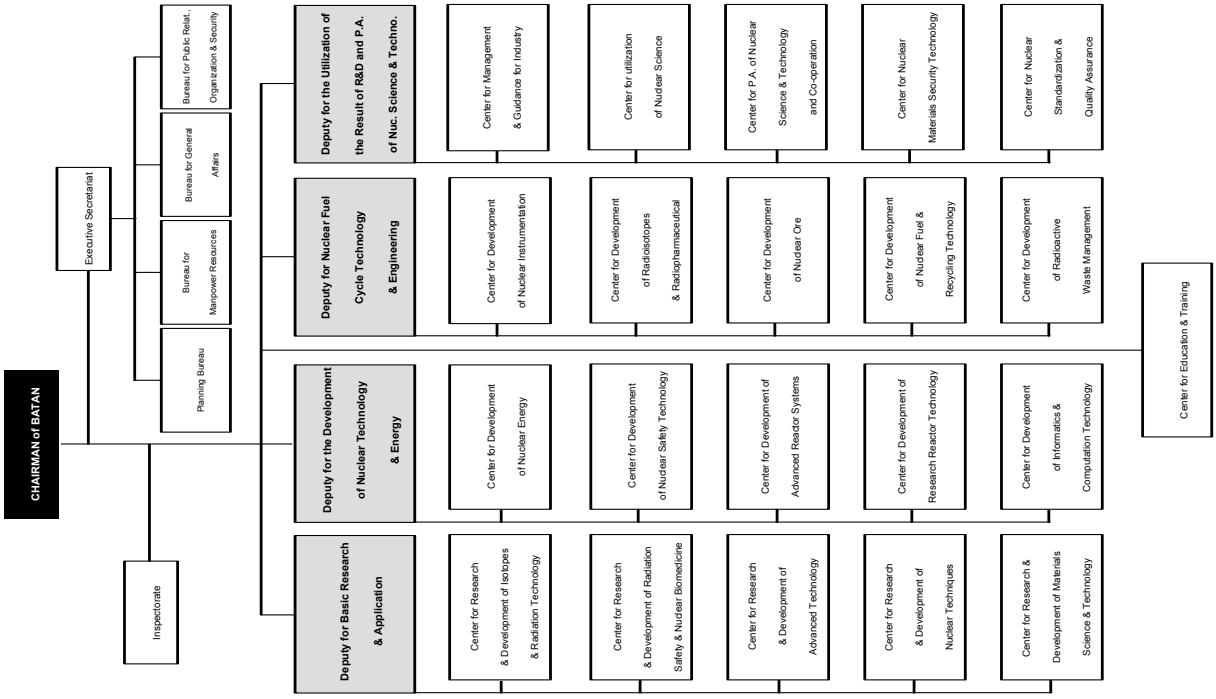


Figure 2 Batan Organizational Chart

One of the responsibility to regulate and to control nuclear energy is vested in the regulatory body, and in April 1998 the new President Decree No.76 of 1998 was issued to established the Nuclear Energy Control Board (NECB, also known as BAPETEN) which has been responsible for regulating and controlling the use of radioactive materials, radiation sources, nuclear reactors and nuclear materials in Indonesia. BAPETEN as an independent regulatory body has responsibility to assure that any activity related to the use of any nuclear energy is obligated to maintain the safety, security, and peace, as well as the health of the workers and the public, and also the protection of the environment.

BAPETEN which is headed by a Chairman, 2 Deputies, one Safety Committee, and one Safeguards Unit, has 6 Directorate, and one Secretariat which is to regulate, and control the use of radioactive material, radiation, nuclear reactors and the nuclear material in Indonesia and these are located at Jakarta, the capital city of Indonesia. Figure 4 shows the organizational structure of BAPETEN based on the Decree of the Chairman of BAPETEN No.01/K-OTK/VIII-1998 and the BAPETEN is directly responsible to the President.

2.1.3. Basic Policy

The basic policy of BATAN has been formulated in accordance with and in support of the Broad National Policy Guidelines (GBHN) and national policies to implement the GBHN. Strategy has been established and priority areas have determined to facilitate the development and utilization of nuclear science and technology, and for the effective dissemination of information, relating to its benefits, to the public.

- Implementation Strategy

The implementation strategy is designed to give the highest impact in the most cost effective manner. The strategy includes the following elements:

  - The programs and activities are designed to provide cost-effective S&T solutions to various national development problems. In that sense, these activities are largely

demand/market drive, end-user oriented and have a significant socio-economic impact. Some activities relating to capacity building and scientific research and development in new technologies are being pursued in parallel.

- Development of national networks comprising the relevant Government agencies/institutions at the regional levels, national R&D institutions, Universities, end-user/beneficiary groups
- Development of links and cooperation with technologically advanced countries and international organizations, such as the Agency.

- Priority Areas

For the last few years, programs of activities have been designed and implemented to strengthen the development of following sectors of national interest.

- Priority Area 1: Basic Human Needs
  The objective is to establish research and development programs in support of the Government Policy and to utilize the results to meet the basic needs of the Indonesian people.

  Priority Areas
  a) Agriculture
     - ❖ Evolution of mutants of nationally important crops such as nice, soybean and mungbean, with improved yield, disease resistance, and other desirable characteristics
     - ❖ Optimization of plant-soil interaction
     - ❖ Integrated pest management
     - ❖ Biotechnology, including the development of bio-fertilizers
     - ❖ Post-harvest treatment using gamma and particle beam irradiation.

  b) Livestock
     - ❖ Enhanced milk and meat production through improved nutrition and reproduction technologies
     - ❖ Health and disease control

  c) Health
     - ❖ Radiopharmaceuticals production
     - ❖ Development and production of low cost tissue grafts and other biocompatible materials
     - ❖ Establishing new radiotherapy, x-ray diagnostic and nuclear medicine facilities, and launching QA/QC programs in existing units

  d) Environmental Protection
     - ❖ Identification and characterization of pollutants.

- Priority Area 2: Management and Sustainable Utilization of Natural Resources
  The objective of this priority is to identify, develop and utilize natural resources, in particular water, geothermal, and mineral resources in support of the national development programs by using appropriate nuclear techniques

  Priority Areas
  a) Water resources development and management
  b) Geothermal energy resources
  c) Mineral resources

- Priority Area 3: Nuclear Energy, Nuclear Safety and Radiological Protection of the Environment
  The objective is energy planning with nuclear option for the Indonesian archipelago– introduction of small and medium sized power reactors in the national energy system.

  Priority Areas

a) Updating long-term energy planning with nuclear option in national energy system
b) Preliminary Economic Feasibility Study of Nuclear Desalination
c) Mapping, drilling, reserve estimation, research and development and feasibility studies relating to the mining of nuclear materials.
d) Public information and education to get better public acceptance on utilization of nuclear power plant.
e) Human resource development for the introduction of nuclear power in Indonesia and related nuclear safety and radiological protection infrastructure.

- Priority Area 4: Industrial Development

  The objective is to support the development of national industries, through the utilization of appropriate nuclear techniques.

  Priority Areas

  a) Partnership with industry in promoting applications of isotopes and radiation in general, and for the production of radioisotopes and basic human needs in particular
  b) Utilization of nuclear techniques as applied to material science, physics, chemistry, electronics and informatics to support national industry.

- Priority Area 5: Strengthening National Capability in Nuclear Science and Technology

  The objective is to establish a systematic human resource development program for sustained support to national nuclear R&D efforts.

  Priority Areas

  a) Sustained support for nuclear R&D
  b) Nuclear safety, radiation protection and waste management, both regulatory and operational aspects
  c) Human resource development

BATAN has prepared a landmark to guide its program. This landmark can be seen in the following table.

No.	Government Focus	Short Term, Year of Achievement	Medium and Long Term, Year of Achievement
1	Food (Agriculture/ Animal Husbandry)	10% of the number of national high varieties of food crops and additional the kinds of animal feed supplements, and their sustainable availability, **2004**	National reference centre for the application of isotope and radiation technologies in the field of agriculture and animal husbandry, **2008**
2	Ocean and Earth	Regional laboratory reference centre in utilization of nuclear techniques for the development of exploration and exploitation of geothermal, **2005**	National facility for non-reactor radioactive waste management, **2007**
3	Biotechnology/ Health	Nuclear technology based equipments to overcome the cancer and bacteria infectious diseases in Indonesia, **2005**	National reference centre for nuclear technology based public health, **2010**
4	Informatics and Microelectronics	Reliable Information technology for digital library and human resources management, **2005**	Nuclear technology information centre for public information and education, development of computation methods, computer modelling and simulation and knowledge preservation, **2010**
5	Energy	Nuclear option as a part of a long term national energy system, **2004**	Nuclear science and technology base in operation, **2010** First NPP in operation, **2016**
6	Manufacture	Commissioning of electron beam machine for industry, **2003**	Reference centre for engineering and maintenance of nuclear equipment in health, nuclear safety and industry, **2008**

2.2. Status of Nuclear Research Reactor

At present, National Nuclear Energy Agency of Indonesia has operated 3 (three) research reactors. The first reactor was commissioned in 1964. It was TRIGA MARK type with capacity of 250 KWt located in Bandung Nuclear Facility Area. To fulfil the demand on utilizing of the reactor, then, the capacity was upgraded to be 1 MWt. This reactor was mainly used for radioisotope production and used as training facility. In the year of 2000, this reactor was upgraded again to the power of 2 MWt. The second research reactor was also TRIGA MARK type that commissioned in 1979 located in Yogyakarta Nuclear Facility Area. The power capacity of this reactor was 100 kWt. This research reactor was utilized for training and conducting experiment on reactor physics and experiment related to sub-critical assembly. This research reactor is planned to be up-rated to the power of 250 kWt. The first and the second research reactors have limited in function due to low neutron flux and limited space for irradiation facilities.

As the BATAN organization growth, BATAN developed a program on introducing the Nuclear Power Plant in Indonesia. Therefore BATAN needed an adequate nuclear facility to support that program. For that reason, BATAN established nuclear facility area near Jakarta called Serpong Nuclear Facility Area where the third research reactor was established. It could be said that the establishment of this nuclear facility was connected to the program of introducing the first NPP in Indonesia. For supporting to the introduction of the NPP in Indonesia, some laboratories were established i.e. research reactor in MTR type and as the third research reactor in Indonesia, radioactive waste treatment laboratory, fuel fabrication plant, engineering and safety laboratory, radio-metallurgy laboratory, radioisotope production laboratory, nuclear mechano-electric laboratory, etc.

The third research reactor due to its function was called the Multi-purpose reactor that can be utilized for fuel and material testing, radioisotope production, to conduct experiment utilizing neutron beam for neutron radiography and for basic research. The power of Multi-purpose reactor is 30 MWt so it is suitable for material testing facility.

By the presence of those laboratories, research and development (R & D) activities related to the nuclear power plant technology were carried out. For examples, by utilizing the research reactor, R & D on fuel and material related to NPP can be carried out, by utilizing Engineering and Safety laboratory, R&D related to safety technology can be carried out including safety analysis and accident analysis.

The nuclear facility in Serpong Area was established starting in 1982 and finished in 1999. The multipurpose research reactor was commissioned and getting the first criticality in 1987. The purpose to establish nuclear facility was, besides to support technologically to the introducing of NPP, to prepare and provide the adequate man power development for facing the project on establishment of NPP in Indonesia.

By conducting experiments using laboratories the experiences, knowledge and capability of the personnel would be developed. The man power development was also carried out by sending the personnel to abroad in the form of study, training and design participation. Study and training were conducted by government to government cooperation in the field of nuclear technology. Design participation was conducted by joining of Indonesian staffs to the vendor of nuclear power plant, for examples to Westinghouse on the design of AP600, to General Electric on the design of SBWR, etc.

2.3. Status of Nuclear Power Plant

At the present time, there are no power reactors in the country. In the seventies the National Atomic Energy Agency (BATAN) initiated a program for introducing nuclear power in the country. The activities on site selection were then conducted in several places in Java Island and a site at Muria peninsula has been recommended.

The first idea to have a nuclear power plant in Indonesia occurs in 1956 coming from the

university circles in Bandung and Yogyakarta in the form of seminars. The real task was started in 1972 when the Commission for Construction Preparation of NPP (KP2PLTN) was created by National Atomic Energy Agency (BATAN) and Civil Work Department (PUTL Dept.).

The Karangkates Seminar in 1975 organized by BATAN and PUTL Department has obtained the result about the decision of nuclear power development in Indonesia. It was proposed 14 possibilities of NPP location in Java Island, among them 5 locations were lately declared to be the potential site, and then the Muria site in Central of Java was chosen as the best site.

The first feasibility study for the introduction of a nuclear power plant was conducted in 1978 with the assistance of the Government of Italy. However, following this study the Indonesian government deferred the decision until the nuclear research facilities in Serpong became fully operational.

In 1985 work began on updating the studies with the assistance of the International Atomic Energy Agency (IAEA), US government through the Bechtel International, the French government through SOFRATOME and the Italian government through CESEN. These updated reports, and the analytical capabilities developed by the Indonesian partners during the process of this cooperation, have become the foundation for the present planning activities.

In September 1989, the Indonesian government through the National Energy Co-ordination Board (BAKOREN) decided to perform a new NPP feasibility study including comprehensive investigations of the Muria Peninsula as a candidate site for NPPs. The study itself was carried out by the National Atomic Energy Agency (BATAN), under the directives of the Energy Technical Committee (PTE) of the Department of Mines and Energy, including other institutions as well.

In August 1991, an agreement was signed in Jakarta between the Indonesian Ministry of Finance and BATAN on behalf of Indonesia, and the consultant's company NEWJEC Inc. This agreement contract NEWJEC for a four and a half years period to perform a site selection and evaluation, as well as a comprehensive nuclear power plant feasibility study for a nuclear power plant (7000 MWe). The principal part of the contract's value will be spent on studies related to the site, which is to be sought in the northern coast of the Muria Peninsula in Central Java. The first two phases (Steps 1-2) were performed during years 1992 and 1993 and three candidate sites were compared and ranked. As conclusion of these studies, the "preferred candidate site" was obtained (i.e., Ujung Lemahabang site). The last phase of the investigations (Step 3) is the evaluation of indicated preferred site in order to confirm its acceptability and it was finished by the end of 1995.

In May 1996, the feasibility study for the first NPP in Indonesia was completed. The result of the feasibility study, especially on the electrical system analysis using the WASP-III of the ENPEP program, shows that the introduction of nuclear power plants in the early 2000s to the Java-Bali electric system represents an optimal solution.

In addition after the feasibility study, another studies have been done, such as the preparation of bid invitation specification, development of financing study (BOO and Barter), re-evaluation of nuclear energy for electricity planning and study development of Muria site. Considering the impact of the economic crisis in 1998, a re-evaluation study on electricity planning has been done. The study was still going on, while BATAN performed research and development activities including reactor safety, radiation protection, fuel, and radioactive waste treatment.

The recent study of long-term energy and electricity planning "*Comprehensive Assessment of different Energy Sources for Electricity Generation in Indonesia*" prepared by Indonesian Team and supported by IAEA has already finished in 2001. The result of this study shows that the Indonesia energy demand is projected to increase in the future. And the introduction of NPP on Java-Bali electricity grid will be possible in 2016 for 2 GWe and it will reach more than 6-7 GWe in 2025, using proven reactor PWR1000 (1000 MWe) with 85% capacity factor and investment cost $2000/kWe. The study continued on environmental aspect and externalities studies for year 2002, and the environmental constraints lead apparently to an earlier introduction of nuclear power plant.

2.4. Organization of NPPs

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

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

2.5. Fuel Cycle and Waste Management

Since Indonesia is not operating any NPP, program on fuel cycle and waste management is focused to that related to research reactor and industry using nuclear source. There are a facility for production and experiment of research reactor fuel element, and a facility for production and experiment of nuclear power plant fuel element. There is also an installation to manage nuclear waste.

2.6. Research and Development

Nuclear R&D activities are classified into reactor safety, radiation safety, environmental safety, and radioactive waste treatment. The Serpong Nuclear Energy Research Establishment (PPTN-Serpong) is a research facility and complete nuclear technology development. By the completion of the establishment of the Multipurpose Reactor and Supporting Laboratories, PPTN Serpong is able to play as the motivator and supporter for the nuclear industries development for the needs of peace in Indonesia. The role is carried out through:

- Mastering and developing of nuclear technology and Science.
- Education and training for becoming experts and skilled workers on the field of nuclear.
- Manufacturing the basics components for the nuclear process equipment.

BATAN as a government institution is now performing nuclear research and development in energy, health, industry, and other sectors. In relation with the introduction of NPP, especially, expertise of BATAN man-power, and the availability of BATAN facilities can be utilized. Research and development on the following fields can be performed by BATAN:

- Neutronic:
  Reactor core configuration, criticality calculation, core optimizing, in-core fuel management, reactor kinetics, gamma-neutron flux mapping, etc.
- Thermal-hydraulics and reactor system technology:
  Heat transfer, safety parameter evaluation, cooling system, core analysis related to thermal and hydraulics, etc.
- Reactor instrumentation and control system:
  R&D on instrumentation and control system
- Engineering & Auxiliary system:
  Design, assessment, construction of electro-mechanical system such as mechanical workshop, steam generator/boiler, turbine, generator, manufacturing, piping, etc.
- Fuel element:
  Exploration, exploitation and fabrication of nuclear fuel element.
- Radioactive Waste:
  R&D on radioactive waste management, and implementation of radioactive waste management.
- Computer code application:
  - Neutronic analysis, core management, reactor kinetics, core thermal-hydraulics, and reactor system technology: IA-FUEL, WIMS/D4, BATAN-II DIF, MCNP, UEREKA, SRAC, CITATION, ORIGEN-2, COOLOD-N, HEATHYD, PARET.

– Reactor risk and accident analysis: RELAP5, CATHENA, THALES-2, SAPHIRE.

The unit organizations in the PPTN Serpong are as follows:

- Centre for Research and Development of Material Science and Technology.
- Centre for Development of Research Reactor Technology.
- Centre for Development of Nuclear Fuel and Recycling Technology,
- Centre for Development of Nuclear instrumentation
- Centre for Development of Radioisotope and Radiopharmaceutical.
- Centre for Development of Radioactive Waste Management.
- Centre for Management and Guidance for the industry.
- Centre for Development of information and Computation Technology.
- Centre for Development of Nuclear Safety Technology.
- Centre for Development of Advanced Reactor System.

The activities on reactor safety cover safety assessment, using deterministic and probabilistic methods, reliability of material, component and system, thermal hydraulic experiment, and coolant chemistry study. These activities mainly carry out at the Centre for Development of Nuclear Safety Technology, BATAN.

The activities on radiation safety cover evaluation and application of standards and principle of radiation safety, radiation protection, radiation effect, radiation measurement, calibration and standardization of measuring equipment. These activities mainly carry out at the Centre for Research and Development of Radiation Safety and Nuclear Biomedicine, BATAN.

The activities on environmental safety cover environmental impact analysis and emergency planning and preparedness. These are carried out together by some centres, mainly at Centre for Development of Nuclear Safety Technology and Centre for Research and Development of Radiation Safety and Nuclear Biomedicine, BATAN.

The activities on radioactive waste treatment cover waste treatment, storage, and disposal studies. These activities are mainly carried out by the Centre for Development of Radioactive Waste Management, BATAN.

2.7. International Cooperation and Initiatives

2.7.1. Memberships in international organizations

IAEA membership since August 7, 1957.

2.7.2. International agreements

• NPT related agreement INF/CIRC No. 283	Entry into force: 14 July 1980
• Project related safeguards agreement INF/CIRC No. 136	Entry into force: 19 Dec. 1969
• Additional Protocol	Signature: 29 Sept. 1999
• Improved procedures for designation of safeguards inspectors	Accepted on 8 June 1989
• Supplementary agreement on provision of technical assistance by the IAEA	Entry into force: 4 July 1980
• RCA	Entry into force: 12 June 1987
• Agreement on Privileges and Immunities	Entry into force: 4 June 1971
• NPT	Entry into force: 12 July 1979
• Convention on physical protection of nuclear material	Entry into force: 8 Feb. 1987
• Convention on early notification of a nuclear accident	Entry into force: 13 Dec. 1993
• Convention on assistance in the case of a	

nuclear accident or radiological emergency	Entry into force: 13 Dec. 1993
• Vienna Convention on Civil Liability for Nuclear Damage	Non-Party
• Joint Protocol	Non-Party
• Protocol to amend the Vienna Convention on Civil Liability for Nuclear Damage	Signature: 6 Oct. 1997
• Convention on Supplementary Compensation for Nuclear Damage	Signature: 6 Oct. 1997
• Convention on Nuclear Safety	Signature: 20 Sept. 1994
• Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management	Signature: 6 Oct. 1997
• ZANGGER Committee	Non-Member
• Nuclear Export Guidelines	Not adopted
• Acceptance of NUSS Codes	No reply

2.7.3. Bilateral agreements

• Agreement signed with JAERI (Japan) on Operation of Research Reactors. This assistance is related to the operation and utilization of the Multipurpose Research Reactor in BATAN.

• Agreement signed with MITI (Japan) on Nuclear Safety Regulation and on Safety Analysis (Assessment) for transient and accident condition in a nuclear power reactor.

• Agreement signed with STA (Japan) on Scientific Exchange Program. Indonesian Scientists work together with Japanese Scientists to conduct experiments.

• Agreement signed with Germany on Thermo-hydraulic Experiments and Thermo-hydraulic Analysis (use of code ATHLET).

2.7.4. Past technical co-operation with IAEA

INS/1/015 Utilization of Multi-Purpose Research Reactor (1985), with an objective to establish a coordinated experimental program on the use of the multi-purpose research reactor and ancillary facilities.

The National Atomic Energy Agency (BATAN) embarked on a large scale development program to establish a new complex of nuclear research centres in Serpong. The program comprises a group of facilities/laboratories including a 30 MW multi-purpose research reactor, installations for manufacturing fuel elements for research reactors and NPPs as well as for the production of radioisotopes and the treatment of radioactive wastes. This footnote-a/ project, made operational through an extra-budgetary contribution from Germany, provided a two-year expert mission and two short missions to assist in planning this development. Three fellowships and one scientific visit were awarded and some extra equipment was provided. The experimental capabilities for materials research of the multi-purpose research reactor centre at Serpong have been upgraded and its technical and managerial competence has been strengthened. Radioisotopes are being produced.

INS/4/023 Research Reactor Calculations and Experiments (1989), with an objective to gain expertise in reactor physics calculations with the MPR-30 reactor.

In order to utilize fully the integrated facilities at the 30 MW multi-purpose research reactor at Serpong and the 1 MW TRIGA Mark-II research reactor at Bandung, a good understanding of the reactor physics parameters is essential. The project was originally approved for the research reactor at Serpong and was later extended to include the reactor at Bandung. The Agency provided a signals analyser, a radiation detector, and related equipment, together with extensive expert advice on measurements, calculations and neutron noise analysis. Four fellowships and one scientific visit were

awarded. The manpower and infrastructure at Serpong and Bandung have been strengthened to allow effective utilization of both research reactors.

INS/4/029 Upgrading Safety Instrumentation of Bandung Research Reactor (1993), with an objective to upgrade the aging instrumentation system related to nuclear safety of the Bandung Triga Mark II research reactor.

At the Research Centre for Nuclear Techniques in Bandung, a 1 MWth TRIGA Mark II research reactor has been used for radioisotope production, research and training since 1964. The Government requested the Agency's assistance to upgrade the instrumentation system related to safety. The Agency provided monitoring equipment, radiation detectors, and equipment for reactor tank cleaning. Two expert missions assisted in planning an instrumentation upgrade, advised on planning power upgrading, and helped in improving the emergency core cooling system and the ventilation system of the reactor building. Three fellowships were completed. The operational safety of the reactor has now been improved and it is expected that the life of the reactor will be extended.

INS/4/030 Research Reactor Calculations and Experiments - Phase II (1993), with an objective to develop manpower for research in neutronics, thermo-hydraulics, kinetics and noise analysis using the 30 MWth multi-purpose research reactor at Serpong.

The Reactor Physics Division of the Multipurpose Reactor Centre, BATAN, sought the Agency's assistance to continue its research activities initiated under a completed TC project INS/4/023. Under this project, Agency experts assisted in developing neutron noise analysis techniques, measuring reactor parameters, and performing neutronic and thermo-hydraulics calculations. An instrumentation tape recorder and a noise amplifier were provided to the Centre. Two fellowships were awarded to local staff. The project resulted in an upgraded reactor physics laboratory at Serpong. The well trained counterpart staff is now capable of undertaking reactor physics theoretical calculations and experiments at low and high power for a 30 MWth multipurpose research reactor to support its applications.

INS/9/012 Nuclear Power Plant Sitting (1988), with an objective to evaluate a power reactor site investigation plan in order to obtain firm data on which conclusions concerning the most suitable site can be based.

20 missions of IAEA experts have been carried out from 1989 to 1996.

INS/9/013 Strengthening Nuclear Safety Infrastructure (1989), with an objective to strengthen research capabilities in different fields of reactor safety.

The National Atomic Energy Agency (BATAN) is responsible for research and development in reactor safety technology for the Reactor Safety Technology Research Centre at Serpong. Under this multi-year project, the centre has been furnished with a general thermo-hydraulic loop, a corrosion loop, a test rig and a material testing laboratory with government support. In the meantime, the Agency has provided expert services to assist counterpart staff in various aspects of reactor safety. They undertook five missions and advised on reactor material testing, reactor protection system, accident analysis for nuclear power plants, and man-machine interface design. A national seminar on emergency preparedness and a national workshop on nuclear safety regulatory control of nuclear power plants were also held to train the local staff. The project has strengthened the capabilities of the Centre in ensuring reactor safety in Indonesia.

INS/9/014 Research Reactor Safety (1989), with an objective to acquire expertise in the thermo-hydraulic aspect of reactor safety of the MPR-30.

A 30 MWth multipurpose research reactor was commissioned in 1987 in Serpong, West Java. Commissioning of the integrated facilities was the responsibility of the National Atomic Energy Agency. To study the safety aspects of reactor operation and to evaluate the thermo-hydraulic data derived during commissioning, it was necessary to determine accurately the reactor's thermo-hydraulic parameters by means of measurements and calculations, using computer codes. The project was approved in 1989 with footnote-a status and was upgraded in 1990. Germany also made additional extra-budgetary contributions for the provision of an expert. The Agency supplied

equipment, including a computer system. Three Agency experts carried out four missions and advised on thermo-hydraulic assessment of the reactor, accident analysis, safety analysis calculations, and development of computer codes for flow distribution calculations. Two counterpart staff were awarded long-term fellowship training. As a result of the project, the counterpart at the Siwabessy Multipurpose Reactor Centre, Serpong, has developed expertise in the thermo-hydraulics of reactor safety.

2.7.5. Ongoing technical co-operation with IAEA

INS/0/015 Human Resource Development and Nuclear Technology Support (1999), with an objective to upgrade and strengthen the skills and capabilities of technical personnel within the broad range of the applications of nuclear science and technology.

INS/4/028 Support for the First Nuclear Power Plant (1993), with an objective to train personnel to be able to discharge the owner's function in relation to the acquisition of the first nuclear power plant in Indonesia.

INS/9/021 NPP Site Confirmation and Structural Safety (1997), with an objective to confirm acceptability of the site for an NPP with regard to volcanic and geological stability and foundation safety; to finalize the definition of site-related design basis parameters and resolve site-related structural safety problems.

The current technical cooperation can be seen in the following table.

Project Number	Title	**1st Year of Approval**
INS/0/016	Comparative Assessment of Different Energy Sources for Electricity Generation	2001
INS/0/017	Human Resource Development And Nuclear Technology Support	2003
INS/5/030	Sustainable Agriculture Development in Yogyakarta	2001
INS/5/031	Mutation Breeding of Horticultural Crops	2001
INS/5/032	Improving Beef and Dairy Cattle Production in Yogyakarta	2001
INS/6/011	Detecting Drug-resistant Strains of Tuberculosis	2003
INS/6/012	Initiation of Radiotherapy Centre on Borneo Island	2003
INS/8/023	Groundwater Resources Exploitation in the Gunung Kidul Area	2001
INS/9/022	Inspection Procedures and Methods for Assessing Reactor Tank Liners	2003

2.8. Human Resources Development

Human resource development program is prepared by the Human Resource Bureau and the Centre for Education and Training (CET). The program consists of carrier development, education and training. Education and training could be implemented in the CET. There are also many universities engage in technical education. At Yogyakarta, Gadjah Mada University has been engaging in nuclear engineering education since 23 years ago. Whereas Institute for Nuclear Science and Technology has started operation since 2001 under the direction of the management of National Nuclear Energy Agency (BATAN). Another high-level educational institution engaging in technology with profound infrastructure is Bandung Institute of Technology and University of Indonesia in Jakarta. These institutions also provide vocational training in various disciplines including engineering and safety aspect for industrial purposes.

3. NATIONAL LAWS AND REGULATIONS

3.1. Safety Authority

3.1.1. Governmental Organizations

In recognition of the need to develop a viable nuclear regulatory infrastructure in order to proceed with the development of nuclear power, the government of Indonesia has issued the new basic nuclear energy act on April 1997 (Act No. 10 of 1997) to replace the Act No. 31 of 1964 which have become inappropriate.

In this new Act, the authority in executing and regulating nuclear energy is separated into two different institutions to avoid the overlapping of activities on the use and control as well as to optimize the control of nuclear energy in order to improve nuclear safety.

One of the responsibility to regulate and control of nuclear energy is vested in the regulatory body, and in April 1998 the new President Decree No.76 of 1998 was issued to established the Nuclear Energy Control Board (NECB, also known as BAPETEN) which has responsibility to regulate and control the use of radioactive materials, radiation sources, nuclear reactors and nuclear materials in Indonesia.

The other is the institution which has responsibility to promote the applications of nuclear energy is vested in the promotional body, and the other new President Decree No.197 of 1998 was also issued to established the National Nuclear Energy Agency (NNEA, also known as BATAN) which has responsibility to execute, and to promote the research and the use of nuclear energy in Indonesia.

In the year of 2000, the Government of Republic of Indonesia issued Presidential decree No. 178/2000 concerning the new structural organization of Non Ministry Governmental Agency where BATAN is one of its components. For implementation of the presidential decree, the chairman of BATAN issued decree No. 166/Ka/IV/2001 concerning structural organization of BATAN. In this recent organization BATAN is headed by a Chairman with four Deputies and one Executive Secretariat as described in Figure 2.

3.1.2. Nuclear Safety Legislation

In the Act No.10/1997 on Nuclear Energy, basic changes to the previous Act No.31/1964 are as follows:

1. Separation of the Regulatory Body from the Promotion Body:
   - The Promotion Body will be responsible to undertake only basic and non-commercial researches.
   - The Regulatory Body will be responsible to regulate and control all nuclear activities in Indonesia.
2. Introduction of a Nuclear Energy Council which will be responsible to give advice to both Promotion and Regulatory Bodies concerning nuclear energy development in Indonesia.
3. Radioactive waste management control including the need of approval from parliament regarding decision for permanent site of high level waste disposal.
4. Financial protection in the form of liability insurance (strict liability/liability without fault) required in all aspects of nuclear activities.
5. Cooperation of private sectors in the nuclear application activities for commercial purposes.
6. Criminal and financial penalties for regulation violation.

In case to a specific requirement, IAEA NUSS Code(s) might be adopted and apply as a base in drafting such a specific legislation need. Moreover, the possibly document(s) from related NPP supplier countries might also be adopted as further standards to the extent practicable.

In consideration that nuclear energy involves the life and safety of the people, a public role shall be enhanced in the form of an advisory counsel, a non-structural and independent institution that consists of experts and public figures, having the task to give advices and opinion on the use of nuclear energy.

To take in mind the public aspiration on the use of nuclear energy, especially a construction of a nuclear power plant and a final radioactive waste repository, the Government, before taking decision, shall consult with the People's House of Representatives of the Republic of Indonesia.

Furthermore, it is also necessary to give considerations on other regulations related to the Act on Nuclear Energy, such as Act Number 1 Year 1970 on Work Safety, Act Number 8 Year 1978 on the Ratification of Treaty on Nuclear Proliferation of Nuclear Weapons, Act Number 4 Year 1982 on Basic Stipulations on Environmental Management, Act Number 5 Year 1984 on Industry, Act Number 15 Year 1985 on Electricity, Act Number 3 Year 1992 on the Insurance for Workers, Act Number 23 Year 1992 on Health, Act Number 24 Year 1992 on Landscape, and Act Number 10 Year 1995 on Customs.

3.1.3. Role & Responsibility of the Regulatory Body

BAPETEN as an independent regulatory body has responsibility to assure that any activity related to the use of any nuclear energy is obligated to maintain the safety, security, and peace, as well as the health of the workers and the public, and also the protection of the environment. These are administered by:

- Drafting and establishing nuclear safety regulations
- Controlling nuclear installations and nuclear materials through licensing and inspection systems that covered all stages of NPP establishment (from site selection to decommissioning stages);
- Controlling the use of radioactive materials and other radiation sources through licensing and inspection systems.

The primary objective of the regulatory body is to ensure that site personnel, the public and the environment are protected from possible adverse effects arising from nuclear activity. In order to achieve these objectives, BAPETEN has responsibility in:

- the rulemaking of national policy in the field of the control of nuclear energy utilisation;
- the planning of national program in the field of the control of nuclear energy utilisation;
- the guidance and the rulemaking and the implementation of nuclear safety, radiation safety, and safeguards assessments;
- the implementation of licensing and inspection to the development and the operation of nuclear reactor, nuclear installation, nuclear material facility, radiation source, and the development of nuclear preparedness;
- the implementation of co-operation in the field of control of nuclear energy utilization with other Government agencies or organizations either internally or externally to the Government of Indonesia;
- the implementation of safeguards and SSAC (State's system on accounting for and control of nuclear material);
- the implementation of the guidance and counselling for the effort that related to the safety and health of the worker and the people, and the effort of environmental conservation.

3.1.4. Organization of the Regulatory Body

BAPETEN which is headed by a Chairman, 2 Deputies, one Safety Committee, and one Safeguards, has 6 Directorate, and one Secretariat which is to regulate, and control the use of radioactive material, radiation, nuclear reactors and the nuclear material in Indonesia and these are

located at Jakarta, the capital city. Figure 3 shows the organizational structure of BAPETEN based on the Decree of the Chairman of BAPETEN No.01/K-OTK/VIII-1998 and the BAPETEN is directly under the responsibility of the President.

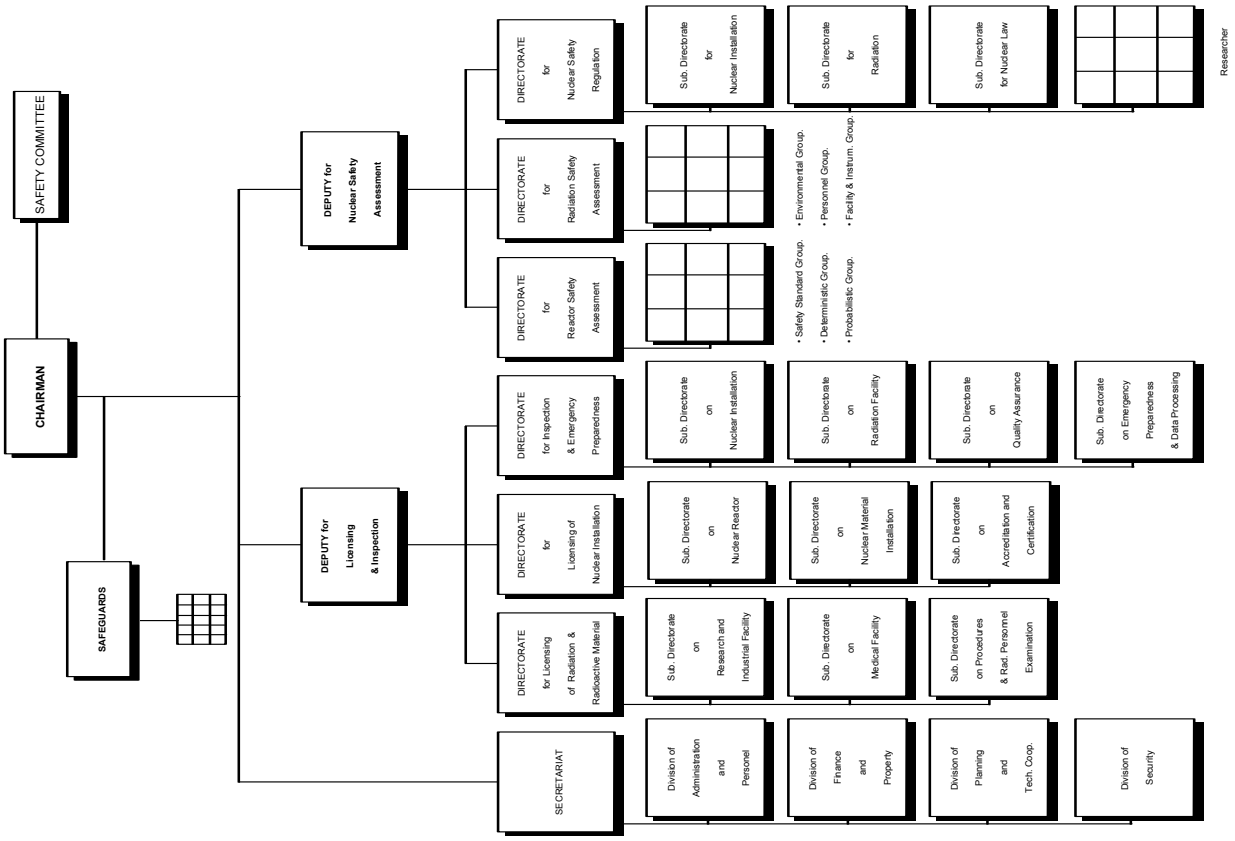
3.1.5. Regulations & guides

- Act:
  - No. 10 of 1997 on Nuclear Energy.
  - No. 8 of 1978 on Ratification of NPT.
- Decree of Chairman of BAPETEN:
  - No.01/Ka-BAPETEN/V-99 on Working Safety Provision Against Radiation.
  - No.02/Ka-BAPETEN/V-99 on Limit Values for Radioactivity in Environment.
  - No.03/Ka-BAPETEN/V-99 on Safety Provisions for Radioactive Waste Management.
  - No.04/Ka-BAPETEN/V-99 on Safety Requirements for Transport of Radioactive Material.
  - No.05/Ka-BAPETEN/V-99 on Safety Requirements for Design of Research Reactor.
  - No.06/Ka-BAPETEN/V-99 on Construction and Operation of Research Reactor.
  - No.07/Ka-BAPETEN/V-99 on Quality Assurance for Nuclear Installation.
  - No.08/Ka-BAPETEN/V-99 on Safety Provisions for Industrial Radiographic Operation.
  - No.09/Ka-BAPETEN/V-99 on Safety Provisions for Well Logging.
  - No.10/Ka-BAPETEN/VI-99 on Safety Provisions for Research Reactor Operation.
  - No.11/Ka-BAPETEN/VI-99 on Construction and Operation of Irradiators.
  - No.12/Ka-BAPETEN/VI-99 on Working Safety Provisions for Nuclear Ore and Mine.
  - No.13/Ka-BAPETEN/VI-99 on State System on Accounting for and Control of Nuclear Material.
  - No.14/Ka-BAPETEN/VI-99 on Safety Provision for Gas Mantle Fabrication.
  - No.15/Ka-BAPETEN/VIII-99 on the Appointment of Nuclear Safety and Radiation Safety Inspectors for the year 1999/2001
  - No.16/Ka-BAPETEN/IX-99 on the Appointment of Nuclear Safety and Radiation Safety Inspectors' Assistance for the year 1999/2001
  - No.17/Ka-BAPETEN/IX-99 on Requirements of Radiation Worker Authorization.
  - No.18/Ka-BAPETEN/II-00 on Certification and Accreditation for Laboratory, Radiation Protection Course, and Certification Institutions.
  - No.19/Ka-BAPETEN/II-00 on License Exemptions
  - No.01-P/Ka-BAPETEN/VI-99 on Guide for Selection of Nuclear Reactor Site.
  - No.02-P/Ka-BAPETEN/VI-99 on Guide for Physical Protection of Nuclear Material.
  - No.03-P/Ka-BAPETEN/VI-99 on Technical Guide for Preparation of Environmental Impact Analysis Report in the NPP's Construction and Operation Planning.
  - No.04-P/Ka-BAPETEN/VI-99 on Technical Guide for Preparation of Environmental Impact Analysis Report in the Nuclear Installation's Construction and Operation Planning.

  to be issued:
  - Guide for Preparation of Safety Analysis Report.
  - Technical Guide for Radioactive Waste Management by Licensee
  - Calibration of Nuclear Instrument, Radiation Output, Radionuclide Standardization Facilities, and Calibration Facilities.
  - Requirements for the Transport of Specified Types of Radioactive Materials Consignments.
- Government Regulation (GR)
  - No. 11 of 1975 on Working Safety Provision against Radiation (*to be revised*).
  - No. 12 of 1975 on Licensing of the Use of Radioactive Material and/or Radiation Source (*to be revised*).
  - No. 13 of 1975 on Transport of Radioactive Material (*to be revised*).
  - GR on Radioactive Waste Management(*to be issued*)
  - GR on Construction and Operation of Nuclear Reactors(*to be issued*)

- President Decree:
- No 49 of 1986 on Ratification of Convention on the Physical Protection of Nuclear Materials.
- No. 80 of 1993 on Ratification of an Amendment of Article VI of The Statute Of The International Atomic Energy Agency.
- No. 81 of 1993 on Ratification of Convention on Early Notification of A Nuclear Accident.
- No. 76 of 1998 on Nuclear Energy Control Board (BAPETEN)

Most of these documents were written to control the implementation of nuclear energy specifically as it applies to research activities. For applicability to a commercial NPP, the documents would have to be reviewed; and revisions or additions as appropriate.



3.2. Licensing process

Based on the draft government regulation, the construction and operation of a nuclear reactor can be performed after approval has been issued by NECB.

The approval will be issued in stages: Site Permit, Construction Permit, Operating License, and Decommissioning Permit.

Evaluation of application of each stage is carried out within a certain period: 12 months for Site Permit, 24 months for Construction Permit, 18 months for Operating License, and 12 months for Decommissioning Permit. During the period of evaluation, NECB can ask the applicant to provide additional information(s) on the proposed installation as deemed necessary.

Most notably is the length of time required in the whole licensing process, but there is a consideration to revise the draft to, for example, shorten the time required and also to provide such a flexibility as in the case where a rigorous safety review has already taken place by a competent regulatory authority in another country, it is showed on the diagram of the entire licensing process.

3.2.1. Site Permit

Application of site permit should be submitted to NECB by proposing the candidate site. The basic objectives in the site permit stage are to establish the conceptual design of the facility and to determine whether it is feasible to design, construct, and operate the facility on the proposed site to meet the safety objectives and requirements established by NECB. The primary documentation required is a Site Evaluation Report providing information on:

- The characteristic of conceptual design of the reactor and its installation and the planned operation of the reactor;
- The latest data on population density as well as estimation of population density in the future and the specific characteristics in the surroundings of the proposed site;
- The physical conditions of the site, including seismological, meteorological, geological, hydrological and radiological aspects;
- Steps taken to maintain the security of the environmental conditions (ecological, meteorological and cultural values), and the existence of natural reservations, airports, food industries, and other places/building based on Government Provision(s).
- Analysis of the supposed “major accident” and “hypothetical accident” shall be conducted to check that radiation dose received by individual is still within the dose criteria showed on the diagram.

The other important document required is an Environmental Impact Analysis Report, which consists of:

1. Terms of Reference for Environmental Impact Analysis
2. Environmental Impact Analysis
3. Plan for Environmental Management
4. Plan for Environmental Monitoring

The Environmental Impact Analysis consists of the following:

- Design description of the complete nuclear reactor, ECCS, safe shutdown system, containment system, and waste management system;
- Estimation of the impact on the environment during reactor construction, operation, decommissioning, and a nuclear accident through air, water and soil, as well as biological and socioeconomic impacts to the public within the area surroundings the reactor.

The Site Permit will be issued after the application, including all enclosures there in meet the provision and other requirements set by the NECB. The Site Permit is valid for a period of 4 years, and could be extended up to 2 x 1 year.

Diagram of the Entire Licensing Process

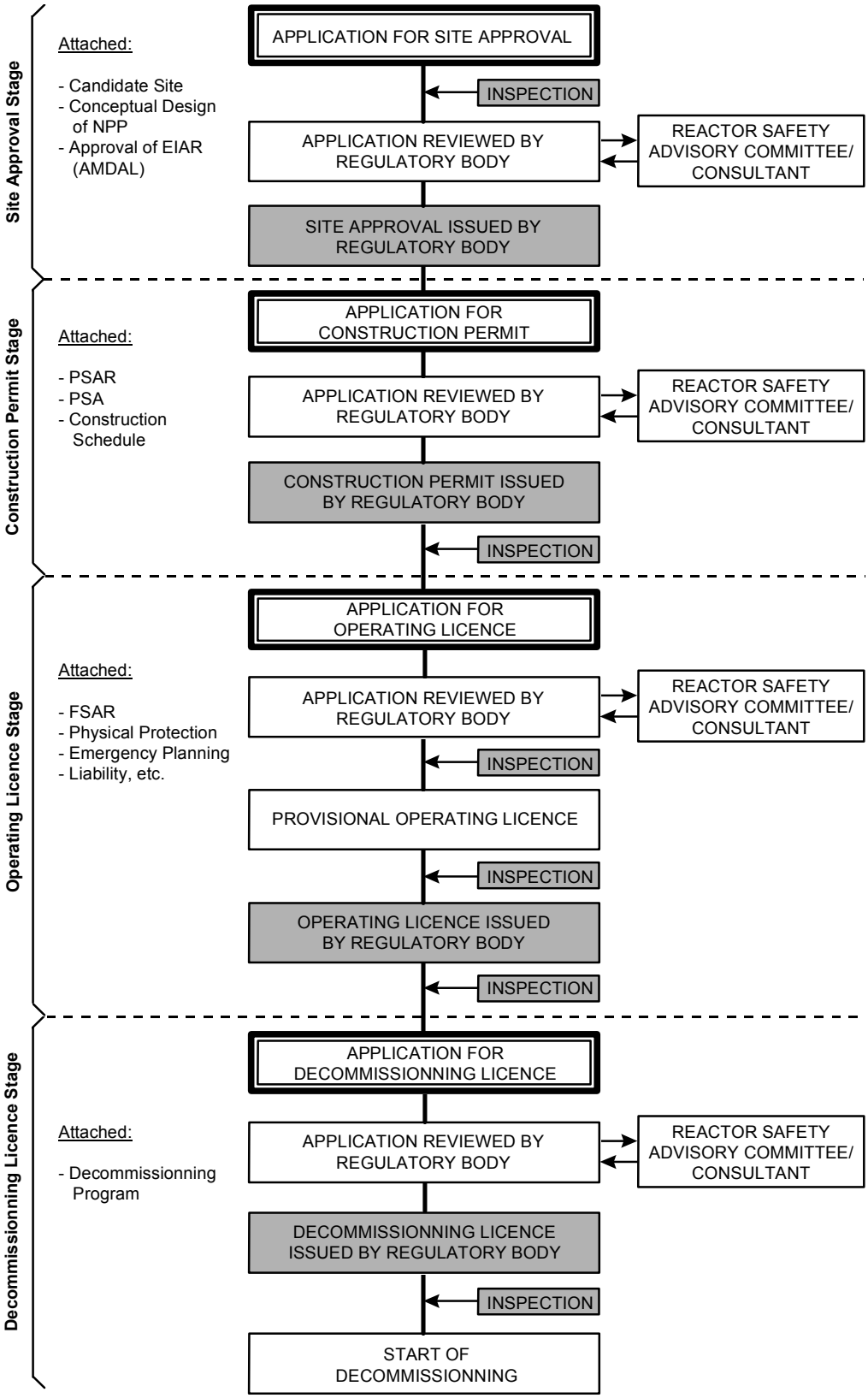


Diagram of the Radiation Dose Received by Individual

Exclusion Area

□ Whole body : 0.25 Sv (25 rem) □ Thyroid : 3.00 Sv (300 rem)	*during 2 hours immediately*

Low Population Zone

□ Whole body : 0.25 Sv (25 rem) □ Thyroid : 3.00 Sv (300 rem)	*after the accident*

Distance from a population center is at least one and one-third times the distance from the reactor to the outer boundary of the low population zone (refer to the criterion of 20,000 man-Sv).

3.2.2. Construction Permit

Prior to granting a construction permit, the NECB must be assured that the reactor design meets the safety principles and requirements set out by the NECB and the plant will be built in accordance to appropriate quality standards. The primary documents required are Preliminary Safety Analysis Report, a Probabilistic Safety Assessment, and a statement on construction schedule.

The Construction Permit is given for a period up to 8 years, after all requirements, including design alterations and all modifications intended to minimize negative impacts have been fulfilled.

The Permit is granted by imposing a condition that any modification to the design, structures, systems or components which influence the nuclear safety can be performed only after consent has been obtained from the NECB.

In case the construction is not started within a period of 18 months after the issuance of the Construction Permit, then the Licensee should notify the NECB, presenting the reasons for the delay. If the reasons are not acceptable, the permit might be revoke by NECB.

In case the Licensee considers that the construction could not be completed within the defined time period, an application for extension of the permit should be submitted at least 3 months before it expires, presenting the underlying reasons. Extension of the Construction Permit can be given each time for 1-year period.

3.2.3. Operating License

When the construction approaches its completion and at the latest before fuel loading, the Licensee should submit an application for an Operation License. NECB, before issuing, have to be assured mainly that the plant, as built, conforms to the design previously submitted and approved, and that the plans for operation are satisfactory.

The requirements include submission of a Final Safety Analysis Report, completion of a previously approved commissioning program, examination and authorization of personnel, approval

of operating policies and principles, preparation of plans and procedures for dealing with nuclear emergencies, and specific programs for QA during Operation and Maintenance of the nuclear reactor.

The Operating License is issued in 2 stages as follow:

1. A Provisional Operating License is issued for a maximum period of 24 months, including pre-operational and preliminary operational stages;

2. If and only if the provisional operation stage runs well and all requirements including implementation of the environmental management and monitoring plans are fulfilled, then a Long Term Operating License could be issued for a maximum period of 40 years. Otherwise, the Provisional Operating License will be extended for a certain period as stated by the NECB based on results of evaluation from the latest condition.

Among the term included in the Operating License is the requirement that the Licensee informs the NECB promptly of any occurrence or situation, which could alter the safety of the plant. The NECB retains the right to impose additional conditions at any time.

Although the primary responsibility for the safe operation of the plant remains with the Licensee, there is periodic inspection and audit by NECB inspectors, annual reviews of operation, and major reviews at the time of renewal of the Operating License.

The Operating License may be revoked by the NECB for the following one or more reasons:

- There is an evidence that false information have been submitted to the NECB in the application or report concerning the reactor and reactor operation;
- The Licensee does not comply with the specifications and/or the conditions approved by the NECB;
- The Licensee does not comply with the provisions mentioned in the existing regulations.

3.2.4. Decommissioning Permit

If the Licensee does not wish to renew the Operating License, he should submit an application for decommissioning to the NECB. The application for the permit should include decommissioning plans and procedures in accordance with provisions set by the NECB.

During and after decommissioning, NECB carries out the inspection to check whether the job has been done satisfactorily and safely, and the installation holds no more hazards to the public and the environment.

3.2.5. Licensing Operating Personnel

According to BAPETEN's decree No.17/Ka-BAPETEN/IX-99 on Requirements of Radiation Worker Authorization, personnel willing to work as reactor operators should apply for Work Licenses to NECB. The Operator License and Supervisor License are issued separately for reactor operators and reactor operator supervisor, respectively through examination conducted by NECB. Both Licenses are valid for a period of 2 years and can be extended for another period of 2 years if all requirements are fulfilled.

Besides the examination for the new reactor operator, NECB also conduct refreshment examination for the Work License holder.

3.2.6. Requirements on the Licenses

The applicant or licensee shall be required to submit and make available to the regulatory body in due time all information requested in each stages of the licensing process as follow:

- For Site Permit:

1. Site Evaluation Report
2. Environmental Impact Analysis Report

- For Construction Permit:

3. Preliminary Safety Analysis Report

4. Probabilistic Safety Assessment
5. Construction Schedule

- For Operating License:

6. Final Safety Analysis Report (FSAR)
7. Physical Protection Plan for nuclear materials and nuclear installation
8. Financial capability evidence for operating the nuclear reactor
9. Evidence of nuclear liability insurance
10. Approval or license(s) from other government authority (license for land use, building erection, etc.)

- For Decommissioning Permit:

11. Plan for Decommissioning

3.2.7. Review & Assessment

During the Licensing Process

At present time, there is no clearly defined and established procedure for the review and assessment of documents during the licensing process. NECB only made an evaluation, referring to IAEA NUSS, some people made the procedure(s) for their own use, while others use the procedure(s) based on the way the previous person did.

As a new established institution, NECB has only a very limited personnel, both quantitatively and qualitatively and furthermore, NECB still does not has neither technical supports institution nor technical assistance from any consultants to cooperate with for undertaking such an assessment and technical review needed in every step of the licensing process. As a consequences, at present NECB does not perform a thorough review and assessment (through testing and examination of system, structures and components) of the operators technical submission appropriately, and rely on the results done by the operators in all technical aspects in the licensing process.

However, NECB define the safety principles and criteria (based on IAEA NUSS documents) on which its judgment is based.

During Operation

a. Submitted Documents and Assessment

An operating license holder is obliged to submit the documents related to:

- Implementation guides, technical guides for operation, maintenance and repairs.
- Establishment of organization responsible to nuclear emergency program.
- Establishment of organization responsible to radiation protection program.
- Establishment of QA organization and program

NECB evaluate all those submitted documents.

b. Plant Modifications

No thorough review and assessment is undertaken (such as testing, examinations and the like) of the document(s) related to plant modifications.

c. Periodic Safety Reviews (PSR)

There is no regulation concerning these requirements.

d. Submitted Information on the Operation

The Licensee is obliged to report periodically the following program:

- Routine operation program
- Environmental monitoring program and meteorological conditions.

The submitted documents which consist of those programs are then evaluated by NECB on a monthly basis and, resume and report are made yearly.

e. Event Assessment

If an abnormality or a discrepancy during operation or an accident occurs to assert the radiation hazard, the operator shall take safety measures in accordance with the procedures previously agreed by NECB, to prevent radiation hazard and to mitigate the radiation damage. After that, the operator shall made an evaluation and assessment of the cause of event appropriately, and report it to NECB together with all the safety measures taken by the operator.

3.3. Inspection, Enforcement and Emergency Preparedness

The objective of the inspections is to ensure conformance of materials, components, systems and structures, as well as operational activities, processes, procedures and personnel competence with the predetermined requirements.

3.3.1. Inspection Program and Procedures

At present time, NECB only has established the program and procedures of inspection for normal operation stage, since NECB only deal with research reactors and mainly in the operation stage. The program and procedures, especially the procedures, are being revised from time to time in order to meet the conditions of each research reactor.

The program and procedures for other stages are still not established yet.

3.3.2. Inspections

The NECB performs inspections periodically (announced) and occasionally (including unannounced) during the licensing process to ensure whether all safety requirements are met.

- Prior to the issuance of site license, the site inspection is performed to evaluate the data submitted by the applicant.
- During the construction stage, inspections are performed to verify whether provisions affixed to the construction license are fulfilled and complied.
- Prior to the issuance of temporary operating license, inspections are performed to verify whether all provisions and inspection follow-up instruction are complied.
- Prior to the issuance of long term operating license, inspections are performed to verify continuing compliance of all the provisions, and
- Prior to the issuance of decommissioning permit inspections are performed to verify the compliance of all the provisions and of the decommissioning preparation.

NECB also perform national-level safeguards inspections on nuclear fuel materials.

3.3.3. Enforcement

At present time, the NECB have adequate powers to enforce compliance with its regulations and safety requirements, i.e. power to enforce licensee to modify or correct any aspect of safety, i.e. procedures, practices, systems, structures or components as necessary to ensure nuclear safety. According to the BAPETEN's decree No.15/Ka-BAPETEN/VIII-99 on the Inspector of BAPETEN year 1999/2001, the inspector are authorized to make warning or directive, order to curtail activities, revocation of license or authorization, or penalties to the licensee.

3.3.4. Emergency Preparedness

The program and activities of emergency planning and preparedness in Indonesia are based on the existing nuclear facilities, i.e. research reactors, research reactor fuel fabrication plant, radioactive waste treatment installation and radioisotopes production installation. The preparation covers on-site or within facilities, off-site facilities and in the public domain including transport accidents.

Bapeten is introducing to facilities a National Emergency Preparedness based on IAEA Tec-Doc 953, conducted an evaluation to sites/facilities, National Seminar on Emergency Preparedness which invited all related organization and institution.

The following numbers of facilities are subjects to emergency planning and categorized based on TEC-DOC 953 are applied:

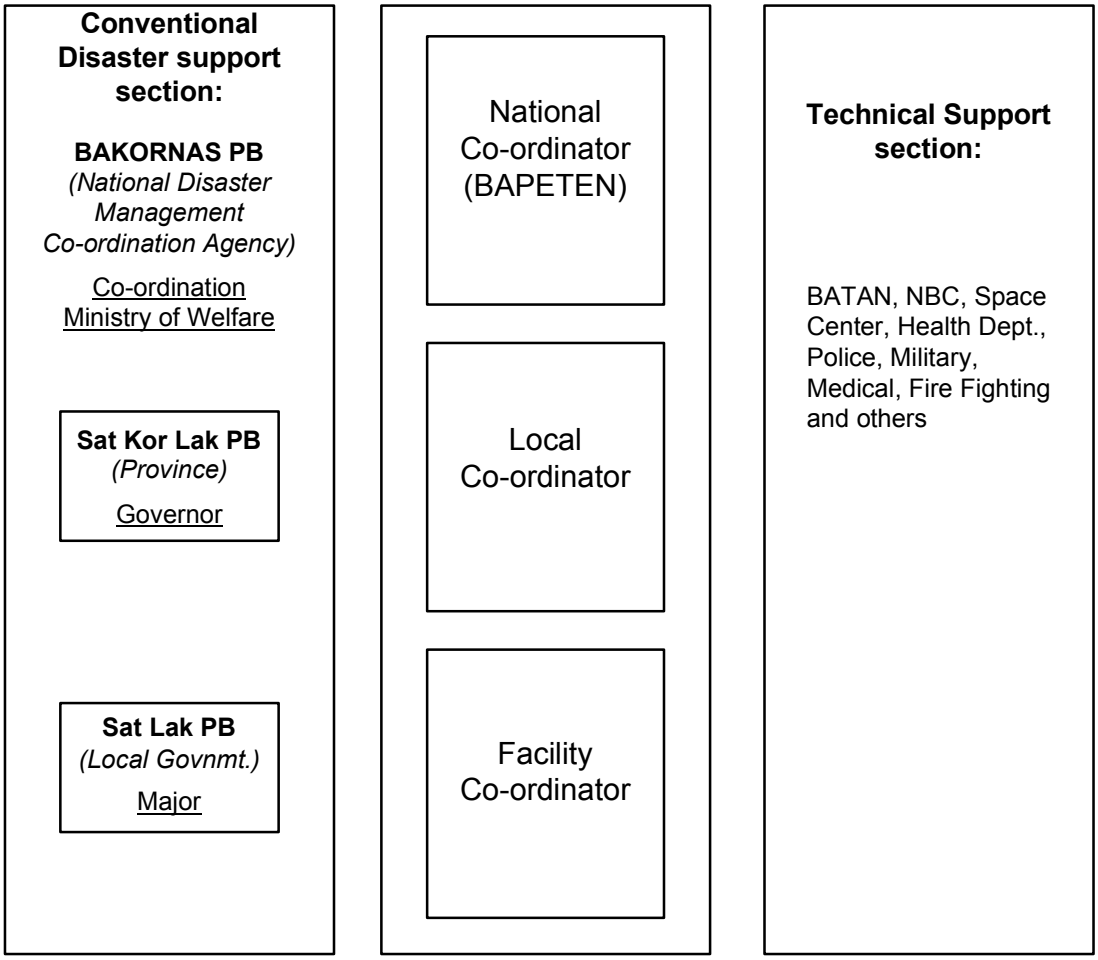
FACILITY	**Number of Facility**	**Category**
Medium research reactor : – MPRR 30 MWt	1	II
MPR Fuel fabrication Installation	1	II
Small research reactor : – Bandung-NRC 2 MW – Yogyakarta-NRC 250 kWt	2	III
Radioisotope production	1	III
Nuclear installation : – Radio-metallurgy inst. – Radioactive waste proc. – Nuclear fuel element research centre – Inventory spent fuel fac.	4	III
Radiography	80	IV
Logging	19	IV
Gauging	161	IV
Analysis	49	IV
Research	20	IV
Thorium appl.	2	IV
Baggage fluoroscopy	3	IV
Tracer	2	IV
Radioactive Material Storage	59	IV
Irradiator	3	IV
Calibration	4	IV
Diagnostic	1767	IV
Nuclear medicine	20	IV
Therapy	25	IV

Based on national experience and EPREV Mission recommendation, BAPETEN has proposed a draft on National Nuclear Emergency Preparedness in Indonesia which will be developed mainly for Category II of Radiological emergency preparedness.

Although there is still not yet a formal co-ordination between levels of government (national, provincial, regional, and district) in nuclear or radiological emergency preparedness, some nuclear facilities already have an emergency plan and preparedness. Moreover, there is National Disaster Management Coordination Agency (NDMCA) with Coordination Ministry of Welfare act as the national-level coordinator, that responsible to non-radiological emergency response. NDMCA has a relatively established co-ordination line from the upper national level down to the district level.

Diagram as below shows the draft on The National Nuclear Emergency Preparedness Organization in which nuclear emergency function, both co-ordinators and technical supports are implemented into the NDMCA co-ordination line. However, in case of nuclear accident, BAPETEN shall take over a role of national-level coordinator from Coordination Ministry of Welfare since the Act No.10/1997 stipulates that BAPETEN is the only government organization that has a right to declare an emergency situation in Indonesia.

Diagram of National Nuclear Emergency Preparedness Organization



In the Serpong Nuclear Energy Research Establishment (PPTN-Serpong), preparation of the emergency preparedness Involve all BATAN's Centers located on that area, Puspiptek as an area supporting center, Local Government (district), and other district authorities such as district police, fire fighters and hospital. Those emergency arrangements were established since beginning operation period of the nuclear facility in 1987. For the time being, the emergency procedure is being revised to accommodate interaction between each nuclear laboratory. During the last 10 years, 3-4 times emergency exercise were conducted together with national police authority, special section of the Indonesian army responsible for nuclear, biology and chemicals.

For the RSG-GAS reactor personnel, periodic exercises on fire fighting with simulation of radioactive releases and evacuation have been done once a year.

3.4. International Engagement

3.4.1. International Activities of the Regulatory Body

Up to the present time, the contact with international organization is only with the IAEA. Indonesia is party to the Convention on Early Notification of a Nuclear Accident and Convention on Assistance in the Case of Nuclear Accident or Radiological Emergency.

The contact is based upon formal exchange information, and the contacts are made at Governmental level.

The participation of the Regulatory Body in the activities of international organizations are in the form of seminars, in training courses and in giving the opportunity to the IAEA's trainees to come to the Regulatory Body.

3.4.2 International Engagement

The Preamble of the Indonesian Constitution stipulates among others, that Indonesia will take part in maintaining the world order based on freedom, eternal peace and social justice. Therefore when the Treaty on Non Proliferation (NPT) entered into force in 1970 the Government of Indonesia immediately acceded to the Treaty on the same year, as part of its commitment to take part in maintaining the world order based eternal peace. The Treaty was then ratified in 1978, in the form of Indonesian Law No. 8 of 1978. The ratification was then followed by signing Safeguards Agreement with IAEA in 1980. This Safeguards Agreement is a legal basis for the implementation of internationally controlled safeguards in Indonesia and the establishment of State System of Accounting for and Control of Nuclear Material or SSAC. Please note that in 1967 (13 years before the signing Safeguards Agreement with IAEA), Indonesia has already signed three lateral agreements on Safeguards between Indonesia, USA and IAEA for the nuclear fuel of TRIGA MARK II Research Reactor in Bandung.

This milestone explicitly reflects the initial step towards the fulfil ness of the Indonesian commitment to establish the world free of nuclear weapons. This step was further followed by joining the IAEA program on strengthening the safeguards systems such as Early Notification of Design Information (1992), Reporting Scheme (1995) and others. In addition, Indonesia joined the others states in approving the Indefinite Extension of NPT in 1995.

Finally, to answer the need for more transparency in peaceful uses of nuclear energy, by 29 September 1999 Indonesia signed and entered into force the Protocol Additional to the Safeguards Agreement, joining others to become the first seven states to implement the Additional Protocol.

4. CURRENT ISSUES AND DEVELOPMENTS ON NUCLEAR POWER

4.1. Nuclear Energy Policy

In order to meet the rapid increase of domestic energy demand, it is becoming more difficult to depend on the existing resources which are now getting more limited. It is projected that oil will still play an important role in the domestic energy mix. Although its share is declining, the total consumption is increasing. As a result, the current status of Indonesia as an oil exporting country will likely to change into an oil importing country in the not too distant future.

Gas and coal will be dominating the domestic energy mix in the Second Long Term Development Plan. However it creates several environmental problems. The utilization of clean coal technology and energy diversification program will, therefore, need to be given priority to anticipate future energy problems. The development of the wise utilization of natural gas, both in domestic use and export, is to be considered in response to the increasing energy demand.

The introduction of Nuclear Power Plant (NPP) in Indonesia is not only to reach an optimum energy mix considering costs and environment, but also to relieve the pressure arising from increasing domestic demand for oil and gas (so that oil and gas could be used for export). Thus, the role of Nuclear Power Plants is clearly to stabilize the supply of electricity, conserve strategic oil and gas resources and protect the environment from harmful pollutants as a result of the use of coal or fossil fuels. This concept is exactly congruent to the national energy policy which stresses diversification, conservation and environmental awareness in energy supply development.

BATAN is now preparing a roadmap of the NPP introduction to be integrated to the domestic energy mix. The roadmap is prepared based on the following assumptions:

- the Government issues a statement for *go nuclear* in year 2004
- the electrical grid can accommodate electrics produced by NPPs
- the first to fourth NPPs will be constructed by turnkey-scheme
- total energy produced by NPPs till year 2025 is around 6000-7000 MWe or 6-7% of estimated total national electricity demand
- the price of electricity from NPPs is competitive
- the Act No.20 year 2002 about electricity is consistently applied.

4.1.1. Study on National Energy Planning

A study on national energy planning is conducted in 2001. The study's objective is to support the national planning and decision making process in Indonesia's energy and electricity sectors, taking into account key economic, environmental and social aspects. The study is intended to comprehensively assess the potential contribution of various energy sources to the optimal long-term development of Indonesia's energy and demand up to 2025 consistent with sustainable development.

The study team comprised members from the following Indonesian institutions: the Agency of Assessment and Application of Technology (BPPT), the National Nuclear Energy Agency (BATAN), the Directorate General of Electricity and Energy Development (DJLPE), the Directorate General of Oil and Gas (DJMIGAS), the Environmental Impact Control Agency (BAPEDAL), the National Center for Statistics Agency (BPS), the State Electricity Company (PT. PLN Persero) and the Non-Governmental Organization for Environment (NGO). The International Atomic energy agency (IAEA) assists the Government of Indonesia in executing this study by giving aid in the form computer software and assistance from its experts.

The results of the study can be summarized as the following:

a. The results of this study provide a realistic projection of energy demand in Indonesia taking into account the economic crisis of 1998, projected population and economic growth and changes in lifestyles and technology. This projection is consistent with other projections and reflects current Government policies.

b. The final energy demand will grow on an average rate of 3.4% annually reaching the figure of about 8146 Peta-Joules (PJ) in the year 2025. It will grow more then 2 times as compared to the beginning of study. The biggest growth of energy demand about 4.5 times will be in the form of electricity. Its share in total primary energy demand will grow about 1.5 times.

c. The contribution of commercial energy will increase very significantly from 2,245 PJ to 6,980 PJ. On the other hand the contribution of non-commercial energy to the total energy demand will decline from 1,784 PJ to 1,165 PJ.

d. Installed electricity net generating capacity in Indonesia reaches 100 GWe at the end of the planning study horizon (2025), comparing 29 GWe in the beginning of study (2000). Almost 60 % of this capacity is required in Java, corresponding to 59 GWe.

e. For all cases, the Gas Base-load Plant is the top ranked technology for electricity generation in Java-Bali. For example in case IEA1000, gas is used up to the maximum volume set exogenously in the supply study, corresponding to a share of 45 percent or about 27 GWe.

f. From solely an economic point of view, the Coal Base-load Plant is ranked second among electricity generation options in Java-Bali. In case IEA1000, for example, 22 GWe of electricity based on coal is used, corresponding to a share of 37 percent. This generation mix will emit 19.6 kt/a of particulate matter, 411.4 kt/a of NO_X and 171.7 kt/a of SO_2.

g. The more the use of fossil fuels is constrained and environmental standards are enforced, the earlier nuclear power becomes part of the optimum generation mix.

h. At the end of the study period, nuclear power is the third principal generation option. There are no real technical infrastructure constraints or limiting interdependencies with other sub-sectors of the energy system that would prevent its introduction. Nuclear power plants can be added to the system when increased demand requires new capacity or if reality unfolds differently from the scenarios underlying this study.

i. The prospects for expanding natural gas exports (LNG and pipeline) are promising as the global dash for gas continues. The early introduction of nuclear power in Java-Bali could free up substantial amounts of natural gas for export revenue generation.

j. However, the above conclusions are based on two nuclear options that both appear conservatively for 2010 and beyond. Sensitivity analyses indicate the above results are indeed sensitive to variations in nuclear cost and performance parameters across a reasonable range for post-2010 technologies, with earlier nuclear introductions becoming optimal for a number of plausible cost and performance assumptions.

k. The first nuclear power reactor may be introduced as early as 2016. Another option, nuclear desalination plant is expected in operation by 2018, while by 2025, it is expected that about 6-7 % of the total national electricity will be generated from nuclear energy. Survey, exploration, transformation and generation of energy constitute vital activities in the energy sector. In order to achieve those long term target, decision on nuclear option as a part of a long term national energy system should be taken in year 2004-2005, and then the construction should be started in 2010. While, another target is operation of a nuclear science and technology base should be achieved at 2010.

4.2. Nuclear Energy Program

4.2.1. Site Preparation.

The site of Muria Peninsula is ready to use since there are many data taken from this site. BATAN will prepare PSAR-SP (*Preliminary Safety Analysis Report – Site Part*) for Muria Site that can be used as a reference to the owner. Before NPP construction takes place a site investigation should be implemented to get data on foundation needed in construction design. Along with the above activities, BATAN will also perform other site investigation to get potential sites for the subsequent NPPs.

4.2.2. URD and BIS Preparation

Documents on User Requirement Document and Bid Invitation Specification should be prepared. The URD consists of 2 volumes:
Volume I. (Policy & Top Tier):

- Site Imposed Requirements
- Nuclear Program
- Licensing & Health Protection Requirements
- Technical Requirements
- Fuel Cycle & Waste Management Requirements
- Economic Requirements
- Special National Requirements

Volume II. (Common Requirement) :

- Safety
- Performance
- Structure
- Material
- Reliability & Availability
- Constructability
- Operability &Maintainability
- Quality Assurance (QA)

- Licensing
- Design Process
- Mechanical Equipment

Document of BIS consists of 7 volumes as the following:

VOL. I. INSTRUCTION TO BIDDER (ITB)
VOL. II. GENERAL CONDITION (GC)
VOL. III. SCOPE OF SUPPLY AND SERVICES (SSS)
VOL. IV. TECHNICAL SPECIFICATION
1. General Technical Specifications for the Entire Plant (GTS)
2. Technical Specifications for Nuclear Systems (TSN)
3. Technical Specification for Turbine Generator Systems (TST)
4. Technical Specification for Electric Power Systems (TSE)
5. Technical Specification for Instrumentation and Control (TSI)
6. Technical Specification for Civil Works (TSC)
7. Technical Specification for Balance of Plant (TSB)
8. Particular Technical Specification for Mechanical and Electrical Equipment (PTS)

VOL. V. SPECIFICATION FOR THE NUCLEAR FUEL (SNF)
VOL. VI. SITE DATA AND INFORMATON (SDI)
VOL. VII. SITE DRAWINGS

4.2.3. Option for NPP type

BATAN is now developing some criteria for deciding the NPP type that will be utilized in Indonesia. The criteria consist of items as the following:

- Its safety and reliability is proven
- It shows a good track-record in many countries.

Based on the above criteria and a wish to master one of NPP technologies, BATAN suggests that it is better for Indonesia to build PWR-type NPP in a DUPIC-scheme (*direct use of spent PWR fuel in Candu reactors*).

4.2.4. Preparation for Licences

Many licences should be prepared for NPP operation. The licences that should be prepared are:

- Regulations related to the construction and operation of NPP: year 2005-2008
- Document preparation for getting licences: 2007
- Application for Site Licence: 2007
- Application for Construction Licence: 2009
- Document preparation for Commissioning: 2014
- Application for Commissioning Licence: 2015
- Application for Operation Licence: 2015

4.2.5. Study for Financial Scheme

The goal of study on economics and financing is to predict the fund for construction of NPP in Indonesia based on conventional model (credit export, self-financed) and on other models (BOO, Counter Trade). The study result could be used as a reference by Government and Utilities. The study will be implemented in year 2003-2007.

4.2.6. Study on Technology Transfer and National Participation

The introduction of NPP in Indonesia is aimed to heighten Indonesian manpower in nuclear science and technology, to support national industries, and to lower unemployment. In order to get a sound scenario for technology transfer and national participation, BATAN has been implementing study on Technology Transfer and National Participation. It is hoped that the study will produce a recommendation that can be used to prepare a specific strategy.

4.2.7. Man-power development

Man-power development related to nuclear power program is performed by BATAN, Universities and other institutions. The main goal of the development is to obtain skilled man-power who has high dedication and safety-culture in enough number to participate in nuclear power program from planning to decommissioning stages.

The development program is hoped to produce man-power that can participate in each stage of NPP construction and operation.

- Pre-project stage
  Skill and knowledge to obtain:
  - Planning of energy demand & supply
  - Planning of power system
  - Preparation of international agreements
  - Survey on national infrastructure
  - Planning of national participation
  - Man-power planning
- Project implementation stage
  Skill and knowledge to obtain:
  - Project management
  - Project implementation planning
  - Procurement of materials
  - Quality assurance and quality control
  - Plant safety
  - Physical protection and safeguard
  - Public information and public education
- Operation stage
  - Operation and Supervision of NPP
  - NPP maintenance
  - Plant safety and radiation protection
  - Quality assurance.

4.2.8. Public Acceptance

One of the most important issues in introduction of nuclear power is the Public Acceptance. The basis of public acceptance is public understanding, in which accurate and justified actual information on the benefits and risks of nuclear power must be provided to the public. A continuing and effective public acceptance program must always be pursued to enhance public perception on nuclear technology. Accidents like the Chernobyl and Three Mile Island (TMI) have had a large impact to the public, but, through a program of sound public acceptance, misinformation and misunderstandings resulting in negative perceptions could be well prevented. We are hoping the following elaboration of our public acceptance program would have high expectations and results.

The objective of the public acceptance program is to provide the public with information on every activity in the nuclear energy conducted by nuclear facilities such as BATAN and other stakeholders in Indonesia, and also to encourage the involvement of all parties concerned in the decision-making through inter-departmental organization activities.

The objective is to provide information are publicly opened, factual, and presented in the context of all energy sources.

It is recognized that the contents of information given should be varied enough in order to satisfy the different public expectations and in the language appropriate and understandable to the audience.

An important aspect in conducting Public Acceptance is the means on how to do it in an effective manner. We believe that the different audiences in Indonesia will be reached through several

events normally held each year, such as: exhibitions, opening events, visits by the decision makers to the nuclear facilities, national seminars on nuclear technology and energy, etc.

Public Acceptance activities shall be more frequently conducted in areas near the site, as well as in certain areas where top level decision makers are present, such as the central government and the parliament in the capital city.

Recent activity in this area was "IAEA Seminar on Public Information for Mass Media and Top Level Government" held in Jakarta on July 14-16, 1997. Information concerning results of research in Agricultural, Medicine and the Outlook of Nuclear Power Generation was presented to the audience that consist of mass media, government officials and participants from other countries. Such seminars with a focused audience will be held more often in the future.

According to Environmental Law No. 4 of 1982, people are entitled to look at the documents submitted as the application for the license of NPP.

One of obstacles for the introduction of NPP in Indonesia is public acceptance. Therefore, BATAN established a program for public education and public information on nuclear technology in cooperation with institutions and universities in the country. The program consists, among many, the following items:

- Presentation before House of Representatives, Local and Central Government
- Presentation before people from mass media
- Training courses for lecturers and teachers
- Short training courses for students
- Public information through newspaper, radio and television.

4.3. Nuclear Energy and Climate Change

It is said that nuclear energy has a positive effect to the environment since it does not emit any pollutant, such as CO_2, CO, SO_x, NO_x, PM_{10}. Its always be associated with thermal-power plant. Although NPP can be used to hinder climate change, Indonesia does not officially declare the utilization of nuclear energy as a mean in environmental control.

4.4. Safety and Waste Management Issues

Safety issues are the first priority in activities related to nuclear application in all fields. Therefore, one of criteria to choose a NPP to be applied is that the NPP is already proven in many countries.

BATAN has expertise in managing radioactive waste produced by nuclear activities in Indonesia. Most of the waste is in low level. In the future, one of issues in waste management related to NPP operation is high-level waste management, and study to prepare a site for waste disposal.

REFERENCES

[1] Data & Statistics/The World Bank, www.worldbank.org/data.

[2] IAEA Energy and Economic Data Base (EEDB).

[3] IAEA Power Reactor Information System (PRIS).

Appendix 1

INTERNATIONAL, MULTILATERAL AND BILATERAL AGREEMENTS

INTERNATIONAL AGREEMENTS

• NPT related agreement INF/CIRC No. 283	Entry into force: 14 July 1980
• Project related safeguards agreement INF/CIRC No. 136	Entry into force: 19 Dec. 1969
• Additional Protocol	Signature: 29 Sept. 1999
• Improved procedures for designation of safeguards inspectors	Accepted on 8 June 1989
• Supplementary agreement on provision of technical assistance by the IAEA	Entry into force: 4 July 1980
• RCA	Entry into force: 12 June 1987
• Agreement on Privileges and Immunities	Entry into force: 4 June 1971
• NPT	Entry into force: 12 July 1979
• Convention on physical protection of nuclear material	Entry into force: 8 Feb. 1987
• Convention on early notification of a nuclear accident	Entry into force: 13 Dec. 1993
• Convention on assistance in the case of a nuclear accident or radiological emergency	Entry into force: 13 Dec. 1993
• Vienna Convention on Civil Liability for Nuclear Damage	Non-Party
• Joint Protocol	Non-Party
• Protocol to amend the Vienna Convention on Civil Liability for Nuclear Damage	Signature: 6 Oct. 1997
• Convention on Supplementary Compensation for Nuclear Damage	Signature: 6 Oct. 1997
• Convention on Nuclear Safety	Signature: 20 Sept. 1994
• Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management	Signature: 6 Oct. 1997
• ZANGGER Committee	Non-Member
• Nuclear Export Guidelines	Not adopted
• Acceptance of NUSS Codes	No reply

BILATERAL AGREEMENTS

- Agreement signed with JAERI (Japan) on Operation of Research Reactors. This assistance is related to the operation and utilization of the Multipurpose Research Reactor in BATAN.
- Agreement signed with MITI (Japan) on Nuclear Safety Regulation and on Safety Analysis (Assessment) for transient and accident condition in a nuclear power reactor.
- Agreement signed with STA (Japan) on Scientific Exchange Program. Indonesian Scientists work together with Japanese Scientists to conduct experiments.
- Agreement signed with Germany on Thermo-hydraulic Experiments and Thermo-hydraulic Analysis (use of code ATHLET).

Appendix 2

DIRECTORY OF THE MAIN ORGANIZATIONS, INSTITUTIONS AND COMPANIES INVOLVED IN NUCLEAR POWER RELATED ACTIVITIES

NATIONAL ATOMIC ENERGY AUTHORITY

National Atomic Energy Agency (BATAN)
Jl. Kuningam Barat,
Mampang Prapatan, P.O. Box 4390
Jakarta 12043
Indonesia

Tel: (62-21)511110; 5204243
Fax: (62-21)511110; 5204243
E-mail: arnold@cbn.net.id, arnold@batan.go.id
Homepage: www.batan.go.id

Nuclear Energy Control Board (BAPETEN)
Jl. MH. Thamrin No. 55 Lt. VI
Jakarta 10350
Indonesia

Tel: (62-21) 2301249; 2301252
Fax: (62-21) 2301253
E-mail: darurat@centrin.net.id
Homepage: www.bapeten.go.id